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Associations of neighborhood socioeconomic and racial/ethnic characteristics with changes in survey-based neighborhood quality, 2000–2011

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Abstract

We investigated the relationships between neighborhood socio-demographic characteristics (socioeconomic status [SES], percentage of Black residents, and percentage of Hispanic residents) and survey-based measures of the social environment (social cohesion, safety) and the physical environment (healthy food environment, walking environment) in six sites from 2000 through 2011. Neighborhood environments were patterned by area SES and racial/ethnic composition, such that higher SES and lower percentage minority neighborhoods had better physical and social environments. Increasing disparities over time were observed for some neighborhood

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environments. Further research should explore the role of neighborhood environments in maintaining or increasing social disparities in health.

Keywords

Neighborhoods; longitudinal; physical environment; social environment

Measures of neighborhood quality – including characteristics of both the physical environment and the social environment – have been associated with health outcomes ranging from behaviors to incident disease to mortality.[1] A number of studies have also shown that neighborhood physical environments (e.g. access to food and physical activity resources) and social environments (e.g. perceived safety, social ties and trust) are patterned by the socioeconomic or racial/ethnic composition of the area. For example, low SES and minority neighborhoods tend to have fewer supermarkets and more fast food restaurants[2–7] and fewer resources for physical activity.[8–10] Research on the social environment is less abundant, but neighborhood poverty has been associated with lower levels of safety[11,12] and with less social cohesion.[13] Research from sociology also suggests that higher racial segregation may be associated with lower neighborhood social cohesion.[14–16]

In the U.S., neighborhood environments are strongly patterned by the socio-demographic composition of residents.[1,17,18] This patterning likely results from a variety of interrelated causes including differences in political advocacy and buying power, which can influence the location of beneficial and hazardous resources and services that shape the physical and social environment of a neighborhood over time.[19,20] As a consequence, persons of different socioeconomic position and race/ethnicity may be exposed to very different neighborhood environments, with possible consequences for heath disparities.[21] Thus, neighborhood quality may also be an important factor in understanding persistent social gradients in health in the U.S.

Growing research is using commercial or GIS-based data sources, particularly for measures of the physical environment; but these data sources are less useful for capturing the social environment, and in general capture distinct aspects of neighborhood environments compared with survey-based questions of resident perceptions. However, existing research using survey-based data on the relationship between neighborhood socio-demographic characteristics and neighborhood quality is largely limited to cross-sectional investigations in single urban areas. Drawing conclusions about broad trends in neighborhood quality over time has been hampered by the use of variable methodologies and heterogeneous measures.

Our goal was to utilize one of the most extensive longitudinal datasets on neighborhood quality to explore how physical and social environments have changed over time and how changes are patterned by neighborhood socioeconomic status (SES) and racial/ethnic composition. We hypothesized that high SES and low minority neighborhoods would have better physical and social environments than their low SES and high minority counterparts. Given the large and growing evidence that neighborhood environments affect a variety of health outcomes, documenting trends in neighborhood quality by sociodemographic

characteristics may contribute to our understanding of the mechanisms that perpetuate social disparities in health.[1,21]

Methods

Study population

Data on neighborhood quality came from two studies. The first study, the Multi-Ethnic Study of Atherosclerosis (MESA) Neighborhood Study, recruited 6,191 MESA participants (aged 45–84 at baseline, from six field sites [Forsyth County, NC; New York City, NY; Baltimore, MD; St Paul, MN; Chicago, IL; and Los Angeles, CA]). MESA Neighborhood participants completed a questionnaire about their neighborhood environments at three times (2000–2002, 2003–2005, and 2010–2011) during MESA follow-up visits.[22]

The second study, the Community Surveys (CS), collected survey data via phone from adult residents who lived in the MESA study areas but were not MESA participants. Respondents were sampled via random digit dialing and list-based sampling.[23] CS 1 was completed in 2004 by 5,988 participants from the Maryland, New York, and North Carolina study sites. CS 2 included 5,409 participants in the California and New York sites in 2006–2008. CS 3 was fielded in 2011–2012, with 4,212 participants from a subsample of tracts in all six MESA sites. CS 1 and 2 included all tracts with MESA participants in the selected MESA sites. CS 3 selected sampled tracts across all six sites. Sampled tracts were chosen following a statistical algorithm developed with the goals of oversampling tracts with large changes in neighborhood characteristics or changes estimated with good precision while maintaining balance across sites. The studies were approved by the Institutional Review Boards at each site and all participants gave informed consent.[22]

Neighborhood data

Four survey scales, two related to the physical environment (healthy food environment and walking environment) and two related to the social environment (social cohesion and safety) were selected for investigation because of their relevance to health[24–28] and because they had been assessed using identical questions in the MESA and CS questionnaires at multiple time points. Each Community Survey included all four survey scales of interest; MESA participants responded to each scale twice (social cohesion in 2000–2002; safety, healthy food, and walking environment in 2003–2005; and all four scales in 2010–2011). By combining datasets, each site had data from the three MESA data collection time periods and at least one Community Survey, ensuring adequate temporal representation in each site (and census tracts within sites) for the estimation of trends. Scales were based on previous work and have acceptable internal consistency, ecometric properties, and reliability.[23] Participants in all surveys were asked to refer to the area about one mile around their home when responding to the questions. All survey scales used a 5-point Likert scale with response options from ‘strongly agree’ to ‘strongly disagree.’

Each participant’s ratings for each question in the scale were averaged to produce a summary score, such that higher scores indicate a better neighborhood environment.

Summary scores ranged from 1–5, and were not calculated for participants who did not answer one or more of the questions within a scale.

Neighborhood sociodemographic characteristics of interest included neighborhood SES and racial/ethnic composition (percentage of non-Hispanic Black residents and percentage of Hispanic residents), using census tracts to define neighborhoods. Census tract characteristics were obtained from the U.S. Census in 2000[29] and from the American Community Survey (ACS) for 2005–2009[30] and from 2007–2011.[31] Tract characteristics were linked to individuals based on their address at the time they completed a neighborhood survey. Data from the 2000 Census were applied to 2000–2004; data from ACS 2005–2009 were linked to survey years 2005–2007, and data from ACS 2007–2011 were linked to survey years 2008–2011.

Tract SES was measured using a summary score obtained from principal factor analysis with orthogonal rotation of 16 tract-level variables related to income, wealth, education, occupation, poverty, employment, and housing. The first factor explains 49.2% of the total variance, and represents education, occupation, housing value, and income; this factor score was used to summarize tract-level SES, such that a higher score represents increasing socioeconomic advantage.

Additional covariates

Individual-level characteristics of respondents were considered potential confounders of the relationship between neighborhood sociodemographic characteristics and neighborhood quality, as both sorting of individuals into neighborhoods and perception of neighborhood quality varies by individual-level characteristics.[23] Individual-level covariates included in all models were age (centered at 55), gender, race/ethnicity, education level (as a continuous variable representing years of education based on mid-point of educational attainment categories), income level in six categories (including a missing category, since 7.2% of observations were missing income), and data source (MESA participant or Community Survey participant). Time was measured continuously as the number of years since 2000 (baseline).

Statistical methods

All observations of neighborhood quality from the MESA Neighborhood Study and Community Surveys 1–3 from participants who lived in census tracts included in the baseline MESA exam were eligible for this analysis (30,081 observations from 20,351 participants). Observations with missing data on site, age, gender, education, race/ethnicity, or any of the tract-level predictors were excluded (917 observations from 884 participants). To keep the analytic sample as comparable as possible across survey scales, participants with missing data on any of the neighborhood scales assessed at that time were also excluded (93 MESA participants [1.5%] and 2,288 Community Survey participants [17.1%]). (More than half of the excluded Community Survey participants were only missing the social cohesion scale; inclusion of these participants in models for the other scales did not affect the results.)

Tract SES, percentage of Black residents and percentage of Hispanic residents were categorized into tertiles for descriptive analyses. ANOVA (or equivalent non-parametric tests) and χ^2 tests were used to compare differences among census tracts and individuals at baseline by tertiles of the tract predictors. There was no evidence that the association of neighborhood SES with the scales was non-linear so neighborhood socio-demographic characteristics were modeled as continuous variables, standardized to mean 0 and standard deviation (SD) 1 to facilitate comparisons.

Mixed linear regression models were used to estimate associations of neighborhood SES and racial/ethnic composition with neighborhood quality over time, adjusting for individual-level characteristics of respondents. The four domains of neighborhood quality were considered in separate sets of models. Each individual's summary score for each survey scale was modeled as a function of individual-level characteristics of the respondent (age, gender, race/ethnicity, education, income, and data source), site, neighborhood socio-demographic characteristics (in separate models and in a mutually adjusted model), time (years since baseline), the interaction of site with time (to account for varying trends by site), and the interaction of neighborhood socio-demographic characteristics with time (to capture differences in trends by socio-demographic characteristics). A random intercept for each census tract was included to account for within-neighborhood correlations. We were unable to account for the repeated observations from MESA participants (18% of the total sample) due to model convergence issues, but sensitivity analyses that excluded the repeated measures and that restricted analyses only to MESA participants with random intercepts for individuals both produced similar results to those presented here.

The final analytic sample consisted of 26,769 observations (15,714 from 6,170 MESA participants and 11,055 from Community Survey participants) in 1,171 census tracts over an approximately 10-year period. These tracts cover all but one of the tracts where MESA participants lived at baseline. The average number of responses per census tract from the three MESA assessments was 5.3, 4.5, and 3.4, respectively, and 10.4, 8.2, and 14.1 for the three Community Surveys. Due to variable timing of assessment of the four survey scales, there were 20,998 observations of social cohesion and 20,624 observations for safety, food environment, and walking environment.

Results

Table 1 describes the 1,171 census tracts included in the analysis at baseline (year 2000) overall and across tertiles of tract SES, percentage of Black residents, and percentage of Hispanic residents. The median household income was $37,670 (IQR: $26,670–$51,678), the median percentage of Black residents was 6.7% (IQR: 1.4% to 40.3%), and the median percentage of Hispanic residents was 15.8% (IQR: 3.1% to 55.3%). The correlations among tract SES and racial/ethnic composition were moderate: between tract SES and percentage Black, −0.24; tract SES and percentage Hispanic, −0.42; and percentage Black and percentage Hispanic, −0.29.

Healthy food environment scores were the lowest of any of the domains at baseline (Table 2; 3.30 [3.25, 3.34]) but increased the most over the study period, with an average 5-year

change of 0.19 (0.17, 0.21) points. Social cohesion and safety had similar baseline average scores with minimal change over time. The walking environment scores were highest at baseline (3.86 [3.83, 3.89]) and increased slightly over time (0.04 [0.03, 0.06] points over 5 years).

Table 2 also shows results of regression models for each domain of neighborhood quality, adjusted for each tract-level predictor separately (Model 1) and mutually adjusted for all three tract characteristics together (Model 2). Results from Model 2 were attenuated but broadly similar to results from Model 1. Figure 1 presents the results of Model 2 in graphical form to facilitate interpretation.

Overall, after adjustment for the characteristics of respondents and tract minority composition, higher SES tracts had higher safety and walking environment scores at baseline (mean difference per SD higher SES factor score, 0.07 [0.01, −0.12] and 0.14 [0.10, 0.18] points, respectively). Higher SES neighborhoods also experienced greater improvements in social cohesion and healthy food environment scores over time (mean difference in 5-year change: 0.03 [0.01, 0.05] and 0.08 [0.04, 0.11] points, respectively).

Higher minority neighborhoods had lower scores on all four scales at baseline, after adjusting for characteristics of respondents and tract SES. The strongest associations were observed for safety (mean differences per SD higher: −0.26 [−0.30, −0.21] points for percentage of Black residents and −0.29 [−0.35, 0.23] points for percentage of Hispanic residents) and for the healthy food environment (mean differences: −0.16 [−0.21, −0.10] and −0.18 [−0.25, −0.10] points for percent Black and Hispanic, respectively). A greater proportion of Black residents was also associated with greater declines in safety and attenuated increases in the walking environment over time (mean differences in 5-year change: −0.05 [−0.07, −0.02] and −0.03 [−0.05, −0.01] per SD higher, respectively).

Discussion

Census tract SES and racial/ethnic composition were associated with survey measures of neighborhood physical and social environments over time. After adjusting for individual covariates and all three tract-level predictors of interest, higher tract SES was associated with higher levels of all four survey scales at baseline, though the differences were only statistically significant for the walking environment and safety. In addition, high SES areas had increasing social cohesion and more pronounced increases in the healthy food environment over time compared with lower SES areas. As a result, disparities in social cohesion and the food environment by tract SES widened over time. Areas with a high percentage of Black residents and Hispanic residents had lower levels of social cohesion, safety, healthy food environment, and walking environment at baseline. Disparities of safety and the walking environment by percentage of Black residents increased over time.

We found that survey scales related to the social environment (social cohesion and safety) were more strongly patterned by racial/ethnic composition of tracts than by tract SES. Additionally, high percentage Black areas experienced declines over time in safety while low SES areas experienced declines in social cohesion. Our results showing that higher

percentage Black or Hispanic residents is associated with lower levels of social cohesion is consistent with prior work reporting that minority racial composition and concentrated disadvantage are associated with lower levels of trust or social capital.[14,15,32] Differences by racial/ethnic composition were particularly large for the safety scale, which fits with previous research showing that minority neighborhoods experience a disproportionate burden of crime and violence.[33–35] Differences in safety may also reflect neighborhood aesthetics and incivilities that were not measured.[36,37] The increasing disparity by percentage of Black residents in safety from 2000 to 2010 may be influenced by the subprime mortgage crisis and the Great Recession, which disproportionately affected minority areas[38] and may have shaped perceptions of crime and safety (though the impact on actual crime rates is debated).[39,40]

A large body of previous research has shown that low SES and predominantly minority areas tend to have poorer access to healthy foods[4–7] and poorer environments for physical activity.[8,41–43] Our results support and extend this research to suggest that disparities in the physical environment by tract SES and racial/ethnic composition are stable or widening over time. Between 2000 and 2010, average neighborhood food environments improved substantially,[44] though more gains were seen in higher SES areas than in lower SES areas and disparities by minority composition were unchanged. However, secular trends during this time period may also have influenced perceptions of food environments, with increasing public interest in food quality and availability. Future research should explore how social awareness of food issues affects perceptions of food environments.

Previous research has found that people in low SES areas report better access to sidewalks and walking destinations, but less access to public recreation facilities and less attractive neighborhoods than people in high SES areas.[45,46] In this study, walking environments were strongly patterned by tract SES, a pattern which remained stable over time, while differences by racial/ethnic composition increased slightly over time (particularly for percentage of Black residents). Additional research is needed to compare and contrast survey-based measures of neighborhood food and walking environments with GIS-based measures to better understand the relevance of each for health outcomes.

The magnitude of differences in neighborhood quality in this analysis may be relevant for health. Previous work in MESA found that better walking and food environments, measured by a difference equivalent to the interquartile range (slightly larger than the standard deviation differences used in this analysis) was associated with 20% lower incidence of diabetes over five years of follow up.[26] Similarly, one standard deviation higher scores for the food environment was associated with 10% lower obesity incidence over 5 years of follow up in MESA.[47] It is also worth noting that our analysis focused on isolating the influence of tract SES from racial/ethnic composition; in reality, high-minority areas are disproportionately more likely to also be areas of concentrated poverty,[21,48] which may mean that differences in neighborhood quality are actually larger than estimated by our analytic approach.

Limitations of this analysis include the variable availability of survey data by domain and site over time. However, the design was such that each site had sufficient temporal

representation to estimate trends; we adjusted for site and its interaction with time to minimize confounding. We also relied on overlapping time frames from the American Community Survey (2005–2009 and 2007–2011) to estimate tract SES and racial/ethnic composition at two different time points, resulting in non-independence in our predictors of interest. This could have resulted in under-estimates of changes in tract characteristics, which may have hampered our ability to detect associations with changes in survey scales over time. We were unable to account for repeated measures contributed by MESA participants, which may have produced under-inflated error estimates in the survey measures. However, this bias is likely to be non-differential with regards to tract sociodemographic characteristics. Additionally, there may be residual confounding that we were not able to adjust for in this analysis, by characteristics such as personal social connectedness or residential stability. Finally, given the extensive racial/ethnic residential segregation in the U.S., estimating the effect of percentage of Black residents after adjusting for tract SES and percentage of Hispanic residents may be subject to structural confounding and lead to off-support inferences.[49] However, with the large sample size and racial/ethnic diversity in our data set, the three tract-level predictors were only moderately correlated. The tracts included in this analysis do not represent the entire U.S. Yet the collection of survey-based perceptions of neighborhood quality from multiple respondents over a ten year period in almost 1,200 tracts from six urbanized areas around the country represents an unprecedented wealth of information about average trends in neighborhood quality during this period.

This research supports the body of evidence that disadvantaged and minority neighborhoods tend to have lower quality environments, and adds new information about the ways that these inequalities are evolving over time. It is plausible that lower quality neighborhood environments may be related to the persistent health disparities observed among disadvantaged and minority individuals. The solutions to disparities in neighborhood quality are as complex as their causes, but identifying policies that can most effectively mitigate the social patterning of neighborhood quality may be important in reducing racial/ethnic disparities in health.

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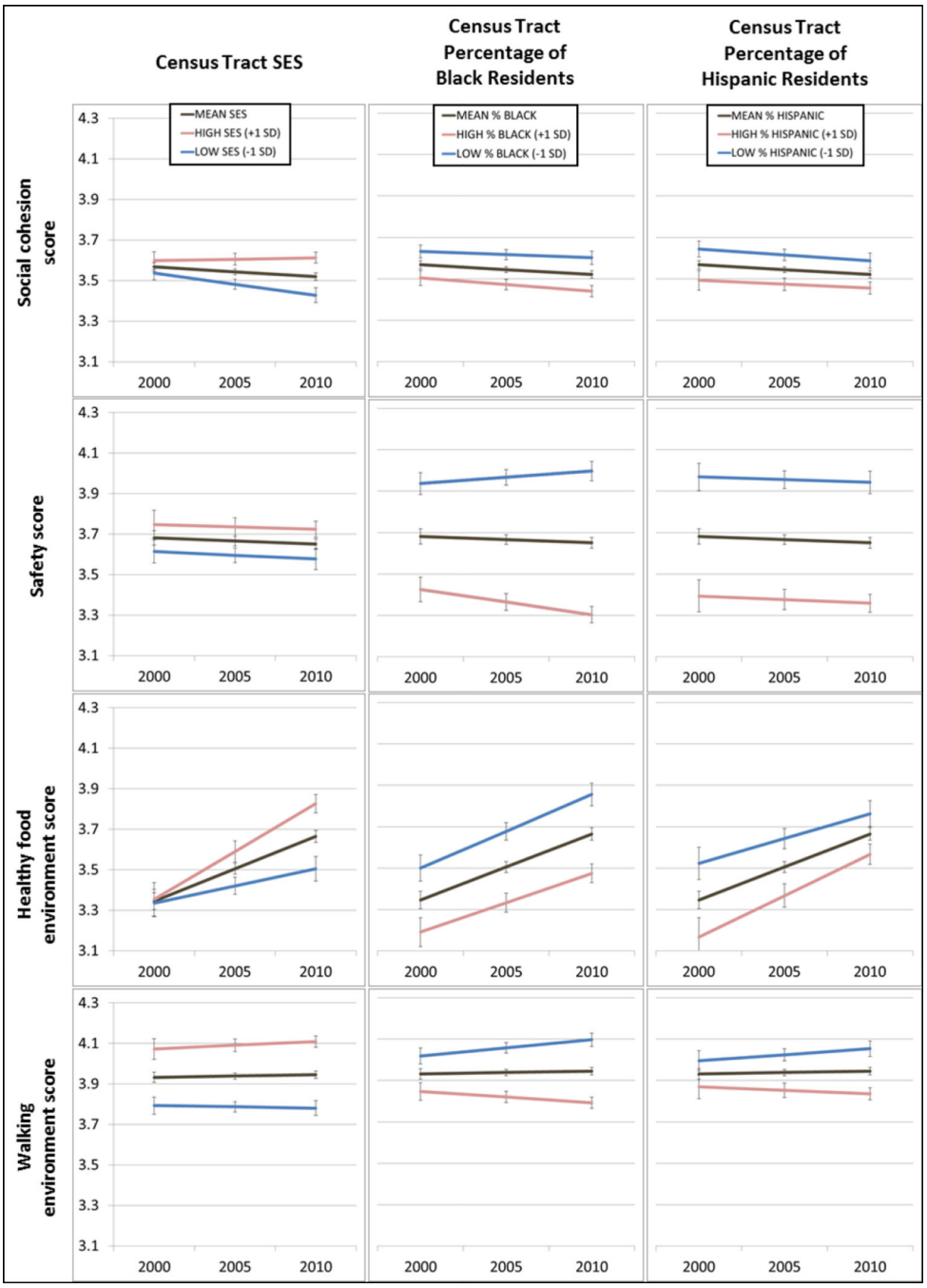

Figure 1.

Estimated neighborhood quality (and 95% CIs) by levels of each tract characteristic, from mutually adjusted models (Table 2, Model 2).

One standard deviation is equivalent to 1.38 units on the factor scale for tract SES, a 30% difference in percentage of Black residents, and a 28% difference in percentage of Hispanic residents. Intercepts reflect mean values for all covariates.

Table 1

Characteristics of census tracts at baseline (year 2000) by census tract socioeconomic status and racial/ethnic composition.

	Overall	Tract SES			Tract % Black			Tract % Hispanic		
		Low	*Med*	*High*	*Low*	*Med*	*High*	*Low*	*Med*	*High*
TRACT	*N=1171*	*N=400*	*N=385*	*N=386*	*N=389*	*N=383*	*N=399*	*N=387*	*N=386*	*N=398*
Median SES Factor Score [a]	0.17	1.11	0.13	−1.29	0.23	−0.27	0.43	−0.32	−0.29	0.98
Median of median household income [a]	$37,670	$29,399	$36,311	$56,189	$45,373	$41,579	$27,355	$47,978	$40,950	$27,995
Median % residents with HS education or more [a]	74.0	51.8	73.0	91.4	74.0	82.6	67.8	87.8	81.5	50.1
Median % residents with BA or more [a]	19.4	7.4	20.0	49.9	20.6	29.9	13.8	32.8	27.1	8.1
Median % Black residents [a]	6.7	7.2	14.2	4.2	0.7	6.4	58.3	10.4	7.1	3.3
Median % Hispanic residents [a]	15.8	59.8	21.1	4.8	30.3	12.5	11.5	1.9	15.5	67.7
Site (%) [b]										
Los Angeles, CA	35.2	53.2	28.3	23.3	64.5	23.5	17.8	1.8	41.5	61.6
Chicago,IL	12.9	4.8	10.6	23.6	12.3	11.0	15.3	24.3	11.9	2.8
Baltimore,MD	12.4	11.2	15.3	10.6	3.1	9.7	24.1	35.4	2.1	0
St Paul,MN	10.5	6.2	12.5	13.0	12.9	17.8	1.3	20.9	10.6	0.3
New York,NY	22.5	18.0	26.0	23.6	6.7	26.6	33.8	5.2	26.4	35.4
Forsyth County,NC	6.6	6.5	7.3	6.0	0.5	11.5	7.8	12.4	7.5	0

[a] ANOVA tests (for SES Factor Score) and Kruskal-Wallis tests (for other characteristics) to compare medians across tertiles of tract SES, % Black, and % Hispanic were all significant at $p<0.0001$

[b] $\chi 2$ tests to compare the distribution across tertiles of tract SES, % Black, and % Hispanic were all significant at $p<0.0001$

Table 2

Mean differences (95% CI) at baseline and mean differences (95% CI) in 5-year changes in survey-based neighborhood quality per standard deviation increase[1] in tract characteristic.

		MODEL 1[2]		MODEL 2[3]	
Domain	**Tract-level characteristic**	***Difference (95% CI) at baseline***	***Difference (95% CI) in 5-yr change[4]***	***Difference (95% CI) at baseline***	***Difference (95% CI) in 5-yr change[4]***
Social cohesion *Mean (95% CI) at baseline: 3.55 (3.53, 3.57)* *Mean (95% CI) 5-year change: −0.01 (−0.02, 0.00)*	SES factor score	**0.08 (0.06,0.11)**	**0.03 (0.02, 0.04)**	0.03 (0.00,0.06)	**0.03(0.01,0.05)**
	Percent Black	**−0.06 (−0.08, −0.03)**	**−0.02 (−0.03, −0.01)**	**−0.06 (−0.09, −0.04)**	−0.01 (−0.02,0.01)
	Percent Hispanic	**−0.09 (−0.11, −0.06)**	−0.01 (−0.03,0.00)	**−0.08 (−0.11, −0.04)**	0.00 (−0.02,0.03)
Safety *Mean (95% CI) at baseline: 3.64 (3.60, 3.69)* *Mean (95% CI) 5-year change: −0.01 (−0.03, 0.01)*	SES factor score	**0.24 (0.20,0.28)**	**0.03 (0.01,0.05)**	**0.07(0.01,0.12)**	0.00 (−0.03,0.03)
	Percent Black	**−0.23 (−0.27, −0.19)**	**−0.05 (−0.07, −0.02)**	**−0.26 (−0.30, −0.21)**	**−0.05 (−0.07, −0.02)**
	Percent Hispanic	**−0.28 (−0.33, −0.23)**	0.00 (−0.02, 0.03)	**−0.29 (−0.35, −0.23)**	0.00 (−0.04,0.03)
Healthy food environment *Mean (95% CI) at baseline: 3.30 (3.25, 3.34)* *Mean (95% CI) 5-year change: 0.19 (0.17, 0.21)*	SES factor score	**0.12 (0.08,0.17)**	**0.06 (0.04,0.09)**	0.01 (−0.05, 0.07)	**0.08(0.04,0.11)**
	Percent Black	**−0.12 (−0.16, −0.07)**	**−0.05 (−0.07, −0.02)**	**−0.16 (−0.21, −0.10)**	−0.02 (−0.05,0.01)
	Percent Hispanic	**−0.15 (−0.2, −0.09)**	−0.01 (−0.04, 0.02)	**−0.18 (−0.25, −0.10)**	0.04 (0.00,0.08)
Walking environment *Mean (95% CI) at baseline: 3.86 (3.83, 3.89)* *Mean (95% CI) 5-year change: 0.04 (0.03, 0.06)*	SES factor score	**0.18 (0.16,0.21)**	**0.04 (0.02,0.05)**	**0.14(0.10,0.18)**	0 0.01 (−0.01,0.04)
	Percent Black	**−0.11 (−0.14, −0.08)**	**−0.03 (−0.05, −0.02)**	**−0.09 (−0.12, −0.05)**	**−0.03 (−>0.05, −0.01)**
	Percent Hispanic	**−0.14 (−0.18, −0.11)**	−0.02 (−0.04,0.00)	**−0.06 (−0.11, −0.02)**	−0.02 (−0.05, 0.00)

[1] One standard deviation is equivalent to 1.38 units on the factor scale for tract SES (where a higher scare represents more socioeconomic advantage), 30 percentage points for proportion of Black residents and 28 percentage points for proportion of Hispanic residents

[2] Adjusted for individual-level characteristics (mean-centered age, gender, race, education, income, study source, and site), time (years since baseline), tract characteristic, and interactions of site with time and tract characteristic with time. Tract characteristics were each considered in separate models.

[3] Model 1 + all three neighborhood-level predictors and their interactions with time.

[4] The difference in 5-yr change is defined as the coefficient for the interaction term between time (since baseline, in 5-yr increments) and the neighborhood characteristic.