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Burgoine T, Sarkar C, Webster CJ, Monsivais P. Examining the interaction of fast-food outlet exposure and income on diet and obesity: evidence from 51,361 UK Biobank participants. Int J Behav Nutr Phys Act. 2018;15(1):71.

What We Know, Think We Know, or Are Starting to Know

In the London Borough of Kensington and Chelsea, life expectancy in the lowest income area of the borough is 22yrs shorter than in the richest areas [(1)]. Let that sink in.

While there are myriad social, economic, and environmental factors which add up to create such an appalling discrepancy within the very same geographic area of one of the richest cities and countries in the world, it is now recognised that diet is the major driver of non-communicable disease mortality and disability-adjusted life years*, surpassing tobacco smoking [(2)]. Globally, the main dietary risk factors identified by the 2017 Global Burden of Disease Study included high sodium, low whole grains, low fruit, low nuts and seeds, low vegetables, and low omega-3 fatty acids [(2)].

In developed countries like the UK, it is unequivocal that the burden of chronic disease is disproportionately borne by people living in conditions of social deprivation [(1)]. In recent years, more attention has been placed on the food environment and the influence of the food environment on dietary choices. While many of these factors are broadly considered "social determinants" of health, the term "structural determinants" has been used to describe the effects of the food environment on shaping eating behaviour [(1)].

For example, an analysis by Public Health England which modelled the numbers of fast food outlets by local authority district throughout the UK demonstrated a correlation between higher levels of social deprivation and greater density of fast food outlets [(3)]. Fraser et al. demonstrated that the density of McDonald' s, Pizza Hut, Burger King, and KFC, were each linearly associated with increasing social deprivation, i.e., the more socially deprived the area, the more of each of these fast food outlets were located in the area [(4)]. This is not without potential consequence for diet, as exposure to fast food outlets correlates with intake, among other variables [(4)].

Indeed, research in this area remains in relative infancy, and various methodology have been utilised to try to more accurately characterise the relationship between the food environment and dietary intake. The present study investigated the effects of exposure to fast food outlets and household income on processed meat intake in a UK cohort.

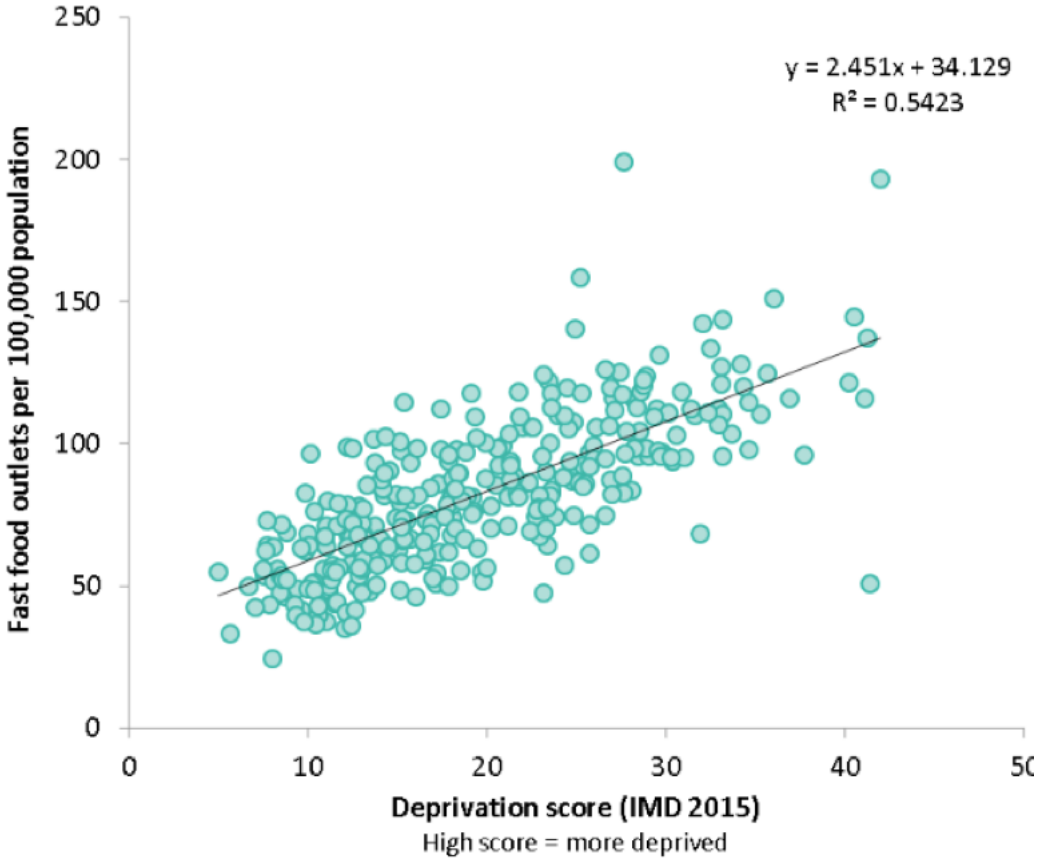

Figure *from (**R**) illustrating the relationship between social deprivation index (**bottom X axis, increasing deprivation from left to right**) and density of fast food outlets per 100,000 population (**left Y axis, increasing fast food outlets from bottom to top**). Local authority areas with a higher social deprivation score tended to have a greater density of fast food outlets.*

*Geek Box: Disability-Adjusted Life Years (DALYS)

While epidemiology tends to focus on 'hard' outcomes in terms of events, e.g., myocardial infarction or lung cancer, these events may only represent the endpoint of a long disease process. With chronic lifestyle diseases, it is common for individuals to be treated for the disease before an event occurs. Thus, it is important to not only be able to quantify the incidence of events, but the amount of years a person lives disease-free. If people are diagnosed with a disease at a younger age, this means a greater number of the lifespan is spent combating a disease. Disability-adjusted life years [DALYs] are a method of quantifying the burden of disability associated with a disease, and reflect the number of years spent dealing with an illness or disability, and premature death, within a population. DALYs are calculated by adding the number of years of life lost to the number of years spent living with an illness or disability. Thus, DALYs estimate the sum of both premature death and years spent with illness. The life years lost is based off average life expectancy in the population. By using the reference standard life expectancy, it is possible to use DALYs to summarise population health, because DALYs can reflect a gap in health, i.e., the actual state of population health compared to the ideal goal [which is for people to live the full life expectancy with full health]. It is possible to quantify DALYs by age, sex, and location, to provide absolute measures of the years of healthy life lost due to illness and death and provide meaningful comparisons across different populations and groups.

The Study

40-69yrs, registered with the National Health Service [NHS] in the United Kingdom. Participants were recruited between 2007 and 2010. The present study focused on the Greater London centre of the Biobank cohort, which had data on neighbourhood fast food outlets [FFO] accurate up to 1-meter. Proximity to FFO was assessed as a 1-mile radius from a participants address. FFO were defined as "outlets selling food and/or drink for consumption off the premises (excluding general and convenience stores, coffee shops and supermarkets)". The number of FFO was expressed as a proportion (as percentage) of all food outlets (including FFO, supermarkets, restaurants, convenience stores, cafes, and specialist stores). Household income was self-reported by participants in the following income brackets:

- £31,000-£51,999
- £52,000-£100,000
- >£100,000

The two primary exposures were:

- Proportion of neighbourhood FFO
- Household income

The primary outcomes were processed meat consumption, Body Mass Index [BMI] and body fat. The analysis examined the relationship between each exposure with odds of frequent processed meat consumption [defined as more than once per week] and of obesity [defined as BMI >30 and percentage of body fat], and also examined the interaction between both exposures and each outcome. 51,000 participants were included in the final analysis.

Results: The mean age of participants was 56yrs [range 38-72yrs], 56% female, and 80% white ethnicity. Mean BMI and body fat were 26.9 and 30.8%, respectively. 27.7% consumed processed meat >1/week. FFO accounted for 18.4% of neighbourhood food retail, an average of 39.2 outlets. Participants with greater exposure to FFO were more likely to be Black or Asian Minority Ethnic [BAME], lower income, with less educational qualifications. In the top quarter of FFO exposure, between 24-45% of neighbourhood food vendors were FFO.

- ***Association of FFO with Processed Meat, BMI and Body Fat:*** Participants with the highest proportion of FFO had a 28% greater odds [95% CI 1.19-1.38] of being a frequent processed meat consumers, compared to the lowest proportion exposure group. There was a linear association between increasing proportion of neighbourhood FFO and odds of frequent processed meat intake. The highest proportion of FFO was associated with a 0.99 heavier BMI and 1.37% higher body fat [after adjusting for income, education, and other food outlets].

- ***Association of Household Income with Processed Meat, BMI and Body Fat:*** Participants in the lowest income bracket [<£31,000] had a 0.68 higher BMI, 0.83% higher body fat, and 54% higher odds of obesity, compared to the highest incomes [after adjusting for income, education, and other food outlets]. Participants with lowest income had a 25% greater odds [95% CI 1.15-1.35] of being a frequent processed meat consumers, compared to the highest incomes.

- ***Interaction between FFO & Household Income with Processed Meat, BMI and Body Fat:*** The combination of highest FFO exposure + lowest household income in combination was associated a 143% greater odds of obesity, compared to those with the lowest FFO exposure + highest incomes. Participants with highest FFO exposure + lowest income had a 46% greater odds [95% CI 1.29-1.65] of being a frequent processed meat consumers, compared to the lowest FFO exposure + highest incomes.

The Critical Breakdown

Pros: The study had a large sample size. The sample included a wide range of each income bracket, with relatively equal distribution across each bracket [18-26% in each]. The analyses were adjusted for relevant confounders, including household income, number in household, highest educational attainment, and sum of other neighbourhood food vendors [i.e., supermarkets, cafes, etc.]. Objective measures of body fat were available, providing additional data to BMI.

Cons: The definition of FFO may lack sensitivity to capture the full picture of the local food environment [more under ***Key Characteristic***, below]. Processed meat intake was classified dichotomously between 'never' and '>once per week', which given that a food frequency questionnaire was used to assess diet, may have artificially biased results toward FFO even if foods like bacon or ham were consumed in the home, i.e., processed meat may be a poor proxy for fast-food. The odds of being a 'frequent' consumer makes no distinction between twice per week and once per day, despite this range of frequencies being expected to have quantitatively different outcomes. Given that ultra-processed foods, i.e., foods concomitantly high in refined starch, added fats and sugars, and sodium, constitutes up to 50% of energy intake in the UK population, focusing on processed meat seems overly reductionist and likely omits important related exposures, e.g., sugar-sweetened beverages and foods like French fries. Given the correlations between ethnicity and the relevant exposures, the overall lack of BAME representation in the cohort is a limitation.

Key Characteristic

The method of quantifying FFO, a a measurement of the food environment, is an ongoing subject of debate within this research area [5]. It is possible that many of the methods commonly used may mischaracterise the food environment. The classification of food stores is often arbitrary: FFO are often classified as 'unhealthy' while a supermarket may be classified as 'healthy', despite the availability for purchase of many unhealthy foods and beverages [5]. The present study used proportions to reflect the food environment, i.e., the number of FFO relative to total food vendors. The risk with this approach is that certain food stores are excluded, depending on what classification the researchers used. In the present study, the other food vendors included supermarkets, restaurants, convenience stores, cafes, and specialist stores. This seems broad enough to more accurately reflect the proportion of FFO relative to total food vendors, rather than over or underestimate the true proportion [although this can not be ruled out entirely]. However, issues may still arise: for example, the proportion of FFO in an area would be the same if there were 3 FOO vs. 3 restaurants as if there was 12 FOO vs. 12 restaurants, but these food environments would likely be qualitatively different. The present study clearly defined FFO, included a broad classification of all other neighbourhood food vendors, and thus may provide a representative measure of the density of FFO in a neighbourhood. However, there is clearly scope to expand and improve on methodology for characterising the food environment [5].

Interesting Finding

The additive effect of both low income and greater neighbourhood FFO exposure provides an important addition to the general evidence on the geography of fast food outlets. While previous analyses have demonstrated a strong correlation between level of social deprivation and density of FFO [3,4], the present study adds to this literature by demonstrating relationships between both income and FFO exposure with processed meat intake and adiposity. As the percentage of FFO increased, both the odds of obesity and higher body, and the odds of higher processed meat consumption, increased linearly. The fact that these associations remained, albeit attenuated in strength of association, after adjusting for socio-economic factors and the total of neighbourhood food outlets, strongly implicates the convergence of low income and greater exposure to FFO in diet quality and adiposity.

Relevance

Dietary choices remain primarily viewed through the lens of a behavioural risk factor, i.e., it is a behavioural choice at the level of the individual. However, the research demonstrates that structural factors are strongly tied to agency [1]. For example, people on low incomes are more likely to demonstrate price consciousness and budgeting, which dictates food choices and may increase reliance on FFO as sources of cheap energy [1,6]. In the Tower Hamlets Study, schoolchildren demonstrated that it was more cost effective for them to save school meals money and use it on fast food later in the day, and felt that school meals were poor value compared to FFO [6].

Normative influences may also be important, as research from the Netherlands indicated that fast food intake correlated with the neighbourhood social norms regarding fast food consumption, i.e., when eating from FFO is normalised within the neighbourhood it correlates with odds of consumption [7]. Conversely, an intervention which altered the display of drinks in a convenience store to more readily display non-calorically sweetened beverages reduced purchase of sugar-sweetened beverages by 25% over a month, demonstrating the potential for behavioural 'nudges' to influence outcomes [8].

However, the issue of bottom-line purchasing power remains: a cross-sectional analysis in Scotland which investigated diet quality patterns relative to social deprivation indicated that the most unhealthy dietary patterns related linearly to levels of social deprivation [9].

Potential limitations of the methodology used to quantify the food environment aside, and the difficulty of making inferences regarding choice, the reality is that both structural and social determinants - the built environment and income levels - exhibit strong influences on diet and health. There is a need for multilevel, multi-sector prevention strategies at the level of policy, environment and practises, and local communities.

Application to Practice

Perhaps one of the deepest rooted tropes about diet and health is that everything boils down to "personal responsibility". This creates false equivalence with regard to the choices available both at the community and individual level. This is an area of research that is often overlooked, and we can all benefit from giving more consideration to the challenges, barriers, and potential solutions to the gross disparities in access to good nutrition and health.

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