Fast-Food Consumption and the Fast-Food Environment

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Abstract

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Epidemiology

Background: Nearly one-third of Americans are obese, and two thirds are overweight. While sedentary lifestyles are part of the cause, a diet of processed foods, such as fast-food, also shares much of the blame. Fast-food restaurant exposure has been positively correlated with higher BMI and lower socioeconomic status. However, there is a lack of causal evidence linking residing in a fast-food dense area with increased frequency of fast-food consumption. Also, emerging evidence suggests that fast-food restaurant variety may play a larger role than density in understanding consumption. Little research exists on how socio-economic factors, such as neighborhood level deprivation, may affect this relationship.

Methods: The population included 748 same-sex twin pairs living in the Puget Sound. Data on fast-food density, fast-food variety, and fast-food consumption frequency came from the University of Washington Twin Registry and public and commercial geospatial data bases. Fast-food density was calculated as the number of fast-food restaurants available within a 3km radius of each subject's home address, and fast-food variety was the number of different chains available within that same radius. Fast-food density and variety were regressed against fast-food consumption frequency, using a generalized estimating equation and ordinary least squares through the origin to account for both between and within twin pair correlations in upbringing and genetics. All models controlled for individual measures of sex, income, and education. Mean neighborhood property values were added to the last model.

Results: No statistically significant associations were found between fast-food density/variety and consumption, regardless of model, adjustments, or neighborhood size. Both the GEE and logistic regression analyses indicated that an increase in the presence of fast-food restaurant was associated with decreased consumption, although the results lacked statistical significance and were of negligible magnitude.

Discussion: The lack of association between fast-food restaurant density/variety and consumption may be due to several factors, including the impact of exposures at other locations (e.g., work and school), the low fast-food consumption in the sample, and the convenience of automobiles diminishing the impact of neighborhood-level exposures. How the fast-food environment may influence consumption needs to be better understood to guide future efforts against obesity.

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Introduction

Over one-third of adults and roughly 17% of children in the U.S. are currently classified as obese by body mass index (BMI, kg/m^2) standards[1]. Obesity is linked to a host of different health problems including type 2 diabetes, sleep apnea, stroke, liver disease, and cancer [2]. Obesity is due to a chronic energy imbalance wherein energy intake through consumption of food and beverages exceeds energy expenditure through physical activity and normal biological processes (e.g., the thermic effect of food and basal metabolic rate). With respect to energy intake, poor dietary habits, including increased consumption of meals at fast-food restaurants, has been linked to obesity [3]. Indeed, the rise in fast-food consumption has closely mirrored the rise in obesity in the U.S. [4]. Consequently, there has been an outpouring of media and legislative opposition to the fast-food industry as witnessed by books such as *Fast Food Nation* [5] and legislation such as menu labeling [6].Also, many residents oppose the spread of fast-food restaurants in the local environment. Yet there is a lack of causal evidence linking residing in an environment with many fast-food restaurants with poor dietary habits and health outcomes. Studies examining the effects of neighborhood level fast-food restaurant density on health have typically been cross-sectional designs and have focused on either BMI/prevalence of obesity or the frequency of fast-food consumption as outcomes. In both cases, the methods have been problematic and the results have been mixed, as discussed next.

Importantly, although fast-food consumption has been linked to obesity, studies must control for the many variables also affecting obesity status including physical activity [7], fruit and vegetable consumption [8], and genetic and environmental influences [9]. Additional factors such as area-level deprivation, represented by a number of established indices and more recently as home property values [10, 11], may also play a role in the location of fast-food restaurants, as fast-food restaurant density is often higher in areas that are more deprived [12-14]. Home property value is a particularly good indication of deprivation because it has been found to correlate strongly with self-reported health status, at least in the Puget Sound area[10]. However, no studies have yet examined how deprivation may modify the relationship between fast-food restaurant density and fast-food consumption. In addition, using BMI as an endpoint is problematic because BMI status is the result of cumulative rather than acute eating and physical activity habits. Thus, measures of recent fast-food consumption may not be appropriate in examining the fast-food – health relationship and instead measures reflecting longer-term consumption patterns are needed.

Among the studies looking into fast-food consumption and fast-food restaurant density, results have again been mixed. Two recent studies found that increased fast-food restaurant density correlated with increased fast-food consumption among certain sub-populations, specifically those more sensitive to physical rewards (eg., fat and sugar) and low income populations [15, 16], while numerous others have found no link [16-22]. However, some of these studies have only examined children [17, 20-22], which is problematic because children typically do not have complete control over their food choices, and the degree of choice they do have varies widely based on their school and home environment. Other studies are problematic because they have limited fast-food consumption to only those fast foods purchased from the five largest chain restaurants and subsequently consumed at home [19], thus leaving out consumption patterns at all fast food restaurants, or have used very restrictive inclusion criteria with corresponding low participation rates; both of these issues have the potential to skew and bias the results [16]. For example, those with cardiovascular or metabolic disorders were excluded from one study, and given the correlation between regular fast food consumption and cardiovascular disease [23], this may have led to the exclusion of a high fast food consumption group. Another study of interest used data from the National Longitudinal Study of Adolescent Health, finding no association between fast food restaurant density and frequency of consumption in a large study of adolescents aged 18 to 28 [18]. These participants were recruited in middle and high schools and followed over time. Again, contrary to popular belief, fast-food restaurant density did not correlate with increased consumption of fast food. Collectively, most studies have not found a significant link between fast-food consumption and fast-food restaurant density, and most too have suffered from a variety of problems. Studies that have reported significant relationships between fast-food consumption and fast-food density have limitations, including being generalizable to the broader population.

A novel factor recently proposed [19] to explain the frequency of fast-food consumption is the variety of fast-food restaurants available in the local environment, rather than the sheer quantity or density of fast-food restaurants. For example, the number and variety of fast-food restaurant chains available in the proximal home environment was a significant predictor of fast-food consumption, whereas fast-food restaurant density was not, in a recent cross-sectional study [18]. To address some of the methodological problems of previous studies, the proposed study aims to examine the relationship between fast-food restaurant density, fast-food restaurant variety, and fast-food consumption in a twin sample. Twins are well suited for health studies because they are either identical (monozygotic, MZ) or very similar genetically to one another (dizygotic, DZ), and when reared together are increasingly similar in terms of shared environmental (familial) factors. The primary hypothesis is that twins with higher fast-food restaurant density and variety in their proximal home environment will have higher fast-food consumption (meals/week), compared to their co-twins living in environments with lower fast-food restaurant density and variety. We also hypothesize that controlling for home neighborhood property values will attenuate the fast-food restaurant density/variety and consumption relationship.

Methods

Sample. This study used secondary data from the University of Washington Twin Registry (UWTR). The UWTR was established in June 2002 with the goal of creating a large database of twins in the U.S. that could be used to study multiple factors that influence health. The UWTR works with the Washington Department of Licensing (DOL) to identify twins through driver license and ID applicants. An individual identified as a member of a twin pair (the index twin) through the DOL is mailed an invitation and health questionnaire that collects data on a number of health conditions, lifestyle behaviors, and psychosocial factors. Contact information on the co-twin is provided by the index twin, and once the survey on the co-twin is received, the pair is added to the UWTR database. The specifics of the UWTR, including recruitment and detailed statistics of the population, were previously described [24]. For this study, only same sex twin pairs were used, which allowed us to control for any sex effects on outcomes and exposures.

Setting. The study geographical extent included the four counties of the Puget Sound region (King, Kitsap, Pierce, and Snohomish counties). These counties encompass the urbanized area around Seattle. Together, they house about half of the Washington State population and offer diverse urban and suburban conditions. Fine-grained GIS data were available for this region, which included attributes of residential units, eating establishments, and transportation infrastructure.

Exposures. The primary exposure in this study is fast-food restaurant density and proximity within each twin's proximal home environment. The twin's home addresses were geocoded by the Urban Form Lab (UFL) using in ArcGIS 9.3.1 and ESRI StreetMap Premium North America NAVETQ 2009 Release 1. Data on fast food establishments came from InfoUSA (2011). Fast food restaurants were classified by the UFL as those nationally or regionally recognized chains that sell inexpensive, quickly served foods with no table service. Known fast food chains were selected based on the establishment name such as A&W, Arby's, Burger King, Carl's Junior, Chipotle, etc. Restaurants classified as fast-food and included in the study are shown in Table 1. The UFL geocoded fast-food restaurants by their address using ArcGIS 9.3.1 and each county's parcel-based tax assessor's data. Fast-food restaurant density was calculated in GIS as the number of fast-food restaurants available within a 3km, 2km, and 1km radius of each twin's home. While 3km is the neighborhood size of main interest because it is often used as the cutoff for studying neighborhood level effects within driving distance of respondents' homes [18, 19, 22], 2km and 1km neighborhoods were also included to examine the effect of neighborhood size on fast food restaurant distribution and related consumption patterns. Network distance (in km) to the nearest fast food restaurant from each twin's home was calculated in ArcGIS 9.3.1 using ESRI StreetMap Premium North America NAVETQ 2009 Release 1. "Nearest" was defined by the fastest route subjects would drive from their home to a fast-food restaurant. Fastest routes were then measured in km using the street network assigned to the fastest connection between home and restaurant The secondary exposure was fast-food restaurant variety, calculated as the number of chains available within each radii (3km, 2km, 1km) of the subject's home address [18]. For example, a subject with 3 McDonald's, 2 Burger Kings, and 2 Pizza Huts within their home neighborhood would have a fast food variety score of 3.

Outcomes and covariates. The primary outcome measure was derived from questions regarding fast food-consumption, recorded as a scalar variable of 0, 1-2, 3-4, or 5+ meals consumed in a typical week. Demographic variables including zygosity and race were included as covariates, along with both individual and neighborhood level SES measures that are known to influence the fast-food restaurant density and fast-food consumption relationship - education and income level were derived from the UWTR surveys and represented individual level SES; mean home property values came from the Puget Sound four counties' parcel-level tax assessor's records and were used as a measurement of area level deprivation [25, 26]. Mean home property value was calculated as the average property value in a 3km, 2km, or 1km radius, matched to the neighborhood radius being used for fast-food restaurant density or variety.

Statistical analyses. Demographic information was expressed as means and standard deviations or medians (continuous variables) and percentages (categorical variables) where appropriate. Within-pair correlations in fast-food consumption were calculated to measure the correlation in fast-food consumption within twins and between MZ and DZ pairs as an estimate of heritability. Fast-food restaurant density and variety were regressed against fast-food consumption frequency using methods described by Carlin and colleagues[27]. First, a generalized least squares (GLS) approach with a generalized estimating equation (GEE) was used to estimate the common (twins as individuals), unadjusted regression coefficient. This method explicitly allows for the correlation structure of twin data. GEE models were subsequently adjusted for individual measures of income, sex, and education, and a third model was run with mean neighborhood-level property values to adjust for the area level deprivation for each subject. Second, twin paired-difference values were analyzed using ordinary least squares (OLS) through the origin regression. These models were run for all twins combined and then stratified by zygosity. In both GEE and OLS analysis, fast-food consumption was transformed into a continuous variable by picking mid-point numbers to substitute for the ranges (0, 1.5, 3.5, 7). Seven was chosen to represent the 5+ category based on NHANES data on frequency of fast food consumption showing that approximately two thirds of those who consumed fast food five or more times a week did so between six and eight times a week [28]. Finally, logistic regression for the consumption of any fast-food versus consuming no fast-food was run with fast-food restaurant density and variety as the predictors, adjusting for income, sex, and education. All statistical work was done using Stata (version 11.0, 2009, Stata Corporation, College Station, TX).

Results

Descriptive Statistics. In total, 1,496 individuals, comprising 748 twin pairs, met criteria for inclusion in the study. Demographic information is provided in table 2. These individuals had a mean age of 30.4 years, and were predominantly white (85.8%) and female (63.7%). Based on the self-report questions and classification algorithm described previously [23], about 75% of the sample could be classified as MZ. The income level of the twins was high, with roughly one-third of the sample having an annual income of over $80,000, and over half of the sample making over $50,000 a year. Education level was also high in our sample, with about 77% having at least some college education. Median property values within a 3km radius of each twin's home address was $257,073, expectedly higher than the Washington state median of $208,300 [29].

Twins had on average 5.4 fast-food establishments within a 3km radius of their home, represented by 4.6 different chains. The mean distance to the nearest fast-food restaurant from each twin's home address was about 2km. Fast-food consumption was relatively low in the sample, with about 85% of twins consuming 2 or less fast –food meals per week and nearly half consuming no fast-food at all. The within-pair correlation for fast-food consumption was 0.38 [p=0.000, 95% CI: 0.30, 0.44]; only a minor difference in the correlation coefficient was noted when stratified by zygosity (r_{mz} = 0.39 [p=0.000, 95% CI: 0.31, 0.45] and r_{dz} = 0.35 [p=0.000, 95% CI: 0.26, 0.32]).

Fast Food Restaurant Density. The GEE analyses are shown in Table 3. There was no association between fast-food restaurant density within 3km of the home location in both the unadjusted model and the model adjusted for age, sex, and education. However, the association between fast-food restaurant density and fast-food consumption for the model adjusted for age, sex, income, and neighborhood property values within a 3km radius of the home was significant (β=0.027, p=0.004); similar results were found using the other distance measures (2km: β = -0.033, p=0.027; 1km: β =-0.074, p=0.037). No models for OLS through the origin, shown in Table 4, reached statistical significance.

Logistic regression models comparing any fast-food consumption versus none, shown in Table 5, indicated small but non-significant (Ps > 0.05) decreases in odds of any fast-food consumption with higher fast-food restaurant density around the home location using the three distance measures.

Fast Food Restaurant Variety. The GEE analyses showed that fast-food restaurant variety was not associated with frequency of consumption at any distance, regardless of what adjustments were made (Ps > 0.05). Similarly, the OLS through the origin model did not show any associations between within-twin pair differences of fast-food restaurant variety and consumption (Ps > 0.05). Finally, logistic regression models comparing any fast-food consumption versus none also failed to reach statistical significance at any distance threshold using fast-food restaurant variety as the predictor (Ps > 0.05).

Discussion

Contrary to our hypothesis, we found that neither fast-food restaurant density nor variety had any noticeable impact on fast-food consumption in this sample of twins. Changing the radius of the neighborhood and adjusting for area level deprivation also failed to produce any meaningful associations between fast-food restaurant density/variety and consumption, indicating that mean property value did not alter the fast-food density/variety and consumption relationship. Although statistical significance was achieved in several models, the actual magnitude of the impact was minimal. For example, for fast-food restaurant density, the largest statistically significant point estimate corresponded to a decrease of 1.8 meals per year for each additional fast-food restaurant within the proximal home environment. In fact, contrary to the hypothesized direction of association, all GEE models indicated that increased fast-food restaurant density and variety corresponded to lower consumption, although the OLS through the origin model did not confirm this. Logistic regression models for consuming any fast-food did show that increased fast-food restaurant density appeared to reduce frequency of consumption, although the magnitude of the impact was also minimal. These findings support numerous other studies that have failed to find an association between fast-food restaurant density and consumption, thus casting doubt as to the role that fast-food restaurant density may play in fast-food consumption. Similarly, these findings do not support the concept that fast-food restaurant variety is associated with fast-food consumption.

Several reasons may explain why we failed to find any associations between fast-food restaurant density/variety and consumption. First, many different factors drive food choices, including marketing, price, convenience, societal and peer influences, and taste-preferences, among others[30, 31]. Therefore, density and variety of fast-food restaurants around the home, which are essentially measures of access, may not be strong enough to over-ride other influences and have any significant impact on fast-food consumption, at least in our sample of twins. Second, our study only looked at the density and variety of fast-food restaurants around twins' home addresses. It is very likely that our twins spent significant amounts of time outside their home, including at work, at school, or running household errands. Therefore, we only measured a small part of their overall fast-food exposure. It is possible that exposures at other locations such as work or school may have a more powerful impact on consumption than does the home neighborhood exposure. Third, the availability and convenience of automobiles may significantly weaken the neighborhood level effects we tried to assess. As is the case in many metropolitan areas, automobile ownership rates in the Puget Sound are high; for instance, in Seattle, nearly 85% of households own at least one automobile. This ready access to automobiles may diminish the significance of neighborhood level food exposures because individuals can easily stop at a fast-food restaurant while driving around for a number of different purposes (e.g., doing errands, coming home from work, visiting friends, etc.). Fourth, fast-food restaurants typically cluster with other similar restaurants, possibly diminishing the relationship between fast-food restaurant density/variety and consumption, as respondents may have chosen to go to other non fast-food restaurants in their neighborhood [32]. Finally, our sample was biased towards groups that typically have low fast-food consumption – white women with high education and high income [25, 26] - and this lack of variability may have played a role in our lack of findings.

Strengths and Limitations. The main strengths of the present study are that we used a large database of adult twins, who presumably had complete autonomy over their dietary choices, unlike children. In addition, twins are very well matched in terms of genetics, and in most cases, their upbringing and life experiences growing up. Thus, by comparing fast-food restaurant density, variety, and consumption across pairs of twins, we were able to control for any innate preferences for fast food that may have developed during childhood or due to a genetic predisposition.

There are several limitations to this study as well. Fast food consumption was self-reported as the average number of times a person consumed fast food over the last 4 weeks, and recall error/bias is present in all self-report measures. Fast-food consumption was recorded as a scalar variable, and the transformation into a continuous variable resulted in discrete values rather than a true continuum of numbers, which may have affected the precision of statistical tests. Finally, the makeup of the UW Twin Registry is not representative of the population as a whole, being largely white females who were younger, more educated, and who had higher incomes than the general population.

Implications. The findings of this study demonstrate that neighborhood level exposure to fast-food restaurants, whether through density of restaurants or variety of chains, does not have a significant impact on fast-food consumption. Therefore, strategies to decrease fast-food consumption may be better off targeting the demand for fast-food, rather than access to the restaurants themselves. Additionally, future research into the fast-food environment may need to take into account more than just home exposures, and instead expand to include the workplace, school, shopping malls, and any other areas that subjects travel to on a regular basis. Any such models will invariably be complicated, but such complexity may be necessary to capture the intricacies of the modern food environment.

Conclusion. Contrary to logic and popular belief, the availability of fast-food restaurants in the proximal neighborhood is not associated with the frequency of fast-food consumption, at least in this sample of twins. This may be indicative of several things, including the strength that media, taste-preference, and societal influences have on food choice, which may override the convenience of having additional fast-food restaurants in the neighborhood. This may also point towards our incomplete knowledge of the intricacies of the fast-food environment, and how fast-food exposure in the many different places we travel to on a daily basis may tie-in together to influence our food choices. For now, what it does indicate is that in the fight against obesity, strategies targeting consumer preference for fast-food may be a more effective approach than access per se, at least until the fast-food environment can be better understood.

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Table 1. Fast-food restaurant chains located in the Puget Sound.

Fast-food restaurant chain	Number of establishments in the Puget Sound
A&W	3
Arby's	24
Burger King	44
Carl's Jr	4
Chipotle	8
Church's	3
Del Taco	2
Domino's	58
Fatburger	5
Five Guys	3
Herfy's Burgers	20
Jack in the Box	89
KFC	43
Kidd Valley	8
Little Caesar's	32
McDonald's	26
Panda Express	21
Papa John's	37
Pizza Hut	52
Popeyes	9
Qdoba	15
Sonic	2
Taco Bell	44
Taco Del Mar	51
Taco Time	52
Weinerschnitzel	1
Wendy's	41

Table 2. Select demographic characteristics of the sample (n=1,496).

Characteristic	Mean	Standard Deviation
Age (years)	30.4	13.6
BMI	25	5.6
Fast-food restaurants density within 3km*	5.4	4.8
Fast-food restaurant variety** available within 3km*	4.6	3.4
Distance to nearest fast-food restaurant (km)*	1.9	2.3
Days per week exercised moderately for 30 minutes	2.7	2.1
Days per week exercised vigerously for 30 minutes	2.4	2.0
Servings per day of:		
Fruit	1.3	0.7
Vegetables	1.4	0.7
Soda	0.6	0.8

* All distance measures are calculated in proximity to the home address.

**Fast-food restaurant variety is defined as the number of chains available within a radius of each subject's home address

Table 3. Associations between fast-food restaurant density and variety with fast-food consumption among twins.

		Model 1: Unadjusted	Model 2: Adjusted for education and income, gender	Model 3: Adjusted for education, income, gender, and property value
3km radius*	Fast-food density	-0.0146248 (p=0.087)	-0.0136057 (p=0.124)	**-0.0268962 (p=0.004)**
	Fast-food variety**	-0.0077513 (p=0.526)	-0.0063662 (p=0.613)	-0.024652 (p=0.066)
2km radius*	Fast-food density	-0.0127911 (p=0.35)	-0.0127859 (p=0.369)	**-0.0328595 (p=0.027)**
	Fast-food variety**	-0.0043435 (p=0.799)	-0.0038164 (p=0.826)	-0.0281481 (p=0.124)
1km radius*	Fast-food density	-0.0254918 (p=0.455)	-0.0351529 (p=0.309)	**-0.0740278 (p=0.037)**
	Fast-food variety**	-0.0163499 (p=0.661)	-0.0281168 (p=0.454)	-0.071171 (p=0.066)

* All distance measures are calculated in proximity to the home address.

**Fast-food restaurant variety is defined as the number of chains available within a radius of each subject's home address

Table 4. Associations between within-twin pair differences in fast-food restaurant density and variety* with fast-food consumption.

		Overall	MZ	DZ
3km radius**	Fast-food density	0.0117667 (p=0.388)	0.0245124 (p=0.187)	-0.0089912 (p=0.644)
	Fast-food variety	0.0127302 (p=0.550)	0.0174874 (p=0.508)	-0.0030895 (p=0.93)
2km radius**	Fast-food density	-0.010915 (p=0.957)	0.0040742 (p=0.88)	-0.0122326 (p=0.674)
	Fast-food variety	0.0019485 (p=0.942)	-0.0026666 (p=0.929)	-0.0110145 (p=0.825)
1km radius**	Fast-food density	-0.0053712 (p=0.903)	0.0384341 (p=0.497)	-0.094572 (p=0.168)
	Fast-food variety	0.00665 (p=0.895)	0.0527231 (p=0.388)	-0.123042 (p=0.163)

*Fast-food restaurant variety is defined as the number of chains available within a radius of each subject's home address

** All distance measures are calculated in proximity to the home address.

Table 5. Odds ratios for consuming any fast food*

	Fast food density	Fast food variety**
3km***	0.98 (0.96-1.0, *p*=0.072)	0.99 (0.96-1.02, *p*=0.725)
2km***	0.97 (0.93-1.0, *p*=0.064)	0.97 (0.93-1.01, *p*=0.778)
1km***	0.92 (0.84-1.00, *p*=0.066)	0.93 (0.84-1.02, *p*=0.124)

*Odds ratios comparing consuming no fast-food versus consuming 1-2, 3-4, or 5+ meals of fast food per week, adjusted for income, sex, and education

**Fast-food restaurant variety is defined as the number of chains available within a radius of each subject's home address

*** All distance measures are calculated in proximity to the home address.