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Home and Work Neighborhood Environments in Relation to Body Mass Index: The Multi-Ethnic Study of Atherosclerosis (MESA)

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Abstract

Background—Little is known about neighborhood characteristics of workplaces, the extent to which they are independently and synergistically correlated with residential environments, and their impact on health.

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Methods—This study investigated cross-sectional relationships between home and workplace neighborhood environments with body mass index (BMI) in 1,503 working participants of the Multi-Ethnic Study of Atherosclerosis (MESA) with mean age 59.6 (SD=7.4). Neighborhood features were socioeconomic status (SES), social environment (aesthetic quality, safety, and social cohesion), and physical environment (walking environment, recreational facilities, and food stores) derived from census data, locational data on businesses, and survey data. Paired t-tests and correlations compared environments overall and by distance between locations. Cross-classified multi-level models estimated associations with BMI.

Results—Home neighborhoods had more favorable social environments while workplaces had more favorable SES and physical environments. Workplace and home measures were correlated (0.39–0.70) and differences between home and workplaces were larger as distance increased. Associations between BMI and neighborhood SES and recreational facilities were stronger for home environment ($P \le 0.05$) but did not significantly differ for healthy food, safety, or social cohesion. Healthy food availability at home and work appeared to act synergistically (interaction $P=0.01$).

Conclusions—Consideration of workplace environment may enhance our understanding of how place affects BMI.

Keywords

Neighborhood; Body Mass Index

INTRODUCTION

The high prevalence of obesity and overweight in the United States (U.S.) is well established(1, 2). A growing body of work has examined environmental factors that may affect obesity. Persons who live in more walkable environments have been found to have lower BMI(3, 4). Availability of healthy food outlets and supermarkets have been inversely associated with BMI and obesity in some(5–8), but not all studies(9, 10). Access to fast food and all types of restaurants have been found to be associated with higher levels of BMI in some studies(5, 11), but null and even inverse associations have also been reported(6, 12, 13). In general, neighborhoods that are more unsafe or have lower levels of aesthetic quality have been linked to higher levels of BMI and obesity(14, 15), whereas findings for other features of neighborhood social environments, such as social cohesion and psychosocial hazards, have been more mixed(16, 17).

A major challenge in studying the impact of environmental factors on health is defining the relevant environment or "neighborhood". Most research has operationalized neighborhood exposures using characteristics of the residential environment because home address is commonly the only address available and it is assumed that people spend much of their time around their residence. However, U.S. adults spend an average of 7.6 hours per day at work(18) and individuals may choose to perform some activities potentially related to obesity (such as food purchasing or engaging in physical activity) around their work, this environment could influence health outcomes. Despite the importance of non-residential environments(19–22), a review found fewer than 5% of studies use any non-residential location information(20).

Little is known about neighborhood characteristics of workplaces and the extent to which features of the home and work environments are correlated. One recent study found that non-home environments had greater numbers of restaurants, parks, and traffic volume than home environments but this study did not directly compare the correlation between measures around the home and non-home(23). Understanding the degree to which home and workplace measures are correlated, and the extent to which this correlation differs for different kinds of environmental features would shed light on whether home environments can be used to reasonably proxy work environments. It may also help understand discordant findings reported in studies using only the home environment.

Using unique data on the neighborhood features of home and work locations for a population sample participating in the Multi-Ethnic Study of Atherosclerosis (MESA), we examined the extent to which neighborhood environments surrounding an individual's home and workplace were correlated in terms of their socioeconomic (SES) and social and physical environments. We also evaluated how residential and work environments may separately and jointly relate to BMI.

METHODS

Study sample

MESA is a longitudinal study of cardiovascular disease among adults aged 45–84 years at six field sites (Forsyth County, NC; New York City, NY; Baltimore, MD; St Paul, MN; Chicago, IL; and Los Angeles, CA) in the U.S. Persons with a history of clinically overt cardiovascular disease were excluded. The study recruited 6,814 participants at baseline. Baseline assessment was conducted from 2000 to 2002, with three follow-up exams occurring at approximately 1.5–2 year intervals and follow-up phone calls occurring every 18 months(24). The study was approved by the institutional review boards at each site and all participants gave written informed consent.

Addresses for workplaces were collected as part of the MESA Air Questionnaire from 2005–2007 as part of Exams 3 and 4 and home address information was also updated(25). All addresses were geocoded using TeleAtlas EZ-Locate web-based geocoding software(26, 27). Of the 6,814 MESA participants at baseline, 6,179 agreed to participate in both the Neighborhood and Air ancillary studies. The following exclusions were then made: 317 did not complete a visit during 2005–2007; 3,036 reported not currently work at least part-time; 1,044 where the workplace address was unavailable; and 279 where the home or workplace address was not geocoded to the street level. This yielded a final sample size of 1,503 with at least one neighborhood measure available for both home and workplace. Participants included in the analysis were slightly younger (60 vs. 63 years), female (50% vs. 42%), and had higher household income ($66,000 vs. $56,000 per year) and education (14.3 vs. 13.8 years) than working MESA participants excluded due to missing street address (all $p<0.0001$).

Neighborhood environment exposures (home and workplace)

Three datasets were used to assess neighborhood features socio-demographic census data, Geographic Information System (GIS) data, and survey-based measures of neighborhood physical and social environments.

Neighborhood socioeconomic characteristics

Measures of neighborhood (census tract) were obtained from the American Community Survey (ACS) 2005–2009 estimates(28). To derive a measure of SES, we conducted principal factor analysis with orthogonal rotation of 16 census variables, which reflected aspects of education, occupation, household income and wealth, poverty, employment, and housing. Variables were standardized and those which represented a less favorable SES environment were reverse coded such that higher values indicate increasing socioeconomic advantage. Four factors representing 74% of the variance were retained. Weighted scales were created by multiplying the standardized variables by the factor weights. These analyses used the first factor called "SES" (49% of the variance). Variables with high loading on this factor included education, occupation, housing value, and income.

GIS-based measures

Densities of recreational facilities and healthy food environment were derived from GIS data using Dun and Bradstreet data as compiled by Walls and Associates in the National Establishment Time Series (NETS) database(29) for 2005–2007. Addresses were geocoded using TeleAtlas EZ-Locate web-based geocoding software(26). For the recreational facilities, 114 Standard Industrial Classification (SIC) codes were selected to represent the recreational and physical activity establishments such as indoor conditioning, dance, bowling, golf, team and racquet sports, and water activities derived from lists used in previous studies(30, 31). Healthy food stores were defined as fruit and vegetable markets (SIC #5431) and supermarkets (food stores with at least $2 million in annual sales or at least 25 employees and augmented this data using name lists as described elsewhere(32)). Weighted kernel densities per square mile were created for 1-mile (1609 meters) buffers around both the home and workplace addresses using the kernel density command in ArcGIS 9.3(33, 34).

Survey based measures

Questionnaires on neighborhood characteristics were administered to MESA participants in 2003–2005. Similar questionnaires were administered to a random sample of residents of selected census tracts in three of the MESA study sites (Baltimore, MD; Forsyth County, NC; and New York, NY) between January and August 2004. This sample was identified through random digit dialing and one adult age 18 or older within the household was randomly selected to complete the survey(35). To increase sample size and reliability of scale estimates, responses from this sample were pooled with neighborhood survey responses from the MESA respondents.

In the survey, participants were asked to rate the area within approximately 1 mile around their home. On the basis of a conceptual model(36) and prior work(37), five neighborhood dimensions were assessed: aesthetic quality (3 items), safety (2 items), social cohesion (4 items), walking environment (4 items), and healthy food availability (2 items) as described elsewhere(35). Responses for each item ranged from 1 (strongly agree) to 5 (strongly disagree). Questions were reverse coded when needed such that a higher score indicates a more favorable environment. Scales had acceptable internal consistency (Cronbach alpha 0.64–0.82)(35). Scales based on a 1-mile buffer around the home and workplace addresses were created by taking the crude mean of the responses for all respondents living within a 1-mile buffer, excluding themselves. Only respondents who answered all questions within the domain were included. Analyses were restricted to only those who had 5 or more respondents within 1 mile to increase reliability.

Weighted measures

We created summary measures of each person's exposure to the neighborhood characteristics by calculating weighted averages of the home and work measures, with the weights being the proportion of the hours during the week spent at each location. The number of hours per week spent at the work address was obtained via questionnaire.

Individual-level measures

BMI was calculated as weight in kilograms divided by height in meters squared. Information on sociodemographic factors were obtained via questionnaire. These included age, race/ethnicity, gender, education, and household income. Race/ethnicity was classified as

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Hispanic, non-Hispanic white, non-Hispanic Chinese, and non-Hispanic black. Participants selected their education from 8 categories and continuous years of education was assigned as the interval midpoint of the selected category. Participants selected their total combined family income from 13 categories and continuous income in U.S. dollars was assigned as the interval midpoint of the selected category. The distance between the home and workplace locations was calculated as Euclidean distance in miles.

Statistical analyses

Paired t-tests and Spearman rank correlations were used to compare neighborhood features at each participants' work and home location. To determine whether home and work neighborhood environment measures varied as a linear function of the distance between them, the distance in miles between the home and workplace was divided into quartiles and analysis of variance (ANOVA) was used to test for trend.

Estimates of the associations of home and workplace neighborhood environments with BMI in separate models were obtained using two-level mixed regression models with a neighborhood-level random intercept (Model 1). Difference between the beta coefficients for the home and work were tested using methods described elsewhere(38).

Estimates of the associations of the home and workplace neighborhood environments with BMI simultaneously in the same model were obtained using a two-level cross-classified regression models (Model 2)(39). Product terms were added to test for interactions between the home and workplace environments (Model 3). We also contrasted results obtained with home and work measure separately to those obtained using the weighted average (Model 4). Each neighborhood exposure was analyzed separately.

RESULTS

The 1,503 participants included in analyses had a mean age of 59 years, were 49% male, and were predominately non-Hispanic white (42%) followed by non-Hispanic black (27%), Hispanic (20%), and non-Hispanic Chinese (11%). Over 78% of the sample was working full-time (mean number of hours spent at the workplace: 40.4 hours during the winter and 38.3 hours during the summer) (Table 1). The mean distance between the home and workplace address was 6.0 miles (standard deviation [SD]=7.0), but this varied from a mean of 3.6 miles in NY to 7.0 miles in CA and NC. Only 4.7% had a home and workplace within the same census tract, but one-mile buffers around the home and the workplace overlapped in 29.8% of participants (range: 12% in CA to 42% in NY).

Persons travelling farther distances to work were more likely than those travelling shorter distances to be male (60% and 46% for highest vs. lowest distance quartile), non-Hispanic white (38% and 50%), and have higher household income ($71,905 vs. $62,363) and education (14.8 years vs. 14.2 years). Among those working farther from home, over 86% were working full time compared to 77% of those travelling the least distance.

Home and workplace neighborhoods differed in neighborhood features (Table 2). Home environments had greater population density and more favorable aesthetic quality, safety, and social cohesion compared to work environments (all $P \leq 0.005$). However, workplace environments had more favorable SES, greater density of recreational facilities and healthy food stores, as well as more favorable walking environment, and healthy food availability compared to home environments (all $P \leq 0.0003$). Despite these differences, home and work environments for participants were substantially correlated for each type of neighborhood exposure (ranging from 0.39 to 0.70).

For most of the neighborhood features, the difference between the home and work environment became greater as the distance increased (Table 3). Neighborhood SES was similar for locations close together, but the workplace had higher SES at greater distances ($P = 0.01$). At greater distances, densities of recreational facilities and healthy food stores were lower around the home than around the work ($P < 0.0001$) yet population density became more similar ($P < 0.0001$). In general, persons who travelled further for work both lived and worked in areas with lower population densities than those who travelled less for work.

Aesthetic quality, safety, and social cohesion were similar for home and work environments located close to each other but differences increased as the distance between locations increased ($P < 0.0001$ for all), with home environments showing more favorable aesthetic quality, safety and cohesion, than workplace environments as the distance between them increased. There was little difference for walking environments between home and work locations and no clear pattern by distance ($P = 0.79$). Survey reported healthy food availability was similar when home and work were closer but became less similar at greater distances; work environments had more favorable healthy food availability ($P = 0.02$).

In general, point estimates of associations revealed that higher neighborhood SES, recreational facilities, safety, social cohesion, walkability, and healthy food availability were associated with lower BMI for both the home and workplace environments, although associations were not statistically significant for the workplace neighborhood SES or for home environment safety and social cohesion (Table 4, Model 1). In the case of neighborhood SES, the home environment had a much stronger association with lower BMI than the workplace environment (P for difference in coefficients = 0.047). The magnitude of the coefficients for density of healthy food stores, safety, social cohesion, and healthy food availability were higher for the workplace environment, although differences were not statistically significant. The density of recreational facilities had a stronger association for the home environment (P for difference in coefficients = 0.052). Associations of the walking environment with BMI were of similar magnitude for both environments. Associations became weaker but patterns were approximately similar when both environments were included in the same model (Model 2).

Interactions between home and work environments were not statistically significant at $P < 0.05$ level except for survey reported healthy food availability. The negative interaction term suggested a synergistic effect of greater healthy food availability at both locations on lower BMI (Model 3). Weighted estimates for neighborhood SES, recreational facilities, and walking environment suggested synergy between home and workplace although uncertainty was higher ($P < 0.1$). In general, the magnitude of estimates using weighted averages of the home and workplace environments fell between the home and workplace estimates; the exception was walking environment for which the weighted measure had a stronger association than the separate measures for home and work (Model 4). This would suggest a synergistic effect between the home and workplace consistent with the negative interaction term (Model 3), although the latter was not statistically significant.

DISCUSSION

We found that neighborhood environments around the home and workplace were correlated, but differed in SES and social and physical characteristics. Neighborhoods around the home tended to have more favorable aesthetic quality, safety, and social cohesion whereas those around the workplace had more favorable SES and availability of foods and recreational resources. The difference between home and work locations increased as the distance travelled to work increased.

Few studies have directly examined the correlation between residential and workplace environments. One recent study found greater numbers of restaurants, parks, and traffic around non-home environments, while home environments had greater numbers of supermarkets, fitness facilities, and street density but analyses were based on a small sample in one U.S. city(23). In our multi-city sample, analogous measures for work and home environments tended to be correlated, suggesting that the use of the home environment as a proxy for place-based exposures may not be entirely inadequate. However, correlations were moderate for SES and social environment features, like safety and social cohesion, and higher for population density, and density of food stores and recreational resources; suggesting that the impact of proxing environmental exposures through the home environment may differ depending on the construct being examined. In addition, the study found home and work environments differed as a function of the distance between the locations. Home and work neighborhood correlations may differ from sample to sample depending on home-work geographic patterning which is likely strongly influenced by region(40).

Prior analyses of the full MESA sample showed that greater access to healthy foods and physical activity resources were associated with lower BMI(16). Contrary to expectation, a more favorable social environment was linked to a higher BMI in males, but the social environment was not associated with BMI in females(16). Moreover, MESA participants living in environments with greater access to healthy foods experienced lower incidence of obesity over time(8). Consistent with these findings, our analysis of a subsample of working MESA participants show that better physical activity and food environments were associated with lower BMI. Associations were generally of similar direction and magnitude for the home and work environments, with the exception that recreational density around the home was more predictive of BMI than recreational densities around the workplace. Findings from a study examining physical activity also found stronger associations between built environment measures at the workplace compared to the home, however the joint effects or a time-weighted measure were not explored(41). Interestingly, in our study, a weighted measure of the walking environment (which reflected time spent at home and at work) was more strongly related to BMI than separate measures for home and work. In principle, this aligns with other work that found impacts of walking to work and walking around work as important contributors to lower BMI(42, 43). Our study was able to explicitly examine synergistic effects and found protective associations between food environment and BMI were more evident when both work and home environments had favorable food access. Others have reported similarly strong findings between the workplace food environment and BMI. Stronger positive associations between BMI and fast food restaurants were found for work (or entire activity space) environment than home(13, 19), but these studies did not examine the synergistic effect. Taken as a whole, our results suggest that place effects may be underestimated when the workplace environment is not considered.

In contrast to prior MESA work which was based on only three of the study sites(16), we found no statistically significant association of residential social environment features including safety, social cohesion, or aesthetic quality with BMI. Workplace safety and social cohesion were inversely associated with BMI, although differences between home and work coefficients were not statistically significant. Limited sample size precluded investigation of the sex interactions with social environments documented in prior work(16). Future work is needed to examine the impact of residential and workplace social environments on BMI by sex.

The finding that workplace features were related to BMI in the expected direction is notable because they are less likely to be confounded by individual-level SES which is often closely associated with residential environments as a result of residential segregation by SES and race. Neighborhood SES, which can proxy a range of social and physical environment features, was only associated with BMI for residential measures which aligns with what others have found with self-reported health(44). That said, workplace population-based census characteristics can be difficult to interpret when they are non-residential neighborhoods, such as commercial business parks, semi-urban malls, and corporate parks for example.

Previous studies that incorporated both residential and non-residential environments were generally limited to samples taken from one geographic area(13, 19, 23, 41, 44). A strength of our work is that we are able to use information from multiple study sites across the United States. We also had information on the amount of time a person spent at the workplace location which allowed us to evaluate a weighted average for the amount of time spent at each location. Whereas most prior work incorporating both residential and non-residential measures has focused on either SES(44) or the physical environment(13, 19, 41) we were able to include a range of measures constructed using various measurement techniques including measures of social environments.

A limitation of this study is that the sample is an older working population over 50 years of age. The associations of the workplace environment could differ in younger populations. The differences between work and residential environments may vary depending on patterns of commuting to work and may be highly sample dependent. Another limitation is that the survey-based scales asked respondents only about the area around their home. When linking these measures to the workplace locations, this leads to missing data around workplaces that do not lie within residential areas. Workplace addresses for which we were unable to calculate the survey-based measures were in areas with greater density of recreational facilities and food stores and lower population density.

Although neighborhood environments have been identified as possible important factors in understanding obesity and other health outcomes, research has been focused mainly on the residential environment. This study suggests that even when work and home residence have correlated features, differences remain and for some environmental domains the neighborhood surrounding the workplace may be as influential as or possibly more influential than the area surrounding the home. More work needs to be done in this area to characterize similarities and differences between home and work environments and to understand how work and residential environments may interact to affect health and changes in health across time.

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What is already known on this subject

- Neighborhood characteristics such as higher socioeconomic status, healthy food availability, more favorable walking environment, and safety have been associated with lower body mass index and obesity.
- The majority of studies to this point only utilize information about the residential or home neighborhood environment and do not take into account environments around the workplace.

What this study adds

- Home neighborhoods had more favorable social environments while workplaces had more favorable socioeconomic and physical environments but were correlated.
- Associations between body mass index and neighborhood socioeconomic status and recreational facilities were stronger for home environment but did not significantly differ for healthy food, safety, or social cohesion.
- Healthy food availability at home and work appeared to act synergistically.

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Table 1

Selected characteristics of participants included in the analyses for the full sample and by categories (quartiles) of the distance between home and workplace (miles), Multi-Ethnic Study of Atherosclerosis (MESA) (n=1503)

	OVERALL	Distance 0.0–1.7	Distance 1.7–4.0	Distance 4.0–7.9	Distance 7.9–89.2	
	Mean (SD[a]) or percent	Mean (SD) or percent	Mean (SD) or percent	Mean (SD) or percent	Mean (SD) or percent	P-value[*]
Age (years)	59.6 (7.4)	60.1 (7.8)	59.3 (7.3)	60.1 (7.7)	58.9 (6.8)	0.0724
Gender (%)						<.0001
Male	49.3	45.9	42.8	48.1	60.4	
Female	50.7	54.1	57.2	51.9	39.6	
Race/Ethnicity (%)						<.0001
Non-Hispanic White	42.4	50.1	39.1	42.6	38.0	
Non-Hispanic Chinese	10.8	7.7	8.0	9.3	18.1	
Non-Hispanic Black	27.1	16.3	30.9	31.6	29.5	
Hispanic	19.7	25.9	22.1	16.5	14.4	
State of residence (%)						<.0001
California	13.2	9.1	12.0	13.6	18.1	
Illinois	21.0	27.2	14.9	17.0	24.7	
Maryland	11.0	7.5	8.8	13.6	14.1	
Minnesota	17.0	18.9	18.6	14.6	15.7	
New York	20.7	31.2	26.3	16.8	8.5	
North Carolina	15.7	4.8	18.1	23.1	16.8	
Other	1.5	1.3	1.3	1.3	2.1	
Income (US dollars)	65786 (33264)	62363 (35200)	63197 (31730)	65697 (33546)	71905 (31740)	0.0003
Education	14.3 (3.4)	14.2 (3.5)	14.1 (3.7)	14.3 (3.2)	14.8 (3.2)	0.0117
Working Status (%)						0.0043
Employed Full Time	78.9	77.1	75.8	76.1	86.7	
Employed Part Time	14.2	16.8	15.7	16.8	7.4	
Retired, Working	6.8	6.1	8.2	6.9	5.9	
Missing	0.1	0.0	0.3	0.3	0.0%	
Hours per week at workplace in winter	40.4 (13.9)	39.3 (14.3)	40.6 (13.2)	40.5 (14.2)	41.2 (13.7)	0.2850
Hours per week at workplace in summer	38.3 (16.0)	36.2 (16.9)	38.5 (15.7)	38.7 (15.7)	39.8 (15.4)	0.0217

	OVERALL	Distance 0.0–1.7	Distance 1.7–4.0	Distance 4.0–7.9	Distance 7.9–89.2	
	Mean (SD[a]) or percent	Mean (SD) or percent	Mean (SD) or percent	Mean (SD) or percent	Mean (SD) or percent	P-value[*]
Distance between home and workplace (miles)	6.0 (7.0)	0.8 (0.5)	2.7 (0.7)	5.7 (1.1)	14.8 (9.1)	<.0001
Home and workplace within the same census tract (%)	4.7	18.1	0.8	0.0	0.0	<.0001
Home and workplace 1-mile buffers overlap (%)	29.8	100.0	19.4	0.0	0.0	<.0001
Body Mass Index (kg/m^2)	28.8 (5.8)	28.2 (5.8)	29.4 (5.8)	29.0 (6.0)	28.6 (5.5)	0.0428

[*] P value from Chi-square for categorical variables and one-way ANOVA for continuous variables

[a] SD=standard deviation

Table 2

Comparison of neighborhood characteristics of home and workplaces

	N	Home Mean (SD[a])	Workplace Mean (SD)	Difference* Mean (SD)	P-value**	Spearman Correlation
CENSUS TRACT MEASURES						
Neighborhood SES[b]	1362	0.94 (1.31)	1.24 (1.46)	−0.30 (1.46)	<.0001	0.39
Population Density (per square mile)	1477	1579 (2304)	1202 (1822)	376 (1616)	<.0001	0.70
GIS-BASED MEASURES[c]						
Recreational Facilities	1490	7.82 (12.67)	15.09 (26.92)	−7.27 (22.97)	<.0001	0.57
Healthy food stores	1490	3.10 (4.78)	3.59 (4.85)	−0.49 (3.40)	<.0001	0.62
SURVEY-BASED MEASURES[d]						
Aesthetic Quality	944	3.64 (0.46)	3.54 (0.41)	0.11 (0.36)	<.0001	0.61
Safety	944	3.66 (0.43)	3.62 (0.44)	0.04 (0.45)	0.0053	0.48
Social Cohesion	950	3.52 (0.28)	3.48 (0.26)	0.04 (0.27)	<.0001	0.49
Walking Environment	944	3.95 (0.34)	4.00 (0.36)	−0.05 (0.28)	<.0001	0.58
Healthy Food Availability	944	3.50 (0.54)	3.55 (0.56)	−0.05 (0.43)	0.0003	0.67

*Difference is Home-Workplace

**P-value is from a paired t-test

[a]SD=Standard deviation

[b]Based on first factor of principal components analysis of percent of adults age 25 or older with at least a high school education, percent of adults age 25 or older with at least a Bachelor's degree, percent of persons age 16 or older with executive, managerial, or professional occupation, median value of housing units, percent of housing units without a telephone, percent of housing units without a vehicle, median household income, percent of households with income of at least $50,000, percent of household with interest, dividend, or net rental income, percent of households receiving public assistance, percent below poverty level, percent of those age 16 or older who are unemployed, percent of those age 16 and older who are not in the labor force, percent of occupied housing units, percent of housing units that are owner occupied, and percent of persons living in same house as previous census. Higher value indicates a more favorable environment.

[c]1-mile kernel density. Number per square mile

[d]1-mile mean. Higher value indicates a more favorable environment

Table 3

Comparison of neighborhood characteristics of home and workplaces by quartiles of distance between home and work addresses

	N	Distance in miles	Home Mean (SD[a])	Workplace Mean (SD)	Difference* mean (SD)	P-value**	Spearman Correlation
CENSUS TRACT MEASURES							
Neighborhood SES[b]	323	0.0–1.7	1.41 (1.56)	1.51 (1.52)	−0.10 (0.99)	0.0107	0.76
	334	1.7–4.0	0.78 (1.29)	1.07 (1.44)	−0.28 (1.33)		0.41
	349	4.0–7.9	0.86 (1.20)	1.30 (1.44)	−0.44 (1.68)		0.14
	356	7.9–89.2	0.74 (1.09)	1.08 (1.40)	−0.35 (1.67)		0.15
Population Density (per square mile)	373	0.0–1.7	2640 (2748)	1847 (2121)	794 (1798)	<.0001	0.82
	370	1.7–4.0	1700 (2496)	1287 (1889)	413 (1758)		0.76
	368	4.0–7.9	1216 (1941)	983 (1749)	233 (1513)		0.67
	366	7.9–89.2	739 (1293)	680 (1185)	59 (1241)		0.39
GIS-BASED MEASURES[c]							
Recreational Facilities	375	0.0–1.7	13.22 (14.97)	16.18 (21.45)	−2.96 (10.26)	0.0001	0.86
	375	1.7–4.0	8.03 (13.13)	15.04 (29.42)	−7.01 (21.30)		0.66
	372	4.0–7.9	6.24 (12.46)	16.91 (32.00)	−10.67 (31.25)		0.43
	368	7.9–89.2	3.71 (6.37)	12.19 (23.25)	−8.48 (23.50)		0.30
Healthy food stores	375	0.0–1.7	4.70 (5.08)	4.73 (4.70)	−0.04 (2.53)	<.0001	0.87
	375	1.7–4.0	3.89 (5.80)	3.80 (5.15)	0.09 (3.56)		0.65
	372	4.0–7.9	2.39 (4.31)	3.33 (5.24)	−0.94 (3.94)		0.51
	368	7.9–89.2	1.39 (2.58)	2.46 (3.91)	−1.07 (3.29)		0.28
SURVEY-BASED MEASURES[d]							
Aesthetic Quality[d]	347	0.0–1.7	3.46 (0.41)	3.45 (0.39)	0.01 (0.14)	<.0001	0.89
	284	1.7–4.0	3.60 (0.46)	3.56 (0.43)	0.04 (0.34)		0.69
	217	4.0–7.9	3.85 (0.41)	3.64 (0.38)	0.20 (0.43)		0.41
	96	7.9–89.2	4.01 (0.29)	3.55 (0.39)	0.46 (0.49)		0.04
Safety[d]	347	0.0–1.7	3.57 (0.41)	3.58 (0.41)	−0.01 (0.14)	<.0001	0.93
	284	1.7–4.0	3.62 (0.41)	3.64 (0.43)	−0.02 (0.39)		0.58

	N	Distance in miles	Home Mean (SD[a])	Workplace Mean (SD)	Difference* mean (SD)	P-value**	Spearman Correlation
	217	4.0–7.9	3.76 (0.42)	3.66 (0.48)	0.10 (0.65)		−0.09
	96	7.9–89.2	3.90 (0.38)	3.62 (0.52)	0.28 (0.66)		−0.00
Social Cohesion[d]	347	0.0–1.7	3.43 (0.22)	3.44 (0.22)	−0.01 (0.09)	<.0001	0.90
	287	1.7–4.0	3.50 (0.29)	3.50 (0.26)	−0.00 (0.25)		0.55
	220	4.0–7.9	3.63 (0.29)	3.54 (0.27)	0.09 (0.35)		0.23
	96	7.9–89.2	3.70 (0.27)	3.48 (0.31)	0.22 (0.41)		0.02
Walking Environment[d]	347	0.0–1.7	4.06 (0.38)	4.08 (0.37)	−0.02 (0.14)	0.7897	0.86
	284	1.7–4.0	3.86 (0.28)	3.96 (0.31)	−0.10 (0.30)		0.40
	217	4.0–7.9	3.93 (0.32)	3.97 (0.36)	−0.04 (0.35)		0.34
	96	7.9–89.2	3.87 (0.26)	3.91 (0.38)	−0.04 (0.38)		0.39
Healthy Food Availability[d]	347	0.0–1.7	3.69 (0.54)	3.68 (0.54)	0.01 (0.19)	0.0186	0.93
	284	1.7–4.0	3.36 (0.46)	3.46 (0.51)	−0.10 (0.49)		0.47
	217	4.0–7.9	3.42 (0.58)	3.47 (0.60)	−0.05 (0.54)		0.57
	96	7.9–89.2	3.41 (0.44)	3.53 (0.55)	−0.13 (0.56)		0.48

* Difference is Home-Workplace

** P-value is test for trend from an ANOVA model with the difference as the outcome

[a] SD=Standard deviation

[b] Higher value indicates a more favorable environment

[c] 1-mile kernel densities. Number per square mile

[d] 1-mile mean. Higher value indicates a more favorable environment

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Table 4

Mean differences in BMI associated with the characteristics of the home environment, the work environment and a weighted average of home and workplace environments. All models are adjusted for gender, age, race/ethnicity, income, and education.

		Model 1[a] Mean difference (SE)	p-value for difference	Model 2[b] Mean difference (SE)	p-value for difference	Model 3[b] Mean difference (SE)	Model 4[c] Mean difference (SE)
CENSUS TRACT MEASURES							
Neighborhood SES[d]	Home	−0.658 (0.160)**	0.047	−0.652 (0.180)**	0.016	−0.674 (0.186)**	
	Workplace	−0.226 (0.147)		0.039 (0.161)		0.032 (0.162)	
	Interaction					0.068 (0.141)	
	Weighted						−0.550 (0.159)**
GIS-BASED MEASURES							
Recreational Facilities[e]	Home	−0.363 (0.117)**	0.052	−0.295 (0.139)**	0.132	−0.334 (0.180)*	
	Workplace	−0.113 (0.053)**		−0.030 (0.062)		−0.048 (0.082)	
	Interaction					0.010 (0.029)	
	Weighted						−0.305 (0.106)**
Healthy food stores[e]	Home	−0.513 (0.307)*	0.809	−0.133 (0.457)	0.749	0.051 (0.618)	
	Workplace	−0.617 (0.300)**		−0.401 (0.445)		−0.249 (0.566)	
	Interaction					−0.218 (0.501)	
	Weighted						−0.544 (0.334)
SURVEY-BASED MEASURES							
Aesthetic Quality[f]	Home	−0.013 (0.197)	0.668	0.081 (0.279)	0.542	0.036 (0.298)	
	Workplace	−0.130 (0.189)		−0.181 (0.253)		−0.166 (0.254)	
	Interaction					−0.099 (0.183)	
	Weighted						−0.056 (0.217)
Safety[f]	Home	−0.161 (0.199)	0.346	−0.020 (0.221)	0.291	−0.020 (0.221)	
	Workplace	−0.417 (0.185)**		−0.396 (0.206)*		−0.394 (0.206)*	
	Interaction					0.038 (0.182)	
	Weighted						−0.292 (0.210)

		Model 1[a] Mean difference (SE)	p-value for difference	Model 2[b] Mean difference (SE)	p-value for difference	Model 3[b] Mean difference (SE)	Model 4[c] Mean difference (SE)
Social Cohesion[f]	Home	−0.143 (0.187)	0.463	−0.014 (0.221)	0.384	−0.036 (0.222)	
	Workplace	−0.335 (0.183) *		−0.334 (0.209)		−0.315 (0.210)	
	Interaction					−0.182 (0.157)	
	Weighted						−0.231 (0.208)
Walking Environment[f]	Home	−0.677 (0.205) **	0.977	−0.385 (0.262)	0.922	−0.292 (0.277)	
	Workplace	−0.669 (0.187) **		−0.430 (0.245) *		−0.384 (0.249)	
	Interaction					−0.203 (0.178)	
	Weighted						−0.716 (0.208) **
Healthy Food Availability[f]	Home	−0.374 (0.195) *	0.658	−0.110 (0.254)	0.516	−0.107 (0.252)	
	Workplace	−0.494 (0.188) **		−0.407 (0.253)		−0.352 (0.250)	
	Interaction					−0.453 (0.168) **	
	Weighted						−0.420 (0.207) **

[a] Two-level hierarchical models with home and workplace neighborhood characteristics in separate models. SE=standard error.

[b] Cross-classified models with home and workplace neighborhood characteristics in the same model. This is additionally adjusted for distance in miles between the home and workplace. SE=standard error.

[c] Cross-classified models for home and workplace neighborhood characteristics with additional adjustment for distance in miles between the home and workplace. These models used time-weighted summary measures of each person's exposure by calculating weighted averages of the home and workplace measures, with weights representing the proportion of hours during the week spent at each location. SE=standard error.

[d] Standard deviation unit increase

[e] 1-mile kernel density. 10 businesses per square mile increase

[f] 1-mile mean. Standard deviation unit increase

** P-value<0.05

* P-value<0.10