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Obesity and the Built Environment: Does the Density of Neighborhood Fast-Food Outlets Matter?

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Abstract

Purpose—To examine variation in obesity among older adults relative to the joint influences of density of neighborhood fast-food outlets and residents' behavioral, psychosocial, and sociodemographic characteristics.

Design—Cross-sectional and multilevel design.

Setting—Census block groups, used as a proxy for neighborhoods, within the metropolitan region's Urban Growth Boundary in Portland, Oregon.

Subjects—A total of 1,221 residents (mean age=65 years old) recruited randomly from 120 neighborhoods (48% response rate).

Measures—A Geographic Information System-based measure of fast-food restaurant density across 120 neighborhoods was created. Residents within the sampled neighborhoods were assessed with respect to their body mass index (BMI), frequency of visits to local fast-food restaurants, fried food consumption, levels of physical activity, self-efficacy of eating fruits and vegetables, household income, and race/ethnicity.

Analyses—Multilevel logistic regression analyses.

Results—Significant associations were found between resident-level individual characteristics and the likelihood of being obese (BMI≥30) for neighborhoods with a high-density of fast-food restaurants in comparison to those with a low density: odds ratios [OR] for obesity, 95% confidence interval [CI] were: 1.878 (CI=1.006-3.496) for weekly visits to local fast-food restaurants; 1.792 (CI=1.006-3.190) for not meeting physical activity recommendations; 1.212 (CI=1.057-1.391) for low confidence in eating healthy food; and 8.057 (CI=1.705-38.086) for non-Hispanic black residents.

Conclusion—Increased density of neighborhood fast-food outlets was associated with unhealthy lifestyles, poorer psychosocial profiles, and increased risk of obesity among older adults.

Keywords

Fast Food; Environment Design; Community Health; Obesity; Policy; Prevention Research; Manuscript format: research; Research purpose: modeling/relationship testing; Study design: nonexperimental; Outcome measure: biometric; Setting: local community; Health focus: fitness/physical activity; Strategy: built environment; Target population age: adults/seniors; Target population characteristics: geographic location

Introduction

The increasing trend in obesity prevalence in the U.S. adult population[1-5] has made the problem of overweight and obesity a leading health concern for this country.[6-9] Obesity in adults is associated with increased risk of a number of hypokinetic diseases and metabolic abnormalities including coronary heart disease, type 2 diabetes, hypertension, certain cancers, and osteoarthritis.[8,10,11] Apart from physical ailments, people suffering from obesity also face psychological problems including depression, appearance consciousness, and lack of self-confidence. Being obese decreases life expectancy[12] and increases medical and social costs.[13]

While obesity is a complex health issue related to lifestyle and genetic factors, there is growing evidence linking overweight and/or obesity to unhealthy environments (e.g., land use patterns, food availability, processing, and marketing).[14-18] One particular environmental factor that is receiving increased attention is the availability of local area fast-food restaurants. Recent data reveal that the number of fast-food restaurants in the U.S. has increased significantly over the past decade,[19,20] particularly in low income and predominantly black urban neighborhoods.[20,21] The data appear to coincide with a marked upward trend in total spending on fast food[19,22] and energy intake derived from away-from-home sources, in particular fast-food outlets.[19,23,24,25] With respect to obesity, studies have found associations between fast food consumption and increased body mass index (BMI) and weight gain.[26-30] For example, in a 15-year study, adults who ate fast food more than twice a week gained 10 pounds more, and their insulin resistance increased twice as fast, compared to those who ate fast food less than once a week.[30] On a broader scale, an association has been found between the density of neighborhood fast food restaurants, the number of residents per restaurant, and state obesity rates,[16] and between residents who reside in areas possessing a higher relative number of fast-food outlets to full-service restaurants and a higher weight status.[31]

While existing studies have led to more closely examining how an obesogenic environment[32] is related to overweight or obesity, the majority of studies have focused on direct or independent contributions of either neighborhood-level or individual-level factors related to obesity health risk. Because weight gain and/or obesity have increasingly been recognized to be the result of the interplay among biological, behavioral, and environmental factors,[32] it is reasonable to argue that individual characteristics are naturally correlated with those of their social or neighborhood contexts, suggesting that neighborhood- and individual-level characteristics might interact to jointly influence obesity.[33]

This study, therefore, was designed to examine whether associations between selected individual-level behavioral, psychosocial, and sociodemographic characteristics and obesity were moderated by the availability of local area fast-food outlets. Specifically, within a multilevel analytic framework, we tested the working hypothesis that the strength of the association between individual-level measures of frequency of weekly visits to fast-food restaurants, self-efficacy of eating fruits and vegetables, fried food consumption, levels of physical activity, and obesity would vary as a function of density of fast-food outlets in the neighborhood where older adults live. On the basis of past research,[20,21,34] sociodemographic measures of household income and race/ethnicity were also included in the analyses.

Methods

Design

A cross-sectional, multistage, stratified sampling design was employed to obtain a regionally representative sample of adults between 50-75 years old from randomly sampled U.S. census block groups geographically located within the Portland, Oregon, metropolitan region's Urban Growth Boundary (www.metro-region.org). Census block groups were used as a proxy for neighborhoods and are, therefore, the Primary Sampling Unit (PSU) in this study. The sampling procedures involved three stages: (1) randomly selecting block groups that represented a wide variety of urban forms (land use mix), with socio-economically (median household income) and ethnically diverse populations; (2) randomly selecting households in selected block groups; and (3) identifying and recruiting eligible residents from selected households. The study was conducted between 2006-2007 and the research protocol was approved by the Oregon Research Institute Institutional Review Board.

Sample

A total of 120 neighborhoods, stratified on the variables of urban form, median household income, and race/ethnicity, were selected in 2006. Single and multiple family households (i.e., houses, apartments) within the selected neighborhoods were identified from a database purchased through a commercial vender (www.surveysampling.com). The dataset was compiled from local telephone directories (primary data source), voter registration, and driver's licence information (secondary data source) from 2006, providing the targeted age sample and contact information (name, address, and phone number) for the study recruitment. Proportional allocation was used to determine the size of the sample selected from each block group, with sample sizes varying from 5-8 residents for small population block groups to 9-21 residents for medium-to-large population block groups. In accordance with the study's inclusion/exclusion criteria, the target population was comprised of adults who were between 50 and 75 years old, English-speaking, independently ambulatory (including cane use), and with no major mental deficits.

Each selected household/resident was approached initially through direct mail, followed by a telephone contact. Non-responding or declining households were replaced by continued random sampling of households until the target number of households within each neighborhood was recruited. The sampling efforts resulted in a total of 1,221 participants being recruited, representing a response rate of 48%. An in-person-interview was used to collect a wide range of data, including sociodemographic characteristics, dietary and physical activity behaviors, body weight and height, and perceptions of the neighborhood built environment. All participants provided written, informed consent before assessments and were paid $25-30 plus transportation costs for their participation.

Measures

Individual-Level Measures

Body Mass Index (BMI): Data on weight (in pounds) and height (in inches) were obtained through objective anthropometric measures. These data were used to calculate BMI by dividing weight (in kilograms) by height (in meters) square (weight/height^2). Because of the substantive focus on obesity in this study, BMI was classified into two categories: 1 = obese (BMI ≥ 30); 0 = otherwise (BMI < 30).

Eating-out behavior: Two questions indicative of the frequency of adult weekly fast-food visits were asked: “How often do you eat food from a place like McDonalds, Burger King, KFC, Pizza Hut, or some other fast-food restaurant?” and “How often do you go to buffet-type restaurants?” The response categories were: (1) never, (2) less than once per week, (3) 1-2 times a week, (4) 3-4 times a week, (5) five times a week, and (6) every day. For the purpose of analysis, a binary score of eating out at fast food restaurants/buffet-type was created: 1= 1-2 times or more each week; 0 = never or less than once per week. A 12-month test-retest reliability measure for the two-item scale was .75.

Eating self-efficacy: Adapted from Resincow et al.[35] the efficacy to eat more fruits and vegetables scale was used. This scale consisted of 10 items, assessing the extent to which participants believed they could eat more fruits or vegetables. Each of the efficacy items was measured using response categories ranging from 1 (Not at all confident) to 10 (Completely confident). Validity and reliability of the scale were established by the scale developers.[35] Cronbach's alpha internal-consistency reliability coefficient was .85 for the scale. For ease of interpretation, the raw scores were reversed with higher scores indicating lower confidence eating more fruits and vegetables.

Fried food consumption: A single question was asked of respondents: “How many servings of fried food (e.g., deep fried in oil, pan fried in oil or butter, etc.) do you have in a typical week?” The number of servings was recorded. For the analysis, a binary score of fried food consumption was created: 1 = 1 or more servings; 0 = no servings.

Fruits and vegetables intake: The Fruit and Vegetable screener (the “All-Day” version)[36] was used to assess the frequency and portion size intake of fruits and vegetables. Validity and reliability of the scale were established by the scale developers.[36] Scores were computed per scoring guidelines established by the National Cancer Institute,[37] with higher scores indicating higher levels of fruit and vegetable intake.

Physical activity: Levels of physical activity were assessed using the Behavioral Risk Factor Surveillance System Survey (BRFSS).[38] The BRFSS physical activity questions assess the number of days per week and total time spent per day in moderate and vigorous physical activity. Physical activity levels were computed into three categories per the American College of Sports Medicine and Centers for Disease Control and Prevention (CDC) recommendations for physical activity:[39,40,41] (a) met guidelines for moderate physical activity (i.e., ≥5 times per week, ≥30 minutes per day) or vigorous physical activity (i.e., ≥ 3 times per week, ≥20 minutes per day); (b) insufficiently active (i.e., some physical activity but less than the guidelines recommend); or (c) inactive (i.e., no physical activity reported). For the purpose of this analysis, the latter two categories were combined to create a dichotomous variable of 1 = not meeting the recommended physical activity levels; 0 = meeting the recommended level of physical activity.

Sociodemographic characteristics: These measures included and were operationalized as: (a) age (continuous variable: 50-75 years old); (b) gender (1 = males; 0 = females); (c) education (1 = high school diploma or lower; 0 = some college or higher); (d) household income (1 = $29,999 or less; 0 = $30,000 or above); (e); race/ethnicity (1 = non-Hispanic black; 0 = otherwise); (f) employment status (1 = employed; 0 = not employed); (g) home ownership (1 = yes; 0 = no); (h) alcohol use (1 = current user; 0 = never or no use); (i) tobacco use (1 = current user; 0 = never or no use), and (j) health status (5 = excellent; 1 = poor).

Neighborhood Measures

Fast-food restaurants: Commercial business data were purchased via infoUSA (www.infousa.com). The dataset, which was updated in 2006, contained information on types of fast food restaurants among sampled block groups. The data were compiled using proprietary 4-digit extensions to the Standard Industrial Classification (SIC) codes, which included various fast food chain restaurants or franchises such as McDonald's, Burger King, and Wendy's. The compiled data were then spatially geocoded and integrated within a Geographic Information System (GIS) using ArcView software.[42] For the analysis, the number of fast food outlets was divided by area in square miles to obtain a density measure of fast-food outlets for each of the 120 neighborhoods. To enhance the interpretability of the odds ratio, the measure was standardized. Resulting scores were further divided into high or low quartiles (determined by the interquartile range) with the high quartile representing high-density and low-quartile representing low-density of neighborhood fast-food outlets.

Land use mix: Data were generated using existing geographic databases managed by Portland's Regional Land Information System (RLIS; www.metro-region.org), which contains complete and current street address information as well as other data layers (i.e., tax assessor's data, regional land use data from digital aerial photography, employment data, census data). All parcel data were spatially integrated within the GIS to characterize the urban built environment of the sampled study area. To generate a land use mix index, the formula developed by Frank et al.[43] was used. Values near zero on this index reflected single-use environments (such as residential suburbs) whereas values near 1 reflected maximal mixed usage. Therefore, the latter represented greater neighborhood land use mix.

Residential density: A residential density measure was developed by calculating the number of persons per residential acre in each block group.

Other sociodemographics: Three additional measures were developed using 2000 census data to represent neighborhood-level socioeconomic characteristics: (a) median household income, (b) percentage of non-Hispanic black residents, and (c) percentage of Hispanic residents. These socioeconomic and land use type measures (land use mix, residential density) were used as study covariates.

Analysis

Given the multilevel design of the study, a multilevel random effects logistic model (with logit link function) was constructed with neighborhoods as level-2 units and residents nested within each neighborhood as level-1 units. The two-level logistic regression model consisted of the binary response variable of obesity (1 = BMI $\geq$30; 0 = BMI < 30) that was predicted from the neighborhood-level independent variables of density of fast-food outlets, land use mix, and sociodemographics (i.e., median household income, percentage of non-Hispanic black residents, percentage of Hispanic residents), and individual-level independent variables of eating-out at fast-food restaurants, eating self-efficacy, fried food consumption, physical activity, fruit and vegetable intake, and sociodemographic variables (i.e., age, gender, education, household income, race/ethnicity, home ownership, employment status, health status). A number of *a priori* specified cross-level interaction terms were constructed in addition to main effects; specifically, density of fast-food outlets by: (a) eating out at fast-food restaurants, (b) meeting recommended physical activity, (c) eating fruit and vegetable self-efficacy, (d) fried food consumption, (e) race/ethnicity, and (f) household income. Model testing was conducted using Hierarchical Linear and Nonlinear Modeling software.[44]

Results

The majority of study participants were male (57%) and non-Hispanic white (92%), with a mean age of 62 (±7) years, some college or higher (77%), and a household income of $30,000 or higher (73%). Of the total sample for this study, 38.2% (n = 466) were classified as obese (BMI $\geq$ 30). Furthermore, approximately 36% of the respondents reported not meeting physical activity recommendations. A majority of the participants (72%) reported fried food consumption (servings range: 1-23 times per week) and approximately 24% of the sample (n = 296) reported visiting their neighborhood fast-food restaurants 1-2 times weekly or more. The sample had a low mean score of 2.57 (±2) on the self-efficacy of eating fruits and vegetables measure.

Descriptive statistics on individual characteristics across the low- and high-quartile range of neighborhood fast-food outlet density are presented in Table 1. As can be seen, a shift from the low- to high-quartiles of neighborhood fast-food density was associated with an increase in the rate of obesity among residents who made frequent visits to fast-food restaurants, did not meet recommended levels of physical activity, and who had lower self-efficacy in eating fruits and vegetables. Also notable was the observation that the prevalence of obesity among non-Hispanic black residents increased for neighborhoods with a high-density of fast-food outlets.

Of the six *a priori* specified interaction terms in the original model, density of fast-food outlets by fried food consumption and by household income were not found to be statistically significant ($p = .43$, $p = .21$, respectively). The model was reestimated by removing these two non-significant interaction terms. Odds ratios (interaction terms) generated from the multilevel logistic model testing are shown in Table 2. The results showed a number of statistically significant cross-level interaction effects, adjusting for the various resident- and neighborhood-level covariates. The estimated odds ratios indicate that residents living in high-density fast-food outlet neighborhoods who visited fast-food or buffet restaurants 1-2 times weekly were 1.878 (95% CI: 1.006, 3.496, $p < .05$) times more likely to be obese than those who lived in low-density fast-food outlet neighborhoods. Similar results for high-density fast-food outlet neighborhoods compared to low-density fast-food outlet neighborhoods were found for residents that did not meet recommended levels of physical activity, OR=1.792 (95% CI: 1.006, 3.190, $p < .05$); reported low self-efficacy in eating healthy food, OR =1.212 (95% CI: 1.057, 1.391, $p < .005$); or were non-Hispanic black residents, OR =8.057 (95% CI: 1.705, 38.086, $p < .005$).

Discussion

This study builds on previous research by exploring the hypothesis that older adult obesity may be the result of the interaction between individual eating habits, not meeting physical activity guidelines, self-efficacy in eating healthy food, and ethnicity, and the built-environment feature of density of local area fast-food outlets. Findings provided support for the individual-environment cross-level interaction hypothesis in that, among neighborhoods with higher fast-food restaurant density, there was a strong association among older adults visiting fast-food or buffet style restaurants, lower self-efficacy of eating fruits and vegetables, not meeting physical activity guidelines, and the likelihood of being obese.

Results from this study suggest that, while older adult lifestyles and psychological factors may contribute to increased weight and obese risk, the availability of fast-food outlets in neighborhoods where they live may further increase the likelihood of being obese. The multilevel influences of the built environment and individual characteristics on the obesity problem have not been reported in part because, methodologically, most studies lack a multilevel design and level-specific measures that are delineated at each level of the data hierarchy. The use of the multilevel design in this study allows the relative importance of both neighborhood- and resident-level factors in relation to obesity to be examined simultaneously.[45]

While findings from this study are in agreement with various ecologic-based predictions[33,46,47] and congruent with empirical findings that frequent fast-food consumption is associated with higher weight status,[16,26,28,30,31] the current study extends the extant research by specifically examining cross-level interactions between individual-level behavioral and psychological factors and local area fast-food outlets at the neighborhood level that are hypothesized to jointly contribute to obesity. The study findings also add to the growing body of knowledge on the race/ethnicity and obesity relationship commonly examined,[20,21,34] demonstrating that African-Americans living in neighborhoods with greater densities of fast-food outlets are more likely to be obese compared to other races/ethnicities.

Limitations

Findings in the current study are limited by the cross-sectional design, which precludes drawing conclusions about causality. For example, we could not conclude that the distribution of restaurant availability determines the frequency with which individuals make weekly trips to fast-food outlets and, consequently, increase body weight. A more rigorous approach in future studies in this line of research would be to design longitudinal studies that specify a temporal lag between the cause (i.e., obesogenic environment and individual characteristic factors) and effect (i.e., change in BMI or obesity), so that, for example, a longitudinal analysis of change in restaurant density and individuals' eating-out behavior, and change in weight status can be conducted to infer causal processes associated with restaurant availability, individual behavior, and obesity. While change in modifiable individual lifestyles (e.g., food consumption, physical activity) can be made through short observation units (e.g., months), it may require substantially longer periods (i.e., years) to observe change in built environment characteristics, if any. This poses a great challenge in the study of interaction effects of individual and environmental food outlet factors on obesity.

Additionally the focus on characteristics of the built environment associated with the presence of fast food outlets presents limitations. For example, we have not considered information regarding the built environment surrounding participants' places of work or homes, such as the absence of neighborhood sidewalks that may contribute to being more sedentary or more likely to want to order food in or drive to fast-food outlets. Similarly, neighborhood environment features, such as being automobile-dependent or live-and-work, suburban-style environments, could also affect individuals choosing to eat lunch out or patronize restaurants after work. Future studies should consider modeling these factors into the overall built environment, individual eating-out behaviors, and obesity.

Finally, this study was limited by the use of participant self-reports as measures of fast-food restaurant visits. Also, because the exact location of each restaurant visit was not recorded, we could not verify whether the reported locations were within the sampled study area. Greater confidence may be placed in the findings if future studies use GIS-based measures to capture whether the locations of fast-food outlets visited are within a specified radius of respondents' residences and linking them to the neighborhood-level density of fast-food outlets.

Significance and Implications

The public health significance of this study is the indication that individuals' unhealthy lifestyles (i.e., physical inactivity, poor dietary habits) and lack of confidence about eating healthy food may be exacerbated by an obesogenic environment, such as, in this case, the increasing density of neighborhood fast-food outlets. In this regard, the findings add to the growing body of literature about obesity and healthy living communities, suggesting the need to emphasize the important role of built environment influences that facilitate unhealthy lifestyles and the obesity epidemic. From a public health perspective, the results suggest the need for public health authorities to develop better food and land use regulations that limit the growth of fast-food outlets in neighborhoods, and/or encourage a more healthful eating environment.[31] Unless consideration of obesogenic aspects of the built environment are addressed, the success of community-wide educational programs informing individuals about healthy lifestyles, including healthy eating practices and increasing physical activity, is likely to be muted.

Conclusion

This study is a step in alleviating the paucity of multilevel research on evaluating the influence of neighborhood built environment factors, specifically fast-food outlets, on obesity in middle-aged and older adults. The findings underscore the importance of examining the availability of fast-food restaurants in moderating the relationship between individual-level lifestyle indicators, self-efficacy, and other well-established demographic characteristics (e.g., race/ethnicity) and obesity. Collectively, these finding suggest that a high concentration of fast-food outlets in community neighborhoods, combined with unhealthy lifestyles and poor psychosocial profiles, contribute to an increased risk of obesity. Public health promotion that targets reducing obesity needs to incorporate policy change or regulation initiatives that restrict the proliferation of fast-food outlets in neighborhoods.

So What?

This study extends previous research by showing how the density of neighborhood fast-food outlets moderates the relationship between individual-level behavioral, psychological and sociodemographic characteristics, and obesity in middle aged and older adults. The findings highlight the importance of considering the role of an obesogenic environment – density of fast-food outlets, and the mechanisms through which it may influence behavior and health. By better understanding the interaction between food environments, lifestyle and other salient characteristics, we are more likely to develop effective land use and public health policies that limit the impact of detrimental elements of the local food or nutrition environment on the public's health.

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Table 1

Aggregated Descriptive Statistics on Obesity by Individual Characteristics Across High- and Low-Density of Neighborhood Fast-Food Outlets

	Density of Neighborhood Fast-Food Restaurants	
	Low-Density	**High-Density**
Aggregated Individual-Level Measures at the Neighborhood level	**Prevalence of Obesity (number of neighborhoods)**	
Visits to fast-food restaurants		
Yes (n = 113)	36.08 (n = 58)	43.40 (n = 55)
No (n = 7)	23.75 (n = 2)	41.71 (n = 5)
Meeting recommended physical activity		
Not meeting (n = 115)	35.80 (n = 56)	42.87 (n = 59)
Meeting (n = 5)	33.75 (n = 4)	36.67 (n = 1)
Low self-efficacy in eating fruits and vegetables		
Above or at median (n = 62)	35.51 (n = 26)	45.79 (n = 36)
Below median (n = 58)	35.78 (n = 34)	39.47 (n = 24)
Fried food consumption		
Yes (N = 120)	35.67 (n = 60)	43.26 (n = 60)
No	0	0
Race/ethnicity		
Non-Hispanic black (n = 29)	33.34 (n = 11)	47.19 (n = 18)
Others (n = 91)	36.19 (n = 49)	41.54 (n = 42)

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Table 2

Multilevel Logistic Regression Analyses of Associations between Obesity and Resident-Level Measures of Characteristics and Neighborhood-Level Measures of Density of Fast-Food Outlets

	Obesity (BMI ≥ 30)				
Cross-level interaction effect	**b coefficient**	**Standard Error**	**t-value**	**Odds Ratio**	**95% CI**
Density of fast-food outlets by visits to fast-food restaurants	0.629	0.318	1.980	1.878	1.006, 3.496
Density of fast-food outlets by not meeting recommended physical activity	0.583	0.294	1.982	1.792	1.006, 3.190
Density of fast-food outlets by self-efficacy of eating fruits and vegetables	0.193	0.070	2.752	1.212	1.057, 1.391
Density of fast-food outlets by race/ethnicity (non-Hispanic Black)	2.087	0.792	2.633	8.057	1.705, 38.086

* Odds ratios were adjusted for the following variables: at the resident-level: age, gender, education, household income, employment status, home ownership, alcohol and tobacco use, vegetable intake, and fried food consumption; at the neighborhood-level: land use mix, residential density, median household income; percentage of non-Hispanic black residents; and percentage of Hispanic residents.