Food environments of young people: linking individual behaviour to environmental context

Dr Rachel L. Tyrrell, Evaluation Officer[1,2], Ms Fiona Greenhalgh Dietetian[2], Dr Susan Hodgson Lecturer in Environmental Epidemiology & Exposure Assessment [3], Dr Wendy J. Wills Reader in Food & Public Health[4], Professor John C. Mathers Professor of Human Nutrition[5], Professor Ashley J. Adamson Professor of Public Health Nutrition and NIHR Research Professor[2,7] and Dr Amelia A. Lake Lecturer in Knowledge Exchange in Public Health [2,6,7*]

[1] NSPCC, Centre for Early Child Development, Number One, Bickerstaffe Square, Blackpool, UK

[2] Human Nutrition Research Centre, Institute of Health & Society, Newcastle University, Newcastle upon Tyne, UK

[3] MRC-PHE Centre for Environment and Health, Department of Epidemiology and Biostatistics, Imperial College London, London, UK

[4] Centre for Research in Primary and Community Care, University of Hertfordshire, Hatfield, UK

[5] Human Nutrition Research Centre, Institute of Cellular Medicine, Newcastle University, Newcastle on Tyne, UK

[6] Centre for Public Policy & Health, School of Medicine, Pharmacy & Health, Wolfson Research Institute, Durham University, Stockton-on-Tees, UK

[7] Fuse – UKCRC Centre for Translational Research in Public Health, UK

* Corresponding author E-mail: amelia.lake@durham.ac.uk (AAL)

Abstract

Background

We aimed to identify and characterise the food environments from which young people obtain food and to explore associations between *type* of food environment and food intakes.

Methods

Young people (n=86, mean age 17 years; combined data of two sequential pilot studies (collected in 2008-9) and a study conducted in 2011-12) recorded in 4-day self-complete food diaries *what* food they consumed and *where* food was sourced. Nutrient, fruit and vegetable intake was calculated according to the source of food, categorised using a food environment classification tool.

Results

Over 4-days, respondents sourced food from an average of 4.3 different food environments. Home was used daily and was more favourable in terms of nutrient profile than out-of-home food. Food sourced from specialist outlets, convenience stores and retail bakers had the highest energy density. Food from retail bakers and 'takeaway and fast food' outlets were the richest sources of fat while vending machines and convenience stores had the highest percentage of energy from sugar.

Conclusions

This work provides details of *where* young people obtain food and the nutritional consequences of choosing those food environments. While home food was a significant contributor to total dietary intake, food was obtained from a broad range of environments; particularly take-away, fast food, and education establishments.

Introduction

There is a lack of research about eating habits (1, 2) and other lifestyle behaviours in the period of transition from adolescence to adulthood (3). This is an important life-shaping period of increasing independence from parents (4) which includes the formation of own eating habits, the move from school into employment or further education (5) and the shaping of individual identity, values, beliefs and morals (6). These processes influence the food choices made by young adults and may precipitate or reinforce behaviour changes (7). More research is needed to understand the influence that this period of transition may have on establishing long term health related behaviours (8). The young people in this study (aged 16-22 years) cross the boundaries of adolescence (10-17 years) and the transition to adulthood (18-25 years) (9, 10).

Individual behaviours and, therefore, health are modulated by surrounding environmental factors (11) which influence both sides of the energy balance equation and subsequently obesity. Food choices are made within the food environment which encompasses any opportunity to obtain food and includes physical, socio-cultural, economic and policy factors at both micro- and macro-levels (12). While the relationship between the food environment and obesity is complex (13), preventative measures, such as modifying the food environment, are likely to have a significant impact on obesity (14).

Understanding the influence of the food environment on food choice could provide a basis for future interventions aimed at preventing obesity and, more broadly, at enhancing healthy eating. Few studies have examined the environmental factors that influence adolescent and young adult dietary behaviours (15). However, progress

with investigations of the relationships between the food environment, eating behaviours and, ultimately, adiposity is hampered by the lack of reliable tools (16). Most studies have relied on geographical measures of access in terms of availability of different types of food outlets near participant's homes (17). Although there is information on the density of fast-food outlets per head of population (18) and location of retail food outlets in relation to schools (19, 20), these studies do not account for an individual's 'activity space'. This refers to the geographic space used by individuals to perform their day-to-day activities extends beyond the immediate proximity of home and/or school often used as a proxy (21). Few studies have considered the multiple environments to which an individual is exposed and which they use (22). Whilst there has been a call for studies which explore nutrient intake according to where food is obtained (23), little is known about the types of food environments frequented by young people and their associations with dietary intake and body weight (24).

The aim of this work was to identify and characterise the detailed food environments from which young people obtain food and explore the associations between the *type* of food environment and intakes of nutrients, fruit and vegetables. This paper presents research from pilot work (Study 1) conducted in 2008/09 and a PhD study (Study 2) conducted in 2011/12. The approach used to characterize the food environment in these studies was different from those adopted in the food environment literature in that we started with the individual and identified the multiple food environments from which they obtained food in an attempt to reveal the nutritional characteristics of food consumed from these specific environments.

Methods

Recruitment

This paper presents the combined findings from two studies exploring the food environment of young people. Both studies and their consent process were approved independently by Newcastle University's ethics committee (Reference numbers 000106/2008 and 000322/2010).

Study 1 includes data collected in two sequential pilot studies completed between February 2008 and January 2009. Study 2 includes data collected between August 2011 and April 2012 as part of PhD research. In both studies, participants (over 16 years) were invited to take part following a brief verbal presentation, provision of written information sheets and an opportunity to ask further questions before written informed consent was obtained. Participants were free to withdraw from the study at any time. Both studies were carried out in the same geographical location (Newcastle upon Tyne, England) using similar experimental protocols. The study participants were alike in terms of demographic characteristics (see Table I) and therefore datasets were combined for the main analyses presented in this paper.

Dietary intake and food outlet classification

A self-completion food diary was used to record food and drinks consumed (description and quantity) and where items were sourced on four consecutive days (including at least one weekend day). As analyses focus on total dietary intake sourced from environments, reported food and drink intakes are collectively referred to as "food" throughout this paper. The diary design was based on formats used previously (25-27) and written diary information was supplemented by text message responses and digital images taken by respondents.

A researcher-led face-to-face interview was conducted within two days of diary completion to ascertain portion sizes using an age-specific photographic food atlas (28, 29) and to determine record completeness. Sources of food items were coded as home (including friends or relatives homes), and out-of-home. For example, sandwiches prepared at home and consumed at school would be recorded as 'home'. Food items sourced out-of-home were further classified using an updated and modified version of Lake et al.'s food environment classification tool (30). The tool contained 15 out-of-home food outlet categories with 88 detailed sub-categories. With the addition of 'home', use of 16 possible food environments were recorded.

The nutrient composition of each food item was estimated using the UK food composition tables (31). Total weights of fruits and vegetables consumed were calculated from weight of items consumed plus 0.5 times weights of fruit juice and vegetable based soups and sauces consumed (32). Percentage energy derived from each of the macronutrients plus fruit and vegetable density (g/100g) are summarised in Table I. Energy density (KJ/g) of intake from different food environments was calculated according to the method described by Cox and Mela (33). Descriptive analyses were conducted to illustrate the environment types used by young people and the nutritional characteristics of the food sourced from these environments. All dietary intake variables were calculated as mean daily intake per person and total daily mean was calculated for respondents who reported using the specified food environment category. Whilst data were collected on alcohol intake and source, this was not the focus of work and no further interpretation of these data are included here.

Analysis was conducted using SPSS Version 21. All continuous variables were checked for normality and summarised by means and standard errors. Normally distributed data were analysed using independent samples t-tests and where data were not normally distributed, non-parametric Mann-Whitney tests were used.

Results

Demographics

Table I presents a comparison of the characteristics of the Study 1 and Study 2 participants. Since there were no significant differences in the age and sex distribution and socio-economic status of participants (using IMD score), data from the two studies were amalgamated to form a single dataset. Eighty-six respondents (40 male, 46 female, mean age 17.4 years, range 16-22 years) were recruited from schools (n=45) college (n=29), university (n=7), workplaces (n=2), word of mouth (n=2) and a health centre (n=1). The majority lived with family members (n=79) and seven (all Study 1 participants) were living in other forms of accommodation (e.g. halls/ shared flats). There were no significant differences in the dietary intake of those living at home or away from home in Study 1.

Dietary intake

Average daily nutrient intakes for Study 1, Study 2 and the combined dataset are presented in Table I. Although the percentage energy from saturated fat was significantly greater in Study 1 ($P<0.05$), intakes of all other nutrients and of vegetables and fruits were comparable between the two studies.

The nutrient profile of foods consumed by type of food environment

Over the four-day diary period, the 86 respondents obtained food from a total of 372 food environments as summarised in Table II. Each food environment classification was counted only once per individual, if they visited two different takeaway outlets

e.g. a Chinese and an Indian on different occasions, this would be counted once as 'takeaway and fast food' environment. This reflects the *different* food environments used by individuals but not the *number* of visits to food outlets. An average of 4.3 (range 0 to 9) food environments were used to source food over four-days and these could be classified into 15 out of a possible 16 different food environment categories (30). All participants reported using the home environment as a source of food at least once per day. After home, the most frequently visited food environment was closed/private food outlets (including schools and workplaces) (n=52, 60% of respondents), followed by 'takeaway and fast food' (n=46, 53%), convenience stores (n=35, 41%), and restaurants (n=29, 34%).

The mean daily intakes of foods and nutrients from each of the 15 reported food environments visited by the respondents are presented in Figures 1-4. The majority of food, based on food weight, was obtained from home (1427g/d) while the least quantity of food was obtained from specialist outlets (such as greengrocers, butchers and health food stores) (85g/d) (Table II). As shown in Table II, the home environment provided the highest amount of energy (4.9MJ/d) and whilst health and leisure outlets provided the least dietary energy (0.4MJ/d).

Food sourced from health and leisure, pub (no food), and home environments had the lowest energy densities while food sourced from specialist outlets, convenience outlets, and retail bakers (i.e. national commercial bakers) were the most energy dense (Figure 1). Foods sourced from retail bakers, 'takeaway and fast food' and specialist outlets had the highest percent of energy from fat (47%, 43% and 42%, respectively). The highest percent energy from saturated fat was provided by foods from vending

machines (16%), followed by retail bakers (15%) and ‘takeaway and fast food’ (14%) (Figure 2).

Foods sourced from vending machines, convenience stores and non-food stores (includes outlets where food is not the main item for sale e.g. pharmacies) had the greatest percent contribution to energy intake from sugars (54%, 52% and 47%, respectively) (Figure 3).

The density of fruit and vegetable in foods obtained from each food environment was calculated as g/100g total food weight. Food from non-food stores, specialist outlets and supermarkets provided the greatest density of fruit consumed by respondents (12g, 11g and 7g/100g, respectively) whilst food sourced from takeaway café/sandwich shops, non-food stores and supermarkets had the highest density of vegetables (6g, 5g and 5g/100g, respectively). However, vegetables were obtained from more food environments than was fruit (12 versus 9), with home and closed/private outlets also being important sources of fruit and vegetables (Figure 4).

Discussion

Main findings of this study

Addressing the social, political and economic conditions that shape the obesogenic environment for young people is challenging (11). Relative to other age-groups, less is known about health related lifestyle patterns in older adolescents (34). Despite numerous studies exploring the food environment and diet (17), the relationship between environmental factors and dietary intakes merits further exploration (35). For the first time, this work provides detailed information regarding *where* young

people obtain food and the nutritional consequences of choosing those food environments.

We have observed that, in an urban setting, young people obtain their food from a wide range of environments encompassing 15 out of the 16 food environment categories identified by Lake et al. (30). Over four days of observation, all respondents sourced food from home and from an average of 3.3 different out-of-home food environments. Excluding home and school, 'takeaway and fast food' environments were the most commonly used with 53% of respondents sourcing food from this environment; 41% obtained food from convenience stores, at least once over the four-day period.

What is already known on this topic

The eating habits of young people are poorly understood but are perceived to be typified by irregular patterns with frequently missed meals, and a diet containing foods high in energy, a dominance of convenience or fast foods, a tendency to eat outside the home and to 'graze' (36). These eating patterns accompany a change in socialization from family to independence and stronger associations with peers (37). Market research data from over 16's in Great Britain indicated that young adults (20-24 years old) were the largest group to have visited fast-food outlets in the last six months (38). With 53% of this population having visited a 'takeaway and fast food' environment at least once over a four-day period and the second highest amount of energy obtained here, greater attention must be paid to these environments. The nutrient profiling indicated food obtained from these environments was energy dense (7.5 KJ/g) and high in percent energy from fat and saturated fat (43.0% and 13.6%). The environment classification including restaurants, pubs and hotel restaurants,

though providing food lower in energy density than some other environments, also contributed highly to the group's overall energy intake, as did retail bakers, which provided highly energy dense food (9.3 KJ/g) also high in total fat and saturated fat. A popular food environment was the convenience store, which 41% of respondents visited at least once over a four-day period. Food obtained from here was also energy dense (9.4KJ/g) and high in percent energy from total sugars (52.4%) but provided only 0.6MJ of energy indicating the lower volume of food purchased from these environments. It is interesting to note that the energy density of food obtained from supermarkets was slightly higher than that obtained from 'takeaways and fast food' (8.0 KJ/g versus 7.5 KJ/g).

Supermarkets are often used as a proxy measure of more healthful food access in food environment studies (39, 40). This study shows that although the supermarket environment may provide high availability of more healthful foods (e.g. fruits and vegetables), the foods sourced from these environments by young people are not necessarily more healthful. This illustrates that food environment classification alone cannot give a full picture of food availability (41).

What this study adds

Our results show that home food has a more favourable nutrient profile in terms of energy density and percentage energy from fat than that sourced outside of the home. This is in line with previous work which indicates that eating out-of-home is associated with higher intakes of energy and fat (42). High proportions of fruit and vegetable intakes were seen in some out-of-home environments including non-food stores, specialist stores and supermarkets. Although high proportions of fruit and vegetable intake was reported from these environments, they were used by fewer

individuals and provided less food overall than the home or other environments. The home was the most important food source in terms of grams of food consumed and all respondents consumed food sourced from home each day. This is in line with earlier qualitative work which highlighted the importance of the home environment and parents in influencing food choices in this age group where convenience in terms of time and cost is a high priority (2). Food from home had the most favourable nutrient profile, having relatively low energy density and a high percent energy from protein and carbohydrates. The home contributed 5.8g/100g food of fruit and 4.0g/100g food of vegetables. A more favourable home food environment has been reported in previous studies including the US EAT study (mean age 14.4 years) (43) and Ding et al.'s (44) US study (mean age 14.6 years).

Although the home food environment provided the most food by weight, this research highlights the importance of the out-of-home food environment within these young people's diets. Our findings particularly illustrate the importance of education establishments as a food source for young people; over half of respondents used these food environments at least once over the four-day period (60%). While the school food environment is regulated to some extent in England (45), at the time our fieldwork was conducted (2008/9 and 2011/12), free schools [b], colleges and workplaces were not. However, this policy has now been revised taking into account academies and free schools but not colleges (46). This suggests that the broader education and additionally workplace environments should be considered when seeking to change eating behaviours in this age group. This work also highlights that 'takeaway and fast food' environments are a significant contributors to this age-group's diet. However, unlike school food, there are few policies covering this type

of environment in the UK, apart from the voluntary Public Health Responsibility Deal. This voluntary code has focused on salt reduction, the removal of trans fat, calorie reductions and calorie labelling on menus (47) and is targeted towards larger companies and franchises, rather than small independent outlets.

Limitations of this study

The relatively small sample size of this work is limiting as is the combining of datasets collected at different time points (2008/9 and 2011/12). However, collecting such detailed information regarding individual's eating habits is labour and time intensive. An opportunistic approach was therefore taken in order to make the most of limited resources. Another limitation of this study was the duration of food diary recording. A longer period of recording (e.g. 7 days rather than 4 days), though challenging in terms of respondent burden, may have provided a clearer picture of weekly habits. Although the 4 days recorded by these individuals provided adequate data for analysis, a larger sample size would allow for exploring any differences in food sources and intakes between weekdays and weekend days which could not be completed within the current study. In addition, friends' and relatives' homes were included within the home food environment on the assumption that food available in these environments would be similar. However, later work has established that friends' homes are an important food source to this young population (48). In addition, Cohen et al (49) suggested that consumption of less healthy foods at friends' homes was more frequent than out-of-home consumption of these foods; the nutritional value of food from friends' home therefore warrants further exploration. While data was collected on alcohol intake and alcohol source, this was not the focus of this work but also merits further exploration (2).

Obtaining reliable estimates of food consumption for any population group is challenging (50) and dietary mis-reporting could introduce bias. Because we did not have body mass data for all our participants, we were not able to estimate potential energy mis-reporting at an individual level based on prediction of energy needs (51). However our estimates of energy intake were very similar to those reported for 11-18 year olds (7.5MJ) and 19-64 year olds (7.8MJ) in the recent National Diet and Nutrition Survey (NDNS) (52) suggesting any mis-reporting in our study is similar to that in the large national survey. We did not count the frequency of visits to each environment, recognising this limitation; later work has included this as a variable.

Conclusions

In summary, this is the first study to provide detailed quantitative information on the range of environments from which young people living in an urban setting obtain food and, importantly, it has revealed the differences in nutritional quality of foods sourced from both home and out-of-home outlets. Such information will be helpful in informing the design of dietary interventions and policy interventions e.g. those aiming to reduce the risk of obesity, by focussing not only on what is eaten but also the food environment from which those foods are obtained.

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Conflicts of Interest

The authors have declared that no competing interests exist.

Authorship

RT co-ordinated Study 2, collected, analysed and interpreted data for both studies and drafted the manuscript. FG collected, analysed and interpreted data for Study 1. SH, WW, JM and AA advised on the study design and interpretation of data. AAL conceived the study, and participated in its analysis, design and interpretation. AAL co-ordinated Study 1 and held an advisory role in Study 2. AAL helped to draft the manuscript. All authors read and approved the final manuscript.

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Table I Comparison of participant demographics and mean daily dietary intakes (SD) for Study 1 and Study 2

	Study 1 2008/09	Study 2 2011/12	Combined Studies 1+2
	n=41	n=45	n=86
Demographics			
Age (years) – Mean (SD)	17.8 (0.26)	17.1 (0.10)	17.4 (0.14)
Males (%)	56	38	47
Socio-economic status (IMD score) [a]	27.3 (19.2)	34.2 (23.2)	30.9 (21.6)
Living arrangements (% living with parent/guardian) [b]	83	100	92
Food and nutrient intake - Mean (SD)			
Food weight (g)	2053 (111)	2183 (95)	2121 (72)
Energy (MJ)	7.8 (0.5)	7.8 (0.4)	7.8 (0.3)
Energy density (KJ/g)	3.9 (0.2)	3.7 (0.2)	3.8 (0.1)
% energy from protein	14.7 (0.6)	13.8 (0.6)	14.3 (0.4)
% energy from fat	35.1 (1.0)	33.1 (0.9)	34.0 (0.7)
% energy from saturated fat	**12.6 (0.7)**	**10.6 (0.5)**	11.6 (0.4)
% energy from carbohydrate	47.8 (1.1)	49.6 (1.2)	48.7 (0.8)
% energy from total sugars	20.4 (1.1)	22.5 (0.8)	21.5 (0.7)
% energy from alcohol	2.3 (0.6)	5.1 (1.1)	3.8 (0.6)
Non-starch polysaccharides (NSP) (g)	10.1 (0.7)	8.7 (0.5)	9.4 (0.4)
Vitamin C (mg)	82.1 (8.2)	71.9 (7.9)	76.8 (5.7)
Iron (mg)	9.9 (0.8)	8.3 (0.5)	9.1 (0.5)
Fruit (g)	110 (19)	90 (12)	99 (11)
Vegetables (g)	81 (9)	71 (7)	76 (5)

Bold significant difference ($p<0.05$) between study 1 and study 2.

[a] Index of Multiple Deprivation (IMD) is a summary measure of area level deprivation. IMD scores were attributed to each individual based on the lower layer super output area (LSOA) containing the participants home postcode.

[b] There was no significant difference in the dietary intake of those living with parent/guardians and those living in other accommodation (n=7)

Table II Nutrient profile (mean daily intake per person) of food obtained from Food Environment Categories (30)

Food Environment Category	Energy (MJ)	Energy Density (KJ/g)	%E Protein	%E Fat	%E Saturated Fat	%E Carbohydrate	%E Total Sugar	%E Alcohol	Fruit (g/100g food)	Veg (g/100g food)	Food Wt (g)	Frequency n(%)*
Home	4.9	3.6	15.0	32.1	11.4	53.7	23.8	3.2	5.8	4.0	1472	86 (100)
Total out-of-home food outlets	2.9	4.7	12.5	35.9	11.6	47.9	21.1	3.6	2.6	2.7	649	86 (100)
Takeaway and fast food	1.4	7.5	14.4	43.0	13.6	42.6	13.6	0.0	0.6	3.0	210	46 (53)
Restaurant, pub and hotel restaurant	1.2	4.4	16.2	38.3	10.2	40.9	14.9	6.8	1.9	4.6	297	29 (34)
Baker – retail	1.1	9.3	11.4	46.5	14.5	38.1	12.0	0.0	0.0	1.5	160	17 (20)
Closed/ private food outlets (not accessible to the public e.g. schools and office canteens)	0.8	5.1	10.7	31.9	11.8	50.5	25.8	2.0	2.9	4.8	223	52 (60)
Pub, no food	0.8	2.7	0.7	<0.0	0.0	39.3	38.5	61.9	0.4	0.0	388	6 (7)
Supermarket	0.7	8.0	10.7	31.3	11.4	50.2	26.0	6.6	7.3	5.0	205	25 (29)
Takeaway café/coffee, specialist and sandwich shop	0.7	6.9	18.6	37.7	12.7	45.9	9.7	0.0	0.0	5.6	152	11 (13)
Convenience	0.6	9.4	3.4	25.3	11.7	70.9	52.4	1.6	0.5	0.2	153	35 (41)
Sit in café/coffee, specialist and sandwich shop	0.6	6.1	17.8	37.1	11.5	41.3	15.6	0.0	0.0	1.1	110	16 (19)
Specialist	0.6	10.5	9.0	41.9	8.7	52.0	34.4	0.0	11.3	4.8	85	15 (17)
Entertainment	0.6	4.4	9.6	28.7	10.4	54.4	28.6	1.4	0.0	0.0	252	11 (13)
Non-food stores (e.g. pharmacies)	0.5	8.4	9.4	27.2	9.6	67.3	47.3	0.0	11.9	5.1	113	11 (13)
Vending machines	0.5	7.1	4.5	32.9	16.1	66.8	54.1	0.0	0.0	0.0	129	8 (9)
Health and leisure	0.4	1.9	8.8	23.2	8.8	45.7	29.8	0.0	0.0	3.7	174	4 (5)
Mobile food and market	-	-	-	-	-	-	-	-	-	-	-	-

%E = percentage energy

*Number of participants reporting use of food environment classification category. Each category was counted only once per person over the four day data collection period