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Association of food environment and food retailers with obesity in US adults

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ABSTRACT

The food environment has been shown to be a factor affecting the obesity rate. We studied the association of density of food retailer type with obesity rate in U.S. adults in local regions controlling for socioeconomic factors. Parametric nonlinear regression was used on publically available data (year=2009) at the county level. We used the results of this association to estimate the impact of the addition of a new food retailer type in a geographic region. Obesity rate increased in supercenters (0.25–0.28%) and convenience stores (0.05%) and decreased in grocery stores (0.08%) and specialized food stores (0.27–0.36%). The marginal measures estimated in this work could be useful in identifying regions where interventions based on food retailer type would be most effective.

1. Introduction

The prevalence of obesity in the United States has increased dramatically over the past two decades (Flegal et al., 2002; Nguyen and El-Serag 2010). In 2008, 32 states had obesity prevalence greater than 25%, while in 1990 no state had prevalence greater than 15% (Nguyen and El-Serag, 2010). In 2010, 35.7% of U.S. adults and 16.9% of children and adolescents were obese (Ogden et al., 2012). Obesity substantially increases the risks of heart disease, stroke, type-2 diabetes, and certain types of cancer (National Institutes of Health 1998). Individuals who are obese have significantly worsened health-related quality of life, and they are also more likely to have a functional limitation (Fontaine and Barofsky, 2001; Swallen et al., 2005). In addition, the annual medical costs for people who are obese were $1429 higher than those of normal weight in 2006 (Finkelstein et al., 2009).

Several studies have found that the disparities in the local food environment are a major contributor to poor diet and obesity (Block et al., 2004; Caspi et al., 2012; Chen et al., 2010; Evans et al., 2010; Franco et al., 2008; Larson et al., 2009; Pearce et al., 2007; Walker et al., 2010). The food environment, which is complex and multi-level in that it includes virtually all potential determinants of what people eat, is often influenced at the local level by the distribution of food retailers by type, relative prices of different food products, healthfulness and quality of food products, car ownership, and public transit access (Nguyen and El-Serag, 2010; Morland et al., 2002). The community food environment consists of the location, type, number and accessibility of food outlets (grocery stores, convenience stores, restaurants), while the consumer food environment is what consumers encounter around the places they purchase food. Minority and lower-income populations have greater difficulties in accessing high-quality fresh food, and the influence from food environment tends to be higher than their counterparts (Chen et al., 2010; Morland et al., 2002; Moore and Roux, 2006; Zenk et al., 2006; Powell et al., 2007). Further, persons living in rural areas have fewer supermarkets and grocery stores, and they generally need to travel longer distance to stores, as compared to those live in metropolitan areas (Powell et al., 2007; Ver Ploeg et al., 2009; Morton and Blanchard, 2007; Moore et al., 2008; Michimi and Wimberly, 2010; Liese et al., 2007).

Supermarkets and large grocery stores, which offer a wide variety of high-quality foods at lower prices, have been extensively studied in relation to obesity prevalence (Block and Kouba, 2006; Krukowski et al., 2010); health outcomes improve with increasing accessibility to supermarkets and grocery stores (Chen et al., 2010; Morland and Evenson, 2009; Brown et al., 2008; Moore et al., 2008; Morland et al., 2006). On the other hand, increased accessibility to convenience stores is generally associated with lowered fresh food intake and worse health conditions (Morland and Evenson 2009; Brown et al., 2008; Morland et al., 2006; Galvez et al., 2009; Jago et al., 2007). Studies of other types of stores, such as specialized food stores, are relatively limited, and differ in their conclusions (Moore and Roux, 2006; Block and Kouba, 2006; Morland and Evenson, 2009; Galvez et al., 2009; Evans et al., 2012).

Affordability of food is another important factor since the changes in relative prices of different foods affect demand.

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The consumption of energy dense and nutrient poor foods by low-income groups may be explained in part by those foods being less expensive and most resistant to inflation than nutrient rich foods (Liese et al., 2007). The relative difference in cost between healthy and unhealthy foods is higher in lower-income areas (Block and Kouba, 2006; Evans et al., 2012). Further, the cost of a healthier basket accounts for a significant portion of low-income consumers' food budgets (Jetter and Cassady, 2006). Some have suggested that taxing energy-dense, low nutrition food while providing subsidies to healthy food alternatives may help to control the increasing obesity rate (Powell et al., 2010).

The cause of the disparities in accessibility and affordability is a complex problem. For a variety of reasons, large food retailers are less likely to establish stores in poor communities (Cummins and Macintyre, 2002). The trend of supermarket chain stores moving locations from urban to suburban areas has effectively created "food deserts" in the inner city (Block and Kouba, 2006). The lack of convenient transportation results in traveling significant distances for both rural, low-income and urban residents for access to healthy and affordable food retailers (Eisenhauer, 2001; Sharkey and Horel, 2008; Clarke et al., 2002). As a result, people living in those areas have to rely on small grocery or convenience stores that usually supply a limited range of food at premium prices.

The majority of the previous studies on food environment and health outcomes have focused on selected counties or certain regional areas with data collected from a selective population (Chen et al., 2010; Moore et al., Jacobs; Morland and Evenson, 2009; Brown et al., 2008; Galvez et al., 2009), while very few have been conducted at a national level (Michimi and Wimberly, 2010). In this study, the obesity rate in U.S. adults is modeled using county level data via parametric nonlinear regression in order to identify nationally representative insights on food environmental effects. Several types of food retailers are included in the model: supercenters, supermarkets, convenience stores and specialized food stores. The relative price of healthy and unhealthy food, proximity and car ownership, and food assistance are also included into the model. Socioeconomic factors are also controlled for at the county level. The marginal effect of having additional food retailer types on obesity is estimated from the association determined from the nonlinear regression model.

2. Methods

We used county-level data from the U.S. Department of Agriculture (USDA), American Community Survey (ACS), Centers for Disease Control and Prevention (CDC), and U.S. Census Bureau County Business Patterns (CBP) for food environment, food assistance programs, and characteristics by county type (metropolitan or non-metropolitan). Socioeconomic factors including race, income, unemployment, and age are controlled for at the county level. The response variable for the study is county level obesity rate from the CDC (Centers for Disease Control and Prevention, 2014), where adults are defined as obese if their body mass index is 30 or higher. The complete variable list and corresponding summary statistics are shown in Table 1.

Obesity rate, food environment, and most sociodemographic variables differed based on metro versus non-metro counties (Table 1). For this reason, we analyzed them seperately. This is also consistent with previous literature (Powell et al., 2007; Morton and Blanchard, 2007; Michimi and Wimberly, 2010). Metro areas are defined for all urbanized areas regardless of total area population. Outlying counties are also classified as metro if they are economically tied to the central counties, as measured by the share of workers commuting on a daily basis to the central counties. Non-metro counties are outside the boundaries of metro areas and have no cities with 50,000 residents or more.

The North American Classification System (NAICS) is used by CBP to classify stores into four types. These include: (i) warehouse and supercenters (NAICS: 451910), (ii) supermarkets and grocery stores (NAICS: 445110), (iii) convenience stores (NAICS: 445120), and (iv)

Table 1
Description of data and summary statistics.

Variable	Description	Metro ($N=1972$)	Non-metro ($N=1069$)	
		Mean (SD)	Mean (SD)	Data Source
Response variable				
Obesity rate	Adult obesity rate	29.51 (4.21)	30.57 (3.92)*	CDC, 2009
0.5				
Food environment				
Low access to stores	% of Households, with no car and low access to supermarket or large grocery store	2.38 (1.57)	3.48 (3.72)*	USDA, 2010
Supercenters	Supercenters and club stores/1000 pop	0.02 (0.01)	0.02 (0.02)	CBP, 2009
Grocery stores	Supermarkets and grocery stores/1000 pop	0.18 (0.09)	0.33 (0.28)*	CBP, 2009
Convenience stores	Convenience stores/1000 pop	0.47 (0.19)	0.68 (0.35)*	CBP, 2009
Specialized food stores	Specialized food stores/1000 pop	0.06 (0.05)	0.06 (0.09)	CBP, 2009
Price ratio (milk to sodas)	Ratio of price of low-fat milk to price of sodas	0.92 (0.14)	0.90 (0.12)*	USDA, 2010
0.5				
Food assistance				
SNAP authorized stores	SNAP-authorized stores/1000 pop	0.60 (0.26)	0.90 (0.49)*	USDA, 2008
WIC authorized stores	WIC-authorized stores/1000 pop	0.16 (0.09)	0.34 (0.30)*	USDA, 2008
0.5				
Demographic characteristic				
Race ratio	Ratio of white to non-white population	7.75 (9.50)	13.13 (13.64)*	US Census, 2010
Population density	Population density (per square mile)	671.19 (2909.66)	45.50 (102.39)*	US Census, 2010
Median age	Median age	37.46 (4.07)	40.64 (5.10)*	ACS-5yr, 2009
Education less than high school	% Education less than high school graduate (aged 25–64)	12.31 (5.91)	14.60 (7.69)*	ACS-5yr, 2009
Unemployment rate	Unemployment rate (> 15, civilian)	6.93 (2.12)	6.80 (3.52)	ACS-5yr, 2009
Poverty rate	Poverty rate	14.60 (5.27)	17.62 (6.18)*	US Census, 2010
Sex ratio	Males per females of total population	97.98 (7.27)	100.78 (13.40)*	ACS-5yr, 2009

* Difference in means of metro and non-metro significant at $p=0.05$.