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Sociodemographics and access to organic and local food: A case study of New Orleans, Louisiana

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ABSTRACT

This study examined the association between physical accessibility to organic and local food, and sociodemographic factors in New Orleans, Louisiana. Spatial regression models were used to investigate how sociodemographic variables such as income, race/ethnicity, education, and age correlate with driving, bicycling, and walking distances to stores that sell organic or local food. The distances were calculated from GIS and real-time speed information from Google Maps. The results indicated that physical access to such stores is positively associated with population density, median housing value, education, non-Hispanic Blacks, and Hispanics, and is negatively associated with median housing age. We found no disparities in access to organic and local food on the basis of income and race.

1. Introduction

Organic food and local food, which are associated with the values of naturalness and healthfulness, are among the fastest-growing food trends worldwide over the past decade. Accordingly, the worldwide net sales of organic food amounted to approximately 81.6 billion USD in 2015 (Lusk & Briggeman, 2009; Statista, 2018). In the United States, sales of organic food increased from 11 billion USD in 2004 to 27 billion USD in 2012 (USDA, 2015a); and there were 8144 farmers' markets listed in the USDA's *National Farmers Market Directory* in 2013, representing a 3.6% increase from 2012 (USDA, 2015b).

Organic food is produced and processed without the use of synthetic fertilizers, pesticides, hormones, genetically modified organisms, or ionizing radiation. *Local food* refers to food that is produced, processed, distributed, and consumed within a geographic area that is circumscribed by boundaries and in close proximity to the consumer. Feagan (2007) has pointed out the constructed nature and conflicting meanings of the words “local” in the discourse about local food systems. He argues the local is intrinsically tied to the extralocal and their interdependence complicates spatial delimitation of the local. A study conducted to determine the boundaries of local food in practice also indicated that multiple forces are at play in the travel distance of local food, such as economic ties to local participants and the locations of the trading partners (Trivette, 2015). In addition to geographic proximity of supplier and consumer, local food is also defined by social and supply chain characteristics such as production methods (Thompson, Harper, & Kraus, 2008). For instance, local food enhances food security and promotes the economic, environmental, and social health of a particular place (Hinrichs, 2000). It is also associated with sustainable production and distribution practices that are environmentally friendly and reduce the use of synthetic chemicals and energy-based fertilizers, as well as chemical and pesticide residue on food (Martinez et al., 2010). Similarly, organic food also has strongly local–spatial connotations, in addition to its association with ecologically sensitive conditions of production (Ilbery & Kneafsey, 1998). Thus, local food and organic food are significantly interconnected. The direct effect of the consumption of organic and local food on human health remains unclear (Magkos, Arvaniti, & Zampelas, 2006). However, it has been acknowledged that consumption of organic food would significantly reduce pesticide exposure and that local food has more nutrients and supports the local economy (Lu, Barr, Pearson, & Waller, 2008).

Previous studies have examined the role sociodemographic attributes play in the consumption of organic or local food, but the results on factors that influence consumer decisions have not been consistent (Bravo, Cordts, Schulze, & Spiller, 2013; Lea & Worsley, 2005; Nie & Zepeda, 2011). Education yielded the most important demographic characteristic that correlated with the consumption of organic food, with most studies suggesting that consumers with higher levels of education are more likely to purchase organic and local products (Dimitri & Dettmann, 2012; Zepeda & Li, 2007). The impact of other

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variables such as income, ethnicity, and the presence of children yielded mixed or contradictory findings (Dimitri & Dettmann, 2012; Durham, 2007; Loureiro, McCluskey, & Mittelhammer, 2001). These studies shed some light on associations between sociodemographic factors and the consumption of organic and local food. However, little research to date has examined the relationship between sociodemographic attributes and *access* to organic and local food. It remains unclear if people have equal access to such food options and thus have equal opportunities to make food choices.

The main objective of the current study was to examine the association of accessibility to organic and local food stores with sociodemographic factors in New Orleans, Louisiana. This study used a relatively comprehensive list of variables obtained from the demographic literature to measure demographic characteristics and socioeconomic statuses. Existing research on food access used mainly a few sociodemographic variables such as education, race/ethnicity, and income, as addressed early in this section (Bravo et al., 2013; Lea & Worsley, 2005; Nie & Zepeda, 2011). Our variables also included population density (Ibeas, Cordera, dell'Olio, & Coppola, 2013), age, housing value (Dong, 2015), and employment status (Greenwood, 1975), which are other important measures of demographics and socioeconomic statuses used in the demography literature (e.g., Chi, 2009). The current study also employed a set of innovative and comprehensive measures of real-time accessibility. It quantified the shortest distance a resident must travel to shop at an organic and local food store or market through any of three transportation modes—driving, bicycling, and walking—by using the Google Distance Matrix API. By utilizing spatial regression models, this study analyzed the association of organic and local food access with demographic characteristics and socioeconomic status. These models helped improve the model's fit to the data and provided further insights into the spatial effects of food access and socioeconomics.

2. Previous studies

Many studies have been conducted to investigate the ways in which socioeconomics might affect people's physical access to healthy food—which is defined more broadly than local or organic food, as food that is believed to promote and sustain health, such as fruits and vegetables (Franco, Diez Roux, Glass, Caballero, & Brancati, 2008; Raja, Ma, & Yadav, 2008; Walker, Keane, & Burke, 2010). Disparities in food access demonstrate the uneven distribution of healthy and unhealthy components of the food environment related to the variation of sociodemographic factors such as income and race/ethnicity. For instance, the studies showed that residents living in poorer neighborhoods (those with a higher proportion of low-income and unemployed residents) had less access to supermarkets that offer a good variety of affordable and healthy food, compared with fast-food restaurants and small convenience stores (Morland, Wing, Diez-Roux, & Poole, 2002; Walker et al., 2010; Weinberg, 1995). In addition to income, race/ethnicity is associated with disparities in access to healthy food. Predominantly Black neighborhoods have six times more fast-food restaurants and four times fewer supermarkets than predominantly White neighborhoods (Block, Scribner, & DeSalvo, 2004; Morland, Wing, Diez-Roux, & Poole, 2002). The literature identifies these disadvantaged geographic areas that lack access to affordable and nutritious food as “food deserts” (e.g., Larsen & Gilliland, 2008; Leete, Bania, & Sparks-Ibanga, 2012; Shannon, 2013). The formation of the food deserts in U.S. cities, accordingly, was due to the growth of large chain supermarkets in more affluent areas, which forced the closure of smaller neighborhood grocery stores (Alwitt & Donley, 1997; Guy, Clarke, & Eyre, 2004; Russell & Heidkamp, 2011). Factors such as changes in demographics in larger U.S. cities and the inaccurate perceptions about relatively disadvantaged areas have also contributed to the formation of food deserts (Walker et al., 2010). The demographics shift in the 1970s and 1980s, for instance, led to a significant decrease in more affluent households in the inner cities, which caused the closure of many supermarkets (Alwitt & Donley, 1997; Walker et al., 2010). Furthermore, the perceived images of the inner cities as areas of social disintegration, high crime rates, and poor life quality deterred the development of large supermarkets in these areas (Gittell & Thompson, 1999; Walker et al., 2010).

The research on food deserts and food access has also focused on the impact of the local food environment on residents' dietary choices and ability to consume healthy and nutritious food (Walker et al., 2010). Food access affects food choice because people tend to make those choices based on the availability of food outlets in their near-neighborhood (Furey, Strugnell, & Mcllveen, 2001). In other words, the disparity in access to healthy food affects consumption of such food. Studies indicated that low-income and non-White ethnicity were associated with more fast-food and less fruit and vegetable consumption (French, Harnack, & Jeffery, 2000; James, Nelson, Ralph, & Leather, 1997; Lewis et al., 2005). Convenient access to fast food, combined with decreased availability of healthy food might dictate food preference in Black and low-income communities, especially considering those residents' limited access to transportation (Block et al., 2004). Studies also showed improved locational access to healthy food would increase its consumption, particularly among low-income groups (Chen & Yang, 2014; Larson, Story, & Nelson, 2009; LeDoux & Vojnovic, 2014; Morland, Diez Roux, & Wing, 2006; Rose & Richards, 2004). For example, Black Americans' intake of fruits and vegetables increased by 32% with the presence of each additional supermarket in their census tract (Morland, Wing, & Diez-Roux, 2002). Similarly, previous studies found that the residents of neighborhoods with better access to organic food may be more likely to consume organic food (Curl et al., 2013; Nie & Zepeda, 2011). According to Dimitri and Dettmann (2012), households located within 5 miles of a Whole Foods Market have an increased probability of buying organic food. The findings of those studies demonstrate the association between access to organic and local food, and food choices.

Although these previous studies on food access examined the disparities of different communities in their ability to produce and consume healthy food, little research has focused on access to *organic* and *local* food. It has been acknowledged that the lack of access and/or inconvenience presents an obstacle to organic food purchase (Zanoli & Naspetti, 2002). The organic and local food movement plays a critical role in creating a sustainable food system and improving community food security. Thus, in addition to organic and local food consumption behavior, this study of *access* to organic and local food provides an important dimension to the literature on food justice and food access.

3. Methods

3.1. Data collection

New Orleans, Louisiana, was selected as our study site because of its following characteristics. First, the city has a diverse population regarding race/ethnicity and other demographic characteristics. According to the U.S. Census Bureau, African-Americans were the majority of city residents at 59.1%; and non-Hispanic Whites constituted 31.0% in 2013. The share of both Hispanic (5.5% in 2013) and Asian (3.0% in 2013) populations has been increasing over the past decade. There are also wide gaps among the city's population in income, education, and housing costs (Shrinath, Mack, & Plyer, 2014). This population diversity enabled our research to compare different sociodemographic factors and their correlations with the access to organic and local food. Second, organic and local food markets have played a significant role in the city's life. The Crescent City Farmers Market in New Orleans reported $550,000 in direct sales for vendors and an economic impact of $450,000 on the market's surrounding neighborhoods and regions in 2001 (Hughes, Brown, Miller, & McConnell, 2008). The popularity of organic and local food markets in the city provided relatively varied geographic locations of the food stores for an analysis of the residents' access. Third, as for transportation modes, New Orleans is multi-modal, with a significant amount of pedestrian and biking trips. The city has a relatively level landform and a moderate temperature, and most neighborhoods are located within 10 miles of the city center. Because the historic fabric has been well preserved, the city is dominated by grid street networks with sidewalks. These facts contribute to the popularity of nonmotorized transportation in the city. New Orleans is known to be one of the major U.S. cities in which bicycle commuters have a relatively notable share of urban trips (Dill & Carr, 2003). After the hurricane in 2005, several bike lanes were installed in the city, which led to a significant increase in cycling trips (Parker, Gustat, & Rice, 2011). This characteristic allowed us to explore the variations of access to organic and local stores though different transportation modes.

In our study, all 405 census tracts of the New Orleans metropolitan area were included (indexed by $j = 1, 2\ldots405$). The data for each census tract for the 14 demographic and socioeconomic variables used in the analysis were derived from 2008–2012 American Community Survey (ACS) 5-year estimates. In this study, we selected a relatively comprehensive list of variables measuring demographics and socioeconomic status that have often been used in the demographic and sociological literature (Chi, 2009). These variables included population size, population density, age (the young and the old), race/ethnicity (non-Hispanic White, non-Hispanic Black, and Hispanic), level of education (high school, bachelor's degree, and graduate degree), median household income, employment rate, median housing value, and median housing age. These variables and their descriptions are provided in Table 1.

We initially identified candidate organic food stores and markets in New Orleans by searching the Internet via Google, Yahoo, and Bing. Nineteen keywords were used for searching, such as "New Orleans organic food stores," "New Orleans organic food markets," "New Orleans farmers markets," "New Orleans organic farmers," "Louisiana organic food distributors," and "Louisiana organic food vendors." To verify the selection, we compared it with the results obtained through a search of the online phonebook YellowPages.com. We then contacted each candidate store via email or phone to verify that it sells organic or local food to the public, the store address, and the number of days open each month and each year. This approach, however, is limited by the fact that some small farmers markets or stores may not have websites or phone numbers listed. It also might exclude the local farmers who deliver their produce only to individual households or who provide produce for registered customers to pick up. The longitude and latitude for each store were determined based on their locations on Google Maps (https://www.google.com/maps). We eventually identified 19 organic and local food stores in the area, as shown in Figs. 1, 2, and 3. Those stores consist of two supermarkets, 14 farmers markets, two health food stores, and one food co-op.

3.2. Real-time network accessibility

To estimate the distance between the organic and local food stores and the population in each census tract, the tracts were aggregated to their centroids. This assumption may have an impact on the accuracy of the models because some of the census tracts appear to be larger in size than others (Figs. 1, 2 and 3). The limitation was due to a lack of more detailed figures on statistical units within these census tracts. In addition, the larger census tracts are located mostly in lower- or zero-density areas with longer distances to organic and local food stores, and thus such aggregation does not cause much error in distance estimation. Overall, our approach of aggregation is considered reasonable based on available data. Further, when data with higher resolution become available in the future, the proposed methodology is directly applicable to such data in future studies.

Table 1
Variable descriptions.

Variable	Variable description
Population size	Total number of people of both sexes and all ages, races, and ethnicities living in the area
Population density	Total number of people per square mile living in the area
Household income	Median household income ($)
Housing value	Median value of the housing unit ($)
New housing units	Percentage of household units constructed in 1970 or later
Young	Percentage of population between 10 and 19 years old
Old	Percentage of population 65 years old and over
Non-Hispanic White	Percentage of population that is non-Hispanic White
Non-Hispanic Black	Percentage of population that is non-Hispanic Black
Hispanic	Percentage of population that is Hispanic of any race (e.g., Mexican, Cuban, Puerto Rican)
High school degree	Percentage of population (age ≥ 25) with high school degree
Bachelor degree	Percentage of population (age ≥ 25) with bachelor's degree
Graduate degree	Percentage of population (age ≥ 25) with graduate or professional degree
Employment rate	Percentage of population (age ≥ 16) in the labor force

We used the Google Distance Matrix API[1] to estimate the distance between each census-tract centroid (j) and each organic or local food store (k), denoted by d_{jk}. The input to this API consisted of 405 sets of geographic coordinates (latitudes and longitudes from the World Geodetic System of 1984 [WGS84]) of the census tracts (origins) and 19 sets of coordinates for the organic and local food stores (destinations)—that is, 7695 origin–destination (OD) pairs. We considered three transportation modes for each OD pair: driving, bicycling, and walking. Because very limited areas in the New Orleans metropolitan are covered by the public transit system, this mode of transportation is not considered for the analyses. For each transportation mode, we obtained a 405 × 19 matrix of the OD distances, denoted by $\{d_{jk}\}_{j=1,\ \ldots,\ 405}$.

3.3. Data analysis

The accessibility to organic and local food by residents of each census tract was measured by the shortest distance between the centroid of a census tract j and its organic and local food stores by means of the three transportation modes, i.e., $d_j := \min\{d_{jk}, k = 1, 2\ldots19\}$. The shorter the distance d_j, the easier the access of an average household in census tract j to organic and local food. In Figs. 1, 2, and 3, the census tracts are colored according to their distance to the nearest organic and local food store (i.e., $d_j, \forall j = 1, 2, \ldots, 405$) for driving, bicycling, and walking transportation modes, respectively. The gray census tracts represent the tracts where no routes to the stores existed for the corresponding transportation modes. It is worth mentioning that the population in most of the mentioned census tracts is zero because they are located in natural, uninhabitable areas (e.g., lake and wildlife areas).

We first employed a standard linear regression model to examine the correlation between the census-tract variable matrix V and the accessibility-measure vector D. However, standard regression models take no account of spatial variation in their analysis of relationships between variables (Abadi & Kermanshah, 2014). Therefore, because we theorized that geographic correlation may exist between the accessibility measures of neighboring census tracts, we also experimented with two spatial regression models, a spatial lag model and a spatial error model, depending on the type of spatial dependence in the standard regression model residuals. The diagnostics included Moran's I test for errors, Lagrange multiplier (LM) tests for lag dependence and error dependence, and robust LM tests for lag dependence and error dependence. LM tests assist in detecting spatial dependence in the form of an omitted

[1] https://developers.google.com/maps/documentation/distancematrix/.

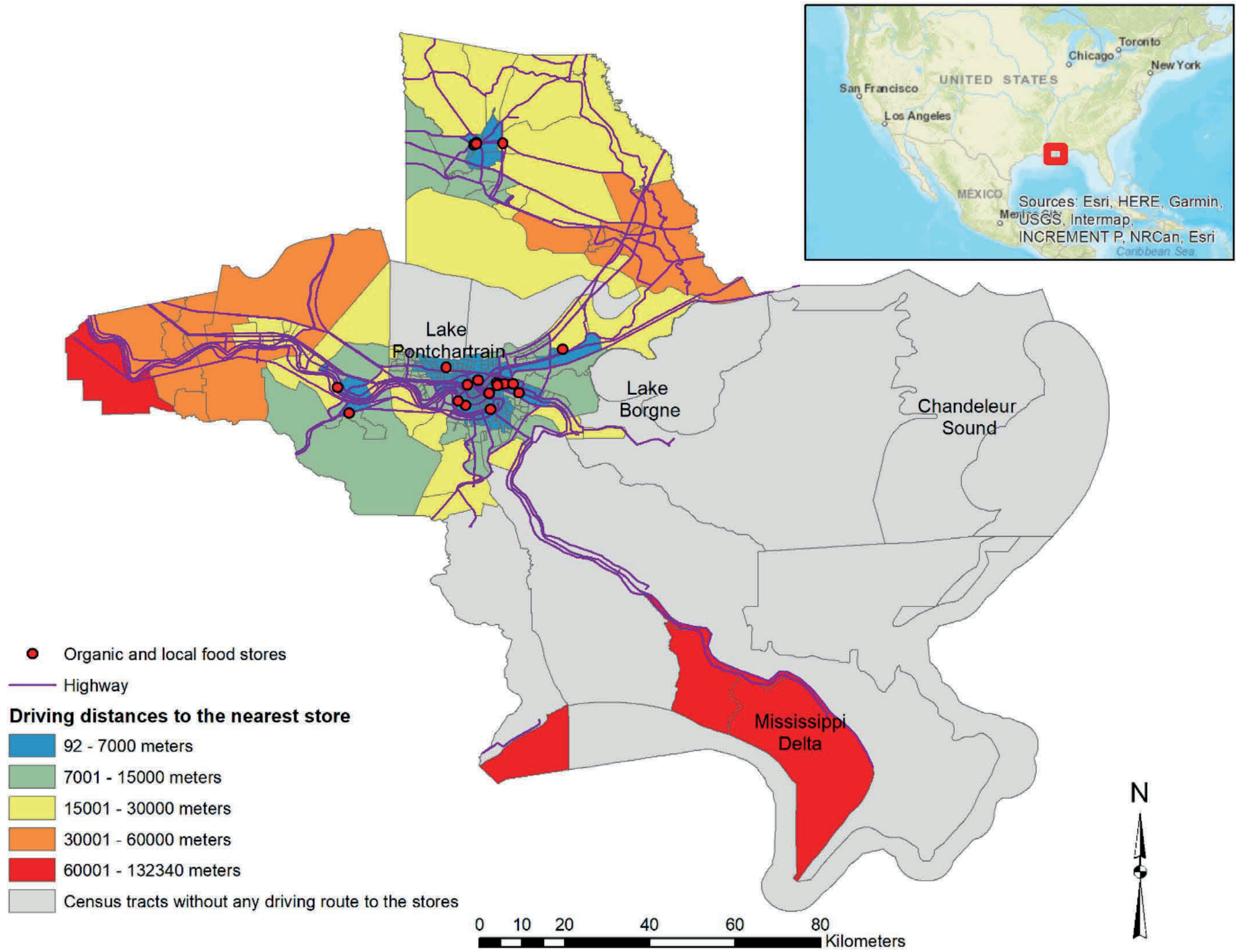

Fig. 1. Census tracts and organic and local food stores in the New Orleans metropolitan area: census tracts are colored according to their driving distance to the organic and local food stores.

spatially lagged dependent variable and/or spatial error dependence (Anselin, 1988). Robust LM tests assist in diagnosing the pertinence of the spatial dependence if the LM tests for both the lag and error dependences are significant (Anselin, Bera, Florax, & Yoon, 1996). Based on the results of the spatial dependence tests, the appropriate spatial regression models were specified to further examine the association of census-tract variables with accessibility.

The spatial lag model (SLM) is specified as follows:

$$D = \rho DW + \beta \bullet V + \varepsilon \tag{1}$$

where ρ is a spatial lag parameter, $W := [W_{ij}]_{i=1,\ \ldots,\ 405,\ j=1,\ \ldots,\ 405}$ is a spatial weights matrix representing the geographical proximity between each pair of census tracts i and j, β is a vector of coefficients for the variables in V, and ε represents the vector of error terms that are independent but not necessarily identically distributed (Chi & Zhu, 2008).

The weights matrix W was obtained in the following way. We set $W_{ij} = 1$ if the great-circle distance between the centroids of census tract i and j was smaller than a prespecified distance threshold d, or $W_{ij} = 0$ otherwise. This threshold was set as the minimum distance required to ensure that each census tract had at least one neighboring census tract. Using the statistical software GeoDa, we calculated the weights matrix for the spatial regression analysis. We then applied the spatial error model (SEM), defined as follows:

$$D = \beta \bullet V + u \tag{2}$$

$$u = \rho Wu + \varepsilon \tag{3}$$

where ρ is a spatial error parameter, W is the same spatial weights matrix as that in the spatial lag model, ε is an uncorrelated and homoscedastic error term that is defined in the same way as the spatial lag model, and u is a derived error vector specified in an autocorrelated form in Eq. (3).

It should be noted that spatial autocorrelation in the spatial lag model was modeled by a linear relation between the response variable (D) and the associated spatially lagged variable (WD), whereas spatial autocorrelation in the spatial error model was represented by an error term (u) and the associated spatially lagged error term (Wu). A significant spatial lag term indicates strong spatial dependence of the dependent variable, while a significant spatial error term indicates spatial correlation of the error terms (u), which may be due to key explanatory variables that are not included in the model.

For the calculation of W, we considered great-circle distances between census-tract centroids. This assumption is reasonable for neighboring tracts that are relatively close to each other. For cases with greater distances, there are higher probabilities that the corresponding W's elements are zero, so this assumption will not significantly impact our results.

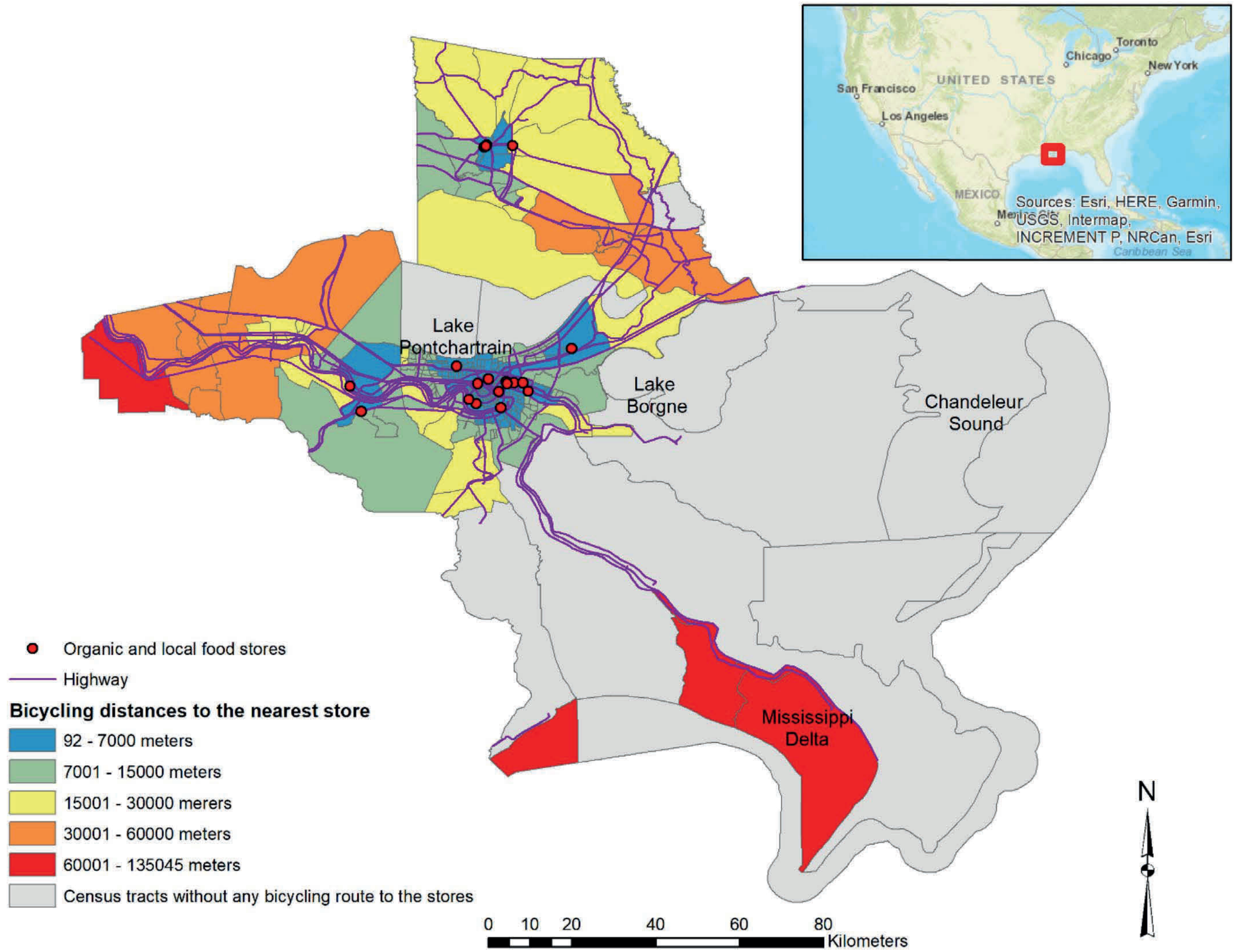

Fig. 2. Census tracts and organic and local food stores in the New Orleans metropolitan area: census tracts are colored according to their bicycling distance to the organic and local food stores.

4. Results

During the process of fitting both the standard regression model and two spatial regression models to the data set, the indicators such as coefficient, standard error, and p-value (probability) were calculated. We tested the null hypothesis that the coefficient for each independent variable is equal to zero (no effect). With a 95% confidence interval, a low p-value indicates the null hypothesis could be rejected, and the independent variable is significant. In other words, a variable that has a low p-value is likely to be a meaningful addition to our model because changes in the independent variable's value are related to changes in the response-dependent variable. Conversely, a larger (i.e., insignificant) p-value suggests that changes in the independent variable are not associated with changes in the dependent variable.

In this study, all variables were used to fit the data in the first step; and only the variables that were significant (with the p-value less than or equal to 0.05) in at least one of the models were kept for running the models in the second step. Therefore, some insignificant variables remained in some of the models so as to have common variables in the models. We ran standard linear regression models for the three transportation modes of walking, bicycling, and driving. The results are presented in Tables 2, 3, and 4. The Moran's I tests for errors indicate statistically significant spatial autocorrelation in the model residuals. The LM tests and robust LM tests for lag dependence and error dependence indicate there exist both spatial lag and spatial error dependence in standard regression model residuals for all three transportation models. Therefore, we chose to run both spatial lag and spatial error models for all transportation models. The results are presented in Tables 2, 3, and 4. The R-squared and Akaike information criterion (AIC) indicate that the spatial regression models are better fitted to data than are the standard regression models.

In summary, the following relationships between demographic factors and accessibility to organic and local food can be deduced:

1. *Population density*: The results indicate that population density is negatively associated with distance to the nearest store that sells organic or local food, via all three transportation modes (walking, bicycling, and driving). This finding means that such stores tend to be located closer to areas with higher population density.
2. *New housing units*: Census tracts with a higher percentage of new housing units tend to have longer distances to the nearest store that sells organic or local food, via all three transportation modes. This finding indicates that such stores are less accessible in areas that have more housing units built in 1970 or later.
3. *Housing value*: Areas with a higher median value of housing units tend to have shorter distances to the nearest store that sells organic or local food, via all three transportation modes, which suggests that such stores tend to be located closer to housing units with higher

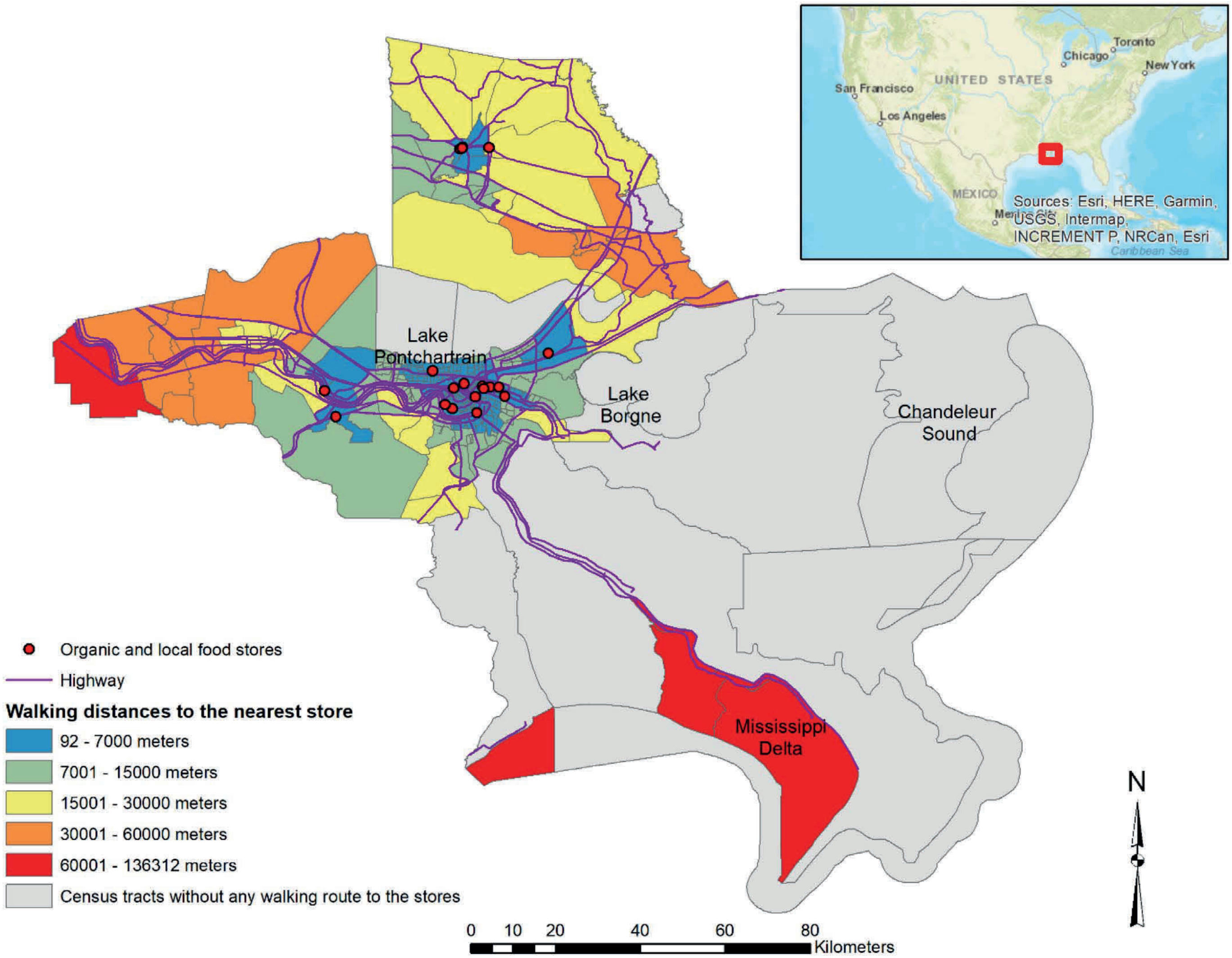

Fig. 3. Census tracts and organic and local food stores in the New Orleans metropolitan area: census tracts are colored according to their walking distance to the organic and local food stores.

Table 2
Modeling results for walking mode of transportation: Coefficients (with standard errors).

	Standard regression		Spatial lag regression		Spatial error regression	
Constant	16,770.440***	(2597.844)	1876.770*	(1050.632)	60,091.800**	(24,213.08)
Population density	−0.578***	(0.183)	−0.191***	(0.073)	−0.204***	(0.074)
New housing units	140.138***	(21.792)	59.044***	(8.961)	70.079***	(9.203)
Housing value	−0.019**	(0.009)	−0.002	(0.004)	−0.003	(0.003)
Non-Hispanic Black	−84.954***	(22.073)	−22.601**	(8.909)	−27.600***	(9.007)
Hispanic	−349.843***	(86.837)	−35.279	(35.165)	−48.574	(35.562)
Bachelor's degree	−126.400	(78.413)	−80.211**	(31.233)	−46.575	(31.496)
Spatial lag/error parameter			0.967***	(0.010)	0.991***	(0.004)
Diagnostics for spatial dependence	AIC = 8465		AIC = 7765		AIC = 7771	
Moran's I (error)	0.64***					
Lagrange multiplier (lag)	2116.26***					
Lagrange multiplier (error)	5040.03***					
Robust LM (lag)	155.61***					
Robust LM (error)	3079.38***					

* $p < 0.10$.
** $p < 0.05$.
*** $p < 0.01$.

Table 3
Modeling results for bicycling mode of transportation: Coefficients (with standard errors).

	Standard regression		Spatial lag regression		Spatial error regression	
Constant	17,765.000***	(2795.903)	1626.709	(1143.112)	65,177.710**	(27,214.770)
Population density	−0.592***	(0.197)	−0.175**	(0.080)	−0.186**	(0.081)
New housing units	153.305***	(23.454)	63.014***	(9.722)	74.167***	(10.034)
Housing value	−0.019**	(0.009)	−0.002	(0.004)	−0.002	(0.004)
Non-Hispanic Black	−93.956***	(23.756)	−24.355**	(9.689)	−28.833***	(9.820)
Hispanic	−360.467***	(93.457)	−19.749	(38.230)	−31.741	(38.774)
Bachelor's degree	−142.729*	(84.392)	−89.334***	(34.015)	−51.575	(34.340)
Spatial lag/error parameter			0.971***	(0.009)	0.991***	(0.004)
Diagnostics for spatial dependence	AIC = 8523		AIC = 7833		AIC = 7839	
Moran's I (error)	0.62***					
Lagrange multiplier (lag)	2068.96***					
Lagrange multiplier (error)	4806.63***					
Robust LM (lag)	160.88***					
Robust LM (error)	2898.55***					

* $p < 0.10$.
** $p < 0.05$.
*** $p < 0.01$.

median values.

4. *Non-Hispanic Blacks and Hispanics*: The percentage of non-Hispanic Blacks and the percentage of Hispanics are negatively associated with the distance to the nearest store that sells organic or local food, via all three modes of transportation. This finding means that areas with higher percentages of non-Hispanic Blacks and Hispanics have better locational access to stores that sell such food. We also tested the correlation between the percentage of non-Hispanic Blacks and Hispanics with population density and found no significant correlation between these two pairs of variables. Therefore, the relationship between the accessibility measure and the percentage of non-Hispanic Black and Hispanics is not related to population density.
5. *Bachelor's degree*: The percentage of the population with a bachelor's degree is negatively associated with the distance to the nearest store that sells organic or local food, via all three transportation modes. This finding suggests that areas with a higher percentage of the population with a bachelor's degree tend to have better locational access to such stores.

5. Discussion

We implemented standard regression modeling and two types of spatial regression—spatial lag and spatial error—to explore the relationship between sociodemographic factors and accessibility to stores that sell organic or local food. Our results show better performance for spatial regression models in comparison with the standard regression model.

The two spatial regression models have good fits, as indicated by their high R-squared values. Six sociodemographic factors (population density, percentage of new housing units, median house value, percentage of non-Hispanic Blacks, percentage of Hispanics, and percentage of people with a bachelor's degree) correlate with locational access to stores and markets that sell organic and local food. We found no indication of poor access to those stores in the less advantaged neighborhoods: household income and employment are not significantly associated with distance to such stores. This finding is consistent with some of the previous studies that found less advantaged groups have no less locational access than more advantaged groups to farmers markets (Pearson & Wilson, 2013; Widener, Metcalf, & Bar-Yam, 2011). It may

Table 4
Modeling results for driving mode of transportation: Coefficients (with standard errors).

	Standard regression		Spatial lag regression		Spatial error regression	
Constant	16,749.570***	(2586.912)	1499.057	(1127.834)	50,696.020**	(20,942.900)
Population density	−0.591***	(0.182)	−0.213***	(0.078)	−0.239***	(0.079)
New housing units	149.435***	(21.700)	69.429***	(9.662)	82.422***	(9.754)
Housing value	−0.017**	(0.009)	−0.001	(0.004)	−0.001	(0.004)
Non-Hispanic Black	−82.337***	(21.980)	−20.327**	(9.554)	−25.874***	(9.546)
Hispanic	−347.814***	(86.472)	−39.051	(37.739)	−58.337	(37.689)
Bachelor's degree	−137.767*	(78.083)	−90.201***	(33.432)	−55.634*	(33.380)
Spatial lag/error parameter			0.953***	(0.012)	0.989***	(0.005)
Diagnostics for spatial dependence	AIC = 8461		AIC = 7817		AIC = 7815	
Moran's I (error)	0.63***					
Lagrange multiplier (lag)	1967.21***					
Lagrange multiplier (error)	4905.89***					
Robust LM (lag)	144.91***					
Robust LM (error)	3083.59***					

* $p < 0.10$.
** $p < 0.05$.
*** $p < 0.01$.

be explained by lower food prices offered by farmers markets (Pearson & Wilson, 2013). Evidence suggests the introduction of farmers markets could lead to a decrease in fruit and vegetable prices in neighboring supermarkets because of their competitive impact (Larsen & Gilliland, 2009). Thus, improved locational access to farmers markets helps to increase fruit and vegetable intake in low-income communities and areas with limited access to retailers of healthy food (Evans et al., 2012). In addition, although some specialty food stores might sell more expensive organic food, studies suggest household income has extremely minor effects on the consumption of organic food (Curl et al., 2013; Lockie, Lyons, Lawrence, & Grice, 2004).

Although race/ethnicity appears to be a strong indicator associated with disparity in access and consumption of healthy food, our study shows that areas with a higher percentage of Black and Hispanic residents have better locational access to stores that sell organic or local food. According to Zepeda, Chang, and Leviten-Reid (2006), although Blacks have lower familiarity than Whites with organic food, they are more receptive to and positive about organic food and are also more accepting of price premiums for organic food. But it should be pointed out that the Zepeda et al. (2006) study was a focus group study, with a relatively small sample of 43 participants, which limits generalization of the findings. Another study also suggested that Hispanic and Asian households are more likely to buy organic products than White households, while Black households are less likely to buy organic products. But the link is weak (Dimitri & Dettmann, 2012). The differences in organic food purchasing behaviors might be partly explained by the distinct diet patterns of each racial group, although the differences in dietary patterns among racial groups (as indicated by the Diet Quality Index) have narrowed over time (Popkin, Siega-Riz, & Haines, 1996). Despite the differences, our results show relatively equal access to organic and local food regardless of differences in household income, employment status, and race/ethnicity. This finding might have a great implication for program planning and policy development aimed at improving access to healthy and affordable food in the food desert areas. A community- or city-level incentive and promotion of farmers markets and small local and organic food stores in these areas will be helpful when thinking about ways to increase healthy food access for the low-income and ethnic minorities.

The correlation between population density, median housing age, and median housing value and access to organic and local food suggests that the organic and local food stores and markets tend to be located near older neighborhoods with higher population densities and house values. One of the reasons might be the relatively small number of stores in New Orleans that sell organic or local food. Although organic food has a high public profile, the number of people who regularly shop for organic or local food is limited (Dimitri & Greene, 2002). Thus, to achieve and sustain a successful business, visibility and easy access might be a priority for owners of stores and markets that sell organic or local food. Furthermore, the organic and local food movement promotes healthy eating and environmental sustainability, which are associated with smart growth and environmental justice. Thus, locating proximate to walkable historic districts instead of newer neighborhoods created by urban sprawl tends to support the ethic ideologies of the organic and local food movements.

Previous research showed that education has a strong correlation with the consumption of organic produce (Curl et al., 2013; Dimitri & Dettmann, 2012). People with a higher level of education were significantly more likely to consume organic produce. Research has also found that psychographic factors such as health, environmental and animal welfare concerns are high internal locus of the choice of organic foods by consumers. Specifically, perceived environmental benefits, healthy diet, and values related to nature and equality were found to positively predict organic food purchase (Hughner, McDonagh, Prothero, Shultz II, & Stanton, 2007; Lea & Worsley, 2005; Makatouni, 2002). But it remains unclear that whether education is correlated with the psychographic factors of values, health attitudes, and lifestyles. Although Lea and Worsley (2005) suggested that those consumers with a university education being less likely than those without to agree that there was a risk involved in eating organic food, further studies are needed to better understand how and to what extent education impact on consumers' organic food beliefs and consumption behaviors. Our study indicates that education is associated with locational access to stores that sell organic or local food. Those stores tend to be located near areas that have a higher percentage of residents with a bachelor's degree. But this might be contributed by the factors that people with higher education tend to have more pro-organic food attitudes. Thus our study shows the need for future research to provide clarity on the relationships between education, psychographic factors, and locational access to organic food.

Our spatial lag and spatial error models provided further insights into the association of organic and local food access with sociodemographic factors. The statistically significant and positive spatial lag effects detected by the spatial lag models suggest that organic and local food access in a census tract is positively associated with that in its neighboring tracts (Chi & Zhu, 2008). The statistically significant and positive spatial error effects detected by the spatial error models helped control for factors that have significant effects on food access but are not included in the model (Chi & Zhu, 2008).

6. Conclusion

Our study used comprehensive data provided by the American Community Survey and a customized GIS program to examine the association between sociodemographic factors and locational access to organic and local food in the New Orleans metropolitan area. Because New Orleans is a city with high diversity (in terms of race/ethnicity, income, and educational attainment), the results are more generalizable to similar cities with a high diversity than those with a low diversity. The analysis indicated that some factors were significantly associated with locational access to organic and local food: education, population density, median house age, median house value, non-Hispanic Blacks, and Hispanics. Specifically, we found that higher education, higher population density, higher house value, older houses, and non-Hispanic Blacks and Hispanics were associated with better locational access to organic and local food. Our models did not find a statistically significant relationship between median household income or employment status and access to organic and local food. This finding suggests that access to organic and local food is relatively pro-equity in terms of income and race/ethnicity, which added an important dimension to the food desert literature. Further research on this topic to compare organic and local food access for the residents who reside in a food desert and a food oasis is warranted to better understand of the correlations between sociodemographic factors and access to organic and local food. It will provide a basis for policy and social interventions such as promoting farmers markets in the food deserts to improve local and organic food access.

In addition to an accessibility analysis, this study presented a performance analysis of the standard linear and the spatial lag and spatial error regression models for the purpose of comparing their performances for accessibility analyses. It showed that spatial regression models outperformed the standard linear regression model for our accessibility analysis.

This study focused on stores and markets specializing in organic and local food. It should be acknowledged that some conventional supermarkets, such as Walmart and Kroger, have special sections for organic food. And in 2007, 82% of U.S. retail food stores carried organic food products. Although the variety of the organic products in these supermarkets was limited—only 2200 different organic food products on average in 2008, compared with an average of 18,000 nonorganic food products (Dimitri & Dettmann, 2012), the number has continued to grow in recent years. Thus, for future studies, it would be helpful to evaluate the assortment of organic and local products in conventional supermarkets and determine whether they should be included in assessing access to local and organic food.

In addition, our study considered distance as an accessibility index; but other types of accessibility indexes could be measured, including travel duration. For future studies, it will be important to include more detailed accessibility indexes to gain better measures of accessibility. Moreover, because the public transit system in New Orleans covers only a few of the 405 census tracts, this transportation mode was not considered in our analyses. However, in a future study, it would be crucial to compare public transportation with other transportation modes to better understand the effects of public transportation on food access.

Finally, census-tract aggregate data used to model accessibility cannot capture heterogeneous behaviors across different individuals in the same census tract (Garrett, 2014). The results of our research may not be generalizable to all individuals because the aggregated data at the census-tract level reflects the collective behaviors of individuals, which is related to the ecology fallacy (Robinson, 1950) or the scale effect of the modifiable areal unit problem (Wrigley, Holt, Steel, & Tranmer, 1996), which argues that results cannot be generalizable from aggregated levels to the individual level nor across aggregated levels. If higher-resolution data become available in the future, it would be worthwhile to use disaggregated models to examine individual behavior in choosing to shop at organic and local food stores. This might be best achieved within a multilevel framework in which individual characteristics and environmental characteristics at the aggregated levels (social, economic, built environment, and natural environment) can be modeled simultaneously (Chi & Voss, 2005).

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