The food environment within the Primary School fringe

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Abstract

Purpose

The school fringe environment (peripheral 400 m buffer) offers an important opportunity for young people to obtain food and drink. There is international evidence to suggest socio-economic influence on food outlet availability and healthfulness within these environments; however the situation in the UK is unclear. The purpose of this paper is to describe food outlet provision (frequency and type) within primary school fringes across the spectrum of deprivation.

Design/methodology/approach

Ten primary schools in Newcastle upon Tyne were purposefully selected from a comprehensive list of all schools within the region. Two schools were chosen at random from each quintile of deprivation. A total of 400-metre buffer zones around schools were audited. School fringe food environments were classified using a Food Outlet Classification System. Access (i.e. frequency), and type of food outlets were compared to area level deprivation, obesity prevalence rates and area type.

Findings

1.

Food outlet frequency was highest in the most deprived school fringe area. Convenience stores and takeaways represented the greatest proportion of total food outlets across all school fringe environments. More total food outlets were observed in fringes with above national average obesity prevalence rates for children.

Research limitations/implications

UK case study approach limits widespread and international applicability.

Practical implications

Informs school, health and urban planning disciplines regarding current picture of UK school fringes.

Originality/value

Provides evidence in UK context that area deprivation and Census 2001 Supergroup class show significant correlations with school fringe food environment.

Background

In the UK current combined overweight and obesity prevalence rates are 33.4% and 22.6% for young people 10–11 and 4–5 years, respectively (National Health Service Information Centre and Lifestyles Statistics, 2011; Dinsdale *et al.*, 2012). Childhood overweight and obesity represent significant concern for health both in the short and long term (Avenell *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 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 well accepted that obesity is complex (Wang *et al.*, 2006). The multifactorial causes of obesity include biological, psychological, behavioural and social aspects as well as broader

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environmental issues including physical, economic, political and socio-cultural factors (Swinburn *et al.*, 1999; Butland *et al.*, 2007). The obesogenicity of an environment has been defined as "the sum of influences that the surroundings, opportunities, or conditions of life have on promoting obesity in individuals or populations" (Swinburn *et al.*, 1999). Environmental factors influence both sides of the energy balance equation. Convenience, cost and accessibility of areas to be active can influence the patterns of physical activity and, ultimately, energy expenditure (Brownson *et al.*, 2009). Similarly food outlet type, proximity and healthfulness are shown to influence food choice and energy intake (Holsten, 2009). Food choices are made within the food environment, defined as 'any opportunity to obtain food' and includes physical, socio-cultural, economic and policy factors at both micro and macro levels (Townshend and Lake, 2009). Food and beverages consumed outside of the home are associated with higher energy intakes than foods prepared at home (Lachat *et al.*, 2012). And dietary behaviours are an important contributing factor to socioeconomic inequalities in overweight and obesity (Giskes *et al.*, 2010). Whilst preventative measures, such as modifying the food environment, potentiate significant impact on obesity, the right measures to be taken remain as yet unclear (Holsten, 2009).

In 2008 the Government document 'Healthy Weight, Healthy Lives' (Department of Health, 2008) called for local authorities "… to manage the proliferation of fast food outlets in particular areas, e.g. near parks or schools". In England some local authorities have produced Supplementary Planning documents restricting food outlet proliferation around certain areas including schools (for example Barking and Dagenham (National Health Service Barking and Dagenham and London Borough of Barking and Dagenham, 2010)). Planning of this nature is controlled at the local level thus there is a lack of consistency countrywide. At the time of study Newcastle upon Tyne did not have any such food outlet planning restrictions, the Area Action Plan states "Outside the Urban Core's identified Primary Shopping Areas where [*sic*] there is scope for small scale complimentary retail uses including… convenience outlets… to meet people's everyday need for food provision"

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(Gateshead Council and Newcastle City Council, 2011, p. 30), and there was general advocacy for all retail investment and expansion.

Despite there being high levels of interest in the school fringe, defined as the immediate area surrounding a school, there have been few systematic studies, and the relationship between environment and diet and weight outcomes in young people is not fully understood (de Vet *et al.*, 2011). Such studies have recently been conducted for the built environment (Williams *et al.*, 2012).

In the US, Kwate and Loh (2010) and Austin *et al.* (2005) reported a clustering of fast food outlets around schools. In Scotland, though clustering of all types of food outlets was observed at 400, 800 and 1,200 metre (m) secondary school fringe buffers there was no clear pattern of outlet type clustering (Ellaway *et al.*, 2012). In Germany no food outlet clustering was observed within 750 metres of schools (Buck *et al.*, 2013). Tester *et al.* (2010) reported that mobile vending outside schools contributed to US children's after school diet, and many purchases were made by children unsupervised. Sinclair and Winkler (2008) focused on two English secondary schools (pupils aged 13-17 years) and found the school fringe contributed significantly to the children's energy intake. There is evidence from the US and Canada that presence of convenience and fast-food outlets within a mile radius of schools negatively influence diet healthfulness and BMI (Davis and Carpenter, 2009; Howard *et al.*, 2011; He *et al.*, 2012; Alviola *et al.*). Seliske *et al.* (2009) and Forsyth *et al.* (2012) however, found no association with food outlet exposure and either weight status or dietary intake, respectively.

Brembeck *et al.* (2013) suggest that young people are highly attuned to commercialism and branding and are themselves independent consumers. Evidence from the UK indicates less healthful dietary intakes are associated with *use* of and *proximity* to 'unhealthy' food outlets (comprising takeaways, fast food and convenience outlets) (Fraser *et al.*, 2011; Jennings *et al.*, 2011; Patterson *et al.*, 2012). Moreover a recent study found proliferation of convenience stores surrounding secondary schools from 2001 to 2005, and a direct association between school fringe food environment outlet type and dietary intake (Smith *et al.*, 2013). In short both food outlet count and

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type are pertinent. Research suggests the school fringe food environment is influential in young people's dietary intake thus potentiating weight status outcome. To our knowledge there is little empirical research in the UK context. The aim of this research was to describe food outlet provision comprising outlet frequency (as a measure of access), and outlet type (as a proxy measure of food type provision) within the school fringe environment. Food outlet access and provision were tested for association with: area level deprivation (using Index of Multiple Deprivation (IMD) (Office for National Statistics, 2007)), obesity prevalence (using National Child Measurement Programme (National Health Service Information Centre and Lifestyles Statistics, 2010)), and area type (using Census Supergroup Class (Ordiance Survey and Office for National Statistics, 2001)). This paper is a detailed area-level case study and as such enables nuanced and comprehensive interrogation of a limited number of school fringe environments. Analysis was undertaken in line with literature standards for larger scale empirical work to facilitate comparison with established knowledge.

Methods

Area Selection and Demographics

Area level deprivation was assessed using IMD (Office for National Statistics, 2007), a compound measure of socio-economic status, combining aspects of: employment, health, crime, living environment, education, housing and income at the Lower Super Output Area (LSOA) level.

School postcodes were obtained for all primary schools within Newcastle upon Tyne from Newcastle City Council website listings. IMD scores were generated for schools by cross referencing postcode data with national 2007 IMD figures (Office for National Statistics, 2007). Schools were stratified into within-sample deprivation quintiles, and two schools chosen at random for each IMD quintile. This provided a range of deprivation from 1 (least deprived) through to 5 (most deprived). Schools were assigned an ID from 1 (least deprived) to 10 (most deprived).

5.

Area types were stratified according to Census 2001 Supergroup Class at the Medium Super Output Area (MSOA) level (Ordiance Survey and Office for National Statistics, 2001). Supergroup classes (20 types) stratify the UK population according to demographic, household composition, housing, socio-economic, employment and industry sector (Bond and Insalaco, 2007; Office for National Statistics, 2008; Office for National Statistics, 2012) enabling labelling of area 'types' on the grounds of population based commonalities. Area type classification was utilised to explore the nuanced area-based influence beyond that of IMD and is in line with NMCP obesity prevalence analysis (Ridler *et al.*, 2011). MSOA level stratification is the smallest area geography available. Using ArcMap GIS 9.3 (a geographic information system (GIS) mapping program) MSOAs were spatially linked to Supergroups; school postcodes (by centroid) were mapped over MSOAs; and Supergroups were assigned.

Percentage rates of childhood obesity for children aged 4–5 and 10–11 years were obtained from the National Child Measurement Programme (NCMP) for MSOAs (National Obesity Observatory, 2010b; National Obesity Observatory, 2010a), NCMP definitions of obesity were conformed to. MSOA level data is the lowest area level data available and is used in line with Supergroup Class geography level. Obesity prevalence rates were spatially linked to MSOAs using ArcMap GIS 9.3. School postcodes (by centroid) were spatially mapped over MSOAs and obesity prevalence rates were assigned to schools according to MSOA level data. Obesity prevalence rates were defined as above or below NCMP defined national average rates for England and Newcastle (combined data 4–5 and 10–11 years) (National Health Service Information Centre and Lifestyles Statistics, 2010).

School Fringe Food Environment

For each of the ten primary schools a 400m radius around the school periphery was mapped by means of a postcode centroid buffer using ArcMap GIS 9.3. The buffer map generated an equal area of close proximity (i.e. straight line buffer) around each school for analysis and measurement of the

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school fringe environment. A 400m radius represents a quarter mile walking distance and is a recognised standard in literature (Tester *et al.*, 2011).

IMD, Supergroup Class and Obesity prevalence rates were assigned at the point of the school postcode centroid within the smallest scale geography available for the given datasets. It is acknowledged that the surrounding 400m buffer zones may have incorporated surrounding LSOAs and MSOAs which may have differing levels of deprivation, Supergroup class and obesity prevalence rates.

An existing Food Outlet Classification System was used to classify the school fringe food environment (Lake *et al.*, 2010). This system was previously developed as a culturally relevant and detailed system for classifying the food environment in the UK (Lake *et al.*, 2010; Lake *et al.*, 2012). From this Classification System food outlet types were grouped into five outlet typologies (defined in Table 1), representing outlet types offering access to discrete types of food items and eating experiences:

- Traditional sit-down eatery – food ordered at till or table, food predominately prepared on-ordering but can be pre-prepared and held at temperature. Food eaten on site;
- Convenience and Instant food Outlets – food ordered at till, food predominately pre-prepared and held at temperature but can be prepared on-ordering. Food for take-away or immediate consumption only;
- Traditional shops – food bought predominately requires preparation before consumption. Food bought for meals and snacks. Wide and specialist ranges available;
- Convenience shops – food predominately bought for immediate consumption but can include food for gifts. Limited range available;
- Other food outlets – food predominately bought for immediate consumption. Very limited range available. Outlets do not include traditional shop formats.

Table 1 about here

7.

One researcher was trained in the use of the Food Outlet Classification System (Lake *et al.*, 2010), data collection and analysis techniques. The 400m school fringe buffer was walked within the hours of 9am–5pm and the food environments within areas classified. The location and Classification System code of all food outlets present within school fringe buffers were marked by hand on the printed GIS maps during data collection. A colour coded Classification System key was created to produce a visual representation of each school fringe food environment.

Data was collected January – March 2010. Only food outlets were recorded, outlets which did not sell food or outlets where it would be highly unlikely that children would visit (i.e. private social clubs, adult outlets) were excluded. When food outlets were of mixed function (for example a convenience store with in-store sandwich delicatessen) outlets were classified according to the main function.

Data Analysis

Logistic Regression (r) was used to measures the relationship between obesity prevalence and both deprivation and area type according to Supergroup class. Normally distributed food outlet frequency data underwent comparative analysis with both deprivation and area type using Analysis of Variance (F). Nonparametric Chi Squared (x^2) tests were used to explore associations between food outlet type and deprivation, area type and obesity prevalence, as distribution was not normal. All data was analysed using SPSS Statistics (Version 19).

Results

Area Statistics

All schools fell within urban areas and had populations of more than 10 thousand people per output area (Ordiance Survey and Office for National Statistics, 2001). Five Supergroup classes (Ordiance Survey and Office for National Statistics, 2001) were represented in this sample (Table 2).

8.

Supergroups were consistent with area level deprivation (according to IMD) with more affluent Supergroup class types more common in less deprived areas and vice-versa.

Table 2 about here

Obesity Prevalence Rates

NCMP data was present for eight of the ten school fringe areas (Figure 1); data reported about obesity prevalence rates thus excludes schools 3 and 5.

Figure 1 about here

Significant moderate positive correlation was observed between deprivation and increasing obesity prevalence according to combined NCMP data for those 4–5 and 10–11 years (r=0.662, p=0.037, one-tailed). In those aged 10–11 years significant moderate positive correlation was shown between increasing deprivation and increasing obesity prevalence (r=0.659, p=0.038, one-tailed), this relationship did not hold for those aged 4–5 years (r=0.582, p=0.065, one tailed).

No correlation was observed between area Supergroup class and obesity prevalence for combined 4–5 and 10–11 years (r=0.379, p=0.177, one-tailed), 10–11 years (r=0.275, p=0.255, one-tailed) or 4–5 years only data (r=0.538, p=0.084, one-tailed). Two of the three school fringes which were categorised in Supergroup classes the NCMP showed to have obesity prevalence rates above the national average were from the most deprived quintile (Ridler *et al.*, 2011).

Food Outlet Frequency

The highest frequency of food outlets was observed in school fringe 10 (most deprived) (n=59); the lowest frequency in school fringe 8 (third most deprived) (n=5). School fringes in IMD quintile 4 (second most deprived quintile) had the lowest combined number of food outlets (School 7 n=6, School 8 n=5); school fringes in IMD quintile 5 (most deprived quintile) the highest (School 9 n=18, School 10 n=59) (Table 3).

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No significant association was observed between food outlet frequency and IMD quintile (F=1.125, *p*=0.627); obesity prevalence rates nationally or locally (both F=0.370, *p*=0.565); or Supergroup class (F=2.314, *p*=0.191).

Despite non-significant results there were more total food outlets in school fringe areas which had obesity prevalence rates *above* the national and local average (n=89, 4 areas) compared to those areas which had prevalence rates *below* (n=57, 4 areas). Furthermore, there were more total mean counts of food outlets in areas classified as 'Professional City Life' (35.75 outlets, n=143 within 4 areas) than for 'Miscellaneous built up' and 'Disadvantaged Urban' areas (both n=18, within 1 area each), 'Urban Fringe' areas (8.5 outlets, n=17 within 2 areas) and 'White Collar Urban' areas (5.5 outlets, n=11 within 2 areas).

Table 3 about here

Food Outlet Type

The most common food outlet types observed across all school fringes were Convenience stores (n=33, 15.9%), Takeaways (n=32, 15.5%) and Restaurants (n=28, 13.5%). The least common were Mobile Food & Market, Health & Leisure and Food Production Service outlets (all n=1, 0.5%).

Frequency of food outlets according to broader typology groupings (Figure 2) were examined for association with deprivation, obesity prevalence rates and Supergroup class (Table 4); results shall be discussed in turn.

Table 4 about here

Figure 2 about here

Deprivation and food outlet type

Significant correlation was observed between school fringe deprivation and frequency of 'Traditional sit down eateries' and 'Convenience and Instant food outlets'; no correlation was observed for 'Traditional shops', 'Convenience shops' or 'Other food outlets' (Table 4). Traditional

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sit down eateries represented more than half the total food outlets in the four least deprived areas; 51.5% (n=17) in IMD quintile 1 and 69.6% (n=32) in IMD quintile 2. Convenience and Instant food outlets represented the greatest proportion of total food outlets in IMD quintile 3 (30%, n=12); these types of outlets represented the lowest proportion of food outlets in IMD quintile 2 (2.2%, n=1).

Obesity prevalence and food outlet type

No significant association was observed between obesity prevalence and any specific food outlet typology (Table 4). Despite non-significant findings, differences in outlet types were observed. Convenience and Instant food outlets represented 22.8% (n=13) of total food outlets in school areas with below national average rates of obesity compared to only 14.6% (n=13) for school areas with above national average rates. Convenience Shops represented 27% (n=24) of total food outlets in school areas with above national average rates of obesity compared to only 19.3% (n=11) for school areas with below national average rates.

Area Supergroup class and food outlet type

Significant association was observed between area Supergroup class and 'Traditional sit down eateries', 'Convenience and Instant food outlets' and 'Convenience Shops'; no association was observed for 'Traditional Shops' or 'Other food outlets' (Table 4). Proportionally there were more 'Traditional sit down eateries' in areas classified as 'Professional City Life' (61.5%) than in 'Disadvantaged Urban' areas (5.6%). Convenience and Instant food outlets represented one third of total outlets in 'Miscellaneous built up' and 'Disadvantaged Urban' areas; proportionally this was much higher than 'Professional City Life' where these outlets represented about one tenth of total food outlets (Table 5). Convenience Shops represented a notably higher proportion of total food outlets in 'Disadvantaged Urban' areas than in areas classified as 'Professional City Life'; 55.6% compared to only 14% respectively.

Table 5 about here

11.

Food Outlet Locations

From the hand-mapping of food outlets on GIS generated printed maps it was observed that food outlets were generally clustered on A and B class roads. A roads are defined by the Department for Transport as "major roads intended to provide large-scale transport links within or between areas" and B roads as "roads intended to connect different areas, and to feed traffic between A roads and smaller roads on the network" (Department for Transport, 2012). Schools 5, 6, 7 and 10 predominately clustered around A roads and Schools 1, 2, 3 and 9 predominately clustered around B roads. There was also clustering of outlets adjacent to neighbourhood landmarks i.e. golf club School 2, metro station School 3 and community centre School 9. Food outlets surrounding Schools 4 and 8 were clustered and scattered on residential roads, respectively. There was no observable or statistical association between type of outlet clustering and outlet count, deprivation, obesity prevalence or area Supergroup class.

Discussion

This study has, for the first time, systematically explored the school fringe food environment of primary schools in a city in England. The 10 school fringe areas followed the national trend for increasing obesity prevalence with increasing deprivation.

School fringe food outlet access was higher in areas with higher than national and local average obesity prevalence rates than those with lower than average rates. This may indicate food outlet access influence on weight status, and is in compliment to findings from the US (Davis and Carpenter, 2009; Howard et al., 2011). Cummins and Macintyre's (2002) review highlighted the, flawed, tendency to rely on area level deprivation alone to define areas. Though the relationship between food outlet frequency and area level factors (according to Supergroup) was not fully explained in this case study, results suggest the potential for using area level characteristics beyond deprivation to explain area level influence.

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Convenience and Takeaway outlets were the most common food outlet types observed across all ten school fringes (Table 3); in line with Scottish findings (Ellaway *et al.*, 2012). These types of food outlets characteristically sell energy dense foods at competitive prices potentiating increasing energy consumption and by extension weight status outcomes (Grafova, 2008; Davis and Carpenter, 2009). Though these types of outlets were consistently observed across all IMD quintiles, they represented the greatest proportion of total food outlets in the two most deprived IMD quintiles indicative of food environment socio-economic disadvantage. This is consistent with findings from Scotland (Cummins *et al.*, 2005), the US (Zenk and Powell, 2008) and New Zealand (Day and Pearce, 2011). This socio-economic disadvantage was mirrored with the lowest provision of 'Specialist' and 'Specialist traditional' outlets in the most deprived areas. Findings are in contrast to research from Glasgow (Cummins and Macintyre, 1999) and Scotland (Smith *et al.*, 2010); this may be explained by access categorisation at the wider neighbourhood level in these studies.

Case study findings were in line with trends in literature for higher 'Convenience and Instant food outlets' concentration in more deprived areas (Macdonald *et al.*, 2007; Lee, 2012). Though cause for this concentration is as yet unknown it is commonly attributed to consumer demand, area population density and land use (Pearce *et al.*, 2007). In this case study more of these outlet types were present in areas with below national and local average obesity prevalence rates than above average rates. This finding is counter-intuitive when access is assumed as a predictor of dietary outcome and again illustrates the complex nature of food choice and energy intake and potential for non-relationship.

More 'Traditional sit-down eateries' were observed in less deprived areas and area Supergroup class 'Professional City Life'. There was consistently low provision of 'Traditional shops', representing only 8.2% of total food outlets observed, augmenting the widely cited trend in UK literature of dominance of the out-of-town shopping retail experience (White, 2007; Elms *et al.*, 2010). Though association did not reach significance more 'Convenience shops' were observed in: more deprived areas, Supergroup class 'Disadvantaged Urban' and areas with above national and

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local average obesity prevalence rates. Findings are in line with trends in US literature (Larson *et al.*, 2009).

Food outlets were predominately clustered on main roads in school fringes observed; this is likely due to UK planning restrictions under Local Authority Development Plans which dictate land usage, and Planning Policy Statements 4 and 12 which impose spatial retail development constraints (Communities and Local Government, 2008; Communities and Local Government, 2009). This was reflected in Newcastle City Council 'Primary Shopping Area' locales (Gateshead Council and Newcastle City Council, 2011). The clustering of food outlets within buffer zones is liable to influence food outlet exposure linked to travel route within the school fringe; such examination is beyond the scope of this study but is worthy of further investigation. In this sample no association was observed between area deprivation, obesity prevalence or area Supergroup class, though this may be due to the crude classification of outlet location types.

Strengths

The strengths of this study are the exploratory case study approach which enabled detailed and robust measurement of the school fringe environment across 10 schools; this is a unique method of investigation with the majority of food outlet access studies reliant on secondary data sources and GIS analysis (Kelly *et al.*, 2011). Data collection by a single auditor limited inter-rater reliability bias thus increasing the validity of results. Selection of school fringe environments purposeful (according to urbanicity and IMD) then random, not on grounds of suitability increases the generalizability of findings. Use of robust and valid methods and categorisation of areas by literature standards (IMD, NCMP and Census data) further increases research robustness however, it must be noted that the geographies of these data sets are not designed for small-area analysis and the potential spanning of LSOA and MSOA boundaries within buffer area is acknowledged.

14.

Limitations

The detailed case study approach can be seen as a limitation of this study – the small sample size impedes generalizability, especially internationally. However as the 10 school fringe areas followed the national trend for increasing obesity prevalence with increasing deprivation, it gives confidence in the generalizability of these findings to England. Furthermore, the insight which detailed case studies offer to established knowledge should not be overlooked.

The cross-sectional food environment analysis impedes comment to outlet *access* only which is not the only contributor to food purchase and consumption (Rose *et al.*, 2009). Single auditor data collection imposed time constraints on auditing time (i.e. 9–5 pm) which potentiated data biasing due to omitted mobile food outlets in-situ only immediately before and after school-time; these outlet types are shown to be an important opportunity for food access in young people (Tester *et al.*, 2010). Random selection of areas may have skewed data. For example, two of the schools (20% sample) did not have NCMP obesity prevalence rate data; and School 10, though fitting broadly into the definition of 'urban' (Ordiance Survey and Office for National Statistics, 2001), was located juxtaposition the edge of the town centre and had the greatest number of outlets.

Conclusions

In conclusion this research indicated area-level influence on food outlet type within the school fringe environment in the UK. There was a trend towards greater proportional provision of 'Traditional sit down eateries' in less deprived areas and greater proportional provision of 'Convenience and instant food outlets' in more deprived areas. Though this was a small scale examination of the school fringe environment it illustrates the potential to explain part of the energy balance equation at a spatial level within the school fringe.

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Table 1:   Classification System food outlets and their typology groupings

Typology	Food Outlet
Traditional sit-down eatery	Restaurant Hotel/Function Rooms/Associations (with restaurant) Pizzeria (sit-in) Pub/Bar (serves food) Takeaway Food (sit-in) Sandwich shop (sit-in) Café/coffee shop (sit-in)
Convenience & Instant food outlet	Pizzeria (take-away) Takeaway Food (take-away) Fast Food Sandwich shop (take-away) Café/coffee shop (take-away) Retail Baker e.g. serves baked & pre-made products, takeaway only Mobile food & Market (food for immediate consumption)
Traditional Shops	Mobile food & Market (food requiring preparation before consumption) Supermarket Specialist e.g. Organic, Holistic, Fair trade & Oriental food stores Specialist Traditional e.g. Butcher, Baker, Fishmonger & Greengrocer
Convenience Shops	Specialist Traditional (candy shop & confectioners only) Convenience store Department Stores e.g. large retail store organised into departments Discount Stores Non-Food Stores e.g. Clothes, Gift, Stationery & Cosmetic shops Vending Medical e.g. Pharmacy
Other food outlet	Hotel/Function Rooms/Associations (without restaurant) Entertainment e.g. Cinema, Bowling, Theatre, Sports venues Health & Leisure e.g. Gyms, Health Clubs, Leisure Centre Work Place/Education Food Production Service e.g. Wholesalers, Distributers, Cash & Carry

Table 2:   School level deprivation and supergroup class

Area ID	IMD quintile	Supergroup class
1	1	Professional City Life
2	1	Urban Fringe
3	2	Professional City Life
4	2	Urban Fringe
5	3	Professional City Life
6	3	Miscellaneous built up areas
7	4	White Collar Urban
8	4	White Collar Urban
9	5	Disadvantaged Urban
10	5	Professional City Life

* IMD quintile 1 is the least deprived, IMD quintile 5 the most deprived

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Table 3: Food Outlet frequency by outlet type for School fringes

IMD quintile	1		2		3		4		5		
School ID	**1**	**2**	**3**	**4**	**5**	**6**	**7**	**8**	**9**	**10**	**Total**
Restaurant	4	1	11		3					9	28
Hotel/Function Room/ Association	1		9							3	13
Pizzeria	1				1						2
Pub/Bar	3	1	2	1	2	1	1	1		7	19
Takeaway	3	1	1	1	5	2	2	1	6	10	32
Fast Food	1		1			2					4
Sandwich shop	3	3		1	4	3			1	1	16
Café/coffee Shop	2		6		2	1	1			10	22
Retail Baker			1			1					2
Specialist										4	4
Specialist Traditional	1		2	1	1	1				2	8
Mobile food & Market										1	1
Convenience	2	2	1	3	3	4	1	3	10	4	33
Supermarket	1		1			1	1		1		5
Vending			3							3	6
Medical			1			1					2
Entertainment	1	2				1				1	5
Non-food stores										1	1
Health & Leisure					1						1
Work/Education/Care										2	2
Food Production Service										1	1
Total	23	10	39	7	22	18	6	5	18	59	

* IMD quintile 1 is the least deprived, IMD quintile 5 the most deprived

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Table 4:   Chi square correlation (x^2 and (p value)) for food outlet typologies according to deprivation, obesity prevalence rates, and area supergroup class

Food outlet Typology	Deprivation	Obesity prevalence rate	Area supergroup class
Traditional sit down eateries	13.470 (0.009)	0.171 (0.679)	32.446 (<0.001)
Convenience and Instant food outlets	13.483 (0.009)	1.596 (0.206)	13.948 (0.011)
Traditional shops	0.334 (0.987)	0.002 (0.964)	0.509 (1.000)
Convenience shops	2.889 (0.577)	1.121 (0.290)	19.800 (<0.001)
Other food outlets	4.314 (0.361)	0.542 (0.462)	2.960 (0.520)

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Table 5:   Proportional representation (count and (percentage)) of food outlet typologies according to area supergroup class

| Area supergroup class	Traditional sit down eateries	Convenience & Instant food outlets	Traditional shops	Convenience shops	Other food outlets
Professional City Life	88 (61.5)	14 (9.8)	12 (8.4)	20 (14.0)	9 (6.3)
Urban Fringe	5 (29.4)	4 (23.5)	1 (5.9)	5 (29.4)	2 (11.8)
Miscellaneous built up	4 (22.2)	6 (33.3)	2 (11.1)	5 (27.8)	1 (5.6)
White Collar Urban	3 (27.3)	3 (27.3)	1 (9.1)	4 (36.4)	0 (0)
Disadvantaged Urban	1 (5.6)	6 (33.3)	1 (5.6)	10 (55.6)	0 (0)

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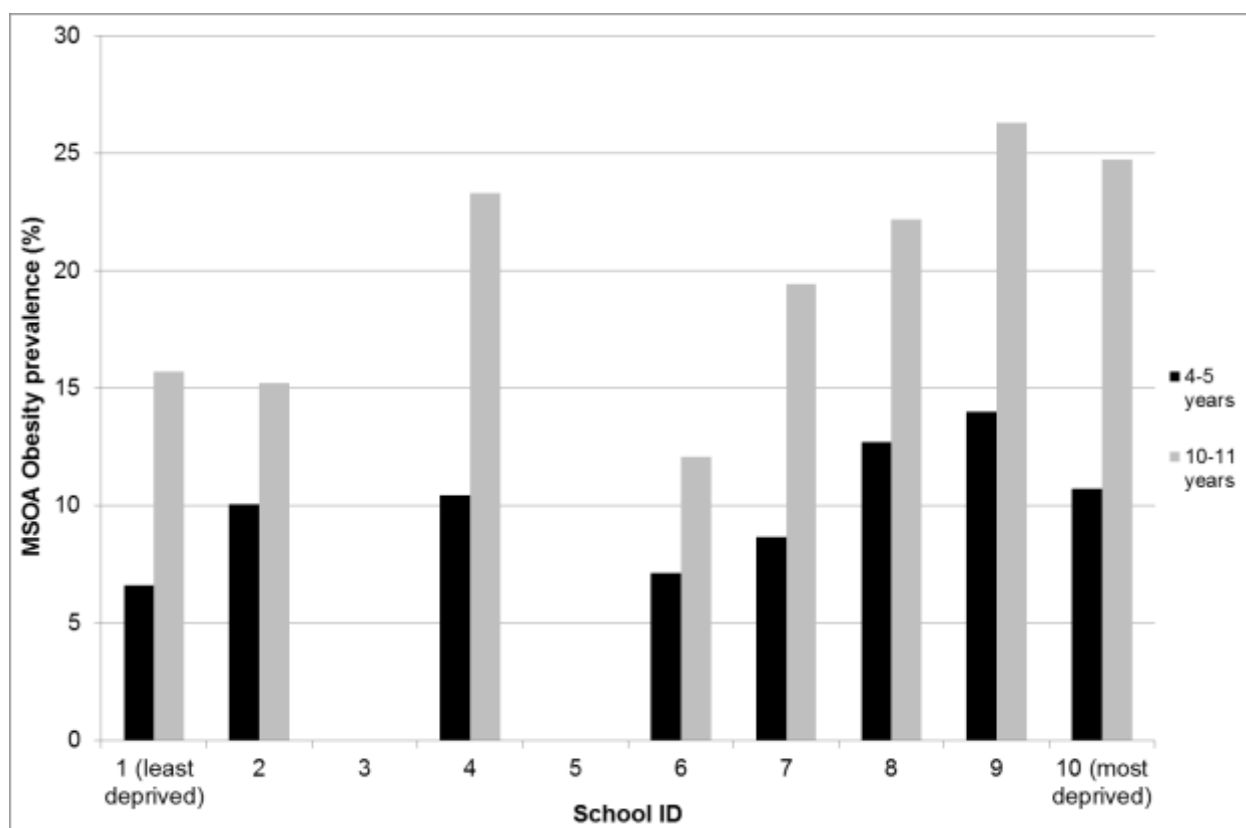
Figure 1:   School area level obesity prevalence

* Areas 003 and 005 are excluded due to absence of NCMP data at MSOA level
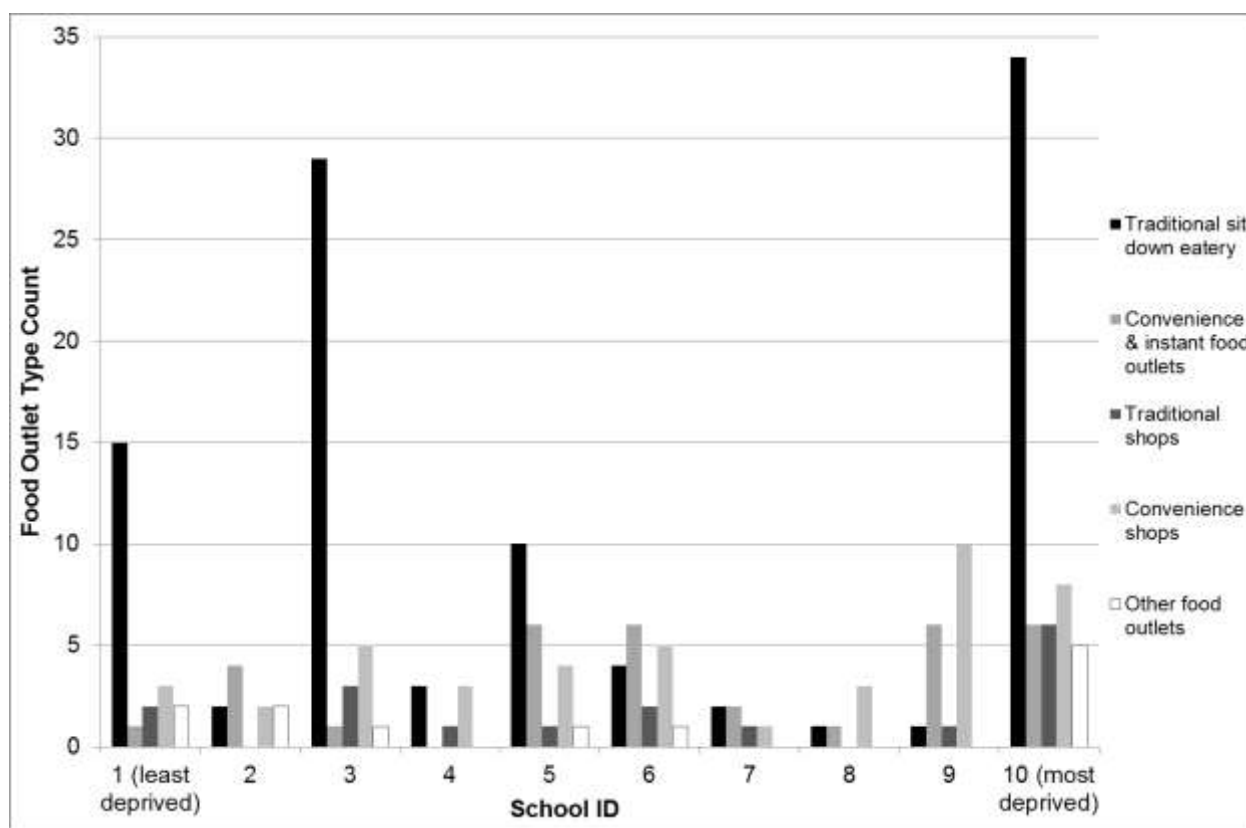
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Figure 2:   Food outlet frequency according to outlet typologies

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References

Alviola, P.A., Nayga, R.M., Thomsen, M.R., Danforth, D. and Smartt, J. (2013), "The Effect of Fast-Food Restaurants on Childhood Obesity: A School Level Analysis", *Economics & Human Biology*, Vol. In Press.

Austin, S.B., Melly, S.J., Sanchez, B.N., Patel, A., Buka, S. and Gortmaker, S.L. (2005), "Clustering of fast-food restaurants around schools: A novel application of spatial statistics to the study of food environments", *American Journal of Public Health*, Vol. 95 No. 9, pp. 1575-1581.

Avenell, A., Broom, J., Brown, T.J., Poobalan, A., Aucott, L., Stearns, S.C., Smith, W.C., Jung, R.T., Campbell, M.K. and Grant, A.M. (2004), "Systematic review of the long-term effects and economic consequences of treatments for obesity and implications for health improvement", *Health Technology Assessment*, Vol. 8 No. 21 iii-iv, pp. 1-182.

Bond, S. and Insalaco, F. (2007), *Area Classification of Super Output Areas and Datazones. Project Final Report,* Office for National Statistics, London, available at: http://www.ons.gov.uk/ons/guide-method/classifications/currentstandard-classifications/national-statistics-2001-area-classifications/methodology-andvariables/super-output-areas/methodology.pdf (accessed February 1 2012).

Brembeck, H., Johansson, B., Bergström, K., Engelbrektsson, P., Hillén, S., Jonsson, L., Karlsson, M., Ossiansson, E. and Shanahan, H. (2013), "Exploring children's foodscapes", *Children's Geographies*, Vol. 11 No. 1, pp. 74-88.

Brisbois, T.D., Farmer, A.P. and McCargar, L.J. (2012), "Early markers of adult obesity: a review", *Obesity Reviews*, Vol. 13 No. 4, pp. 347-367.

Brownson, R.C., Hoehner, C.M., Day, K., Forsyth, A. and Sallis, J.F. (2009), "Measuring the Built Environment for Physical Activity: State of the Science", *American Journal of Preventive Medicine*, Vol. 36 No. 4 (Supplement 1), pp. S99-S123 e12.

23.

Buck, C., Bornhorst, C., Pohlabeln, H., Huybrechts, I., Pala, V., Reisch, L., Pigeot, I., Idefics, o.b.o.t. and the, I.F.c. (2013), "Clustering of unhealthy food around German schools and its influence on dietary behavior in school children: a pilot study", *International Journal of Behavioral Nutrition and Physical Activity*, Vol. 10 No. 1, p. 65.

Butland, B., Jebb, S., Kopelman, P., McPherson, K., Thomas, S., Mardell, J. and Parry, V. (2007), *Foresight Tackling Obesities: Future Choices – Project Report,* The Stationary Office, London, available at: http://www.bis.gov.uk/foresight/our-work/projects/published-projects/tackling-obesities/reports-and-publications (accessed 10 January 2009).

Communities and Local Government (2008), *Planning Policy Statement 12: Creating strong safe and prosperous communities through Local Spatial Planning* The Stationary Office, London, available at: http://www.communities.gov.uk/documents/planningandbuilding/pdf/pps12lsp.pdf (accessed August 23 2012).

Communities and Local Government (2009), *Planning Policy Statement 4: Planning for Sustainable Economic Growth,* The Stationary Office, London, available at: http://www.communities.gov.uk/documents/planningandbuilding/pdf/planningpolicystatement4.pdf (accessed August 23 2012).

Craigie, A.M., Lake, A.A., Kelly, S.A., Adamson, A.J. and Mathers, J.C. (2011), "Tracking of obesity-related behaviours from childhood to adulthood: A systematic review", *Maturitas*, Vol. 70 No. 3, pp. 266-284.

Craigie, A.M., Matthews, J.N.S., Rugg-Gunn, A.J., Lake, A.A., Mathers, J.C. and Adamson, A.J. (2009), "Raised adolescent body mass index predicts the development of adiposity and a central distribution of body fat in adulthood: a longitudinal study", *Obesity Facts*, Vol. 2, pp. 150-156.

Cummins, S. and Macintyre, S. (1999), "The Location of Food Stores in Urban Areas: A Case Study in Glasgow", *British Food Journal*, Vol. 101, pp. 545-553.

Cummins, S. and Macintyre, S. (2002), ""Food deserts" Evidence and Assumption in Health Policy Making", *British Medical Journal*, Vol. 325 No. 7361, pp. 436-438.
24.

Cummins, S.C.J., McKay, L. and MacIntyre, S. (2005), "McDonald's restaurants and neighborhood deprivation in Scotland and England", *American Journal of Preventive Medicine*, Vol. 29 No. 4, pp. 308-310.

Davis, B. and Carpenter, C. (2009), "Proximity of Fast-Food Restaurants to Schools and Adolescent Obesity", *American Journal of Public Health*, Vol. 99 No. 3, pp. 505-510.

Day, P.L. and Pearce, J. (2011), "Obesity-Promoting Food Environments and the Spatial Clustering of Food Outlets Around Schools", *American Journal of Preventive Medicine*, Vol. 40 No. 2, pp. 113-121.

de Vet, E., de Ridder, D.T.D. and de Wit, J.B.F. (2011), "Environmental correlates of physical activity and dietary behaviours among young people: a systematic review of reviews", *Obesity Reviews*, Vol. 12 No. 5, pp. e130-e142.

Department for Transport (2012), *Guidance on Road Classification and the Primary Route Network,* The Stationary Office, London, available at: http://www.dft.gov.uk/publications/road-classification-guidance/ (accessed August 22 2012).

Department of Health (2008), *Healthy Weight, Healthy Lives: A cross-government research and surveillance plan for England,* The Stationary Office, London.

Dinsdale, H., Ridler, C. and Rutter, H. (2012), *National Child Measurement Programme Changes in children's body mass index between 2006/07 and 2010/11,* National Obesity Observatory, Oxford, available at: http://www.noo.org.uk/NOO_pub (accessed August 25 2012).

Ellaway, A., Macdonald, L., Lamb, K., Thornton, L., Day, P. and Pearce, J. (2012), "Do obesity-promoting food environments cluster around socially disadvantaged schools in Glasgow, Scotland?", *Health & Place*, Vol. 18 No. 6, pp. 1335-1340.

Elms, J., Canning, C., de Kervenoael, R., Whysall, P. and Hallsworth, A. (2010), "30 years of retail change: Where (and how) do you shop?", *International Journal of Retail and Distribution Management*, Vol. 38 No. 11, pp. 817-827.

25.

Forsyth, A., Wall, M., Larson, N., Story, M. and Neumark-Sztainer, D. (2012), "Do adolescents who live or go to school near fast-food restaurants eat more frequently from fast-food restaurants?", *Health & Place*, Vol. 18 No. 6, pp. 1261-1269.

Fraser, L.K., Edwards, K.L., Cade, J.E. and Clarke, G.P. (2011), "Fast food, other food choices and body mass index in teenagers in the United Kingdom (ALSPAC): a structural equation modelling approach", *Int J Obes*, Vol. 35 No. 10, pp. 1325-1330.

Gateshead Council and Newcastle City Council (2011), *Newcastle Gateshead Urban Core Area Action Plan Draft Plan,* Gateshead Council and Newcastle City Council, Newcastle upon Tyne, available at: http://www.newcastle.gov.uk/planning-and-buildings/planning/urban-core-area-action-plan-0 (accessed June 11 2013).

Giskes, K., Avendaňo, M., Brug, J. and Kunst, A.E. (2010), "A systematic review of studies on socioeconomic inequalities in dietary intakes associated with weight gain and overweight/obesity conducted among European adults", *Obesity Reviews*, Vol. 11 No. 6, pp. 413-429.

Grafova, I.B. (2008), "Overweight children: Assessing the contribution of the built environment", *Preventive Medicine*, Vol. 47 No. 3, pp. 304-308.

He, M., Tucker, P., Irwin, J.D., Gilliland, J., Larsen, K. and Hess, P. (2012), "Obesogenic neighbourhoods: the impact of neighbourhood restaurants and convenience stores on adolescents' food consumption behaviours", *Public Health Nutrition*, Vol. 15 No. 12, pp. 2331-2339.

Holsten, J.E. (2009), "Obesity and the community food environment: a systematic review", *Public Health Nutrition*, Vol. 12 No. 03, pp. 397-405.

Howard, P., Fitzpatrick, M. and Fulfrost, B. (2011), "Proximity of food retailers to schools and rates of overweight ninth grade students: an ecological study in California", *BMC Public Health*, Vol. 11 No. 1, p. 68.

Jennings, A., Welch, A., Jones, A.P., Harrison, F., Bentham, G., van Sluijs, E.M.F., Griffin, S.J. and Cassidy, A. (2011), "Local Food Outlets, Weight Status, and Dietary Intake: Associations in Children Aged 9–10 Years", *American Journal of Preventive Medicine*, Vol. 40 No. 4, pp. 405-410.
26.

Kelly, B., Flood, V.M. and Yeatman, H. (2011), "Measuring local food environments: An overview of available methods and measures", *Health & Place*, Vol. 17 No. 6, pp. 1284-1293.

Kwate, N.O.A. and Loh, J.M. (2010), "Separate and unequal: The influence of neighborhood and school characteristics on spatial proximity between fast food and schools", *Preventive Medicine*, Vol. 51 No. 2, pp. 153-156.

Lachat, C., Nago, E., Verstraeten, R., Roberfroid, D., Van Camp, J. and Kolsteren, P. (2012), "Eating out of home and its association with dietary intake: a systematic review of the evidence", *Obesity Reviews*, Vol. 13 No. 4, pp. 329-346.

Lake, A., Burgoine, T., Stamp, E. and Grieve, R. (2012), "The foodscape: classification and field validation of secondary data sources across urban/rural and socio-economic classifications in England", *International Journal of Behavioral Nutrition and Physical Activity*, Vol. 9 No. 1, p. 37.

Lake, A.A., Burgoine, T., Greenhalgh, F., Stamp, E. and Tyrrell, R. (2010), "The foodscape: Classification and field validation of secondary data sources", *Health & Place*, Vol. 16 No. 4, pp. 666-673.

Larson, N.I., Story, M.T. and Nelson, M.C. (2009), "Neighborhood Environments: Disparities in Access to Healthy Foods in the U.S", *American Journal of Preventive Medicine*, Vol. 36 No. 1, pp. 74-81.e10.

Lee, H. (2012), "The role of local food availability in explaining obesity risk among young school-aged children", *Social Science & Medicine*, Vol. 74 No. 8, pp. 1193-1203.

Macdonald, L., Cummins, S. and Macintyre, S. (2007), "Neighbourhood fast food environment and area deprivation—substitution or concentration?", *Appetite*, Vol. 49 No. 1, pp. 251-254.

Monasta, L., Batty, G.D., Cattaneo, A., Lutje, V., Ronfani, L., Van Lenthe, F.J. and Brug, J. (2010), "Early-life determinants of overweight and obesity: a review of systematic reviews", *Obesity Reviews*, Vol. 11 No. 10, pp. 695-708.

National Health Service Barking and Dagenham and London Borough of Barking and Dagenham (2010), *Saturation Point Addressing the health impacts of hot food takeaways. Supplementary*
27.

Planning Document, London Borough of Barking and Dagenham, Barking, available at:

http://www.lbbd.gov.uk/Environment/PlanningPolicy/LocalDevelopmentFramework/Pages/Supplementaryplanning.aspx (accessed August 23 2012).

National Health Service Information Centre and Lifestyles Statistics (2010), *National Child Measurement Programme: England, 2009/10 school year,* Health and Social Care Information Centre, London, available at:

http://www.ic.nhs.uk/webfiles/publications/003_Health_Lifestyles/ncmp/NCMP_2009-10_report.pdf (accessed 29 August 2012).

National Health Service Information Centre and Lifestyles Statistics (2011), *National Child Measurement Programme: England, 2010/11 School Year,* Health and Social Care Information Centre, London, available at:

http://www.ic.nhs.uk/webfiles/publications/003_Health_Lifestyles/ncmp%202010-11/NCMP_2010_11_Report.pdf (accessed 29 August 2012).

National Obesity Observatory (2010a), "BMI Classification UK90 population monitoring cut-offs (2/85/95) Children aged 4-5 years % obese 2009/10", available at:

http://www.sepho.nhs.uk/noo/eatlas/childdouble/atlas.html?indicator=i9&date=2009/10&indicator2=i37&date2=2007 (accessed: January 25 2011).

National Obesity Observatory (2010b), "BMI Classification UK90 population monitoring cut-offs (2/85/95) Children aged 10-11 years % obese 2009/10", available at:

http://www.sepho.nhs.uk/noo/eatlas/childdouble/atlas.html?indicator=i9&date=2009/10&indicator2=i37&date2=2007 (accessed: January 25 2011).

Office for National Statistics (2007), "Indices of deprivation 2007 for super output areas", available at: http://www.neighbourhood.statistics.gov.uk (accessed: February 2 2009).

Office for National Statistics (2008), "Guidance notes for the 2001 Area Classification of Super Output Areas and Data Zones", available at:

http://www.ons.gov.uk/ons/search/index.html?newquery=supergroup (accessed: February 2 2012).
28.

Office for National Statistics (2012), "About the Area Classifications", available at: http://www.ons.gov.uk/ons/guide-method/geography/products/area-classifications/ns-area-classifications/index/overview/index.html (accessed: April 12, 2012).

Ordiance Survey and Office for National Statistics (2001), "2001 Census: Digitised Boundary Data (England and Wales)", available at: http://edina.ac.uk/digimap/ (accessed: February 2 2009).

Patterson, R., Risby, A. and Chan, M.-Y. (2012), "Consumption of takeaway and fast food in a deprived inner London Borough: are they associated with childhood obesity?", *BMJ Open*, Vol. 2 No. 3.

Pearce, J., Blakely, T., Witten, K. and Bartie, P. (2007), "Neighborhood Deprivation and Access to Fast-Food Retailing: A National Study", *American Journal of Preventive Medicine*, Vol. 32 No. 5, pp. 375-382.

Pearson, N., Salmon, J., Campbell, K., Crawford, D. and Timperio, A. (2011), "Tracking of children's body-mass index, television viewing and dietary intake over five-years", *Preventive Medicine*, Vol. 53 No. 4–5, pp. 268-270.

Reilly, J.J. and Kelly, J. (2010), "Long-term impact of overweight and obesity in childhood and adolescence on morbidity and premature mortality in adulthood: systematic review", *International Journal of Obesity*.

Ridler, C., Dinsdale, H. and Rutter, H. (2011), *National Child Measurement Programme: Analysis using ONS Area Classification,* National Obesity Observatory, Oxford.

Rose, D., Hutchinson, P.L., Bodor, J.N., Swalm, C.M., Farley, T.A., Cohen, D.A. and Rice, J.C. (2009), "Neighborhood Food Environments and Body Mass Index: The Importance of In-Store Contents", *American Journal of Preventive Medicine*, Vol. 37 No. 3, pp. 214-219.

Seliske, L.M., Pickett, W., Boyce, W.F. and Janssen, I. (2009), "Association between the food retail environment surrounding schools and overweight in Canadian youth", *Public Health Nutrition*, Vol. 12 No. 09, pp. 1384-1391.

29.

Sinclair, S. and Winkler, J.T. (2008) 'The School Fringe: What secondary school pupils buy from shops around their schools. Key Findings', [Online]. Available at: www.fhf.org.uk/meetings/2008-07-08_School_Fringe.pdf (Accessed: 7 January 2010).

Smith, D., Cummins, S., Clark, C. and Stansfeld, S. (2013), "Does the local food environment around schools affect diet? Longitudinal associations in adolescents attending secondary schools in East London", *BMC Public Health*, Vol. 13 No. 1, p. 70.

Smith, D.M., Cummins, S., Taylor, M., Dawson, J., Marshall, D., Sparks, L. and Anderson, A.S. (2010), "Neighbourhood food environment and area deprivation: spatial accessibility to grocery stores selling fresh fruit and vegetables in urban and rural settings", *International Journal of Epidemiology*, Vol. 39 No. 1, pp. 277-284.

Swinburn, B., Egger, G. and Raza, F. (1999), "Dissecting Obesogenic Environments: The Development and Application of a Framework for Identifying and Prioritizing Environmental Interventions for Obesity", *Preventive Medicine*, Vol. 29 No. 6, pp. 563-570.

Tester, J.M., Yen, I.H. and Laraia, B. (2010), "Mobile Food Vending and the After-School Food Environment", *American Journal of Preventive Medicine*, Vol. 38 No. 1, pp. 70-73.

Tester, J.M., Yen, I.H., Pallis, L.C. and Laraia, B.A. (2011), "Healthy food availability and participation in WIC (Special Supplemental Nutrition Program for Women, Infants, and Children) in food stores around lower- and higher-income elementary schools", *Public Health Nutrition*, Vol. 14 No. 06, pp. 960-964.

The, N.S., Suchindran, C., North, K.E., Popkin, B.M. and Gordon-Larsen, P. (2010), "Association of Adolescent Obesity With Risk of Severe Obesity in Adulthood", *Journal of the American Medical Association*, Vol. 304 No. 18, pp. 2042-2047.

Townshend, T. and Lake, A.A. (2009), "Obesogenic urban form: Theory, policy and practice", *Health & Place*, Vol. 15 No. 4, pp. 909-916.

30.

van der Horst, K., Oenema, A., Ferreira, I., Wendel-Vos, W., Giskes, K., van Lenthe, F. and Brug, J. (2007), "A systematic review of environmental correlates of obesity-related dietary behaviors in youth", *Health Education Research*, Vol. 22 No. 2, pp. 203-226.

Wang, M., Gonzalez, A., Ritchie, L. and Winkleby, M. (2006), "The neighborhood food environment: sources of historical data on retail food stores", *International Journal of Behavioral Nutrition and Physical Activity*, Vol. 3 No. 1, p. 15.

Waters, E., de Silva-Sanigorski, A., Hall, B.J., Brown, T., Campbell, K.J., Gao, Y., Armstrong, R., Prosser, L. and Summerbell, C.D. (2011), "Interventions for preventing obesity in children", *Cochrane Database of Systematic Reviews* No. 12.

White, M. (2007), "Food access and obesity", *Obesity Reviews*, Vol. 8 No. Supplement 1, pp. 99 – 107.

Williams, A.J., Wyatt, K.M., Hurst, A.J. and Williams, C.A. (2012), "A systematic review of associations between the primary school built environment and childhood overweight and obesity", *Health & Place*, Vol. 18 No. 3, pp. 504-514.

World Health Organization (2009), *Global Health Risks: Mortality and burden of disease attributable to selected major risks,* WHO Press, Geneva, available at: www.who.int/healthinfo/global_burden_disease/GlobalHealthRisks (accessed 10 January 2010).

Zenk, S.N. and Powell, L.M. (2008), "US secondary schools and food outlets", *Health & Place*, Vol. 14 No. 2, pp. 336-346.

31.