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Environments Perceived as Obesogenic Have Lower Residential Property Values

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Abstract

Background—Studies have tried to link multiple aspects of the built environment with physical activity and obesity rates.

Purpose—To determine the relation between residential property values and multiple perceived (self-reported) measures of the obesogenic environment.

Methods—The Seattle Obesity Study (SOS) used a telephone survey of a representative, geographically distributed sample of 2,001 King County adults, collected in 2008–2009 and analyzed in 2012–2013. Home addresses were geocoded. Residential property values at the tax parcel level were obtained from the King County tax assessor. Mean residential property values within a 10-minute walk (833-meter buffer) were calculated for each respondent. Data on multiple perceived measures of the obesogenic environment were collected by self-report. Correlations and multivariable linear regression analyses, stratified by residential density, were used to examine the associations among perceived environmental measures, property values, and BMI.

Results—Perceived measures of the environment such as crime, heavy traffic, and proximity to bars, liquor stores, and fast food were all associated with lower property values. By contrast, living in neighborhoods that were perceived as safe, quiet, clean, and attractive was associated with higher property values. Higher property values were associated, in turn, with lower BMIs. The observed associations between perceived environment measures and BMI were largely attenuated after accounting for residential property values.

Conclusions—Perceived measures of obesogenic environments are associated with lower property values. Studies in additional locations need to explore to what extent other perceived environment measures can be reflected in residential property values.

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Introduction

Obesity in the U.S. is a major public health problem.^{1, 2} Higher obesity rates are observed among groups with lower education and incomes³ and in socioeconomically deprived areas.⁴⁻⁶ Several studies have sought to link physical activity, diet quality, and health outcomes with various aspects of the neighborhood environment.⁷⁻²¹

Past research has identified four principal environmental domains: functionality, safety, aesthetics, and destination.²² Among the key destination variables were access to shops and services, parks, and recreational facilities.²³⁻²⁵ A review of tools to measure the perceived built environment²⁶ noted that the most common variables were land use, traffic, aesthetics, and safety from crime. Additional studies have examined the impact of social factors and cohesion on physical activity and obesity rates.²⁷

Positive associations were obtained between obesity and several neighborhood variables. Areas that were safe for pedestrians and from crime, and where people knew and trusted each other, had higher physical activity²⁸ and lower obesity rates.^{7, 12, 17, 29-34} Perceived aesthetics, such as attractive streets, greenery and mature trees, and well-maintained parks were also associated with lower BMIs.^{7, 18, 35} By contrast, poor aesthetics as measured by perceptions of physical disorder, poor sidewalk quality, and presence of garbage, litter, and graffiti tended to be associated with higher BMIs.^{13, 36, 37} In terms of destinations, perceived proximity to supermarkets, parks, sidewalk cafes, and landmark buildings was linked to better diets,^{12, 38} more physical activity^{12, 30, 31} and lower BMIs.^{7, 13, 14, 17, 18, 39, 40} Conversely, perceived proximity to bars, liquor stores, fast food, and convenience stores was viewed as obesogenic, because it was associated with higher BMIs.^{15, 41} However, the results were not always consistent^{23-25, 42} and there is no consensus on the key features of an obesogenic environment.^{16, 43}

Based on the economic theory of supply and demand, the present hypothesis was that land use, traffic, aesthetics, and safety from crime would be largely reflected in neighborhood residential property values.^{44, 45} We therefore examined the associations among perceived measures of the environment, many used in past studies,²⁶ residential property values, and BMIs.

The introduction of residential property values marks a paradigm shift in studies of the impact of the built environment on weight and health.⁴⁶ Only a few published studies^{4, 5, 41, 47} have used property values as an objective index of desirable neighborhood characteristics. Residential property values can also serve as an index of individual- and area-level SES.⁴⁸

Methods

Sample and Study Design

The Seattle Obesity Study (SOS) was based on a stratified random sample of 2,001 adult residents of King County, WA.^{48, 49} King County zip codes with higher proportions of lower incomes and minorities were oversampled. Following standard procedures,

commercial databases were used to match randomly generated telephone numbers with residential addresses. A pre-notification letter was mailed to potential respondents.

Data Collection

One adult per household was randomly selected to participate in the study. A 20-minute telephone survey, administered by trained interviewers collected self-reported data on the physical and social environment, sociodemographics, and height and weight. All home addresses were geocoded.

Perceived environment measures were captured using 11 questions, similar to those used in previous research.^{14, 17, 29–31, 38} These were: (1) *my neighborhood is safe from crime*; (2) *my neighborhood is safe for pedestrians*; (3) *I feel safe walking in my neighborhood*; (4) *my neighborhood is well lit at night*; (5) *people in my neighborhood know each other*; (6) *I trust people in my neighborhood*; (7) *my neighborhood is diverse*; (8) *my neighborhood is clean*; (9) *my neighborhood is attractive*; (10) *fast traffic is a problem in my neighborhood*; and (11) *heavy traffic is a problem in my neighborhood*. Agreement was measured on a 5-point Likert scale: *strongly disagree*, *disagree*, *neutral*, *agree*, and *strongly agree*. For analyses, the *strongly disagree* and *disagree* responses were pooled to create a 4-point scale.

Perceived destination variables were captured by asking whether any of the following were within a 10-minute walk of participant's home: (1) supermarket/grocery store; (2) convenience store; (3) full-service restaurant; (4) fast food restaurant; (5) coffee shop/café; (6) bar, tavern, or pub; (7) liquor store; (8) sports facility, playing fields, or golf courses; (9) park, recreational area, or trail; (10) neighborhood retail stores (drug store/pharmacy, book store, music store, clothing store, or bank); and (11) mall, shopping center, or plaza. Responses were recorded as *yes* or *no*. Data were collected during November 2008–April 2009 and analyzed in 2012–2013. All study protocols were approved by the IRB of the University of Washington.

Residential property values—Data from King County tax assessor records for 2008 were used to develop the residential property value metric.^{5, 48} When parcels had multiple units, the mean value per unit was used. First, a 30-meter grid was generated over the King County area (>6,000,000 points). Each grid cell was visited serially using a moving window or kernel function in GIS to calculate the mean assessed property value per residential unit within an 833-meter airline bandwidth from the center of the cell's center (ArcGIS 9, ESRI, Redlands CA).⁵⁰ The metric was then defined as the mean property value of residential units within 833 meters or a 10-minute walk of the respondent's home.

Residential density was represented as the number of residential units (single-family, condominium, and apartment units) within an 833-meter buffer of the respondent's home. Based on the distribution in our sample, five units/acre was the cut-off that distinguished between urban and suburban King County.

Statistical Analysis

Residential property values and BMI data were both log-transformed to normalize the right-skewed distributions. Bivariate linear regression models examined the associations of

multiple perceived environment and destination measures with log-transformed residential property values. The marginal means were exponentiated to estimate the geometric mean property values for every level of the perception variables. These analyses were stratified by residential density, which was dichotomized into <five units/acre and five units/acre (77% and 23% of the sample, respectively).

The association between residential property values and BMI was examined using linear regression analyses, for the entire study population and stratified by gender. Individual-level measures of SES (income, education) were first tested for colinearity with residential property values using the variance inflation factor and κ statistic. The concordance and κ for property values and education was 0.43 and 0.15, respectively. The concordance and κ for property values and income was 0.29 and 0.15, respectively. From these analyses and evaluation of the crude tables, we are confident that colinearity does not pose a threat to our results or conclusions. Thus, bivariate analyses of BMI with residential property values were further adjusted for age group, race/ethnicity, education, and home ownership followed by annual household income and household size. Adjusted geometric mean BMI was computed for each quartile of residential property value for both men and women.

Associations between each of the perception variables and BMI were examined using multivariate linear regression models. Model 1 adjusted for age group, gender, race/ethnicity, home ownership, and education, whereas Model 2 additionally adjusted for quartiles of neighborhood property values. Analyses were conducted for the entire sample and after stratifying by gender. A *p*-trend was estimated by treating the perceived environment measures as a continuous variable. All results presented were calculated using robust SEs. All analyses used Stata, version 12.0 (College Station TX).

Results

Respondent summaries are shown in Table 1. The majority of respondents were women (60%) and 83% were white. The mean age was 54.5 years (SD=15 years). The median annual household income was \$50,000–<\$75,000 and 55% of respondents had at least a college degree. The median neighborhood property value was \$247,000 and most respondents owned their home (79%).

Perceived Environment Measures and Residential Property Values

Perceived environment measures were significantly associated with residential property values for ten of the 11 variables of interest (*p*-trend<0.050) (Table 2A). Perceived safety (safe from crime, safe to walk, safe for pedestrians) was associated with higher residential property values (*p*<0.001). Perceived aesthetics (attractive and clean) were also associated with higher property values (*p*<0.001). Perceived neighborhood trust was also associated with higher property values (*p*<0.001). By contrast, perceived heavy traffic and fast traffic were associated with lower property values. Neighborhoods perceived as diverse were associated with lower property values. Only the perception of neighborhoods being well lit at night was not associated with a significant difference in residential property values. All these associations were consistent across lower and moderate density areas.

Perceived aesthetics, one component of the Pikora et al.²² framework, had the strongest association with residential property values, accounting for 13.0% of the variance in property values. Trusting people in the neighborhood was also associated with higher residential property values, accounting for 9% of the variance.

Perceived Destinations and Residential Property Values

As shown in Table 2B, perceived destinations, another framework domain, were reflected in property values. Perceived proximity to bars/taverns/pubs, liquor stores, convenience stores, fast food, and other retail, including supermarkets and shopping malls, was associated with lower property values, both before and after stratifying by residential density. By contrast, having parks, trails, and recreational areas within a 10-minute walk was associated with higher property values. Proximity to full-service restaurants and cafes or sports facilities had no significant impact on residential property values.

The largest differences in the mean residential property values were observed for perceived access to fast food restaurants and convenience stores. For respondents who perceived living within a 10-minute walk of a convenience store, property values within a 10-minute walk were \$60,000 lower than for respondents who did not. Similarly, the perception of having a fast food restaurant within a 10-minute walk was associated with property values that were \$50,000 lower. By contrast, the perception of living within a 10-minute walk to a park, recreational area, or trail was associated with property values that were on average \$30,000 higher.

Having convenience stores and fast food restaurants within a 10-minute walk were most strongly associated with property values, accounting for 6.1% and 5.5% of the variance, respectively.

BMI and Residential Property Values

Higher residential property values were associated with lower mean BMIs among women (Figure 1), after adjusting for age, race/ethnicity, education, and home ownership ($p < 0.001$). These associations remained unchanged even after adding income to the model (results not shown). No association between property values and BMI was observed for men.

Perceived Environment Measures and BMI

Seven of the perceived environmental measures were significantly associated with BMI, especially for women (Table 3A). Perceived neighborhood safety was associated with significantly lower mean BMI, after adjusting for age group, race/ethnicity, education, and home ownership (Model 1). Higher neighborhood trust and lower neighborhood diversity were each associated with lower mean BMI. On the other hand, neighborhoods perceived as clean or attractive or without traffic issues were not associated with BMI (Model 1).

Most of the observed associations between perceived environmental measures and BMI were partially or fully attenuated once residential property value was added to model (Model 2).

Perceived Destinations and BMI

Perceived destinations were only weakly associated with BMI (Table 3B). The perception of having a full-service restaurant or a café/coffee shop within a 10-minute walk was associated with marginally lower BMIs among both women and men (Model 1: full-service restaurant=0.97, 95% CI=0.95, 0.99 for both men and women; coffee shop or café=0.97, 95% CI=0.94–0.99, $p=0.014$ for both). The perception of living within a 10-minute walk to a park or recreational area was associated with lower BMI, but only among women, whereas perceived 10-minute walk to a bar was associated with lower BMI among men (Model 1). These associations were attenuated once property values were included in the model (Model 2).

Discussion

Many of the perceived environmental measures previously used to identify obesogenic neighborhoods were related to residential property values in a predictable manner. In this Seattle-based sample, aesthetics and safety were generally related to higher property values; however, perceived destinations varied in their relationship to property values by the type of service. The perception of living in unattractive, unsafe, and high traffic neighborhoods and closer to fast food and convenience stores was associated with lower mean residential property values within a 10-minute walk. By contrast, living in attractive, clean, and safe neighborhoods with less traffic and close to parks and trails was associated with higher mean property values. In past studies, those same domains of the environment were used to determine whether a given neighborhood was obesogenic or not.^{7, 13, 20, 29, 30, 32, 36, 38, 40}

Establishing links between multiple measures of the built environment, activity levels,²⁸ and obesity rates⁵ is a continuing challenge. Several studies have made reference to a complex mix of neighborhood-level barriers and facilitators of healthy body weight.^{17, 51} Property values, a new wealth metric for health studies, offer a way to resolve the complexity. Since real estate is by definition immobile, people move to the dwelling unit as opposed to the other way round. The price of the dwelling unit is an effective way to sort the population by material resources and SES. One question that needs to be asked is how many of the observed effects of the built environment on health can be explained by the buyers' SES?

Our study advances the literature by focusing on property values at the tax parcel lot level. Real estate economics tells us that house prices are highly sensitive to specific environmental variables such as crime, traffic, parks, or street design. In general, residential neighborhoods that are perceived as safe and attractive are more desirable than those associated with heavy traffic, crime, and liquor stores.^{36, 40, 52} Homes in safe areas of higher aesthetic value and with access to shops and services fetch higher prices, and people who live in them tend to be of higher SES than those who do not.^{22, 28} The value of one's home may also be a better reflection of economic security than current employment status and other more traditional measures of SES, such as education and incomes.^{47, 48} In past studies, higher education and incomes were linked to lower obesity rates, especially among women.^{5, 53}

One caution is that the destinations domain can be context dependent. In Seattle–King County, having a park within a 10-minute walk was associated with higher property values. Similarly, the New York Economic Development Commission⁵⁴ reported that median values for Upper East Side properties within a 0–5-minute walk of Central Park were approximately 11% higher than those within a 5–10-minute walk. In Seattle–King County, having a supermarket within a 10-minute walk was associated with lower property values. However, Detroit-based studies deemed the presence of nearby supermarkets as desirable and it appeared to be associated with higher area SES.^{55, 56} In general, supermarket siting closely tracks area SES.

This shifting context may help explain inconsistent associations between environmental measures and BMIs. Physical proximity to fast food and convenience stores was linked to obesity in some studies^{41, 57–60} but not in others.^{24, 25, 42} Physical proximity to supermarkets was linked to lower obesity rates in some studies^{12, 39, 58, 61–65} but not in others.^{42, 49} Physical proximity to parks was linked to lower obesity rates^{66–68} but not always.²⁴ Very recently, proximity to a large supermarket was linked to higher, not lower, BMI values among obese preschool children.²⁵ Studies on the role of social capital in relation to health also had mixed findings.^{69–72} The links between the built environment and BMI were said to be complex and not readily understood.⁴⁰

Residential property values have not as yet been widely used.^{5, 48} Using an index of property values based on tax rolls, Mellor and colleagues⁴¹ observed that students residing in homes with higher assessment values were significantly less likely to be obese. A study conducted in southeast Wales found that low property values were associated with more obesity and lower-quality diets.⁴⁴ In Northern Ireland, residents of homes with lower property values were more likely to report poor health than residents of homes with higher property values.⁴⁵ Follow-up analyses of data from the U.S. Department of Housing and Urban Development Move to Opportunity program showed that families who moved to better neighborhoods had lower rates of obesity and diabetes than those who stayed behind.⁷³ Such studies place the socioeconomic determinants of body weight and health into sharp relief.

The present study had numerous limitations. First, data on BMI were based on self-reported heights and weights, which might be subject to known biases such as under-reporting weight and over-reporting height.⁷⁴ There is some evidence that lower-income women tend to under-report weight and over-report height.⁷⁵ Systematic bias in reporting weights by SES variables has also been observed among men.⁷⁶ This would suggest that the observed associations among men and women, in reality, would be much larger. Second, it is possible that the perceived measures of the environment may not track objective measures^{77–81}; however, some studies have also pointed to the value of the subjective perception of neighborhoods and impact on behavior.³⁸ Third, the comparisons between perceived environment features and BMI also do not account for residential self-selection. Although neighborhood preferences have been attributed to the desire for easy access to healthy foods and physical activity,⁸² area home prices may be the deciding factor. Furthermore, the cross-sectional study design limits our ability to draw causal inferences between built environment variables and obesity. Finally, because characteristics of neighborhoods differ between

cities, the results of this study may not be generalizable to settings outside of Seattle–King County.

Conclusions

Despite these limitations, the study provides strong evidence that property values can be a useful metric for studies on obesity and the built environment.^{83, 84} Because of their ability to capture complex information about perceived neighborhood characteristics and resources, residential property values can be of great use in obesity research. Further research should extend this work to other cities to determine whether other features of obesogenic environments can also be explained by SES.

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Figure 1.

Adjusted geometric mean BMI by quartiles of residential property values, stratified by gender

Note: Adjusted for age group, race/ethnicity, education, and home ownership.

* $p < 0.001$, ** $0.001 < p < 0.01$ compared to fourth quartile (reference category).

Table 1

Sample characteristics, N=1,817

	<i>n</i>	%
Gender		
Female	1,098	60.4
Male	719	39.6
Age group		
18–29 years	93	5.1
30–44 years	378	20.8
45–64 years	901	49.6
65 years	445	24.5
Race/ethnicity		
White	1,509	83.1
Black	123	6.8
Asian	145	8.0
Other	40	2.2
Education		
High School	342	18.8
Some college	473	26.0
College graduate	1,002	55.2
Home ownership		
Yes	1,431	78.8
No	386	21.2
Annual Household income		
(\$1,000)		
<25	223	13.7
25–34.9	166	10.2
35–49.9	261	16.0
50–74.9	309	19.0
75–99.9	253	15.5
100	418	25.6
Missing	187	
BMI (kg/m²)		
Underweight (<18.5)	28	1.5
Healthy weight (18.5–24.9)	777	42.8
Overweight (25–29.9)	634	34.9
Obese (≥30)	378	20.8

Table 2

A. Crude geometric means of residential property values by perceived environment measures, stratified by residential density

	<i>n</i>	Total population (in 1,000) M (95% CI)	Lower density (<5 units/acre) (in 1,000) M (95% CI)	Moderate density (5 units/acre) (in 1,000) M (95% CI)
My neighborhood is safe from crime				
Strongly disagree/disagree	590	230 (224, 237) ****	232 (223, 240) ****	227 (217, 238) **
Neutral	138	248 (233, 264) ****	252 (234, 272) ****	235 (213, 259)
Agree	650	257 (249, 265) ****	262 (253, 272) ****	237 (225, 250)
Strongly agree	418	304 (291, 317)	312 (298, 326)	255 (235, 277)
<i>p</i> -trend		<0.001	<0.001	0.030
<i>R</i> ²		0.06	0.07	0.01
My neighborhood is safe for pedestrians				
Strongly disagree/disagree	274	226 (217, 237) ****	232 (220, 245) ****	208 (192, 225) ****
Neutral	68	242 (218, 268) ***	247 (219, 278) ***	222 (189, 260)
Agree	675	245 (238, 252) ****	249 (240, 258) ****	234 (224, 244) *
Strongly agree	792	281 (273, 289)	290 (281, 301)	249 (237, 261)
<i>p</i> -trend		<0.001	<0.001	<0.001
<i>R</i> ²		0.04	0.04	0.04
I feel safe walking in my neighborhood				
Strongly disagree/disagree	214	211 (201, 221) ****	215 (204, 227) ****	199 (181, 217) ****
Neutral	62	213 (197, 231) ****	210 (191, 232) ****	224 (197, 254)
Agree	592	242 (235, 250) ****	247 (238, 257) ****	228 (218, 238) ***
Strongly agree	936	281 (274, 289)	291 (282, 300)	250 (239, 262)
<i>p</i> -trend		<0.001	<0.001	<0.001
<i>R</i> ²		0.07	0.07	0.06
My neighborhood is well lit at night				
Strongly disagree/disagree	505	263 (254, 273) **	271 (260, 282) *	229 (215, 244)
Neutral	99	260 (241, 280)	263 (242, 287)	244 (209, 284)
Agree	648	257 (249, 265)	264 (253, 275)	240 (229, 251)
Strongly agree	555	250 (242, 258)	257 (247, 267)	232 (219, 245)
<i>p</i> -trend		0.040	0.070	0.820
<i>R</i> ²		0.03	0.00	0.00
People in my neighborhood know each other				
Strongly disagree/disagree	481	230 (222, 237) ****	232 (222, 242) ****	224 (212, 236) ***
Neutral	88	237 (219, 257) ****	240 (215, 267) ****	232 (212, 255) *
Agree	751	261 (253, 269) ****	270 (261, 280) ****	233 (222, 244) **
Strongly agree	466	285 (274, 296)	292 (279, 305)	257 (239, 276)
<i>p</i> -trend		<0.001	<0.001	0.006

A. Crude geometric means of residential property values by perceived environment measures, stratified by residential density

	<i>n</i>	Total population (in 1,000) M (95% CI)	Lower density (<5 units/acre) (in 1,000) M (95% CI)	Moderate density (5 units/acre) (in 1,000) M (95% CI)
<i>R</i> ²		0.04	0.04	0.02
I trust the people in my neighborhood				
Strongly disagree/disagree	206	208 (199, 217) ****	209 (198, 221) ****	204 (191, 219) ****
Neutral	136	221 (208, 234) ****	230 (212, 249) ****	205 (192, 218) ****
Agree	697	244 (237, 251) ****	246 (238, 254) ****	238 (226, 250) **
Strongly agree	762	293 (284, 302)	302 (292, 313)	259 (246, 272)
<i>p</i> -trend		<0.001	<0.001	<0.001
<i>R</i> ²		0.09	0.09	0.09
My neighborhood is diverse				
Strongly disagree/disagree	217	322 (303, 342) ****	340 (317, 365) ****	262 (241, 286) ***
Neutral	51	272 (240, 308) *	271 (237, 311)	275 (230, 329) **
Agree	464	268 (258, 279) ****	273 (260, 286) ****	249 (234, 266) **
Strongly agree	1047	240 (234, 245)	245 (238, 251)	226 (218, 234)
<i>p</i> -trend		<0.001	<0.001	<0.001
<i>R</i> ²		0.06	0.06	0.04
My neighborhood is clean				
Strongly disagree/disagree	184	213 (203, 222) ****	211 (199, 224) ****	216 (202, 232) ***
Neutral	75	215 (203, 229) ****	214 (197, 233) ****	217 (200, 236) ***
Agree	656	237 (230, 244) ****	239 (231, 248) ****	230 (219, 241) **
Strongly agree	900	286 (278, 294)	295 (285, 304)	251 (238, 264)
<i>p</i> -trend		<0.001	<0.001	<0.001
<i>R</i> ²		0.08	0.08	0.03
My neighborhood is attractive				
Strongly disagree/disagree	202	202 (194, 211) ****	202 (193, 212) ****	201 (183, 222) ****
Neutral	112	216 (204, 227) ****	217 (203, 232) ****	212 (195, 231) ****
Agree	699	236 (230, 242) ****	239 (232, 247) ****	228 (218, 238) ****
Strongly agree	797	300 (292, 310)	313 (302, 324)	258 (246, 270)
<i>p</i> -trend		<0.001	<0.001	<0.001
<i>R</i> ²		0.13	0.15	0.07
Fast traffic is a problem in my neighborhood				
Strongly disagree	326	257 (246, 268)	264 (251, 277)	230 (211, 249)
Disagree	430	265 (254, 275)	280 (266, 294) *	228 (216, 241)
Neutral	139	276 (257, 298) *	281 (255, 310)	265 (241, 291) **
Strongly agree/agree	914	250 (243, 256)	254 (246, 262)	235 (225, 246)
<i>p</i> -trend		0.090	0.020	0.390
<i>R</i> ²		0.01	0.01	0.02

A. Crude geometric means of residential property values by perceived environment measures, stratified by residential density

	<i>n</i>	Total population (in 1,000) M (95% CI)	Lower density (<5 units/acre) (in 1,000) M (95% CI)	Moderate density (5 units/acre) (in 1,000) M (95% CI)
Heavy traffic is a problem in my neighborhood				
Strongly disagree	722	273 (265, 281)	279 (269, 289)	246 (233, 261)
Disagree	520	257 (249, 266) ***	263 (252, 274) **	241 (228, 254)
Neutral	113	251 (232, 272) *	263 (238, 292)	224 (204, 245) *
Strongly agree/agree	455	233 (224, 241) ****	237 (226, 248) ****	223 (211, 234) ****
<i>p</i> -trend		<0.001	<0.001	0.005
<i>R</i> ²		0.02	0.02	0.02

B. Crude geometric mean of residential property values by perceived destinations, stratified by residential density

	<i>n</i> (%)	Total population (in 1,000) M (95% CI)	Lower density (<5 units/acre) (in 1,000) M (95% CI)	Moderate density (5 units/acre) (in 1,000) M (95% CI)
Supermarket/grocery store				
No	802 (44.4)	270 (263, 278)	274 (266, 282)	239 (222, 257)
Yes	1,003 (55.6)	246 (240, 252) ****	253 (244, 261) ****	234 (226, 241)
<i>R</i> ²		0.010	0.010	<0.001
Convenience store				
No	655 (36.4)	294 (285, 303)	299 (289, 310)	252 (233, 271)
Yes	1,143 (63.6)	237 (232, 243) ****	240 (233, 247) ****	231 (224, 239)*
<i>R</i> ²		0.060	0.060	0.010
Full-service restaurant				
No	754 (41.8)	259 (251, 266)	262 (255, 270)	219 (202, 238)
Yes	1,049 (58.2)	255 (249, 261)	264 (255, 273)	238 (230, 245)
<i>R</i> ²		0.000	0.000	0.010
Fast food restaurant				
No	969 (54.0)	281 (274, 288)	285 (277, 294)	257 (242, 273)
Yes	825 (46.0)	230 (224, 236) ****	233 (225, 241) ****	225 (218, 232) ****
<i>R</i> ²		0.060	0.050	0.040
Coffee shop/café				
No	737 (41.0)	258 (251, 266)	261 (253, 269)	217 (197, 240)
Yes	1,059 (59.0)	256 (250, 262)	267 (258, 276)	237 (230, 244)
<i>R</i> ²		<0.001	<0.001	0.010
Bar/tavern/pub				
No	849 (48.6)	278 (271, 286)	285 (277, 294)	227 (215, 240)
Yes	898 (51.4)	238 (232, 244) ****	239 (230, 247) ****	237 (229, 246)
<i>R</i> ²		0.040	0.040	<0.001
Liquor store				
No	1,343 (77.5)	267 (262, 273)	274 (268, 281)	236 (226, 246)

B. Crude geometric mean of residential property values by perceived destinations, stratified by residential density

	<i>n</i> (%)	Total population (in 1,000) M (95% CI)	Lower density (<5 units/acre) (in 1,000) M (95% CI)	Moderate density (5 units/acre) (in 1,000) M (95% CI)
Yes	391 (22.6)	228 (219, 238) ****	225 (212, 238) ****	233 (222, 245)
<i>R</i> ²		0.030	0.030	<0.001
Park, recreational area, or trail				
No	394 (21.8)	233 (224, 243)	238 (229, 248)	212 (199, 226)
Yes	1,415 (78.2)	263 (258, 269) ****	271 (264, 279) ****	240 (232, 248) ***
<i>R</i> ²		0.010	0.020	0.020
Sports facility, playing field, court, or golf course				
No	746 (41.3)	254 (247, 262)	261 (252, 270)	233 (222, 244)
Yes	1,062 (58.7)	258 (252, 264)	266 (258, 274)	235 (226, 244)
<i>R</i> ²		0.000	0.000	0.000
Neighborhood retail stores				
No	931 (51.4)	271 (264, 278)	275 (267, 283)	237 (220, 255)
Yes	880 (48.6)	242 (235, 248) ****	247 (238, 256) ****	234 (226, 241)
<i>R</i> ²		0.020	0.010	0.000
Mall, shopping center, or plaza				
No	1,440 (76.6)	264 (259, 270)	270 (263, 276)	243 (234, 252)
Yes	370 (20.4)	227 (218, 237) ****	233 (220, 247) ****	218 (208, 229) ***
<i>R</i> ²		0.020	0.020	0.030

Note: Boldface indicates statistical significance.

 $p < 0.001$,

 $0.001 < p < 0.01$,

**
 $0.01 < p < 0.05$,

*
 $0.05 < p < 0.10$

Reference value for all non-traffic variables is *strongly agree*; reference value for traffic variables is *strongly disagree*.

Note: Boldface indicates statistical significance.

 $p < 0.001$,

 $0.001 < p < 0.01$.

Table 3

A. Adjusted ratios of mean BMI by perceived environment measures, taking residential property values into account

	Overall—ratio of means (95% CI)		Women—ratio of means (95% CI)		Men—ratio of means (95% CI)	
	Model 1 ^a	Model 2 ^b	Model 1 ^a	Model 2 ^b	Model 1 ^a	Model 2 ^b
My neighborhood is safe from crime						
Strongly disagree/disagree	1.03 (1.00, 1.05) **	1.01 (0.98, 1.03)	1.04 (1.01, 1.08) ***	1.02 (0.98, 1.05)	1.00 (0.97, 1.03)	1 (0.97, 1.03)
Neutral	0.99 (0.96, 1.02)	0.97 (0.94, 1.01)	1.00 (0.96, 1.05)	0.98 (0.94, 1.02)	0.96 (0.92, 1.01)	0.96 (0.92, 1.01)
Agree	1.02 (1.00, 1.04) *	1.01 (0.99, 1.03)	1.03 (1.00, 1.06) *	1.01 (0.98, 1.04)	1.01 (0.98, 1.04)	1.01 (0.98, 1.04)
Strongly agree	ref	ref	ref	ref	ref	ref
<i>p</i> -trend	0.110	0.800	0.022	0.470	0.680	0.510
My neighborhood is safe for pedestrians						
Strongly disagree/disagree	1.03 (1.00, 1.06) **	1.02 (0.99, 1.04)	1.06 (1.02, 1.10) ***	1.04 (1, 1.07) **	0.99 (0.95, 1.02)	0.98 (0.94, 1.02)
Neutral	1.07 (1.02, 1.11) ***	1.05 (1.01, 1.10) **	1.06 (1.00, 1.13) *	1.04 (0.97, 1.1)	1.07 (1.00, 1.13) **	1.07 (1, 1.13)
Agree	1.02 (1.01, 1.04) **	1.02 (1.00, 1.03) *	1.03 (1.01, 1.06) ***	1.02 (1, 1.05) *	1.01 (0.98, 1.04)	1.01 (0.98, 1.03)
Strongly agree	ref	ref	ref	ref	ref	ref
<i>p</i> -trend	0.006	0.080	<0.001	0.026	0.860	0.740
I feel safe walking in my neighborhood						
Strongly disagree/disagree	1.04 (1.01, 1.07) **	1.02 (0.99, 1.05)	1.07 (1.03, 1.11) ***	1.04 (1.00, 1.08) *	0.98 (0.93, 1.03)	0.98 (0.93, 1.03)
Neutral	0.99 (0.94, 1.03)	0.97 (0.92, 1.02)	1.00 (0.94, 1.07)	0.97 (0.90, 1.03)	0.96 (0.89, 1.02)	0.95 (0.89, 1.02)
Agree	1.02 (1.00, 1.03)	1.01 (0.99, 1.02)	1.02 (0.99, 1.04)	1.00 (0.98, 1.03)	1.01 (0.98, 1.04)	1.01 (0.98, 1.04)
Strongly agree	ref	ref	ref	ref	ref	ref
<i>p</i> -trend	0.030	0.380	<0.001	0.110	0.480	0.360
My neighborhood is well lit at night						
Strongly disagree/disagree	1.03 (1.01, 1.06) **	1.03 (1.01, 1.06) ***	1.03 (1.00, 1.06) **	1.03 (1, 1.07)	1.04 (1.00, 1.07) **	1.04 (1.00, 1.07) **
Neutral	1.01 (0.98, 1.05)	1.01 (0.97, 1.05)	1.04 (0.98, 1.09)	1.03 (0.98, 1.08)	0.98 (0.93, 1.03)	0.98 (0.93, 1.03)
Agree	1.02 (1.00, 1.04) *	1.02 (1.00, 1.04) *	1.02 (0.99, 1.05)	1.02 (1, 1.05)	1.02 (0.99, 1.05)	1.01 (0.99, 1.04)
Strongly agree	ref	ref	ref	ref	ref	ref
<i>p</i> -trend	0.006	0.005	0.045	0.030	0.053	0.051

A. Adjusted ratios of mean BMI by perceived environment measures, taking residential property values into account

	Overall—ratio of means (95% CI)		Women—ratio of means (95% CI)		Men—ratio of means (95% CI)	
	Model 1 ^a	Model 2 ^b	Model 1 ^a	Model 2 ^b	Model 1 ^a	Model 2 ^b
People in my neighborhood know each other						
Strongly disagree/disagree	1.03 (1.00, 1.05) **	1.01 (0.99, 1.04)	1.05 (1.01, 1.08) **	1.03 (0.99, 1.06)	0.99 (0.96, 1.03)	0.99 (0.95, 1.03)
Neutral	0.98 (0.95, 1.02)	0.97 (0.93, 1.00) *	0.97 (0.92, 1.03) ***	0.95 (0.9, 1) *	0.98 (0.93, 1.03)	0.97 (0.92, 1.02)
Agree	1.01 (0.98, 1.03)	1 (0.98, 1.02)	1.01 (0.98, 1.03) **	1 (0.97, 1.02)	1 (0.96, 1.03)	1 (0.96, 1.03)
Strongly agree	ref	ref	ref	ref	ref	ref
p-trend	0.050	0.390	0.013	0.130	0.700	0.500
I trust the people in my neighborhood						
Strongly disagree/disagree	1.05 (1.02, 1.08) ***	1.03 (1.00, 1.07) *	1.09 (1.05, 1.14) *****	1.06 (1.02, 1.11) ****	0.99 (0.95, 1.04)	0.99 (0.95, 1.04)
Neutral	1.06 (1.02, 1.10) ***	1.04 (1.01, 1.08) **	1.07 (1.02, 1.12) ***	1.05 (1.00, 1.10) *	1.04 (0.99, 1.09)	1.04 (0.98, 1.09)
Agree	1.03 (1.01, 1.04) ***	1.02 (1.00, 1.03)	1.03 (1.00, 1.05) **	1.01 (0.99, 1.04)	1.02 (0.99, 1.04)	1.02 (0.99, 1.04)
Strongly agree	ref	ref	ref	ref	ref	ref
p-trend	<0.001	0.012	<0.001	0.003	0.700	0.700
My neighborhood is diverse						
Strongly disagree/disagree	0.96 (0.94, 0.99) ***	0.98 (0.95, 1.01)	0.93 (0.90, 0.97) *****	0.96 (0.93, 1.00) **	1.00 (0.96, 1.04)	1.01 (0.97, 1.05)
Neutral	0.95 (0.90, 1.00) *	0.96 (0.91, 1.01)	0.92 (0.85, 0.98) **	0.92 (0.85, 0.98) **	1.00 (0.93, 1.07)	1.01 (0.94, 1.08)
Agree	0.98 (0.96, 1.00) *	0.99 (0.97, 1.01)	0.96 (0.93, 0.99) *****	0.97 (0.95, 1.00) **	1.01 (0.98, 1.04)	1.01 (0.99, 1.04)
Strongly agree	ref	ref	ref	ref	ref	ref
p-trend	0.0015	0.080	<0.001	0.007	0.810	0.600
My neighborhood is clean						
Strongly disagree/disagree	0.99 (0.96, 1.02)	0.97 (0.94, 1.00) **	1.01 (0.97, 1.05)	0.97 (0.93, 1.01)	0.97 (0.92, 1.02)	0.96 (0.91, 1.01)
Neutral	1.02 (0.98, 1.06)	1.00 (0.96, 1.04)	1.02 (0.97, 1.07)	0.98 (0.93, 1.03)	1.02 (0.95, 1.08)	1.01 (0.95, 1.07)
Agree	1.00 (0.99, 1.02)	0.99 (0.97, 1.01)	1.02 (0.99, 1.04)	1 (0.97, 1.02)	0.99 (0.96, 1.01)	0.98 (0.95, 1.01)
Strongly agree	ref	ref	ref	ref	ref	ref
p-trend	0.940	0.050	0.450	0.150	0.260	0.140
My neighborhood is attractive						
Strongly disagree/disagree	1.01 (0.98, 1.04)	0.99 (0.96, 1.02)	1.02 (0.98, 1.06)	0.98 (0.94, 1.02)	1.01 (0.96, 1.06)	1.01 (0.96, 1.06)

A. Adjusted ratios of mean BMI by perceived environment measures, taking residential property values into account

	Overall—ratio of means (95% CI)		Women—ratio of means (95% CI)		Men—ratio of means (95% CI)	
	Model 1 ^a	Model 2 ^b	Model 1 ^a	Model 2 ^b	Model 1 ^a	Model 2 ^b
Neutral	1.02 (0.99, 1.06)	1.00 (0.96, 1.04)	1.03 (0.98, 1.08)	0.99 (0.94, 1.04)	1.00 (0.95, 1.05)	1.00 (0.94, 1.05)
Agree	1.01 (0.99, 1.03)	1.00 (0.98, 1.01)	1.01 (0.98, 1.04)	0.98 (0.96, 1.01)	1.02 (0.99, 1.04)	1.01 (0.99, 1.04)
Strongly agree	ref	ref	ref	ref	ref	ref
<i>p</i> -trend	0.190	0.450	0.210	0.240	0.590	0.790
Fast traffic is a problem in my neighborhood						
Strongly disagree	1.01 (0.98, 1.04)	1.01 (0.98, 1.04)	1.03 (0.99, 1.07)	1.03 (0.99, 1.06)	0.99 (0.95, 1.02)	0.99 (0.95, 1.02)
Disagree	0.98 (0.94, 1.01)	0.98 (0.94, 1.01)	0.98 (0.93, 1.03)	0.98 (0.94, 1.03)	0.97 (0.92, 1.02)	0.97 (0.92, 1.02)
Neutral	1.01 (0.99, 1.03)	1.01 (0.98, 1.03)	1.03 (1.00, 1.06)*	1.03 (1.00, 1.06)*	0.98 (0.94, 1.01)	0.97 (0.94, 1.01)
Strongly agree/agree	ref	ref	ref	ref	ref	ref
<i>p</i> -trend	0.660	0.910	0.150	0.200	0.160	0.140
Heavy traffic is a problem in my neighborhood						
Strongly disagree	0.99 (0.97, 1.01)	0.99 (0.97, 1.01)	1.00 (0.97, 1.02)	0.99 (0.97, 1.02)	0.98 (0.95, 1.01)	0.97 (0.95, 1.00)*
Disagree	0.98 (0.95, 1.02)	0.98 (0.95, 1.02)	0.99 (0.94, 1.04)	0.98 (0.92, 1.03)	0.97 (0.93, 1.01)	0.97 (0.93, 1.01)
Neutral	1.01 (0.99, 1.04)	1.01 (0.99, 1.04)	1.02 (0.99, 1.05)	1.01 (0.98, 1.04)	1.00 (0.97, 1.03)	1.00 (0.96, 1.03)
Strongly agree/agree	ref	ref	ref	ref	ref	ref
<i>p</i> -trend	0.260	0.700	0.160	0.480	0.850	0.750

B. Adjusted ratios of mean BMI associated with perceived destinations, taking residential property values into account

	Overall—ratio of means (95% CI)		Women—ratio of means (95% CI)		Men—ratio of means (95% CI)	
	Model 1 ^a	Model 2 ^b	Model 1 ^a	Model 2 ^b	Model 1 ^a	Model 2 ^b
Supermarket/grocery store	0.98 (0.97, 1.00)*	0.98 (0.96, 1.00)**	0.98 (0.96, 1.01)	0.97 (0.95, 1.00)**	0.98 (0.96, 1.01)	0.98 (0.96, 1.01)
Convenience store	1.00 (0.98, 1.02)	0.99 (0.97, 1.00)	1.01 (0.98, 1.03)	0.99 (0.96, 1.01)	0.99 (0.97, 1.02)	0.99 (0.96, 1.01)
Full-service restaurant	0.97 (0.95, 0.99)***	0.97 (0.95, 0.99)****	0.97 (0.95, 1.00)**	0.97 (0.95, 1.00)**	0.97 (0.95, 1.00)**	0.97 (0.95, 1.00)*
Fast food restaurant	0.99 (0.98, 1.01)	0.98 (0.96, 1.00)**	1.00 (0.98, 1.03)	0.98 (0.95, 1.00)*	0.98 (0.95, 1.00)	0.98 (0.95, 1.00)*
Coffee shop/café	0.97 (0.95, 0.98)****	0.97 (0.95, 0.99)****	0.96 (0.94, 0.99)***	0.96 (0.94, 0.99)***	0.97 (0.95, 1.00)**	0.97 (0.95, 1.00)*

B. Adjusted ratios of mean BMI associated with perceived destinations, taking residential property values into account

	Overall—ratio of means (95% CI)		Women—ratio of means (95% CI)		Men—ratio of means (95% CI)	
	Model 1 ^a	Model 2 ^b	Model 1 ^a	Model 2 ^b	Model 1 ^a	Model 2 ^b
Bar/tavern/pub	0.99 (0.97, 1.01)	0.98 (0.96, 1.00)**	1.00 (0.97, 1.02)	0.98 (0.96, 1.01)	0.98 (0.95, 1.00)**	0.97 (0.95, 1.00)**
Liquor store	0.99 (0.97, 1.01)	0.98 (0.96, 1.00)*	0.99 (0.96, 1.02)	0.97 (0.94, 1.00)**	0.99 (0.96, 1.02)	0.99 (0.96, 1.02)
Park, recreational area, or trail	0.97 (0.95, 0.99)**	0.98 (0.95, 1.00)*	0.97 (0.94, 1.00)**	0.98 (0.95, 1.01)	0.97 (0.94, 1.01)	0.97 (0.94, 1.01)
Sports facility, playing field, court, or golf course	0.98 (0.97, 1.00)*	0.98 (0.97, 1.00)*	0.98 (0.96, 1.01)	0.98 (0.96, 1.01)	0.99 (0.96, 1.01)	0.99 (0.96, 1.01)
Neighborhood retail stores	0.99 (0.97, 1.01)	0.98 (0.96, 1.00)**	0.99 (0.97, 1.02)	0.98 (0.95, 1.00)*	0.99 (0.96, 1.01)	0.99 (0.96, 1.01)
Mall, shopping center, or plaza	1.01 (0.98, 1.03)	1.00 (0.98, 1.02)	1.01 (0.98, 1.04)	0.99 (0.96, 1.02)	1.00 (0.97, 1.03)	1.00 (0.97, 1.03)

Note: Boldface indicates statistical significance.

^aModel 1, ratios adjusted for age group, race/ethnicity, education, and home ownership.

^bModel 2, ratios adjusted for factors from Model 1 and quartiles of neighborhood property values.

 $p < 0.001$,

 $0.001 < p < 0.01$,

**
 $0.01 < p < 0.05$,

*
 $0.05 < p < 0.10$.

Note: Boldface indicates statistical significance.

^aModel 1, ratios adjusted for age group, race/ethnicity, education, and home ownership.

^bModel 2, ratios adjusted for factors from Model 1 and quartiles of neighborhood property values.

 $p < 0.001$,

 $0.001 < p < 0.01$,

**
 $0.01 < p < 0.05$,

*
 $0.05 < p < 0.10$.