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No new fast-food outlets allowed! Evaluating the effect of planning policy on the local food environment in the North East of England

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ABSTRACT

The environment in which we live impacts on our health. The food available to us in our environment is likely to influence what we eat and subsequently our weight. The use of planning policy can be one way for both local and national government to help shape a healthy environment. In England there are three main types of planning policy used to promote a healthy food environment: 1) restricting new fast-food outlets near schools; 2) restricting new fast-food outlets if the density of existing outlets has surpassed a certain threshold of all retail outlets, 3) restricting new fast-food outlets if childhood obesity rates are above a certain threshold. In 2015, Gateshead council, a local authority in the North East of England implemented all three types of guidance. We utilise a longitudinal administrative dataset, the Food Standards Agency Food Hygiene Rating Scheme Data, covering the period 2012–2019 on all premises selling or preparing food in Great Britain. To analyse the impact of employing all three types of planning guidance on the density, proportion, and number of fast-food outlets in Gateshead, we employ a propensity score matching difference-in-difference approach. We match small geographical areas in Gateshead (lower super output areas) to other local authorities in the North East with similar demographic characteristics that did not implement planning guidance. Results show a reduction in density of fast-food outlets by 12.45 per 100,000 of the population and a 13.88% decrease in the proportion of fast-food outlets in Gateshead compared to other similar local authorities in the North East. There was a marginally significant reduction in the number of restaurants which became insignificant after controlling for population density. These results suggest that a multi-pronged planning approach significantly changed the proportion and density of fast-food outlets in the food environment in the short term (4 years).

1. Introduction

Obesity is a complex health issue that stems from a variety of causes (Frood et al., 2013; Sahoo et al., 2015). One key determinant of obesity is our environment. Where we live and work influences the food that we eat, our weight, and our health. (Vanderlee et al., 2017; Public Health Association Australia, 2019; Center for Disease Control, 2021). There is a strong association between obesity and area level deprivation. Obesity amongst children aged 11/12 was twice as high (13.3%) for those living in the most deprived areas compared to children in the least deprived areas (6%) (Office of National Statistics 2020). Several studies have found evidence of a significant association between eating fast-food and overweight and obesity (Burns et al., 2002; Prentice and Jebb, 2003; Smith et al., 2009; Lachat et al., 2012), with additional evidence supporting a causal influence of fast-food consumption on obesity and overweight (Currie et al., 2010). In England, as in many high-income countries, fast food outlets (which we define as outlets predominately selling hot food for consumption off premises as classified by

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environmental health officers inspecting the business) are an important component of the food environment. In England, the density of fast-food outlets has been increasing over time. It was 88 per 100,000 population in 2016 which increased to 96.1 in 2017 (Tedstone, 2016; Public Health England, 2018).

The UK government has recently committed to reducing childhood and adult obesity (Department of Health and Social Care, 2020). However, reducing obesity will be challenging. In 2018, about 63 percent of adults were overweight and 27.7 percent were classified as obese (National Health Service, 2020). The cost of obesity on the health service was estimated to be £6.1 billion in 2014/15 (Public Health England, 2017). In England, local authorities (local government) are responsible for improving the health of the local population and the provision of public health services such as sexual health and drug and alcohol misuse. The Secretary of State for Health has the overall responsibility for the nation's health. National public health functions were the responsibility of Public Health England (Heath, 2014), until October 2021 where they moved to the Office for Health Improvement and Disparities. Within this complex framework, local authorities have had their funding for public health reduced by 14% (around £531 million) between 2015 and 2020 (Local Government Association, 2018). This significantly impacts on local authorities' ability to improve population health by reducing obesity rates. The most deprived local authorities have faced the greatest cuts to services absorbing £1 in every £7 cut from public services which is a contributing factor to rising health inequalities (Thomas, 2019).

Because of the clear evidence base showing a relationship between the built environment and health outcomes such as obesity (Papas et al., 2007; Booth et al., 2005; Feng et al., 2010), there is a growing consensus by both local and national policy makers that planning and design of the environment can be used to reduce obesity rates and contribute to helping people lead a healthy lifestyle. Our food choices and eating behaviours are complex and influenced by many factors. While 'nudge theory' Thaler and Sunstein 2009) and 'choice architecture' may have a role, an ecological model (see model developed by Story et al., 2008) conceptually represents the spheres of influence on eating behaviours. While not a "quick fix", nor a complete programme for accounting for all aspects of social determinants of health, there are potentially powerful tools that can shape healthier environments through the planning policy process (McKinnon et al., 2020).

To assist local authorities with developing policy to reduce obesity rates, Public Health England (2020) developed guidance to support local authorities in using planning policy to promote a healthy weight environment. National guidance informs planning guidance at the local authority level and is usually contained within the local plan and core strategies documents (planning policies based upon the needs, priorities or strategic objectives of the local authority) (Ministry of Housing, Communities, and Local Government, 2021). Additional information on restrictions to planning approval are outlined in supplementary planning documents (Keeble et al., 2019b). These documents outline the decision-making process for determining the acceptability of planning applications (Keeble et al., 2019b).

In England, fast-food outlets for planning purposes are defined according to planning use classification (Town and Country Planning (Use Classes) Order 1987 (as amended)) as premises which sell hot food for consumption off the premises.[1] There are three types of planning guidance used to limit the number of fast-food outlets which are described in Table 1. Approximately 50% of local authorities in England have some type of planning guidance in place restricting fast-food outlets to promote local population health (Keeble et al., 2019b).

[1] Note that the planning definition of fast-food outlets varies slightly to the definition of fast-food outlets that we use as our classification is based upon environmental health officer's assessment rather than planner's assessment. We explored the overlap between the two definitions.

Table 1
Summary of planning guidance.

Type	Description	Evidence
School Exclusion Zone	Restrict new fast-food outlets around secondary schools (such as within a 400 m radius)	There is a large body of evidence which has shown a high degree of clustering of food outlets around schools. Children who are exposed to an unhealthy food environment may form lifelong unhealthy food habits (Day and Pearce, 2011; Walton et al., 2009; Chiang et al., 2011).
Limiting the density of fast-food outlets	Restricting planning permission for new outlets if a certain threshold number of outlets (between 5 and 20% of retail space) has been exceeded	Fast-food outlets cluster in deprived and high traffic areas with higher levels of obesity and poor health (Hurvitz et al., 2009; Day and Pearce, 2011; Fraser and Edwards, 2010; Maguire et al., 2015).
Restricting new fast-food outlets based upon childhood obesity rates	Restricting planning permission for new outlets where the percentage of population classified as overweight or obese (15% of children in final year of primary school for example) has been exceeded	There is a clear link between obesity in childhood and negative outcomes throughout the life course (Rössner, 1998; Simmonds et al., 2015).

Gateshead is a local authority located in the North East of England. It had a population of approximately 202,500 in 2019. Gateshead is one of the 20% most deprived local authorities; it is ranked 47th most deprived out of the 317 local authorities in England (Annex to 2014–2020 ERDF Operational Programme). In Gateshead, 21 areas or 16% of the population live in one of the 10% most deprived areas in England. The employment rate for working households in 2019 was 73.6% which was lower than the national average of 75.8%. Life expectancy is lower for both men and women at 77.5 and 81.4 compared to the England average of 79.6 and 83.1 (Gateshead Council n.d.). Obesity rates for 11/12 year olds in Gateshead were 22.6% compared to the national average of 19.6% in 2014/15–2016/17 (National Child Measurement Programme, 2019). Approximately 25% of adults in Gateshead are obese and 69.4% are overweight compared to the England average of 64.8% (Gateshead Council, 2019).

Because of its high childhood obesity rate, Gateshead aimed to reduce this rate to less than 10% by 2025 (Gateshead Council, 2020). To achieve this goal, it implemented all three types of planning guidance (a school exclusion zone, restricting new outlets by retail density, and restricting new outlets by childhood obesity rates). This is effectively a blanket ban on establishing a new premise for use as a fast-food outlet if the building was not already being used for that purpose. Buildings that were being used for fast-food could change ownership and continue to sell fast-food. This guidance was implemented from June 2, 2015 onwards. A previous evaluation of planning guidance restricting planning permission for new fast-food outlets within 400 m of secondary schools, in another local authority in the North East of England, Newcastle Upon Tyne (Brown et al., 2021) found no short-term change (3 years) in the food environment from this planning guidance. However, in Philadelphia, USA, the city government enacted 4 different measures to reduce the number of outlets licenced to sell tobacco product including a density cap, tobacco free school zones, increased tobacco permit fees, and strict permit penalty fees for selling tobacco products to children. In combination, these measures led to a 20.3% decline in retail density 3 years after the implementation of these measures (Lawman et al., 2020). This suggests that multiple planning elements may be required to significantly change the healthiness of the built environment.

We hypothesised that the blanket ban approach employed by Gateshead is likely to have a significant impact on the food environment in the short term (under 5 years); reducing the density and proportion of fast-food outlets compared to other types of food outlets. To test our hypothesis, we employ a difference in differences analysis with propensity score matching approach to identify if the planning guidance implemented by Gateshead local authority had a significant difference on the density, proportion, and count of fast-food outlets compared with other similar local authorities in the North East of England.

2. Data and methodology

2.1. Data

All data used in the analysis is publicly available and can be freely downloaded from https://data.food.gov.uk/catalog/datasets/38dd8d6a-5ab1-4f50-b753-ab33288e3200. Data pre-intervention was from June 2012–May 2015 and data post-intervention is from June 2015–December 2019. Because of the Covid-19 pandemic and temporary changes to planning legislation which came into force in March 2020 (The Town and Planning, 2020), data from 2020 to 2021 were excluded from the analysis. All analysis is undertaken at the lower super output area (LSOA) level; the small area statistical unit used by the UK's official statistic office for population data collection. LSOAs are a geographical area in which the boundaries are defined by the population size. Each LSOA has an average population of 1500 people or approximately 650 households (Oxford Consultants for Social Inclusion, n.d.). The analysis is restricted to LSOAs in Gateshead (treatment group) and LSOAs located in the North East of England belonging to local authorities which had not adopted any type of the planning guidance over the study period (control group). The control group included LSOAs in the local authorities of Stockton on Tees, Durham, Northumberland, Darlington, and Hartlepool. These control areas were all within the most 20% deprived local authorities in England (Annex to 2014–2020 ERDF Operational Programme). Thus, they should be comparable to Gateshead. We excluded LSOAs in the six local authorities in the North East that also implemented planning guidance to restrict planning permission for fast-food over the study period. These six local authorities are Newcastle upon Tyne, South Tyneside, North Tyneside, Sunderland, Middlesbrough, and Redcar and Cleveland. Our final estimation sample includes 109 LSOAs in Gateshead and 109 control LSOAs. It includes 1655 observations of fast-food outlets in Gateshead and 1844 observations of fast-food outlets in the control group.

There is evidence for both children and adults that the proximate environment, which is captured by a small area statistics such as LSOA, is important when making fast food choices (Jekanowski et al., 2001). Caraher et al. (2016) found for school children 200 m was the optimal distance that children were willing to walk to obtain food during the school day with 300 m being the maximum distance. For adults, research from Australia found that those with food outlets within a 20-min neighbourhood were more likely to use these outlets than those without these amenities in a 20-min area (Oostenbach et al., 2022). Additionally, there are other studies from the UK such as Hawkesworth et al. (2017) who classify the local food environment at the LSOA level.

Area level deprivation is the factor we use to match LSOAs in Gateshead to control LSOAs in other local authorities in the North East. Findings from Public Health England (2018) show a strong association between area level deprivation and fast food. The data we use for matching is from the Office for National Statistics (2020) and data from 7 domains of the English Index of Multiple Deprivation (IMD) and the Income Deprivation Affecting Children Index (IDACI) (UK Government, 2015). The 7 domains are Income, Employment, Education-Skills-and-Training, Health-and-Disability, Crime, Barriers-to-Housing-and-Services, and Living-Environment. These characteristics are assumed to be constant over our study period. We also assume because of the association between deprivation and obesity particularly for children, that IMD and IDACI will be associated with the food environment and the BMI of the population. IDACI is part of the income domain of the IMD; the Income domain in IMD measures area level deprivation in relation to low income, whereas IDACI is child poverty related as it measures the proportion of all children aged 0 to 15 living in income deprived families. Thus, we believe it is important to match on both characteristics to find similar LSOAs based upon the criteria used for adopting planning guidance.

As an additional robustness check on our findings, we also match treatment and control groups at the Middle Layer Super Output Area (MSOA) level. This is a larger geographical area compared to the LSOA of between 5000 and 15000 people with the average MSOA containing 7200 people (National Education Union N.D.). At the MSOA level we match local authorities based upon childhood obesity rates in year 6 (aged 11/12) using data from the National Child Measurement Programme (National Child Measurement Programme, 2019) and Average IMD scores. A benefit of using this geographical level for matching is we can match based upon childhood obesity a key factor influencing the adoption of planning guidance. A weakness of using this geographical area, is we lose some of the granularity of a smaller geographical area such as LSOA level.

To measure food outlets, we use annual data from Food Standards Agency – Food Hygiene Rating Scheme (FSA FHRS) from 2012 to 2019 (Food Standards Agency n.d.). The FSA FHRS is an administrative source which records all food outlets inspected by local government environmental health officers. Currently, all local authorities in England have signed up to the FSA FHRS. It is a requirement of the FSA FHRS scheme that the data on food outlets obtained by the environmental health officers during their inspections are uploaded within 28 days of an inspection (Food Standards Agency n.d.). The data has been validity tested and was shown to have more comprehensive coverage of food outlets than other commercial sources for the North East of England (Kirkman et al., 2020). All data is available at the postcode level.

2.2. Outcome variables: density, proportion, and number of fast-food outlets

To identify how the 'blanket ban' planning guidance approach employed by Gateshead council has impacted on the food environment, we employ three outcome variables. Density, proportion and count of fast-food outlets. Density and proportion of fast-food outlets can show us how refusing planning permission for new fast-food outlets is changing the number of fast-food outlets in relation to other similar type of food outlets such as restaurants. Density of fast-food outlets is defined as fast-food outlets per 100,000 residents in the population following the approach employed by Public Health England (2018).[2] We calculated the proportion of fast-food outlets as the number of fast-food outlets divided by the total number of 4 types of food outlets including fast-food outlets, restaurant/café/canteen, pub/night club/bar, and supermarkets.[3] A higher proportion indicates that fast-food is the dominant type of food outlet in the LSOA. Evidence suggests that the restaurant and eating out market over the 2010s experience a period of growth (Statista N.D). Thus, if the planning policy were effective So, other than for those closing for business reasons (or hygiene) then the number of fast food outlets must remain constant and the number of other types of food outlets to increase. Whereas in untreated areas both the number of fast-food and other type of outlets will increase-reducing the proportion

[2] Public Health England (2018) analysed the data at the local authority level. This paper employed data at a smaller geographical level, the LSOA level.

[3] The other type of food outlets in the data set are:o Restaurant/Café/Canteeno Retailo School/College/Universitieso Farmers/Growerso Supermarketso Distributors/Transporterso Hospital/Childcare/Caringo Manufacturing/Packingo Mobile Caterero Import/Exporto Hotel/B&B/Guest Houseo Other Cateringo Pub/Night Club/Bar.

of fast food outlets in the local food environment in Gateshead compared to the treatment LSOAs. In the estimation models, the proportion of fast-food outlets was multiplied by 100 for ease of interpretation. We include the count of the number of fast-food outlets to get a sense of changes in the absolute numbers of fast-food outlets in the LSOA.

2.3. Explanatory variable

In our main estimation model, we controlled for population density (Office for National Statistics, 2020). Population density is calculated by the estimated population in an LSOA divided by the geographical size of the LSOA. Population density is used as a proxy for market size.

2.4. Identifying the control group

The adoption of planning guidance is a complex decision that is based on local area characteristics (Lake et al., 2017; Keeble et al. 2019a, 2021). To identify a suitable control group, we use propensity score matching method (Rosenbaum and Rubin, 1983). The results from a logit model, which is used to estimate the propensity score, are presented in Appendix Table A1. Each LSOA is assigned only one propensity score. We employ single nearest neighbour matching (i.e., 1:1 matching) within a calliper of 0.01 without replacement. We drop a LSOA if the match is outside the calliper, which removed estimation bias from unmatched covariates.

Table 2 presents a summary of the local area characteristics for the treated and control LSOAs. There are 109 out of 126 Gateshead LSOAs that are matched with a control LSOAs. In the matched sample, none of the characteristics in column 7 (control group) are statistically significantly different to those in column 5 (treatment group). This suggests that we have identified an appropriate control group for our analysis. Fig. A1 and A2 show the distribution of the density of fast-food outlets by IMD quintile and IDACI quintile. We can see that there is more similarity in more deprived LSOAs than less deprived LSOAs between the treatment and control group. In Fig. A3, we can see that there is similarity in the density and proportion of fast-food outlets before the implementation of the planning guidance between the treatment and controls suggesting that the parallel trends assumption holds.

Table 3 presents the density of different types of food outlets for the matched LSOAs in the treatment and control groups over the study period. We found that the density of fast-food outlets in the treatment group was fairly constant over time. In comparison, in the control group there is some evidence that this was increasing over time. This compares with the density of pub/bar/nightclubs and supermarkets/hypermarkets which nearly doubled from 2012 to 2019 in the treatment group (however, this increase reflects the addition of historical data on pubs only serving alcohol and supermarkets to the Gateshead dataset in 2016) and remained fairly constant in the control group.

2.5. Statistical analysis

To statistically test if the planning guidance changed the density and proportion of fast-food outlets in Gateshead, we employ a difference in differences (DID) model on the matched data from the PSM. Our model specification for the baseline analysis is:

$$FastFood_{it} = \beta\, Treated_i \times Post_t + \delta X_{it} + \alpha_i + \tau_t + \varepsilon_{it} \quad (1)$$

where, *FastFood* represents the two outcome variables: density and proportion of fast-food outlets in the LSOA respectively. *I* denotes each individual LSOA. The subscript *t* denotes each study year in the sample (2012–2019). $Treated_i$ is an indicator variable that equals 1 if LSOA *i* is within Gateshead, and 0 if it is in a control group. $Post_t$ is an indicator variable set to 1 for the post-planning guidance period (years after 2015), and 0 for the pre-intervention years 2012–2015. X_{it} is a matrix which includes population density. β, and δ are the parameters of coefficients to be estimated. The coefficients from β are the estimate of the treatment effect by comparing the differences of the density/proportion of fast-food outlets over the sample years between the matched treated LSOAs and the matched control LSOAs after the implementation of planning guidance by Gateshead council in 2015. α_i is a year least square dummy, and τ_t is a LSOA least square dummy. The year least square dummy captured the unobserved variation within each year, such as the nationwide economic conditions, that could confound changes over time from the introduction of planning guidance. The LSOA least square dummy controlled for the unobserved variation within each LSOA that could lead to endogeneity bias due to omitted variables in the regression. ε_{it} is the error term.

As a check on the underlying assumptions of the model regarding common trends between the treatment and control groups (Duflo et al., 2007); we follow Bertrand and Mullainathan (2003) and examine the dynamic effect of the intervention on the outcomes. We use the following model to test the common trends between the treatment and control groups,

Table 2
Descriptive statistics on characteristics of treatment and control LSOAs (matched and unmatched).

	Treatment: All		Control: All		Treatment: Matched		Control: Matched		t-tests	
	Mean	SD	Mean	SD	Mean	SD	Mean	SD	Diff	p-value
	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)	(9)	(10)
No. of fast-food outlets	1.85	2.88	1.60	2.74	1.90	3.01	2.11	4.30	0.22	0.22
Density of fast-food	114.9	179.8	100.8	173.2	119.5	189.1	118.8	206.9	−0.67	0.94
Area Size (km sq)	1.13	2.37	10.12	42.12	1.22	2.53	1.13	1.64	−0.08	0.77
Deprivation Deciles:										
Income	4.29	2.62	4.82	2.97	4.44	2.67	4.61	2.86	0.17	0.66
Employment	3.81	2.55	4.10	2.80	3.87	2.59	4.03	2.72	0.16	0.67
Education	4.73	2.80	5.19	2.96	4.86	2.79	5.06	2.97	0.20	0.61
Health	2.91	1.85	3.63	2.36	3.05	1.89	3.22	1.96	0.17	0.51
Crime	6.61	2.43	6.46	2.74	6.61	2.40	6.61	2.71	0.01	0.98
Housing Services	6.37	2.29	6.52	2.80	6.52	2.33	6.44	2.60	−0.08	0.81
Living Environment	8.48	2.00	8.56	2.26	8.68	1.76	8.56	2.17	−0.12	0.66
IDACI	4.69	2.68	4.99	3.01	4.72	2.69	4.86	2.94	0.14	0.72
No. of LSOAs	126		764		109		109			

Note: Gateshead LSOAs are the treated units. LSOAs in Stockton on Tees, Durham, Northumberland, and Darlington are the untreated units. Deprivation decile 1 represents the most deprived LSOAs and decile 10 represents the least deprived LSOAs. Using t-tests, none of the means in column (7) is statistically significantly different from the means in column (5). Column (9) shows the difference between column (7) and column (5).

Table 3
Density of food outlets per 100,000 people by type and year for treatment and control matched LSOAs.

	No. of LSOAs	2012	2013	2014	2015	2016	2017	2018	2019
Business Type	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)	(9)
Treatment LSOAs:									
Fast-Food Outlets	109	120.3	121.6	121.0	119.3	114.3	121.5	122.9	123.9
Restaurant/Cafe/Canteen		102.2	102.3	104.6	112.3	131.8	152.3	150.3	159.5
Pub/Bar/Nightclub		56.6	56.7	56.1	58.8	107.4[a]	109.3	108.3	106.3
Supermarkets/Hypermarkets		12.8	14.0	12.9	14.6	20.9[a]	25.0	25.0	24.5
	(1)	**(2)**	**(3)**	**(4)**	**(5)**	**(6)**	**(7)**	**(8)**	**(9)**
Control LSOAs:									
Fast-Food Outlets	109	121.4	123.6	121.3	123.4	133.6	129.9	131.9	131.4
Restaurant/Cafe/Canteen		152.2	152.5	159.6	163.8	173.2	184.7	182.6	173.8
Pub/Bar/Nightclub		110.8	109.7	112.9	115.7	117.1	123.8	124.3	124.9
Supermarkets/Hypermarkets		28.0	26.7	26.1	24.4	24.2	20.3	20.2	22.3

Note: This table shows the density of each type of food outlets per 100,000 people by year for the matched sample.
[a] Prior to 2016 low risk premises were not uploaded to the website by the Gateshead environmental health, due to the historical nature of their scores. In 2016 it was decided by the Gateshead environmental health team to upload all FHRS data regardless of the age of the data. The increase reflects the wet sales only pubs and supermarkets being uploaded to the FHRS website for the first time in 2016 rather than a large increase in the number of new premises.

$$Y_{it} = \beta_1\, Treated_i \times Pre_t^{-3} + \beta_2\, Treated_i \times Pre_t^{-2} + \beta_3\, Treated_i \times Pre_t^{-1} + \beta_4\, Treated_i \times Post_t^{+1} + \beta_5\, Treated_i \times Post_t^{+2} + \beta_6\, Treated_i \times Post_t^{+3} + \beta_7\, Treated_i \times Post_t^{+4} + \delta X_{it} + \alpha_i + \tau_t + \varepsilon_{it} \quad (2)$$

where,

Pre_t^{-3} is an indicator that is equal to 1 if the year is in 2012, and 0 otherwise;

Pre_t^{-2} is an indicator that is equal to 1 if the year is in 2013, and 0 otherwise;

Pre_t^{-1} is an indicator that is equal to 1 if the year is in 2014, and 0 otherwise;

$Post_t^{+1}$ is an indicator that is equal to 1 if the year is in 2016, and 0 otherwise;

$Post_t^{+2}$ is an indicator that is equal to 1 if the year is in 2017, and 0 otherwise;

$Post_t^{+3}$ is an indicator that is equal to 1 if the year is in 2018, and 0 otherwise;

$Post_t^{+4}$ is an indicator that is equal to 1 if the year is in 2019, and 0 otherwise.

The $treated_i$*Pre_t^0 (i.e., 2015) is the base case. This test examines whether the treatment effects in the given year is significantly different from the 2015. Our main interests in this test are β_1, β_2, and β_3. If our baseline results in Table 3 are affected by reverse causality (i.e., violation of the parallel trends assumption), we should observe a significant change in the pre-treatment years (i.e., 2012 to 2014). If we do not observe this, then we do not violate the parallel trend assumption and our estimation approach should be appropriate for our research question.

In addition to PSM, we also employ inverse probability weighting (IPW) as a robustness check on our results (Horvitz and Thompson, 1952). In this analysis, we use the probability predicted from the logit regression as shown in Appendix Table A1 to calculate the inverse probability weights. Then, the weights are added into a DID estimation.

As an additional robustness check on our findings, we re-estimate our estimation models with the alternative outcome variables of the density of restaurants. As the planning guidance did not impact on permission for new restaurants there should be no statistically significant difference between the control and treatment groups if we have chosen an appropriate estimation strategy.

We do not estimate models for supermarkets or pubs/bars/nightclubs because the Gateshead environmental health team uploaded historical data in 2016, artificially inflating the sample size for 2016, which may impact on the findings.

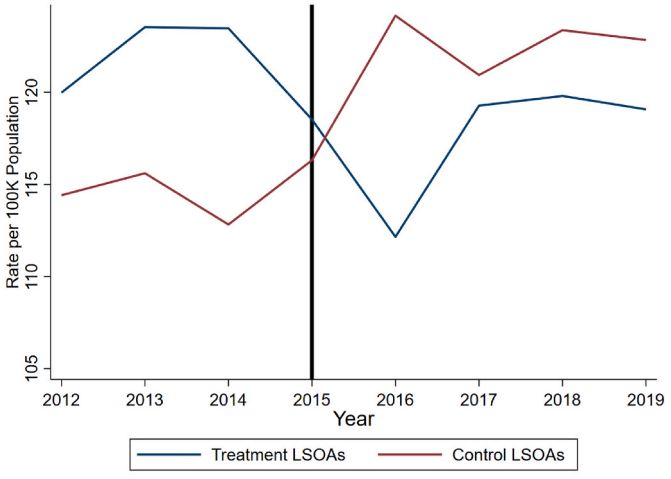
Finally, we re-estimate models at the MSOA level where we match MSOAs in the local authority by area level obesity in year 6 and average IMD scores.

3. Results

3.1. Trends in density of fast-food outlets

First, we compare trends in the density of fast-food outlets in the control and treatment group to provide visual evidence on if the planning guidance has impacted on the density. Fig. 1 plots the average density of fast-food outlets in Gateshead LSOAs and control LSOAs over time. The blue line is the treated LSOAs in Gateshead which are matched to a control LSOA, and the red line shows the density of fast-food outlets for matched LSOAs in the control group. We can see that there is a co-movement between the two groups, and the density of fast-food outlets decreased after the after the implementation of the planning guidance. But, then there was a slight rebound from 2017 (which may just reflect when and how data were imputed) and the density of outlets remained fairly constant for the rest of the study period.

Fig. A4 shows the density of restaurants over the study period in the control and treatment groups. We can see that there is a similar upward trend in both groups.



Note: 2015 is the year Gateshead adopted the planning guidance.

Fig. 1. Average density of fast-food outlets pre and post intervention for the control and treatment groups,
Note: 2015 is the year Gateshead adopted the planning guidance.

3.2. Trends in proportion of fast-food outlets

Fig. 2 presents the average proportion of fast-food outlets over the study period in the matched control and treatment LSOAS. The blue line shows a decrease in the proportion of fast-food outlets after the implementation of planning guidance. Looking at the red solid line for the control group, there is no clear change in trend in the proportion of fast-food outlets after the implementation of the planning guidance in Gateshead in 2015.

3.3. The impact of planning guidance on density, proportion, and number of fast-food outlets

Table 4 presents the PSM-DID regression estimates of the effects of planning guidance limiting new fast-food outlets on the density and proportion of fast-food outlets. Column (1) and (3) reports the result with only LSOA least square dummy and year least square dummy. The densities of other types of food outlets are controlled for in column (2) and (4). In column (1) and (2), our results consistently show that the policy intervention is statistically significant in changing the density of fast-food outlets by −12.45 per 100,000 of the population. We also find that the policy intervention is negatively and significantly correlated with the proportion of fast-food outlets in column (3) and (4). This implies that the planning guidance led to a reduction of 13.88% in the proportion of fast-food outlets compared to other type of food outlets. There is a significant decrease in the number of fast-food outlets when comparing the treatment and control LSOAs. But the coefficient is no longer significant when we include population density in the model in column (6).

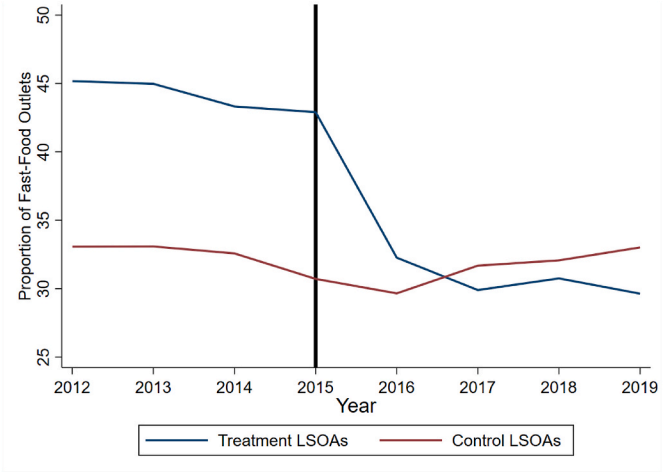
3.4. Sensitivity analysis

Our tests of the common trends assumption Appendix Table A2 show that our analysis does not violate this assumption.

DID estimates without propensity score matching (i.e. on the full estimation sample) are presented in Appendix Table A3. These results are not qualitatively different to our main estimation results. Results from another alternative estimation technique, in which we employ IPW-DID (see Appendix Table A4) are also consistent with our baseline analysis in Table 4.

We also re-estimated the PSM-DID model with the alternative outcome variables of density, proportion, and number of restaurants in Table 5. We find that there is no significant association between the policy intervention and the density of restaurants.

Finally, we re-estimated all models where we match local authorities at the MSOA level by area level deprivation and childhood obesity rates in year 6. The results are qualitatively similar to the main results and can be seen in Appendix 5. However, the common trends assumption does not hold. This may because of the larger geographical area covered by the MSOA versus the LSOA. It is important to note, that because the model assumptions of the DiD approach these results are not robust but they tell the same qualitative story as the analysis at the LSOA supporting our overall hypotheses.



Note: 2015 is the year Gateshead adopted the planning guidance.

Fig. 2. Average proportion of fast-food outlets pre and post intervention in the control and treatment groups.
Note: 2015 is the year Gateshead adopted the planning guidance.

4. Discussion

In this study, we found that employing all three types of planning guidance (school exclusion zones, limits by density, and percentage of children obese) to restrict new fast-food outlets resulted in a significant reduction in the density and proportion of fast-food outlets in Gateshead compared to other local authorities in the North East of England which had not implemented planning guidance. There was not a significant reduction in the number of fast-food outlets after controlling for population density. These results are robust to sensitivity analysis.

It is important to note, that our significant results are likely to stem from the number of fast-food outlets remaining fairly constant over time whilst the number of other types of outlets and the population is increasing. Rather than the results reflecting a decrease in the number of fast-food outlets. Thus, the policy works by limiting the number of new outlets which over the medium to long term will change the status quo improving the health of the population by limiting greater exposure. This is consistent with planning guidance only restricting new outlets but putting no restrictions on existing outlets. Anecdotal evidence provided by the environmental health team in Gateshead, suggests that prospective business owners who applied for permission for a restaurant with ancillary take away service were able to circumvent the planning restrictions. The plausibility of our results was confirmed during discussions with our policy co-authors from Gateshead council.

Through their multi-prong approach, Gateshead Council were able to effectively ban any commercial premises reclassifying as a hot fast-food takeaway across their entire jurisdiction. Conversely those planning schemes limited to a single focused planning consideration, such as school zone, had less of an impact on the overall food environment. Thus, our findings make an important contribution by adding additional evidence of how multi-pronged planning approaches can change the proportion and density of fast-food outlets. This evidence will be useful for decision makers when considering how to make their local environment healthier.

Our results are similar to another multi-pronged evaluation restricting tobacco sales in Philadelphia, USA (Lawman et al., 2020). They found that employing multiple measures to restrict tobacco supply resulted in a 20.3% decrease in retail density three years after implementation. Our results differ to studies which have evaluated single-pronged planning approaches such as Brown et al. (2021) and Sturm and Hattori (2015). Brown et al. (2021) found no impact of the use of a school exclusion zone on the number and type of takeaways in a neighbouring local authority of Newcastle Upon Tyne. Sturm and Hattori (2015) who evaluated the impact of a zoning ban restricting the opening/renovations of standalone fast-food restaurants in South Los Angeles, USA found no statistically significant difference in the share of new restaurants belonging to a large fast-food chain, other chain restaurants, or large food markets.

Our results have important implications for current and future food policy. The growth of food ordering platforms may limit the effectiveness of planning guidance in the future to tackle local area obesity rates if fast-food is independent of place. The relaxation of planning guidance because of the Covid-19 pandemic allowing all types of food outlets to provide takeaway food (Town and Country Planning, 2020) until March 2022 as well as proposed drastic changes to planning guidance (Town

Table 4
Estimation results from the PSM-DID model.

Fast-food outlets	Density		Proportion*100%		Number	
	(1)	(2)	(3)	(4)	(5)	(6)
Treated * Post	−11.84**	−12.45***	−13.95***	−13.88***	−0.19*	−0.17
	(4.75)	(4.72)	(2.34)	(2.34)	(0.11)	(0.11)
Population Density		−0.02**		−0.00		0.00
		(0.01)		(0.00)		(0.00)
Year Dummies	Yes	Yes	Yes	Yes	Yes	Yes
LSOA Dummies	Yes	Yes	Yes	Yes	Yes	Yes
N	1744	1744	1406	1406	1744	1744
R-squared	0.01	0.03	0.17	0.17	0.01	0.03

Note: The proportion has been multiplied by 100. Treated * Post is an indicator that equals 1 if the LSOA is treated and the year is after 2015. Standard errors in parentheses are clustered at the LSOA level. *p < 0.10, **p < 0.05, ***p < 0.01.

Table 5
The impacts of planning guidance on restaurants.

	Density	Proportion*100%	Number
	(1)	(2)	(3)
Treated * Post	13.71	4.23**	0.29
	(12.38)	(1.80)	(0.20)
Population Density	−0.06*	−0.00	0.00
	(0.03)	(0.00)	(0.00)
Year Dummies	Yes	Yes	Yes
LSOA Dummies	Yes	Yes	Yes
N	1744	1406	1744
R-squared	0.09	0.03	0.11

Note: This table presents the DID matching estimations for the density, proportion, and number of restaurants. Standard errors are clustered at the LSOA level. *p < 0.10, **p < 0.05, ***p < 0.01.

and Country Planning, 2020B) restricting all new fast-food outlets but granting blanket permission for new restaurants are likely to limit local authority's ability to promote a healthy food environment in the future. There needs to be greater coordination between national and local government to develop a strategy to ensure the environment in which we live is health promoting.

Although, we found that the multi-pronged planning approach employed by Gateshead to restrict new fast-food outlets led to a significant reduction in the density and proportion of these outlets it is unclear if this change has had any impact on health. This change in the proportion and density of fast-food outlets in comparison to other type of food outlets such as restaurants may change people's food choices if there is a growth in other types of food outlets compared to fast-food outlets (Mikic, 2020). However, further research is needed to understand if reducing the number of fast-food outlets has an impact on diet and subsequent health conditions including obesity and other diet related diseases.

4.1. Strengths and limitations

A key strength of our research is the use of a validated longitudinal dataset for the North East of England on the food environment (Kirkman et al., 2020) which allows us to employ a robust quasi-experimental approach. Thus, we can provide causal estimates of the impact of the implementation of planning guidance by Gateshead on the food environment.

However, there are also some weaknesses. The methods we use to classify fast-food outlets are not the same as those used by planners. The use of FSA categories is also limiting in this study as the FSA use the term take away to cover sandwich shops, as well as traditional fast-food outlets. This makes it difficult to assess the impact on those fast-food outlets serving higher calorific content foods, such as pizza and burgers. We assess the accuracy of our method by checking with the annual planning policy monitoring report for Gateshead council, but it is possible that there are some discrepancies in existing outlets. Because our analysis is limited to the North East of England, our findings may not be generalisable to the rest of England. We use an administrative dataset and historical data was imputed over the study period for pubs only serving alcohol and supermarket which artificially inflated the number of these premises in Gateshead in 2016. We were not able to identify the premises that were entered as historical data as all premises are recorded by the date they were entered into the dataset. However, as these types of premises were not a primary outcome it should not impact on our findings and the interpretation of the results. Finally, we also assume that the LSOA is a geographically important area for assessing the food environment which may not be the case, people may make their food choices based upon a different geography.

5. Conclusion

A multi-pronged approach to planning restrictions on fast-food outlets employed by Gateshead local authority significantly reduced the density and proportion of fast-food outlets compared to other local authorities in the North East who did not implement planning guidance. These results provide important evidence for both local and the national government on effective ways to promote a healthier environment within a period of less than 5 years. It is important to put these findings into the current context of proposed changes to planning legislation when considering how local government can make a difference to their local environment in the future.

Credit author statement

Conceptualisation: HB, LG, AL, NA, SS, EG, VA, Methodology, HB, JW, HX, VA, Data Curation, HX, Writing Original Draft, HB, Visualisation HX, Writing, Reviewing and Editing, All Authors, Supervision, HB and VA.

Data statement

All data used in the analysis is publicly available and can be freely downloaded from https://data.food.gov.uk/catalog/datasets/38dd8d6a-5ab1-4f50-b753-ab33288e3200. The do files used in the analysis can be found at: https://github.com/heatherb1030/Gateshead.

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Appendix A. Supplementary data

Supplementary data to this article can be found online at https://doi.org/10.1016/j.socscimed.2022.115126.

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