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The association between the geography of fast food outlets and childhood obesity rates in Leeds, UK

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ABSTRACT

Objective: To analyse the association between childhood overweight and obesity and the density and proximity of fast food outlets in relation to the child's residential postcode.
Design: This was an observational study using individual level height/weight data and geographic information systems methodology.
Setting: Leeds in West Yorkshire, UK. This area consists of 476 lower super-output areas.
Participants: Children aged 3–14 years who lived within the Leeds metropolitan boundaries ($n=33{,}594$).
Main outcome measures: The number of fast food outlets per area and the distance to the nearest fast food outlet from the child's home address. The weight status of the child: overweight, obese or neither.
Results: 27.1% of the children were overweight or obese with 12.6% classified as obese. There is a significant positive correlation ($p<0.001$) between density of fast food outlets and higher deprivation. A higher density of fast food outlets was significantly associated ($p=0.02$) with the child being obese (or overweight/obese) in the generalised estimating equation model which also included sex, age and deprivation. No significant association between distance to the nearest fast food outlet and overweight or obese status was found.
Conclusions: There is a positive relationship between the density of fast food outlets per area and the obesity status of children in Leeds. There is also a significant association between fast food outlet density and areas of higher deprivation.

1. Background

Childhood obesity rates are rising in both the developed and developing world (Kosti and Pzanagiotakos, 2006). It is a decade since childhood obesity was declared an epidemic by the World Health Organisation (Connelly et al., 2007) and we appear no nearer to an answer as how to control it. The most recent figures from England and Wales (Craig and Shelton, 2008) show obesity prevalence in boys aged 2–15 years is 17% and among girls of the same age is 16%.

The aetiology of childhood obesity is likely to be multi-factorial. Genetics, physical activity and diet have all been shown to be involved. There has not, however, been a significant change in our genetic makeup over the last 30 years that could account for the scale of our obesity problem (Farooqi, 2005). The levels of physical activity that is undertaken by our children has decreased over the last 30–40 years, which is mainly due to technological advances such as cars, television, the internet and games consoles (Tremblay and Wilms, 2003). Western diets have also changed over the last few decades; although we consume less fat in our diets today we are eating more energy dense and processed foods and less fruit and vegetables (Morland et al., 2002; Satia et al., 2004). The birth of the fast food (FF) restaurant and the exponential growth of that industry almost parallels the obesity epidemic, certainly in the western world (Mohr et al., 2007; Ebbeling et al., 2004; Maddock, 2004).

FF is known to be energy dense, high in saturated fat and have low micronutrient content (Blair Lewis et al., 2005; Schmidt et al., 2005; Brown et al., 1998; Harnack and French, 2005; Astrup, 2005; Paeratakul, 2003) and is associated with other poor food choices, such as low vegetable and milk intake (Boutelle et al., 2007). It has been shown that children who eat fast food consume more calories than children who do not eat fast food (Bowman et al., 2004; Taveras et al., 2005).

The majority of ecological studies have shown a positive association between area level variables, such as ethnicity (Kwate et al., 2009; Blair Lewis et al., 2005), income (Reidpath et al., 2004;

Abbreviations: GIS, geographic information systems; FF, fast food; BMI, body mass index; SOA, super-output area; OA, output area; SD, standard deviation

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Simon et al., 2008; Smoyer-Tomic et al., 2008; Block et al., 2004; Zenk and Powell, 2008; Blair Lewis et al., 2005, Thornton et al., 2009), socio-economic status (Burns and Inglis, 2007; Pearce et al., 2007; Cummins et al., 2005; MacDonald et al., 2007; Powell et al., 2007; Thornton et al., 2009) and the density of fast food outlets (per census tract or ward). Only one study showed no association between socio-economic status proxies and fast food exposure (MacIntyre, 2005).

These ecological results have to date largely not been verified with the results from studies using individual level data. The individual level studies which looked at FF outlets in relation to overweight or obesity in children had negative results (Burdette and Whitaker 2004; Sturm and Datar, 2005). Both these studies involved very young children only (up to 5 years of age), the participant numbers were small, and, importantly, very narrow definitions for FF outlets; the FF outlets included were only large franchise chains, which do not account for the large number of smaller, independent FF outlets that exist.

Some studies have looked at the association between FF outlet location and FF consumption (using data from food frequency questionnaires) (Jeffery et al., 2006; Turrell and Giskes, 2008; Thornton et al., 2009). They all found no association between FF outlet exposure (proximity or density) and reported FF consumption. A recent national study from New Zealand (Pearce et al., 2009) added consumption data to the relationship between FF outlets and obesity; using fruit and vegetable consumption as a reverse proxy for FF consumption they found no relationship between access to FF and consumption of fruit and vegetables or weight status.

This is contrary to the results from an Australian study (Timperio, 2008), which found that children who had a FF outlet within 800 m from their home were 38% less likely to eat fruit twice a day. They found no significant association with vegetable consumption.

Accordingly, this study seeks to investigate the association between density and proximity of fast food outlets and childhood obesity in the Leeds metropolitan area, UK. It is felt, by the authors, that the local neighbourhood environment may be more influential to children's dietary habits as they are less independent regarding travel than adults. The definition used for fast food (FF) in this study is "food purchased in self-service or carry-out eating places without waitress service" (French et al., 2000). The hypotheses is that there will be a positive association between a density of fast food outlets and childhood obesity prevalence and that obese children will live closer to fast food outlets than their normal weight counterparts.

2. Methods

2.1. Variables

The study area was Leeds, UK, which is a multicultural city with a diversity of socio-economic groupings within its population. Height, weight, age, gender and postcode data on children aged 3–14 years who lived within the Leeds metropolitan boundaries were collated from three separate data sources: TRENDS study, the Rugby League & Athletic Development Scheme (RADS) study and Primary Care Trusts (PCT) routinely collected data.

The TRENDS (Rudolf et al., 2006) project data was a sample of 5, 9 and 13 year old children measured in summer 2004 and 2005. The RADS (Procter, 2007) project involved all 42 secondary schools in the Leeds area with their year 7 pupils (age 11 years) for children measured in 2005 and 2006. In both these studies measurements were taken by trained staff using validated equipment and heights were taken to 0.1 cm and weights 0.1 kg. The PCT data used was for 3–6 year old children measured between 1998 and 2005 (routinely measured by health visitors and school nurses). Children were excluded if they had invalid postcodes, lived outside the Leeds metropolitan area or had died (Procter, 2007). Ethical approval was obtained from Leeds (East) Research Ethics Committee.

The data on number and location of FF outlets were obtained from the Leeds city council health and hygiene website (Leeds City Council, 2008) and this was cross checked with the online yellow pages (YELL, 2008). These data were collected in January 2008. The FF outlets were mapped using ArcMap 9.2 to the *x*/*y* coordinate of their postcode (geographic centroid). Any FF outlet without a valid postcode was excluded from the analysis. Boundary datasets and postcode lookup tables were obtained from the UK Borders website (EDINA, 2008; ESRI, 2008). The geographical units used in this study are: output areas (OA) , the geographical unit used for the 2001 census and contain on average 125 households and lower super-output areas (SOA), larger geographical areas which contain 4–6 OAs.

The presence of the FF outlets was confirmed by "ground truthing" a sample of the geographical areas; this involved walking around a sample of the areas checking whether the FF outlets existed or not and if there were other FF outlets not picked up in the electronic data collection. In order to determine the number of OAs to be visited, a sample size calculation was performed using a power of 80%, statistical significance of 5% and a detected difference in the number of present FF outlets of 10%. A cluster sampling method was used and accounted for in the calculation. The OAs were split into the 7 super groups by the geo-demographic OA classification (Vickers and Rees, 2006). 29 outlets from each of the 7 super groups (total 203 OAs) were randomly selected (out of a total of 2400) and ground truthed. The results of the "ground truthing" were analysed by the number of outlets present as a proportion of the number of outlets expected.

The body mass index (BMI) was calculated from the height and weight of each child, and the age and gender specific standard deviation score (BMISDS) were calculated using the British reference dataset (Cole et al., 1995). The BMI data were grouped into normal weight (BMISDS $<$85th percentile), overweight/obese (BMISDS $\geq$85th percentile) and obese ($\geq$95th percentile). A deprivation score (index of multiple deprivation (IMD), 2004) was assigned to each child by linking their home address postcode to the SOA area of residence (ONS, 2008).

The number of FF outlets per SOA (which have similar population numbers) were calculated to allow density analysis to be performed. Each child was then allocated the number of FF outlets in their residential SOA.

The straight line distance from each child's home address (postcode centroid) to the nearest FF outlet was calculated using ArcGIS v9.2.

2.2. Analyses

The analyses were performed at individual level (n=33,594). Simple Pearson's correlation to assess the relationship between the deprivation score and number of FF outlets and the distance to nearest FF outlet were undertaken.

Generalised estimating equations (GEE) were used to estimate population-averaged effects whilst accounting for the dependence of the children within each SOA (clustering). The "xtgee" command in STATA was used with the appropriate link command for the binary outcomes (obese, overweight/obese) and the continuous outcome (BMISDS). Robust standard errors were requested to account for the intra-cluster correlation.