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Associations between neighborhood-level factors related to a healthful lifestyle and dietary intake, physical activity, and support for obesity prevention polices among rural adults

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Abstract

Purpose—To examine cross-sectional associations among neighborhood- and individual-level factors related to a healthful lifestyle and dietary intake, physical activity (PA), and support for obesity prevention polices in rural eastern North Carolina adults.

Methods—We examined perceived neighborhood barriers to a healthful lifestyle, and associations between neighborhood barriers to healthy eating and PA, participants' support for seven obesity prevention policies, and dependent variables of self-reported dietary and PA behaviors, and measured body mass index (BMI) (n = 366 study participants). We then used participants' residential addresses and Geographic Information Systems (GIS) software to assess neighborhood-level factors related to access to healthy food and PA opportunities. Correlational analyses and adjusted linear regression models were used to examine associations between neighborhood-level factors related to a healthful lifestyle and dietary and PA behaviors, BMI, and obesity prevention policy support.

Results—The most commonly reported neighborhood barriers (from a list of 18 potential barriers) perceived by participants included: not enough bicycle lanes and sidewalks, not enough affordable exercise places, too much crime, and no place to buy a quick, healthy meal to go. Higher diet quality was inversely related to perceived and GIS-assessed neighborhood nutrition barriers. There were no significant associations between neighborhood barriers and PA. More perceived neighborhood barriers were positively associated with BMI. Support for obesity prevention policy change was positively associated with perceptions of more neighborhood barriers.

Conclusions—Neighborhood factors that promote a healthful lifestyle were associated with higher diet quality and lower BMI. Individuals who *perceived* more neighborhood-level barriers to healthy eating and PA usually *supported* policies to address those barriers. Future studies should examine mechanisms to garner such support for health-promoting neighborhood changes.

Keywords

Obesity prevention; policy; neighborhood barriers; diet; physical activity; Geographic Information Systems (GIS)

Introduction

The prevalence of obesity and associated chronic diseases is disproportionately higher among rural residents relative to urban and suburban residents [1, 2]. Both perceived measures and Geographic Information System (GIS) measures of barriers to physical activity (e.g., measures of crime, living further from parks) [3–5] and barriers to healthy eating (e.g., living further from healthy food sources such as supermarkets and farmers' markets) are associated with obesity and obesity-related behaviors [6–10]. In addition, differential risk for obesity and chronic disease among rural residents may be related to less opportunity to purchase healthy foods and fewer places to be physically active. [3, 4, 11–13].

Environmental and policy changes to increase access to healthy foods and physical activity opportunities are suggested as ways to reduce these disparities [14]. In 2009, the Centers for Disease Control and Prevention (CDC) recommended several evidence-based, and expert-vetted "Common Community Strategies and Measures for Obesity Prevention", or COCOMO [14]. These community-level strategies included "communities should provide incentives to food stores to offer healthier food and beverage choices in rural or low-income areas," and "communities should improve sidewalks to support walking" [14]. Policies that exemplify these strategies include the New York City's proposed portion size limits on sugar-sweetened beverages, [15] and zoning regulations to promote healthier food access in Los Angeles [16].

However, obesity-prevention policy change may be more difficult to enact in rural areas, [17] as challenges to implement such policy-level obesity prevention strategies in rural areas include infrastructure challenges and low population density [18]. Research findings in rural North Carolina indicated that local policymakers perceived that rural residents would oppose some obesity prevention policies, particularly policies relating to government mandates and taxes [19]. Policymakers also ranked policies to increase physical activity opportunities as more 'winnable' (i.e., more feasible, and more widely accepted) among their constituents relative to nutrition-related policies [19]. In one study, female and African American residents indicated higher levels of support for various obesity prevention policies relative to male and white residents [19]. Similarly, Tabak, et al. [20] found that support for policy changes was higher among Mississippi residents who were female, African American, and residents of counties with higher levels of obesity.

While there is strong evidence that access to healthy foods and physical activity opportunities are associated with lower obesity and healthier diet and physical activity behaviors, it is not known if those who live in neighborhoods with more barriers to both healthy eating and physical activity are supportive of obesity prevention policies that would improve access to healthy eating and physical activity opportunities. Such support is needed if policies are to be adopted in areas with disparate access to healthy foods and physical activity opportunities, [21] in efforts to ameliorate disparities. Thus, it is important to identify factors associated with support or lack thereof for obesity prevention policies. Furthermore, identifying factors associated with support for obesity prevention policies in rural areas may lend deeper insight into more relevant policies that should be developed to encourage rural residents to adopt healthier behaviors. Therefore, the purpose of this paper was to examine associations between neighborhood-level factors related to a healthful lifestyle and dietary intake, physical activity, and support for obesity prevention polices among rural eastern North Carolina adults.

Methods

Overview of The Heart Healthy Lenoir Project

This study was ancillary to a larger project called the Heart Healthy Lenoir Project. The goal of the Heart Healthy Lenoir Project is to reduce cardiovascular disease risk and risk disparities in Lenoir County, which is located in eastern North Carolina, in the buckle of the “stroke belt.” The Heart Healthy Lenoir Project includes three coordinated studies with one, the Lifestyle Study, testing the effectiveness of a lifestyle intervention to improve nutrition, physical activity and weight management [13].

For this paper, only data from participants enrolled in the Lifestyle Study were analyzed. Lifestyle Study participants were recruited via flyers posted in various locations, newspaper articles, television, word of mouth, and the study website. Inclusion criteria were age 18 years and above, residing in Lenoir or a nearby county, and an interest in improving lifestyle behaviors to reduce CVD risk. Each prospective study participant was invited to an enrollment visit, where the participant first provided written informed consent. Next, during a face-to-face individual or small group interview with a research assistant, participants completed a series of surveys that addressed sociodemographic questions, health history, diet, physical activity, and psycho-social factors; had their height, weight, and blood pressure measured; and were sent to the lab for study blood tests. For the current study, we used data collected at baseline, before the lifestyle intervention began. Enrollment occurred from September 20, 2011 to July 23, 2012. This study was approved and monitored by the University of North Carolina at Chapel Hill Institutional Review Board.

Perceptions of neighborhood barriers

Participants completed a survey in which they were asked to think about factors in their neighborhoods that hindered them from being physically active or eating healthier. Participants, using response options ranging from 1 (not a problem) to 5 (a big problem), indicated the degree each of 18 items was problematic in their neighborhoods [22]. Representative questionnaire items were: not enough sidewalks; too many fast food places; not enough parks, trails, or tracks for walking; too much crime; not enough farmer’s markets or produce stands. Responses were summed into a “perceived neighborhood nutrition barriers” score and a “perceived neighborhood physical activity barriers” score. Then the two scores were added together to provide an “overall perceived neighborhood barriers” score. The perceived neighborhood nutrition barriers score included five items with possible scores ranging from 5 to 25, with a higher score indicating more barriers. The perceived neighborhood physical activity barriers score included 13 items with possible scores ranging from 13 to 65, with a higher score indicating more barriers. The sum of these scales yielded the perceived neighborhood score, with a range from18 to 90.

GIS measures of neighborhood barriers and facilitators

Residential addresses of all Heart Healthy Lenoir lifestyle intervention participants were geocoded to the highest level of accuracy attainable (with rooftop accuracy being the goal) using the North America Geocode Service address locator, along with manual verification using Google Earth satellite imagery. A 1-mile street-network buffer was drawn around each participant's residential address using ArcGIS Network Analyst-Service Area Analysis. Fast food restaurants, supermarkets, farmers' markets, parks, trails, and gyms were all identified using six structured community audits, using methods described previously [13]. Briefly, food and physical activity venues within the Lenoir County boundary were identified and located using targeted internet searches, the Reference USA business database, windshield tours, community informants, phone verification, and ground truthing, The *density*, or number, of fast food restaurants, supermarkets, farmers' markets, parks and trails, and gyms (private and low-cost) within each participant's 1-mile buffer was computed for each type of venue using a spatial join of the buffer and each venue type point location. In addition, the closest *distance* to each venue from each participant's residential address using street-networks was also computed using an ArcGIS Network Analyst-Closest Facility Analysis.

We created a "GIS nutrition - density" score by summing the densities (number) of supermarkets and farmers' markets and subtracting the density (number) of fast food restaurants in the 1-mile buffer surrounding each participant's residential address, such that a higher score indicated a healthier neighborhood food environment. We also created a "GIS nutrition - distance" score by summing the distances to the closest supermarket and farmers' market and subtracting the distance to the closest fast food restaurant (from each participant's residential address), such that a higher score indicated a less healthy neighborhood food environment (because a higher score indicates that participants live further from supermarkets and farmers' markets). Likewise, we created two GIS-measured neighborhood scores for the density (number) of and distance to the single closest recreation center, park, low-cost gym, and private gym. A higher "GIS physical activity - density" score indicated a healthier physical activity environment and a higher "GIS physical activity - distance" score indicated a less healthy physical activity environment.

Support for obesity prevention policies

As reported elsewhere [7], we asked lifestyle intervention participants about their support for the obesity prevention policies, derived from the list of 24 CDC COCOMO strategies [14]. Seven of the 24 policy strategies were selected to reduce respondent burden and because they represented a range of relevant nutrition and physical activity promoting policies for obesity prevention. These included the following: Communities should (1) provide incentives to food stores to locate in rural or low-income areas; (2) improve access to outdoor exercise and recreation places, like parks and waterways; (3) provide incentives to food stores to offer healthier food and beverage choices in rural or low-income areas; (4) improve sidewalks to support walking; (5) support locating schools within easy walking distance of where people live; (6) limit advertisements of less healthy foods and beverages; (7) increase support for breastfeeding. Participants indicated their level of support for the strategies to support healthy eating and physical activity on a scale from 1 to 10, with 1 indicating "strongly do not support" the strategy and 10 indicating "strongly support" the strategy. Responses were summed to create a "healthy food policy support" score (sum of 4 items related to locating food stores in rural and low-income areas, providing incentives to food stores to offer healthier foods and beverages, limiting advertisements of less healthy foods and beverages, and increasing support for breastfeeding (as above) with scores ranging from 4 to 40), a "physical activity policy support" score (sum of 3 items related to improving access to outdoor recreation, improving sidewalks, and locating schools within walking distance (as above), with scores ranging from 3 to 30), and an “obesity prevention policy” score, summing responses to all seven items (possible scores ranged from 7 to 70). A higher score indicated greater policy support.

Dietary intake

Eating behaviors were measured in two ways. First, diet quality was measured using an index (high representing better dietary quality) derived from a semi-quantitative food frequency questionnaire called the Dietary Risk Assessment (DRA). The DRA is a brief instrument to guide dietary counseling to reduce cardiovascular disease risk [23]. The DRA was re-validated in 2007 to reflect revised cardiovascular dietary recommendations [24]. The diet quality index is a summary score of 4 sub-scales from the DRA that address the usual consumption of 1) nuts, oils, dressings, and spreads, 2) vegetables, fruits, whole grains, and beans, 3) drinks, desserts, snacks, eating out, and salt, and 4) fish, meat, poultry, dairy, and eggs. This survey was administered at the first intervention visit (not at baseline as for the other surveys) which was attend by 273 (75%) of study participants. Second, we assessed fruit and vegetable consumption (servings/day) using the previously validated Block Fruit, Vegetable, and Fiber Screener [25, 26].

Physical activity

Physical activity was measured in two ways: (1) total self-reported physical activity (minutes/ week); and (2) steps/day (pedometer). Total physical activity/week was determined by summing the totals of self-reported minutes/week of walking and moderate to vigorous leisure time physical activity (not including walking) as reported on the RESIDE physical activity questionnaire, [27] previously validated among a sample of low-income women [28]. Steps/day were measured by an Omron HJ-720ITC pedometer (Omron Healthcare, Bannockburn, IL) [29] given to the participant at the enrollment visit with instructions to wear for at least 1 week (7 consecutive days) during the next month. Participants were encouraged to wear the pedometer every day. Pedometer steps were then downloaded when the participant returned for the first counseling or group session. Steps/day was calculated as the mean of daily steps for all days of at least 500 steps/day during the last 31 days.

Body Mass Index (BMI)

After completing the surveys, participants’ weights (to the nearest tenth of a pound) were measured without shoes using an electronic scale (Seca 874, Seca, Hanover, MD), and heights (to the nearest 1/8 inch) were measured with a portable stadiometer (Weigh and Measure, LLC, Olney, MD). Two measures were obtained by trained data collectors and averaged. If the two weight measurements differed by more than 1 pound, a third weight was obtained and the three were averaged. If the two height measurements differed by more than ¼ inch, a third height was obtained and the average of two height measurements differing by ≤ ¼ inch was used. BMI was calculated from measured height (in meters) and weight (in kilograms).

Statistical analyses

We used descriptive statistics for baseline characteristics and participant responses to survey measures. We examined bivariate associations between perceived and GIS measured neighborhood-level factors related to a healthful lifestyle and dietary intake, physical activity, and support for obesity prevention polices using Pearson correlations. We used multiple linear regression models to examine independent associations between these variables and controlled for following covariates: age at enrollment, race, sex, and education level. Race was categorized as African American, White and Other, and education level was used as a continuous variable (years of education).

Results

Table 1 shows baseline descriptive statistics for the sample (N = 366). The mean age was 55 years, and mean education was approximately 13 years. Nearly three quarters were female, and 65% were African American. Mean diet quality score was 27.8, the mean number of servings of fruits and vegetables/day was 3.4 servings, the mean physical activity was 151 minutes/week, (median physical activity was 45 minutes), mean number of pedometer-measured steps/day was 4496, and mean BMI was 35.9 kg/m^2.

Table 2 shows the percentage of participants reporting that each perceived neighborhood-level barrier was a "big problem" in their neighborhood. The most frequently cited nutrition barriers were: 'no place to buy a quick, healthy meal to go'; 'not enough restaurants with healthy food choices'; and 'too many fast food places'. The most frequently cited physical activity barriers were: 'not enough bike lanes'; 'not enough sidewalks'; and 'not enough affordable exercise places.'

Table 3 shows bivariate associations (Pearson's correlation coefficients) between perceived and GIS-measured neighborhood barriers and individual-level diet, physical activity, and BMI. There was an inverse, but weak, association between diet quality and perceived neighborhood nutrition barriers and GIS nutrition distance, such that those with higher diet quality scores perceived fewer neighborhood barriers to a healthy diet and lived closer to healthy food sources as assessed by GIS. There were no statistically significant associations between neighborhood nutrition barriers and fruit and vegetable consumption (data not shown). There was a positive association between BMI and perceived neighborhood nutrition barriers, such that those with higher BMI perceived more neighborhood barriers.

There were no significant associations between total PA and perceived or GIS physical activity - density or distance. In addition, there was no significant associated between pedometer measured steps and neighborhood factors related to physical activity (data not shown). There was a positive association between BMI and perceived neighborhood PA barriers, such that those with higher BMI perceived more neighborhood barriers. There were no associations between BMI and GIS physical activity – density or distance. (Table 3)

Table 4 shows that there was a positive bivariate association (Pearson's correlation coefficients) between perceived neighborhood nutrition barriers and obesity policy change support, and a positive correlation between perceived neighborhood physical activity barriers and obesity policy change support. Overall, these results suggest that those who perceived more nutrition barriers in their neighborhoods had higher support for policy change. In addition, there was a positive association between GIS physical activity density and physical activity policy change support, such that those who had more PA resources around their residences had higher support for physical activity policy changes.

Multiple linear regression associations

In multiple linear regression models, controlling for demographic covariates (age, race, sex, education), there was an inverse association between better diet quality and perceived neighborhood nutrition barriers (estimate = −0.13 (0.05), p = 0.01) and GIS nutrition distance (estimate = −0.39 (0.16), p = 0.02). There were no significant associations between physical activity, BMI, and perceived or GIS-measured neighborhood factors.

After controlling for age, race, sex, and education, perceived neighborhood nutrition barriers were positively associated with nutrition policy change support (estimate = 0.19 (0.07), p = 0.00). Likewise, in adjusted analyses, perceived neighborhood physical activity barriers were positively associated with physical activity policy change support (estimate = 0.05 (0.03), p = 0.03).

Discussion

In this study, major nutrition and physical activity barriers perceived by participants included not enough bike lanes, sidewalks, not enough affordable exercise places, too much crime, and no place to buy a quick, healthy meal to go. This suggests that effective environmental and policy change interventions for this rural county could focus on improving bicycling and walking infrastructure, increasing the number of affordable physical activity opportunities, reducing crime, and increasing the number of restaurants that offer healthy foods. These perceived barriers align well with solutions proposed by the CDC's COCOMO strategies, including "Communities should "Enhance Infrastructure Supporting Bicycling/ Walking", and "Increase Opportunities for Extracurricular Physical Activity" [14].

Higher diet quality was associated with fewer perceived neighborhood barriers to healthy eating, and was also associated with living in closer proximity to healthy food venues, and more PA was associated with living closer to physical activity resources. Higher BMI was associated with greater perceptions of neighborhood-level nutrition and physical activity barriers. Taken together, these results suggest that a neighborhood environment that is conducive to healthier living may promote healthier nutrition and physical activity behaviors. However, as this is a cross-sectional analysis, it could be that those with healthier diets and are more active select to live in places that are closer to healthy food sources and more physical activity opportunities.

Obesity prevention policy change support was positively associated with perceptions of neighborhood barriers. However, no GIS measures of neighborhood barriers were associated with policy change support. It could be that the measures used to assess neighborhood barriers may not have been adequate, and future research should explore better measurement approaches. Selection of appropriate GIS buffer size is imperative for detecting potential associations between built environment variables and behavioral factors related to BMI and our selection of a 1-mile buffer may not have been an adequate measure of the neighborhood exposures most critical to our population [30]. It could also be that perceptions of neighborhood barriers are most important when individuals are making decisions about nutrition and physical activity behaviors. Furthermore, our results indicate that individuals who *perceive* barriers to healthy eating and physical activity would support policies to address those challenges. Future research should examine associations between support for policy change and neighborhood factors related to policy change in varying conditions and contexts.

This study is not without limitations, which include the cross-sectional study design, lack of ability to assume causal direction, self-reported diet and physical activity, and many statistical tests were conducted without accounting for multiple testing. In addition, we used a 1-mile road network buffer to define the neighborhood, which may be an inaccurate representation of the neighborhood, [28] particularly among rural residents, and may be subject to “edge effects”, where proximal food exposure across the county border is not captured. Strengths include that we examined factors on multiple levels of the social ecological framework among a diverse group of rural residents in the South where chronic disease risk is high. We also used GIS-measures to assess the nutrition and PA neighborhood environment.

Conclusion

Perceived and objective environments are associated with both self-reported diet quality, physical activity, and BMI, which supports other research indicating that individual’s behaviors can be affected by the environments in which they live, work, and play. In addition, this study adds to the literature in that we found that perceptions of neighborhood factors related to diet and physical activity may influence support of obesity prevention policies in a variety of ways. Future studies could examine methods by which to garner policy support for health-promoting neighborhood changes.

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Table 1

Baseline descriptive statistics for the sample (N = 366) of eastern North Carolina residents, including perceived and objectively-measured (Geographic Information System, GIS) neighborhood barriers and obesity prevention policy change support.

Demographic characteristics	**N**	**Mean (Standard Deviation) or N (%)**
Age in years	366	55.2 (12.0)
Education in years	366	12.9 (2.7)
Gender (female)	366	278 (76%)
Race	364	
Black (yes)		236 (65%)
Non-black (yes)		128 (35%)
Health Insurance status (yes)	366	269 (74%)
Smoking status (yes)	366	169 (46%)
Married or living with partner (yes)	366	173 (47%)
Behaviors and Body Mass Index (BMI)		
Diet Quality – Dietary Risk Assessment*	287	27.8 (5.3)
Fruit/Vegetable servings per day	366	3.4 (1.9)
Total Physical Activity (min/week)	366	151.0 (259.2)
Steps/day (pedometer measured)**	237	4496 (2862)
BMI (kg/m^2)	365	35.9 (9.4)
Perceived neighborhood barriers		
Perceived Neighborhood Nutrition Barriers	357	14.2 (6.3)
Perceived Neighborhood Physical Activity Barriers	346	30.0 (12.9)
Perceived Total Neighborhood Barriers	343	41.9 (17.1)
GIS-assessed neighborhood factors* **		
Density**** (number) of supermarkets	273	0.4 (0.8)
Distance (miles) to closest supermarket	273	2.2 (2.0)
Density (number) of farmers' markets	273	0.1 (0.3)
Distance (miles) to closest farmers' market	273	3.3 (2.1)
Density (number) of fast food restaurants	273	1.4 (2.2)
Distance (miles) to closest fast food restaurant	273	2.2 (2.1)
GIS nutrition - density*****	273	−0.8 (1.5)
GIS nutrition - distance*****	273	3.3 (2.2)
Density (number) of low cost gym	273	0.4 (0.7)
Distance (miles) to closest low cost gym	273	4.9 (4.6)
Density (number) of parks	273	1.0 (1.4)
Distance (miles) to closest park	273	2.3 (2.3)
Density (number) of private gyms	273	0.7 (1.2)
Distance (miles) to closest private gym	273	2.5 (2.4)

Demographic characteristics	N	Mean (Standard Deviation) or N (%)
GIS physical activity - density*****	273	2.1 (2.7)
GIS physical activity - distance*****	273	9.7 (7.8)
Obesity prevention policy change support***		
Healthy food policy support	360	30.6 (8.0)
Physical activity policy support	360	24.8 (6.1)
Overall policy support	360	55.3 (13.1)

* Note: The dietary survey was administered at the first intervention visit which was attend by 273 (75%) of study participants. For Diet Quality, a higher score is better.

** Note: Pedometer data were collected at the first intervention visit attend by 273 (75%) of study participants and reported for those with greater than 500 steps/day on a minimum of 3 days during the last 31 days of wearing.

*** Note: Distance to the closest food/physical activity venue and density of venues within a 1-mile radius of the residential address could only be calculated for participants with valid address data.

**** Number of venues within a 1 mile radius of the residential address

***** We derived the GIS nutrition density score by summing the densities of supermarkets and farmers' markets and subtracting the density of fast food restaurants (a higher score indicated a healthier neighborhood food environment). We derived the GIS nutrition - distance score by summing the distances to the closest supermarket and farmers' market and subtracting the distance to the closest fast food restaurant, such that a higher score indicated a less healthy neighborhood food environment. Likewise, we created two GIS-measured neighborhood scores for the density of and distance to the closest recreation parks, low-cost gyms, and private gyms. A higher GIS PA - density score indicated a healthier PA environment and a higher GIS PA distance score indicated a less healthy PA environment.

****** Participants indicated their level of support for the strategies to support healthy eating and PA on a scale from 1 to 10, with 1 indicating "strongly do not support" the strategy and 10 indicating "strongly support" the strategy. Responses were summed to create a "healthy food policy support" score (sum of items 1, 3, 6, and 7, with scores ranging from 4 to 40), a "physical activity policy support" score (sum of items 2, 4, and 5, with scores ranging from 3 to 30), and an "obesity prevention policy" score, summing responses to all seven items (possible scores ranged from 7 to 70). A higher score indicated greater obesity prevention policy support.

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Table 2

Percentage of study participants (n = 366) stating that each neighborhood level barrier was a big problem* in their neighborhood.

Barrier	Percent stating that the barrier was a 'big problem'
not enough bike lanes	35
not enough sidewalks	27
not enough affordable exercise places	25
too much crime	25
no place to buy a quick, healthy meal to go	22
not enough parks, trails, or tracks for walking	18
not enough physical activity programs that meet your needs	18
unattended dogs	18
not enough restaurants with healthy food choices	17
too many fast food places	15
no street lights	15
not enough farmer's markets or produce stands	14
speeding drivers	12
not enough food stores with affordable fruits & vegetables	11
heavy traffic	11
rural environment	10
bad air from cars or factories	5
verbal abuse from people on the street	5

*Note: Participants indicated whether each of 18 items was a problem in their neighborhoods, with 1 = not a problem and 5 = a big problem.

Table 3

Bivariate associations (Pearson's Correlation Coefficients and 95% Confidence Intervals) between perceived and objectively-measured (Geographic Information System, GIS) neighborhood barriers and individual-level diet, physical activity, and Body Mass Index (BMI). Correlations with p-values < 0.05 are highlighted in bold.

	Individual-level Characteristics	
Neighborhood factors related to nutrition	**Diet Quality**	**BMI**
Perceived Neighborhood Nutrition Barriers (higher score indicates more barriers)	**−0.17 (−0.28, −0.05)**	**0.13 (0.03, 0.23)**
Perceived Total Neighborhood Barriers (higher score indicates more barriers)	**−0.15 (−0.27, −0.03)**	**0.14 (0.03, 0.24)**
GIS nutrition - density (higher score indicates better access)	−0.03 (−0.17, 0.10)	0.00 (−0.11, 0.12)
GIS nutrition - distance (higher score indicates greater distance and less access)	**−0.16 (−0.29, −0.03)**	−0.03 (−0.15, 0.09)
Neighborhood factors related to physical activity	Total Activity	BMI
Perceived Neighborhood Physical Activity Barriers (higher score indicates more barriers)	0.01 (−0.10, 0.11)	**0.12 (0.01, 0.22)**
Perceived Total Neighborhood Barriers (higher score indicates more barriers)	0.01 (−0.09, 0.12)	**0.14 (0.03, 0.24)**
GIS physical activity - density ((higher score indicates better access)	−0.03 (−0.14, 0.09)	0.00 (−0.11, 0.12)
GIS physical activity - distance (higher score indicates greater distance and less access)	−0.06 (−0.18, 0.05)	0.03 (−0.09, 0.15)

** Correlations between neighborhood barriers and fruit and vegetable servings and pedometer steps not included in table, as there were no statistically significant findings.

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Table 4

Bivariate associations (Pearson's Correlation Coefficients and 95% Confidence Interval) between participant's support for obesity prevention policy change and perceived and objectively-measured (Geographic Information System, GIS) neighborhood barriers to healthy food and physical activity. Estimates with p-values < 0.05 are highlighted in bold.

	Healthy food policy support	Physical activity policy support	Overall policy support
Perceived Neighborhood Nutrition Barriers (higher score indicates more barriers)	**0.18 (0.08, 0.28)**	**0.15 (0.04, 0.25)**	**0.18 (0.08, 0.28)**
Perceived Total Neighborhood Barriers (higher score indicates more barriers)	**0.18 (0.08, 0.29)**	**0.17 (0.06, 0.27)**	**0.19 (0.09, 0.30)**
GIS nutrition - density (higher score indicates better access)	−0.04 (−0.16, 0.08)	−0.07 (−0.19, 0.05)	−0.06 (−0.18, 0.06)
GIS nutrition - distance (higher score indicates greater distance and less access)	−0.08 (−0.20, 0.04)	−0.07 (−0.19, 0.04)	−0.08 (−0.20, 0.04)
Perceived Neighborhood Physical Activity Barriers (higher score indicates more barriers)	**0.17 (0.06, 0.27)**	**0.16 (0.06, 0.27)**	**0.18 (0.08, 0.28)**
GIS physical activity - density (higher score indicates better access)	0.05 (−0.07, 0.17)	**0.12 (0.00, 0.23)**	0.09 (−0.03, 0.20)
GIS physical activity - distance (higher score indicates greater distance and less access)	−0.05 (−0.17, 0.07)	−0.11 (−0.22, 0.00)	−0.08 (−0.20, 0.04)