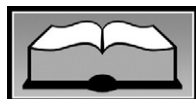


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Examining Associations among Obesity and Per Capita Farmers' Markets, Grocery Stores/Supermarkets, and Supercenters in US Counties

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ABSTRACT

Fruit and vegetable consumption is an important component of a healthful diet, yet fruits and vegetables are underconsumed, especially among low-income groups with high prevalence rates of obesity. This study used data from the US Department of Agriculture Economic Research Service Food Environment Atlas to examine county-level associations among obesity prevalence and per capita farmers' markets, grocery stores/supermarkets, and supercenters, adjusted for natural amenities, percent black, percent Hispanic, median age, and median household income, stratified by county metropolitan status. In models that included all three of the food venues, supercenters and grocery stores per capita were inversely associated with obesity in the combined (metro and non-metro) and metro counties. Farmers' markets were not significant in the model for combined (metro and non-

metro) or for metro counties alone, but were significantly inversely related to obesity rates in the model for non-metro counties. In this ecologic study, density of food venues was inversely associated with county-level obesity prevalence. Thus, future research should examine similar associations at the individual-level.

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Higher fruit and vegetable consumption is associated with a reduced risk of chronic disease such as cancer, heart disease, and obesity (1). However, one commonly cited barrier to increasing fruit and vegetable consumption is the higher cost of produce relative to less-healthy foods (2,3). Farmers' markets have been a commonly suggested way to make produce more available in low-income areas with few or no grocery stores or supermarkets (also called food deserts) (4-7) and have been shown to be effective at increasing fruit and vegetable consumption among low-income populations (8). Considering the 84% increase in farmers' markets in the past 10 years (9), it is important to examine the relationship between obesity prevalence and farmers' market locations. To our knowledge, the only study to examine the relationship between obesity prevalence and fruit and vegetable market locations was conducted in New York City. This New York-based study demonstrated that access to healthier food sources (including fruit and vegetable markets) was inversely associated with obesity (10).

Comprehensive review articles regarding the association between the food environment and obesity are available, and they conclude that more research is needed to fully understand complex relationships between food environment and obesity (7,11). The majority of studies are cross-sectional, and therefore do not meet the causal criterion of temporality (12) and, thus, do not confirm causality. However, in general, there are positive associations between obesity and proximity to convenience

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stores and fast-food restaurants (13) and inverse associations between obesity and proximity to supermarkets that offer a wider selection of lower-cost, healthy food (14).

Concurrent with the increase in obesity prevalence, there has also been an increase in the use of supercenters for general food purchases and for produce purchases specifically (15). One prior study examined the association between Wal-Mart Supercenters (Bentonville, AR) and obesity, finding that an additional Wal-Mart Supercenter per 100,000 residents was associated with a 2.4% increase in obesity prevalence (16). Using statewide panel data, others found that for every increase of one supercenter per 100,000 people, obesity prevalence increased by approximately 1% (17). This increase in obesity may be due to the low cost of food at supercenters, and/or increased bulk food purchases, both of which may result in overconsumption (18), or due to other factors (eg, supercenters may be located in geographic areas that have high obesity rates for other reasons). Prior studies examined associations between obesity and Wal-Mart Supercenters (16,17), yet did not include other supercenter types. Because the United States has a variety of additional supercenters and warehouse clubs (eg, Costco [Issaquah, WA] and Sam's Club [Bentonville, AR]), it is important to include all types of supercenters and warehouse clubs when examining associations between obesity and supercenters.

The study of obesogenic influences in the food environment is needed particularly among disadvantaged populations because low-income, minority (19), and rural/nonmetro (20) populations have greater obesity prevalence than do higher-income, nonminority, urban/suburban populations. Therefore, we conducted an ecologic examination of the associations among county-level prevalence of obesity and per capita farmers' markets, grocery stores/supermarkets, and supercenters among all counties in the United States; and to examine differences in associations by metro vs nonmetro status using the US Department of Agriculture Economic Research Service (USDA ERS) Food Environment Atlas.

METHODS

The USDA ERS Food Environment Atlas (www.ers.usda.gov/FoodAtlas/) is an online tool released in 2010 that contains 90 county-level, regional, and state-level variables related to food choice and availability, health, and community characteristics. Users can create maps to display access to food stores and restaurants, food assistance participation rates, food taxes, physical activity facilities, and socioeconomic characteristics. The Food Atlas includes the most recent year and geographic level available for each variable. Data included in the Atlas are from all 50 states, including 3,141 counties. For the current analyses, 35 counties were excluded from the analyses due to missing data for selected variables.

Community-level measurement of per capita farmers' markets and grocery stores/supermarkets was suggested by the recent report, "Recommended community strategies and measurements to prevent obesity in the United States" (21). Therefore, the following county-level measures from the USDA ERS Food Environment Atlas were included as independent variables in regression models to

examine variation in county-level obesity prevalence: farmers' markets, grocery stores/supermarkets and supercenters per 1,000 capita. Natural amenities, percent of population categorized as black, percent of population categorized as Hispanic, median age, and median income were county-level covariates also obtained from the Food Atlas. Metro and nonmetro status were used to examine rural-urban differences in associations among obesity and farmers' markets, grocery stores/supermarkets, and supercenters. Because we obtained deidentified, county-level data from the Food Atlas, this study was deemed outside university institutional review board jurisdiction.

According to the Food Atlas documentation page, farmers' markets are defined by ERS as retail outlets in which two or more vendors sell agricultural products directly to customers through a common marketing channel. The number of farmers' markets (in 2009) in each county was calculated by ERS using county-level data compiled by the Marketing Services Division, Agricultural Marketing Service of the USDA. The US Census Bureau county estimates for 2008 were used to determine the county population. The mean number of farmers' markets per 1,000 capita was 0.036 ± 0.070 .

Grocery stores/supermarkets are included in the ERS Food Atlas as establishments retailing a general line of food (eg, canned and frozen foods, fresh fruits and vegetables, and fresh and prepared meats). This category of food venue includes delicatessen-type establishments primarily selling a general line of food and excludes convenience stores, with or without gasoline sales, and also excludes supercenters and warehouse club stores. The number of grocery stores/supermarkets in the county per 1,000 county residents (in the year 2007) is included in the Food Atlas. The Food Atlas documentation states that grocery store/supermarket data are from the US Census Bureau's 2007 County Business Patterns dataset, and population data are from the US Census Bureau's 2007 Population Estimates. The mean number of grocery stores/supermarkets per 1,000 capita was 0.288 ± 0.243 .

Supercenters and warehouse club stores are defined by ERS in the Food Atlas as those engaged in retailing a general line of groceries in combination with general lines of new merchandise and excluding grocery stores and supermarkets. The number of supercenters and warehouse club stores in the county per 1,000 county residents is included in the ERS Food Atlas. ERS documentation states that supercenter data are from the US Census Bureau's 2007 County Business Patterns dataset, and population data are from the US Census Bureau's 2007 Population Estimates. The mean number of supercenters per 1,000 capita was 0.010 ± 0.017 .

There were several missing values for food venues (1,367 out of 3,141 counties had missing data for farmers' markets, 57 out of 3,141 for grocery stores/supermarkets, and 1,850 out of 3,141 for supercenters). Information provided by ERS staff indicated that missing values represented either zero or a very low number of food venues. To determine whether metro status was associated with missing values for food venue data, χ^2 tests between metro status and missing status were conducted. As expected, nonmetro counties were significantly more likely to have missing values for food venues (ie, farmers' markets, grocery stores/supermarkets, and supercenters)

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