Weight gain in mid-childhood and its relationship with the fast food environment

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ABSTRACT

Background: Childhood obesity is a serious public health issue. Understanding environmental factors and their contribution to weight gain is important if interventions are to be effective.

Aims: The purpose of this research was to assess the relationship between weight gain in children and accessibility of fast food outlets.

Methods: A longitudinal sample of 1577 children was created using two time points from the National Child Measurement Programme in South Gloucestershire (2006/7 and 2012/13). A spatial analysis was conducted using a weighted accessibility score on the number of fast-food outlets within a 1-km network radius of each child's residence to quantify access to fast food.

Results: The mean accessibility score for all children was 0.73 (SD 1.14). Fast food outlets were more prevalent in areas of deprivation. A moderate association was found between deprivation score and accessibilty score ($r=0.4$, $p<0.01$). Children who had greater access to fast food outlets were more likely (OR=1.89, $p=0.04$) to gain significant weight (>50 percentile points) compared to children who had no access to fast food outlets.

Conclusions: This paper supports previous research that fast food outlets are more prevalent in areas of deprivation and presents new evidence on fast food outlets as a potential contributor towards weight gain in mid-childhood.

Keywords: childhood obesity; fast food; weight gain; national child measurement programme; public health,

INTRODUCTION

Obesity prevalence approximately doubles between the first and last year of primary school in England. Understanding the determinants of child obesity is important if interventions are to be successful. Although the causes of obesity are known to be multi-factorial, a significant amount of evidence suggests that increased energy intake – rather than decreased physical activity – is the main driving force behind the obesity epidemic, particularly amongst lower socioeconomic groups.[1] In particular, many commentators have voiced their concern over the role of the fast food industry and the increase in the number of fast food outlets over the last 20-years.[2]

Consumption of foods prepared outside the home has been associated with weight gain.[3] Research has shown that meals eaten outside the home account for a quarter and a fifth of the calorie intake of men and women respectively. Takeaways account for a quarter of this market, with these foods often containing high levels of saturated fat, sugar, salt and often low in fibre, which contributes to poor health.[4,5] Despite the presence of evidence outlining the importance of the food environment in child obesity, the findings from many studies linking the food environment to weight status are equivocal.[6] Having children in the home has been associated with significantly higher rates of reported eating at "fast food" restaurants.[7] Recent research has found that one fifth of children ate meals out once per week or more; around one fifth of adults and children ate take-away meals at home once per week or more.[8] Research has shown that children who eat fast food are likely to consume higher intakes of energy, fat, sodium, added sugars and sugar-sweetened beverages, and lower intakes of fruits, vegetables, fibre and milk[9].

The significant growth in obesity over the last 30 years combined with the widespread availability of fast food has led UK government policy to advise local authorities to use their planning powers to restrict the opening of new fast-food outlets in local neighbourhoods[10]. This has primarily come in the form of guidance and toolkits to help local authorities develop strategies and programmes to tackle the consequences of fast food takeaways in their local communities.[11] Despite the plethora of national guidance advising on the restriction of fast food outlets in neighbourhoods,[12,13] research to date on neighbourhood food availability and individual BMI have offered mixed results and primarily focused on adults.[14]

The impact of fast food outlets in relation to young children (<11yrs) has often been overlooked due to children having little autonomy over their food choices. Research looking at the association of proximity of fast food outlets and obesity has primarily relied on cross-sectional comparisons which make it difficult to infer causality.[15] Further work involving longitudinal data that trace a cohort of individuals over time is required to establish the extent of different environmental factors and their association with obesity amongst children. This would establish the relative importance of different environments on the causation of obesity amongst children, and how the impact of environmental factors may differ between girls and boys.[16] The aim of this research was to use data from the National Child Measurement Programme (NCMP) to explore associations between weight gain in children and the fast food environment.

METHODOLOGY

Ethics

Ethics clearance was sought from UWE's Faculty Research Ethics Committee (FREC). Research assurance was also sought from the Avon Primary Care Research Collaborative (APCRC) and South Gloucestershire Council.

Sample and Data Matching

The data analysed come from the NCMP for South Gloucestershire, England. The NCMP is recognized internationally as a world-class source of public health intelligence and holds UK National Statistics status. Data on children measured during 2006/7 and 2012/13 were extracted. Measurements for children were undertaken by school health assistants or nurses using calibrated class III scales and the Leicester Height Measure MKII.[17] Coverage rates for 2006/7 and 2012/13 were 88% and 90%, respectively. The matching strategy has been documented elsewhere[18] and involved using a string of partial identifiers to create a 'unique identifier' by concatenating the variables gender, date of birth and first name. Of the 2405 records that were extracted from the 2006/7 cohort, 250 records (10.4%) had missing data. Of the remaining 2155 records, 1797 records were matched automatically and 66 records were matched manually resulting in 1,863 matched records. For the purpose of this study, a further 286 records were removed where a child's residence had changed between the two-time points. A total of 1577 (65.6%) matched records were analysed.

Identification of fast food outlets

Data for fast food outlets were sourced from a database held by the Environmental Health Department at South Gloucestershire Council in 2014. Data obtained this way is a reliable source as food premises are required to register by law with the local authority as stated within the General Food Hygiene Act 1995.[19] A Freedom of Information (FOI) request was submitted to Bristol City Council to identify fast food outlets near the South Gloucestershire boarder to improve the quality of secondary data. Data on fast food outlets were cross checked with the online yellow pages[20] and the Food Standards Agency database 'Scores on the Doors'.[21] Spot checks were also undertaken by examining addresses on individual business websites for fast food outlets if available. The definition of fast food outlets used for the study was 'food service outlets quickly serving inexpensive foods with

minimal preparation and table service'.[22] The following terms were used to identify additional fast food outlets within the yell.com website: 'fish bar', 'fish and chips', 'Indian', 'pizza', 'Chinese', and 'kebab'.

Statistical Analysis

The number of fast food outlets per 1000 persons was calculated using mid-population estimates (2012 Census) for 35 electoral wards. All fast food outlets were geocoded using postcodes of each residence to assign *X* and *Y* coordinates to each participant based on their postcode (geographic centroid). The distance from each child's postcode to the nearest fast food outlet was calculated using Geographic Information Systems (ArcGIS v10.1 ERSI). A 'network distance' (i.e. distance by road rather than straight-line distance) from each geographic centroid to every fast-food outlet within 1km (1000m) of each child's postcode was calculated. An accessibility score was then calculated for each child based on the methodology used in previous research.[23] This method weights the number of food outlets in relation to their distance from each child's residence.

A Shapiro–Wilk test was undertaken to assess whether the fast food accessibility data was normally distributed. Mean and standard deviation (SD) of the accessibility scores were calculated for boys and girls, and the mean score for each ward was calculated. An independent samples t-test was used to test for a difference in accessibility scores between girls and boys. Spearman's rank correlation coefficient was used to assess the relationship between the Indices of Deprivation (IMD) 2010 score and the accessibility score for each child. IMD is a measure of relative deprivation in small areas in England called lower-layer super output areas. IMD ranks every small area in England based on seven aspects of deprivation; income; employment; health deprivation and disability, education skills and training, barriers to housing and services, crime and living environment.[24]

Spearman's rank correlation coefficient was also used to examine the association between accessibility score and weight change between Reception and Year 6. To further investigate whether access to fast food outlets was associated with weight gain, multiple logistic regression was carried out to obtain the odds of children increasing their weight status by 50 percentile points or more (outcome of interest), based on the proximity to fast food outlets (exposure of interest), controlling for gender and IMD (covariates).In this analysis, accessibility score was divided into tertiles and treated as a categorical explanatory variable, while IMD score was treated as a continuous variable.

RESULTS

A total of 175 fast food outlets was identified in South Gloucestershire (see figure 1). The number of fast food outlets per Electoral Ward ranged from 0 to 17 (median 4).

	All (n=1577)	Boys (n=827)	Girls (n=750)
Deprivation Score			
Mean	10.18	10.23	10.12
Standard deviation	6.89	6.94	6.85
Accessibility Score			
Mean	0.74	0.76	0.71
Standard Deviation	1.14	1.16	1.12

Table 1 - Sample characteristics used for the fast food accessibility analysis

There was strong correlation ($r=0.71$, $p<0.01$) between the number of fast food outlets per 1,000 population and deprivation score, with a higher number of fast food outlets per 1,000 located in poorer wards compared with more affluent wards (see Figure 2). A detailed analysis looking at proximity of fast food outlets in relation to each child's postcode found that 44.4% of children had between 1-3 fast food outlets within 1km of their postcode centroid. However, 32.7% of children were found not to have any fast food outlets within 1km of their postcode centroid.

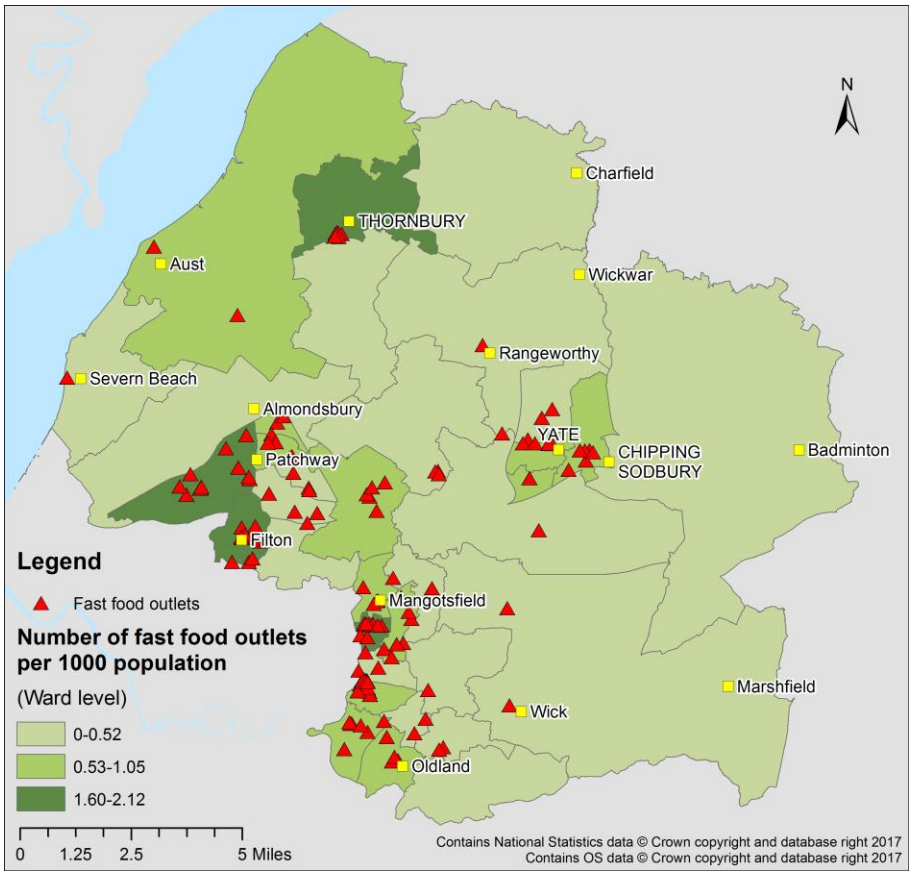

Figure 1. Location and number of fast-food outlets per 1000 population.

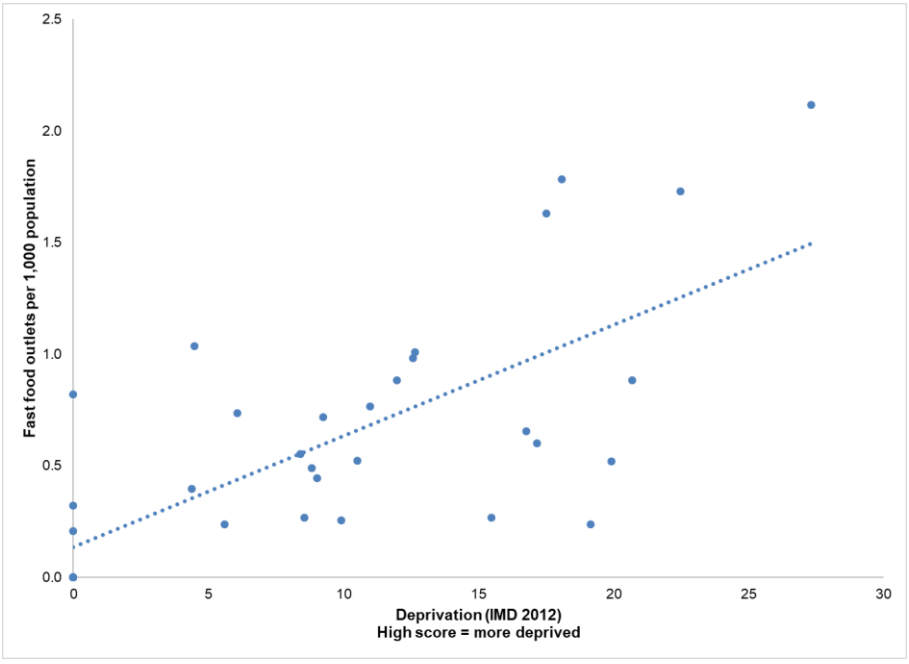

Figure 2. Relationship between fast food outlets and deprivation

The mean accessibility score for all children was 0.74 (SD 1.14). The mean accessibility score for boys was slightly higher at 0.76 (SD 1.16) compared to girls at 0.71 (SD 1.12) but there was not strong evidence of a difference t(-0.77) p=0.45 (see Table 1). Mean accessibility scores for each ward were calculated (see Figure 3). Accessibility scores ranged from 0 to 3.85. Since the accessibility scores were not normally distributed (Shapiro-Wilk statistic 0.65, p<0.01), Spearman correlation was used to assess the relationship between individual childrens' deprivation score and accessibilty score (r=0.4, p<0.01). The Spearman's rank correlation coefficient between change in weight between Reception and Year 6 and accessibility score found no evidence of an association (r=-0.07, p=0.768).

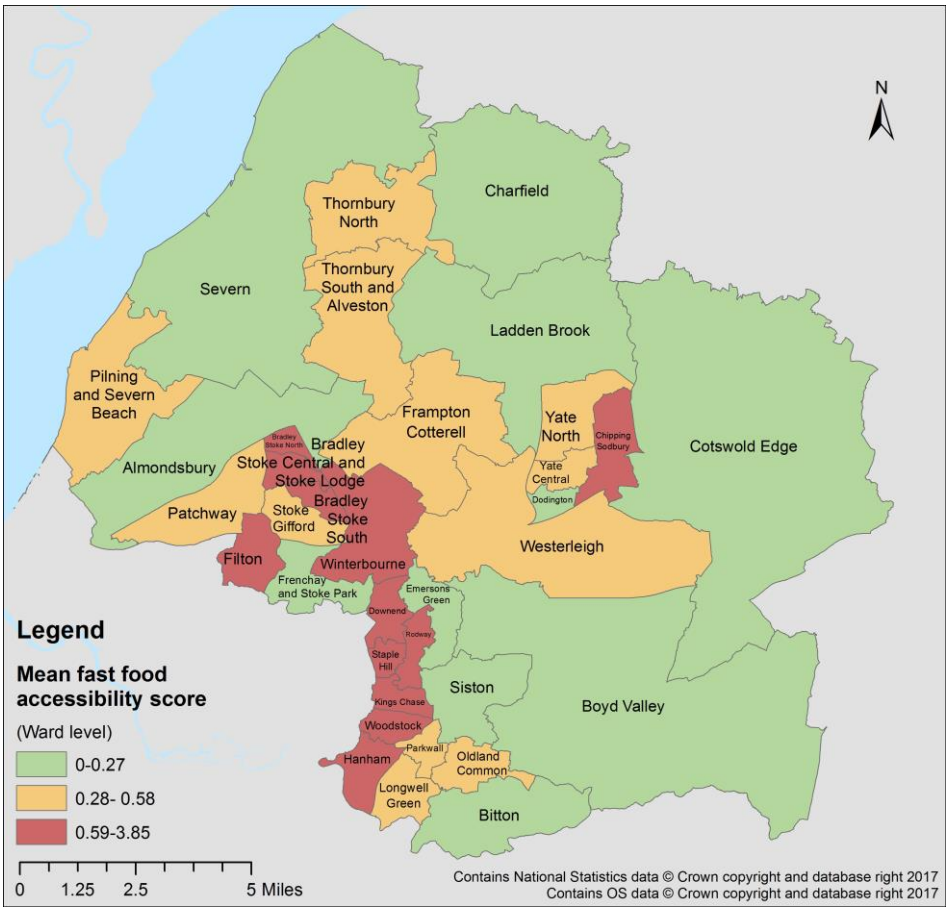

Figure 3. Mean fast food accessibility scores per ward.

For the logistic regression analysis, the outcome of interest was an increase in weight status of 50 percentile points or more between Reception and Year 6. The group of children (tertile 3) most exposed to fast food outlets were more likely to gain significant weight (>50 percentile points) than those least exposed (odds ratio 1.89, 95% confidence interval 1.0-3.6, p=0.04). Furthermore, although the result for the middle tertile was not significant compared with the baseline group with lowest accessibility scores, the odds ratios for this categorical variable show a dose-response trend which is one of the Bradford Hill's criteria for causation.[25] There was no evidence that deprivation score (p=0.59) or gender (p=0.58) were significantly associated with weight gain in this model.

Variable	Odds ratio	Lower CI 95%	Upper CI 95%	P-value
Accessibility Score 0	(ref)	(ref)	(ref)	(ref)
Accessibility Score 0.002 – 0.701	1.26	0.65	2.34	0.50
Accessibility Score 0.702 - 9.144	1.89	1.00	3.56	0.04
Deprivation Score	0.99	0.95	1.03	0.59
Gender	1.15	0.70	1.87	0.58

Table 2: Odd ratio's (95% CI) of weight gain ≥50 percentile points as a function of accessibility score, deprivation score and gender (based on multiple logistic regression)

DISCUSSION

Main findings of this study

We found that children who have greater access to fast food outlets are more likely to gain significant amounts of weight between Reception and Year 6 The data suggests that children who have greatest accessibility to fast food outlets have an 89% increase in the odds of increasing their weight by more than 50 percentile points compared with those children with least accessibility to fast food outlets.

It is well acknowledged that obesity is associated with deprivation, and research has suggested that areas with the highest prevalence of obesity are likely to have the highest density of fast food outlets.[26] This study confirmed this premise and found a greater density of fast food outlets in lower income neighbourhoods than in wealthier neighbourhoods. Reasons put forward for this unequal distribution of fast food outlets have been that fast food companies target more deprived areas because the land is cheaper, or possibly because the demand from consumers in these areas is greater.[27] However, the suggestion of a link between fast food outlets, deprivation and fast food consumption can be seen as being too simplistic. For example, some studies reported that takeaway food is purchased more regularly by residents of high-income households and respondents with higher levels of educational attainment.[28]

What is already known on this topic

There is a wealth of literature that has analyzed the relationship between obesity prevalence and assocations with the fast food environment. Many of these studies have been cross-sectional and provided mixed results.[22] Only a handful of studies have examined weight gain over time. These studies were undertaken in the USA and did not find an independent relationship between child weight gain and fast food outlets[29,30,31]. One consistent finding within the research, however, is the strong link between the location of fast food outlets and areas of deprivation. The disparities in outcomes in the evidence have been attributed to a number of factors: the validity and reliability of measures; the complexity of defining a relevant neighbourhood; and the cross-sectional, observational nature of most research designs[32].

What this study adds

This study provides new insights into weight gain in mid-childhood and its association with the local fast food environment. The study adds to the growing body of literature suggesting that the neighbourhood environment may play an important role in the development of obesity.[33] To our knowledge this is the first study to demonstrate an association between weight gain and proximity to fast food outlets. The findings raise important questions about the role of the local food environment and its influence on children's diet. It is widely acknowledged that young children's eating behaviours are shaped by their parents', therefore understanding the role that the local neighbourhood plays in influencing parental behaviours, both for themselves and for their children, may provide insight into the impact of the built environment on young children.[34]

Although the study is limited to associations between fast food outlets and changes in weight status, it may support findings from other studies that report how fast-food outlets are associated with poorer diet quality.[35] Whilst it is evident that consuming fast food is known to be unhealthy, it cannot be assumed that changes in the availability of fast food will have an impact on weight gain. It is possible that proximity to fast food outlets could simply lead to families substituting unhealthy meals prepared at home, without making significant changes to their fat intake or the number of calories they consume. It is also important to consider the wider food environment and the likely impact of other food sources. For example, research has recently shed light on the potential impact of full-service restaurants which found that people eating in restaurants were consuming no less calorie-heavy food than that of fast-food outlets.[36] Therefore further investigative work into consumption of fast food and weight gain is needed and any policies designed to make fast food healthier or reduce its appeal should also apply to full-service restaurants as well.

The findings from our study are generalisable to other areas in the UK that have a similar demographic make-up to South Gloucestershire given its heterogeneity in terms of both levels of urbanization, rurality and socioeconomic status. However, the findings are unlikely to be applicable in more urban areas, or countries that are culturally different.

Limitations of this study

Previous research has found defining proximity to fast food outlets problematic with many studies using variable and often unrealistic measures of walkability.[44] This may explain the differences reported in the literature. As highlighted in previous research[23] the methodology used in this research provides a more realistic measure than the more commonly used measures of nearest outlet (straight-line distance) or number of outlets within an arbitrary geographic unit (e.g. ward). Although the approach applied here provides a more accurate measure, there is little agreement in the literature as to what might constitute a relevant distance from home to a fast food outlet, and many definitions have been applied.[37] Therefore it could be argued that the network distance used in the research might not be appropriate. However, the distance used in this study was derived from existing evidence which has suggested 1000m as the median trip length that residents are likely to undertake to local food shops and convenience stores.[38]

Defining a level of weight gain that is potentially detrimental to a child's health can be difficult. This study made the assumption that a weight gain of 50 percentile points is likely to be unhealthy. However, it is reasonable to assume that a number of children may have simply moved from the lower end of the healthy weight range (25th percentile) to the upper end of the healthy range (75th percentile). Although this may result in children maintaining a healthy weight status, research has found that approximately two thirds of the children in the highest BMI quartile at ages 9-11yrs remain in the highest BMI quartile in young adulthood (19-35yrs).[42] Therefore, significant weight gain during mid-childhood is likely to increase the risk of obesity in later life.

There are a number of limitations to this study. The use of postcode centroid to determine a child's residence and fast food outlet may lead to slight miscalculations in accessibility measurements. Despite this, postcodes in the UK are relatively precise geocoding, with each postcode area containing only 15 addresses on average.[39] Although data on fast food outlets was retrieved from Bristol City Council, the area of study did not consider fast food outlets within the neighbouring authorities of Gloucestershire, Bath and North East Somerset. This may have led to an underestimation of children's access to fast food. Although every effort was undertaken to use reliable data on the number of fast food outlets, the study would have benefitted from 'field validation' or 'ground truthing' to verify location information.[40] Furthermore, research has shown an increase in recent years in the number of fast food outlets in some areas in the UK, particularly in those areas with greater deprivation[2]. A limitation of this study was that the mapping of fast food outlets was undertaken at a single point in time (2014) and therefore we were unable to quantify changes in the number of fast food outlets between 2006/7 and 2012/13. Although children had lived at their residential address for at least six years, it may be that some of the fast food outlets were only recently established and therefore their impact on a child's weight may be negligible.[7] Building consensus on what constitutes fast food is also important and could potentially reduce inconsistent findings.[22] A vast array of grocery stores, coffee shops, petrol stations and many other venues are likely to provide ready access to energy dense meals, drinks, and snacks.

As this is an observational study, it is difficult to draw causal inferences from the analysis, therefore the findings are restricted to associations between factors. One of the problems with observational studies is that of confounding. In our analysis we controlled for deprivation and gender, but failure to adequately control for other influences (such as those outlined above) could lead to confounding, whereby apparent associations with the environmental components being measured are, in fact, due to social or cultural factors or other environmental factors.**Error! Bookmark not defined.** For example, some studies have found an association between weight status and access to green space, with children having better access to green space likely to have lower BMIs, but this was not measured in this study.[41] In addition, the model did not account for ethnicity, although it is known that certain ethnic minority groups are known to be more susceptible to developing obesity.[42] Research in America has also shown that fast food outlets are more prevalent in areas with higher concentrations of ethnic minority groups in comparison with Caucasian.[22] It is important to acknowledge that the proportion of black and minority ethnic individuals in South Gloucestershire is around approximately half of the national average.[43] Finally, it has also been found that the food environment beyond that of fast food outlets (i.e. supermarkets) may be a contributing factor to excess food consumption.[44]

Conclusion

Whilst it is commonly assumed that fast food outlets contribute to the obesity epidemic, recent evidence has not necessarily supported this stance. This study lends support to the theory that the built environment may play an important role in the development of obesity. To our knowledge this is the first study to demonstrate an association between weight gain in children and proximity to fast food outlets. It is widely acknowledged that the causes of obesity are not fully understood. Shaping the environment to support more favourable conditions to lead a healthy lifestyle is likely to be important if we are to be successful in tackling the obesity epidemic. To develop effective interventions, we will need to understand how children and their families interact with the neighbourhood and environment.

It is unclear whether recent political efforts to restrict fast food outlets will have an impact on obesity. However, this research supports the supposition that fast food outlets are associated with weight gain in children. If the relationship is causal, then strategies designed to influence the number of fast food outlets in neighbourhoods are likely to have a positive effect on population health.

Contributors

Matthew Pearce was the lead researcher and author. **Dr Isabelle Bray** supported statistical analysis and commented on drafts. **Michael Horswell** undertook the spatial analysis component of the research.

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