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Absolute and relative densities of fast-food versus other restaurants in relation to weight status: Does restaurant mix matter?

Jane Y. Polsky [a,b,*], Rahim Moineddin [c,d], James R. Dunn [b,e,f], Richard H. Glazier [a,b,c,d,g], Gillian L. Booth [d,h,i,j]

[a] Dalla Lana School of Public Health, University of Toronto, Toronto, ON, Canada
[b] Centre for Research on Inner City Health, Li Ka Shing Knowledge Institute of St. Michael's Hospital, Toronto, ON, Canada
[c] Department of Family & Community Medicine, University of Toronto, Toronto, ON, Canada
[d] Institute for Clinical Evaluative Sciences, Toronto, ON, Canada
[e] Department of Health, Aging & Society, McMaster University, Hamilton, ON, Canada
[f] McMaster Institute for Healthier Environments, Hamilton, ON, Canada
[g] Department of Family & Community Medicine, St. Michael's Hospital, Toronto, ON, Canada
[h] Li Ka Shing Knowledge Institute, Division of Endocrinology, St. Michael's Hospital, Toronto, ON, Canada
[i] Department of Medicine, University of Toronto, Toronto, ON, Canada
[j] Institute of Health Policy, Management and Evaluation, University of Toronto, Toronto, ON, Canada

A R T I C L E   I N F O

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A B S T R A C T

Background. Given the continuing epidemic of obesity, policymakers are increasingly looking for levers within the local retail food environment as a means of promoting healthy weights.

Purpose. To examine the independent and joint associations of absolute and relative densities of restaurants near home with weight status in a large, urban, population-based sample of adults.

Methods. We studied 10,199 adults living in one of four cities in southern Ontario, Canada, who participated in the Canadian Community Health Survey (cycles 2005, 2007/08, 2009/10). Multivariate models assessed the association of weight status (obesity and body mass index) with absolute densities (numbers) of fast-food, full-service and other restaurants, and the relative density (proportion) of fast-food restaurants (FFR) relative to all restaurants within ~10-minute walk of residential areas.

Results. Higher numbers of restaurants of any type were inversely related to excess weight, even in models adjusting for a range of individual covariates and area deprivation. However, these associations were no longer significant after accounting for higher walkability of areas with high volumes of restaurants. In contrast, there was a direct relationship between the proportion of FFR relative to all restaurants and excess weight, particularly in areas with high volumes of FFR (e.g., odds ratio for obesity = 2.55 in areas with 5 + FFR, 95% confidence interval: 1.55–4.17, across the interquartile range).

Conclusions. Policies aiming to promote healthy weights that target the volume of certain retail food outlets in residential settings may be more effective if they also consider the relative share of outlets serving more and less healthful foods.

Introduction

Overweight and obesity account for a major share of disease burden in North America and increasingly worldwide (GBD, 2010; Murray et al., 2013; Lim et al., 2012). There is a growing recognition of the role that “obesogenic” environments, including the local retail food environments, play in shaping unhealthy eating patterns and excess body weight (Egger and Swinburn, 1997; Story et al., 2008; Swinburn et al., 2011; Roberto et al., 2015). For example, Americans currently spend half of their food dollars on away-from-home foods, (Economic Research Service (ERS), 2014) a trend that is growing in frequency (Kant and Graubard, 2004). Fast-food restaurants (FFR) are the most important source of away-from-home eating in the United States (Lachat et al., 2012), and commonly serve meals of poor nutritional quality and high energy content (Prentice and Jebb, 2003; Jaworowska et al., 2013). Numerous studies have linked regular patronage of FFR to a higher likelihood of becoming overweight or obese (Prentice and Jebb, 2003; Bezerra et al., 2012; Nago et al., 2014). As a result, policymakers are increasingly targeting the local food environment as a means of promoting healthy food choices and healthy weights (Hawkes et al., 2013; Center for Disease Control and Prevention, 2012), with some jurisdictions considering or having introduced policies to restrict FFR near schools or in low-income areas (Buckley, 2009; Sturm and Hattori, 2015).

* Corresponding author at: Centre for Research on Inner City Health (CRICH), 209 Victoria Street, 3rd floor, St. Michael's Hospital, Toronto, ON, Canada, M5B 1T8.
E-mail address: jane.polsky@mail.utoronto.ca (J.Y. Polsky).

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A growing number of studies suggest that greater exposure to FFR is associated with unhealthy food purchases, poorer diets, and higher weight status (Mehta and Chang, 2008; Fleischhacker et al., 2010; Fraser et al., 2010). Other studies, however, have found no association, or paradoxically found lower rates of overweight or obesity in areas with higher densities of FFR (Jeffery et al., 2006; Crawford et al., 2008; Zick et al., 2009; Pearce et al., 2009; Black et al., 2010; Kestens et al., 2012; Bader et al., 2013). Heterogeneity across studies may be due to many methodological differences, including varying definitions of neighborhood and food outlets, and different ways of measuring exposure to restaurants (Fleischhacker et al., 2010; Charreire et al., 2010; Caspi et al., 2012). Additionally, most studies examined effects of FFR exposure using only absolute measures, such as proximity to or number (i.e. density) of FFR (Fleischhacker et al., 2010). Recent reports suggest that *relative* measures, such as the ratio or proportion of various types of food retail outlets, may be as or more important to diet-related behaviors and body weight than absolute measures because they offer local residents competing options (Mehta and Chang, 2008; Kestens et al., 2012; Spence et al., 2009; Thornton et al., 2009; Mercille et al., 2012; Mason et al., 2013; Clary et al., 2015). For example, two recent studies showed that Canadian adults living in urban areas where a greater proportion of local restaurants were FFR had poorer quality diets and a higher likelihood of being overweight (Kestens et al., 2012; Mercille et al., 2012). Finally, adverse effects of greater FFR exposure may be offset by other neighborhood characteristics that have a favorable effect on body weight, such as greater density of healthier food retailers and greater walkability. However, few studies have taken into account the fact that areas with a greater volume of retail and restaurants are by nature generally more "walkable"—a characteristic which, in itself, has been shown to have salutary effects on levels of physical activity and body weight (Black and Macinko, 2008; Grasser et al., 2013; Glazier et al., 2014).

The purpose of this research was to gain a more nuanced understanding of the influence of the local, objectively measured restaurant environment on weight status using a large, urban, population-based sample of adults and controlling for a range of individual and area-level covariates, including area walkability. Specifically, we investigated whether individuals exposed to a higher absolute density (number) of restaurants or higher relative density (proportion) of FFR within walking distance of residential areas have higher body mass index (BMI) or higher levels of obesity. We also investigated whether exposure to a higher proportion of FFR matters more in areas with a higher overall volume of restaurants (due to greater availability of FFR and poor balance of competing options) by assessing the interaction between the effects of relative and absolute restaurant densities on weight status. To our knowledge, this question has not been previously investigated in the literature.

Methods

Study sample

Participant data came from three combined cycles of the Canadian Community Health Survey (CCHS 2005, 2007/2008 and 2008/2010). The CCHS is a cross-sectional nationally representative survey of community-dwelling Canadians, conducted on an ongoing basis to collect information related to health status and determinants (Beland, 2002). This study's sample was limited to adults aged 18+ residing in urban, residential areas of four cities in southern Ontario, Canada (Toronto, Brampton, Mississauga and Hamilton). Our sample included 10,199 adults residing within walking distance of at least one restaurant, and excluded 374 participants (3.5%) with missing data on outcomes or covariates of interest. The study protocol was approved by the University of Toronto and Sunnybrook Health Sciences Centre Research Ethics Boards.

Socio-demographic covariates included age (continuous), age squared (to account for the non-linear association of age with weight status), marital status, cultural/racial group, immigration status and educational attainment, city of residence and survey cycle. Household income adequacy was measured in quintiles and is a relative measure of participants' household income relative to all other Ontario respondents, adjusted for household and community size.

Restaurant and other area-level measures

Data on restaurant locations were purchased from a commercial database (Dun & Bradstreet, Canada) in January 2008. This database contained the geocoded locations of all restaurants in the study area, classified by North American Industry Classification System (NAICS) and Standard Industrial Classification (SIC) codes. The SIC code 5812 for eating places and NAICS codes 722211, 722110 and 722213 for limited-service, full-service, and snack-type outlets were used to extract the initial list of restaurants. We then conducted extensive cleaning of the extracted records to remove duplicate listings and businesses unlikely to be food retail (e.g., headquarter offices). Consistent with a previously adopted protocol (Ohri-Vachaspati et al., 2011), we conducted additional reclassifying efforts using keyword searches, web-based research, telephone calls to individual establishments and cross-referencing of restaurant names using the Techomic list of top 200 Canadian chain restaurants in 2009 (Technomic, Inc.) in order to more accurately classify restaurants. We were also able to validate a subset of our final restaurant list for Toronto against a contemporaneous public health inspectors' list (which ranks among the highest quality of secondary retail food sources available to researchers (Fleischhacker et al., 2013)), and results revealed a high level of agreement (all intra-class correlation coefficients >0.80; data not shown). We defined FFR as a locally owned or chain limited-service restaurant (establishments without table service where patrons pay before receiving their meal) serving full meals. All remaining restaurants were classified as either full-service (establishments where patrons order and are served while seated and pay after eating) or other restaurants (all other eating places such as cafes, coffee shops or snack-type outlets).

Restaurant exposure was derived for small residential parcels of land known as dissemination blocks (DBs; areas equivalent to a city block bounded by intersecting streets) defined by Statistics Canada and assigned to individuals based on their residential postal code. Overall, there was an average of 2.9 study participants per block (minimum of 1 and maximum of 56 participants per block). For each participant, restaurant density was calculated around the geometric centroid of the DB using network analysis tools in ArcGIS 9.3 software (ESRI, Redlands, CA). Specifically, we calculated the number of restaurants within a ~10-minute walking distance (720 m along the street network) of the center of each DB, based on an estimated speed of 1.2 m/s. This number represented the *absolute* density of each restaurant type within a 10-minute walking buffer. *Relative* density of FFR within each buffer was calculated as follows: (absolute density of FFR / absolute density of total restaurants) × 100%.

Because of previously reported associations with the local food environment, our analyses also included composite indices of area material deprivation and walkability at a slightly larger geographic unit than the DBs—dissemination areas (small census areas with an average population of 400–700 people). Material deprivation was measured using the Canadian Marginalization Index, a theoretically informed and empirically derived composite index of Canadian marginalization (Matheson et al., 2012). We have previously shown that area material deprivation relates to the distribution of food retail outlets across this study area (Polsky et al., 2014). Area walkability was assessed using a validated walkability index recently linked to levels of obesity and diabetes in Toronto (Glazier et al., 2014). This index is constructed using four equally weighted components: population density, dwelling density, street connectivity and the availability of retail and service destinations (including public recreation centers, schools and food stores) within a ~10 minute walk of residentially-weighted DB centroids, and aggregated up to the dissemination area level (Glazier et al., 2014).

Outcomes

We investigated two outcomes: BMI (kg/m^2) and obesity (BMI of ≥30). BMI values were derived from self-reported height and weight data collected from study participants. We excluded participants with missing or extreme values (BMI <15 or >60) and pregnant women. In order to correct for bias in BMI estimates resulting from self-report, we applied the following validated error correction factor: (Connor Gorber et al., 2008) for men, corrected BMI = −1.08 + 1.08(self-reported BMI); for women, corrected BMI = −0.12 + 1.05(self-reported BMI).