Association of Walkability With Obesity in Baltimore City, Maryland

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Objectives. To investigate the association between walkability and obesity, we studied adults residing in Baltimore City, Maryland, in neighborhoods of varying racial and socioeconomic composition.

Methods. We conducted a cross-sectional study of 3493 participants from the study Healthy Aging in Neighborhoods of Diversity across the Life Span. We used the Pedestrian Environment Data Scan to measure neighborhood walkability in 34 neighborhoods of diverse racial and socioeconomic composition in which the study participants lived. Confirmatory factor analysis was used to determine walkability scores. Multilevel modeling was used to determine prevalence ratios for the association between walkability and obesity.

Results. Among individuals living in predominately White and high-socioeconomic status (SES) neighborhoods, residing in highly walkable neighborhoods was associated with a lower prevalence of obesity when compared with individuals living in poorly walkable neighborhoods, after adjusting for individual-level demographic variables (prevalence ratio–[PR]=0.58; P=<.001 vs PR=0.80; P=.004). Prevalence ratios were similar after controlling for the perception of crime, physical activity, and main mode of transportation. The association between walkability and obesity for individuals living in low-SES neighborhoods was not significant after accounting for main mode of transportation (PR=0.85; P=.060).

Conclusions. Future research is needed to determine how differences in associations by neighborhood characteristics may contribute to racial disparities in obesity. (*Am J Public Health.* 2011;101:S318–S324. doi:10.2105/AJPH.2009.187492)

In the United States roughly 34% of adults are obese.[1] Obesity increases the risk of many chronic diseases including cardiovascular disease, diabetes, and some cancers.[1–3] Furthermore, non-Hispanic Black people and less-educated individuals are more likely to be obese compared with non-Hispanic White people and more educated individuals.[4,5]

Given the high prevalence of obesity, recent research has focused on the role the built environment plays in influencing individual physical activity, modes of transportation, and health outcomes. Few studies have examined the association between the built environment and obesity across neighborhoods of varying racial and socioeconomic composition. Rather, associations have been documented among varying populations and geographic locations without regard for contextual neighborhood factors.

Numerous features of the built environment have been associated with physical activity (which can prevent and reduce obesity), including residential density, land-use mix, urban sprawl, intersection density, walkability, park availability, and accessibility to physical activity-related resources.[6–13] One study found that neighborhoods with higher socioeconomic status (SES) had an increased likelihood of having 1 or more physical activity facilities; more facilities were also associated with an increased likelihood of achieving moderate to vigorous physical activity.[14] Land-use mix, nearby destinations, and the presence of sidewalks have been associated with less obesity[14–18] but little research has investigated differences stratified by neighborhood characteristics. Furthermore, few studies have developed measurement models for walkability. The use of a composite neighborhood walkability score would reduce the likelihood of finding associations by chance alone (i.e., type I error).[19,20]

To investigate the association between neighborhood walkability and obesity, we implemented an environmental audit in several Baltimore neighborhoods that measures the microscale features of the pedestrian environment.[21] We hypothesized that individuals living in neighborhoods with higher walkability would have a lower prevalence of obesity than individuals living in neighborhoods with lower walkability. Our secondary hypothesis was that the association between neighborhood walkability and obesity would differ by neighborhood race and socioeconomic composition.

METHODS

The Healthy Aging in Neighborhoods of Diversity across the Life Span (HANDLS) study is a multidisciplinary, prospective epidemiologic study set in Baltimore City, Maryland. The study objective is to examine the influence and interaction of race and SES on the development of cardiovascular health disparities among urban-dwelling minority and lower SES groups. Details of the study are presented elsewhere.[22] The HANDLS study was stratified across 4 factors: age, gender, race, and SES. Baseline recruitment included 3493 Black and White adults aged 30 to 64 years of high- and low-SES living in 12 neighborhoods across Baltimore. Each neighborhood was defined by the boundaries of 2 to 5 census tracts. Data collection was implemented in 2 stages: (1) an in-home household survey and (2) a physical examination and medical history in mobile research vehicles. Survey and medical information is confidential and approved by the Medstar Research Institute.

Study Population

HANDLS participants were selected from 12 predefined Baltimore neighborhoods that were likely to meet the age, race, gender, and SES design specifications. Recruitment and sampling contractors produced household listings to identify residential dwellings in each neighborhood. The contractors performed doorstep interviews, identified eligible persons in each household, selected 1 of 2 eligible persons per household and invited the eligible candidates to participate in HANDLS. Participants had to be aged 30–64 years, have the ability to give informed consent, perform at least 5 study measures, and present valid picture identification. Individuals were excluded from the study if they were pregnant, within 6 months of active cancer treatment, or multiethnic individuals who did not identify strongly with either the Black or White race.

Individual-Level Household Interview Measures

Individual-level demographic measures from the HANDLS in-home questionnaire included self-reported age, gender, race, education, household income and general health status. Low-SES was defined as having a household income below 125% of the poverty threshold. General health status was measured using the 12-item Short Form Health Survey (SF-12).[23] Perceived crime was evaluated with 3, 5-point Likert scale questions on how common serious crime, drug and gang activity was in their neighborhood. Participants also reported on the main mode of transportation used for traveling outside of their neighborhood from the following options: car, someone else's car, public transportation, walking.

Neighborhood Census Measures

Neighborhood race and SES were determined using data from the 2000 US Census. Neighborhoods were classified as predominately Black or White if 60% or more of the residents were Black or White, respectively.[24] Only 3 tracts failed to meet these criteria and less than 2% of the people in those tracts were not Black or not White. Consequently, these racially mixed tracts were classified by their racial majority. Neighborhood SES was determined by the percentage of individuals in the tract living in poverty. Census tracts with 25% or more of residents living below the poverty threshold were categorized as low-SES and those with less than 25% living below the poverty threshold were categorized as high-SES. These cut-points were determined based on median percent poverty for the census tracts included in the study.

Neighborhood Walkability

The Pedestrian Environment Data Scan (PEDS) was implemented to evaluate the pedestrian walking environment for exercise and transportation.[21] The audit captures microscale features that are frequently apparent to pedestrians but not easily captured in publicly available data and has been conceptualized into 4 sections: uses and design, pedestrian facilities, road attributes and the walking/cycling environment. The PEDS audit has demonstrated moderate to high reliability for most items and was comparable in reliability to other environmental audits (κ statistics$>$0.70).[21]

To implement the PEDS audit in neighborhoods of HANDLS participants, pairs of trained raters systematically assessed a 20% random sample of street segments. The literature indicates that a 20% sample is an appropriate selection size for measuring physical features in a neighborhood.[25] In addition, roughly 30% of street segments in HANDLS neighborhoods were alley streets. Therefore, a 5% random sample of alley streets was taken from each neighborhood. These segments were sampled separately to increase the likelihood of capturing segments most often traveled by pedestrians; alleys were determined less ideal for walking or physical activity because of safety reasons. Street segments were selected using geographic information system technology and street files from the US Census. Segments inaccessible to pedestrians, such as limited-access highways and ramps, were not included for sample selection. Auditors worked in pairs and discrepancies were reconciled on-site. A 5% reliability sample was conducted for each neighborhood where pairs of raters assessed the same segments for quality control purposes; κ statistics were high, ranging from 0.75 to 0.99 for most PEDS items.

Obesity and Physical Activity

Medical staff measured height and weight using standard measurement tools when the participant visited the mobile research vehicle. Body mass index (BMI, defined as weight in kilograms divided by height in meters squared) was calculated from these measurements, and obesity was defined as a BMI of 30 or higher.[3] Physical activity was self-reported using the Houston Physical Activity Scale for a subset of HANDLS participants (n=717).[26]

Statistical Analysis

To construct a walkability score with data from the PEDS audit, we conducted a confirmatory factor analysis using the statistical modeling program MPlus (Muthén & Muthén, Los Angeles, CA).[27] A 1-factor model for both categorical and continuous dependent variables was chosen with a weighted least-squares mean and variance estimator. After reviewing Spearman and Pearson correlation matrices for PEDS data, 7 indicators were included in the initial model (type of intersection, obstructions in the sidewalk, connections to other sidewalks and crosswalks, stop signs, absence of traffic control devices, crosswalks and absence of amenities such as mailboxes and benches). These were chosen based on both empirical (inter-item correlations$\geq$0.40) and theoretical evidence from previous literature.[17, 28] For each iteration, the adequacy of the model fit was evaluated using the following statistics to assess the degree of fit between the estimated and observed variance/covariance matrix: χ^2 test, the relative likelihood ratio (χ^2/df), the comparative fit index, weighted root mean square residual (WRMR) and the Tucker–Lewis Index. Based on the final model, factors scores for walkability were determined for each HANDLS neighborhood.

Participant characteristics were stratified by tertiles of neighborhood walkability. Mean BMI for each walkability tertile was calculated using 1-way analysis of variance and stratified by neighborhood race and SES.

Prevalence ratios were estimated using multilevel (random-effects) log-binomial models with a random intercept for each neighborhood. The main exposure variable was walkability, a latent construct comprised of the PEDS variables identified by confirmatory factor analysis. Because there are not standard cut-points for this scale, walkability was categorized by tertiles (3 categories) to estimate associations on a gradient of low to high walkability. The main dependent variable was obesity.

All regression models were adjusted for individual-level variables (age, gender, race, education, poverty status, and self-reported health) and stratified by neighborhood race and SES. To investigate possible mediation pathways, the perception of crime, physical activity and main mode of transportation were assessed in independent regression models. Adjustment for all 3 potential mediators in the same model was also investigated. All analyses were conducted using Stata version 10.0 (StataCorp LP, College Station, TX); the generalized linear latent and mixed models procedure. Participants with missing data for primary outcomes were excluded from analyses and evaluated for exclusion bias.

RESULTS

The final model included 4 indicators: connections to other sidewalks and crosswalks, the presence of stop signs, obstructions in the sidewalk, and designated crosswalks (Figure 1). Thus, walkability in this study refers to the connectivity and ease of transportation for pedestrians in a neighborhood. All estimates were significant ($P<.05$) with loadings ranging in magnitude from 0.480 to 0.895. The χ^2 value was 2.31 with 2 degrees of freedom ($P=.316$). This yielded a relative likelihood ratio (χ^2/df) of 1.16 where values less than 3 indicate good fit. In addition, the comparative fit index and Tucker–Lewis Index were high (0.979 and 0.969, respectively) and the WRMR was less than 1 (WRMR=0.278). Walkability factor scores for HANDLS neighborhoods ranged from –0.809 to 0.752 with a mean score of zero. Overall, the results supported the hypothesized model for walkability.

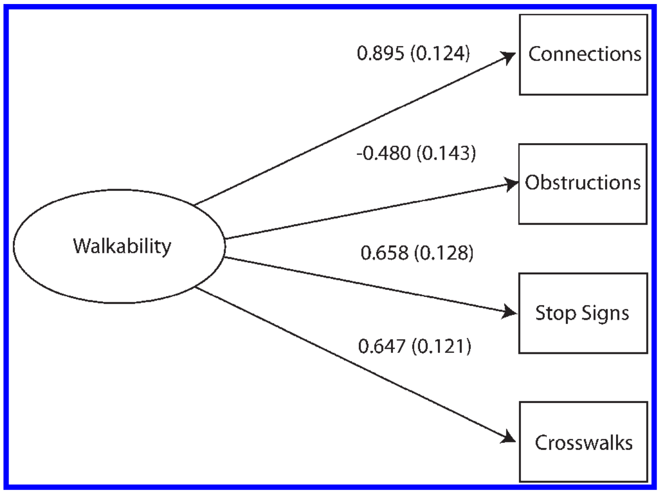

FIGURE 1—Standardized factor loadings (with SEs) for indicators of walkability.

Significantly more Black people resided in medium-walkability neighborhoods (86%) with the majority of White people residing in low-walkability neighborhoods (65%; $P<.001$; Table 1). Individuals above the poverty threshold were significantly more likely to reside in low-walkability neighborhoods ($P<.001$). Reporting the use of a car as a main mode of transportation was significantly more frequent among those that lived in low-walkability neighborhoods ($P<.001$). Of the total participant population, 43% were obese and 29% were overweight. A higher percentage of obese participants resided in low-walkability neighborhoods (45%) compared with high-walkability neighborhoods (38%; $P=.004$). Significantly more individuals in predominately Black neighborhoods resided in medium-walkability neighborhoods although more individuals in low-SES neighborhoods resided in high-walkability neighborhoods ($P<.001$). There was no difference in age, gender, health insurance, education, or self-reported health by neighborhood walkability ($P>.05$).

Among individuals residing in predominately White neighborhoods, mean BMI was lower for participants that lived in high-walkability neighborhoods ($P=.016$; Table 2). A similar significant association was shown for individuals living in high-SES neighborhoods ($P<.001$). There was no significant association between obesity and neighborhood walkability for individuals residing in predominately Black and low-SES neighborhoods ($P>.05$).

Overall, there was no significant association between neighborhood walkability and obesity after adjustment for demographic characteristics (Table 3). Among individuals living in predominately White neighborhoods, residing in a high walkability neighborhood (highest tertile of walkability) was associated with a significantly lower prevalence of obesity compared with individuals living in neighborhoods with poor walkability (lowest tertile) (prevalence ratio [PR]=0.58; $P<.001$). A similar association for obesity was found among individuals residing in high- and low-SES neighborhoods (PR=0.80; $P=.004$ and PR=0.83; $P=.046$, respectively). There was no significant association among individuals residing in predominately Black neighborhoods.

For individuals residing in low-SES neighborhoods, the association between walkability and obesity became insignificant after additionally adjusting for main mode of transportation (PR=0.85; $P=.060$); in a similar approach, independently adjusting for the perception of crime did not alter significance findings for the association between walkability and obesity in these neighborhoods. Furthermore, in predominately White and high-SES neighborhoods, controlling for perceived crime and main mode of transportation did not significantly attenuate prevalence ratio estimates and associations remained significant.

Among individuals residing in low-SES neighborhoods, the association between walkability and obesity was significantly attenuated after controlling for physical activity (PR=1.06; $P=.753$) in this small subset of participants (n=281). Conversely, controlling for physical activity did not significantly alter prevalence ratio estimates for individuals residing in predominately White or high-SES neighborhoods.

DISCUSSION

Previous literature suggests that several attributes of walkability are associated with physical activity and obesity,[6–18] but few studies have examined these associations by neighborhood characteristics such as race and SES.[14] Our findings indicated that among individuals residing in predominately White or high-SES neighborhoods, a highly walkable neighborhood was associated with lower obesity compared with individuals living in poorly walkable neighborhoods after controlling for demographic variables and investigating possible intermediate variables.

There are 2 key explanations for these findings. First, national data have shown that White people report more leisure-time physical activity compared with Black people.[29] Thus, individuals living in predominately White

TABLE 1—Participant Characteristics Stratified by Neighborhood Walkability: HANDLS Study, Baltimore, MD, 2004–2008

Participant Measures	Overall, %	Low Walkability (n = 1231), %	Medium Walkability (n = 1143), %	High Walkability (n = 1116), %	P
Demographics					
Race					
White	39.7	64.5	13.7	39.2	<.001
Black	60.3	35.6	86.3	60.8	
Mean age, y	47.7	47.6	47.9	47.7	.787
Female	54.5	53.6	56.2	53.9	.382
Above poverty threshold	58.9	63.7	58.4	53.9	<.001
Health insurance (yes)	65.8	67.9	64.8	64.8	.192
<High school education	27.0	29.0	24.7	27.3	.066
Self-reported health					
Poor to good	67.8	69.8	66.9	66.5	.17
Very good to excellent	32.2	30.2	33.1	33.5	
Main mode of transportation					
Walking/public transit	36.5	31.7	38.9	39.1	<.001
Car	63.5	68.3	61.2	60.9	
Health outcomes and behaviors					
BMI,[a] kg/m^2					
Normal (<25.0)	28.4	27.2	25.2	32.7	.004
Overweight (25.0–29.9)	29.0	28.0	29.8	29.3	
Obese (≥30.0)	42.7	44.8	45.0	38.0	
Physical activity[b]					
Inactive to moderately active	55.1	60.5	39.6	60.9	<.001
Active	44.9	39.5	60.4	39.1	
Neighborhood characteristics					
Neighborhood race					
Predominately White	36.1	55.6	5.2	46.2	<.001
Predominately Black	63.9	44.4	94.9	53.9	
Neighborhood SES					
High	55.3	64.3	55.0	45.6	<.001
Low	44.7	35.7	45.0	54.4	

Note. BMI = body mass index; HANDLS = Healthy Aging in Neighborhoods of Diversity across the Life Span; SES = socioeconomic status. BMI was defined as weight in kilograms divided by height in meters squared. Sample size was n = 3493.
[a]Includes approximately 77% of household interview participants.
[b]Reported for a subset of HANDLS participants (n = 717).

neighborhoods may be more likely to observe or socialize with active neighbors and, consequently, be more likely to engage in physical activity in an effort to maintain or lose weight. Prior research has indicated that observing the exercise habits of peers and neighbors may be beneficial for improving individual physical activity behaviors.[30–32] In these neighborhoods, a walkable neighborhood environment may promote and increase the likelihood of activity and, subsequently, lower obesity. In contrast, there was no association between neighborhood walkability and obesity among individuals residing in predominately Black neighborhoods. This may be because few individuals inclined to engage in activity, regardless of the environment. One reason for less activity may be concern for neighborhood safety.[30,33,34] A study conducted in Los Angeles and Louisiana determined that Blacks more often perceived their neighborhood as unsafe and that this neighborhood perception was most strongly associated with less frequent utilitarian walking.[35] Indeed, the perception of crime in HANDLS was more often reported among individuals residing in highly walkable, predominately Black neighborhoods; thus, crime may negate any univariate association between walkability and obesity in these neighborhoods.

Second, individuals living in high-SES neighborhoods may drive cars more often for daily transportation (e.g., to work, stores) than do individuals living in low-SES neighborhoods. We found that 64% of individuals residing in high-SES neighborhoods reported using a car as their main mode of transportation compared with 36% of individuals in low-SES neighborhoods. Therefore, high-SES neighborhoods that are conducive for walking may facilitate more leisure activity and, subsequently, lower obesity. The measures used to capture this activity may not have been sensitive enough. In contrast, individuals living in low-SES neighborhoods may walk for transportation out of necessity. Fifty-one percent of individuals in low-SES neighborhoods reported either walking or using public transportation most often and those who reported walking or using public transportation had significantly lower BMI compared with those who drove cars. Indeed, there was no significant association between walkability and obesity after controlling for mode of transportation. Economic factors can have a strong impact on how the built environment is developed.[36] For example, low-SES neighborhoods are more likely to have public transportation routes within walking distance of residential areas. Furthermore, individuals in these neighborhoods may commute longer distances to reach jobs in areas of economic prosperity, which translates to greater active transport.

Although few studies have examined associations between walkability and obesity stratified by neighborhood characteristics, reports in the literature have been consistent in finding that, even after controlling for individual-level SES, living in an economically deprived neighborhood increases the likelihood of being obese or having a high BMI.[37–39] Similar associations for neighborhood race have been documented,[37] although the literature has been less consistent. Two studies found no association between neighborhood race and obesity,[39,40] and 1 study found that neighborhood racial isolation was significantly associated with obesity

TABLE 2—Body Mass Index Stratified by Neighborhood Walkability: HANDLS Study, Baltimore, MD, 2004–2008

Neighborhood Characteristics	BMI, Mean ±SD: Low Neighborhood Walkability	Medium Neighborhood Walkability	High Neighborhood Walkability	*P*
Overall	30.1 ±7.7	30.5 ±8.1	29.3 ±7.6	.007
Neighborhood race				
Predominately White	30.4 ±7.8	30.8 ±7.6	29.0 ±7.8	.016
Predominately Black	29.6 ±7.6	30.4 ±8.1	29.5 ±7.5	.059
Neighborhood SES				
High	30.5 ±7.6	30.8 ±7.7	28.9 ±7.1	<.001
Low	29.2 ±7.9	30.1 ±8.6	29.6 ±8.0	.349

Note. BMI = body mass index; HANDLS = Healthy Aging in Neighborhoods of Diversity across the Life Span; SES = socioeconomic status. BMI was defined as weight in kilograms divided by height in meters squared. Sample size was (n = 2616).

among Black residents only.[41] This research suggests that the effects of neighborhood-level race and SES may be at least partially mediated through differential access to health-promoting or health-constraining environments and resources.[32] Indeed, previous literature indicates that physical activity resources are less likely to be located in lower-SES and minority neighborhoods.[14] In addition, 1 study determined that residing in high- versus low-walkability neighborhoods increased weekly physical activity but found no difference by neighborhood income.[20] Despite these previous and current findings, some caution in interpretation should be noted. Adjusting for individual-level demographics may, in fact, be an overadjustment and result in overestimation if these demographic variables are antecedent to the exposure and not true confounders.

Sampling is paramount when conducting observational studies intended to determine the effects of neighborhood walkability. An almost universal problem is overcoming neighborhood self-selection where individuals choose, or are limited to, neighborhoods with certain attributes (e.g., poor walkability) based on individual characteristics (e.g., low SES) that are likely related to the outcome.[42] Rather than using regression methods to control for the effects of SES, a few recent studies have attempted to sample high- and low-walkability neighborhoods with the caveat that these neighborhoods included a homogenous population with respect to SES and geographic location.[43,44] Although measures of walkability differed in these studies, both found positive associations for physical activity and utilitarian walking. Oakes et al. note, though, that walkability was not meaningfully related to overall mean miles walked or increased physical activity.[43] To assess the effect of neighborhood income, a more recent study recruited participants from high- versus low-walkability and high- versus low-SES neighborhoods.[20] Again, participants were more active if they lived in high-walkability neighborhoods but, in contrast to the current results, there was no difference by neighborhood SES. Although the parent study for our analysis was not designed to sample neighborhoods based on level of walkability, the results do suggest that the effect of neighborhood walkability on obesity differs by neighborhood characteristics. Teasing out the effects of neighborhood race and SES is difficult because these factors may be proxies for other underlying variables. Nevertheless, it is important to document these differences for intervention and policy purposes.

Major strengths of this study were objective measures of the pedestrian environment and individual-level outcome measures. The PEDS audit measured the walking environment for transportation and physical activity at the microscale, thus capturing information that is not available through national databases. Confirmatory factor analysis was used to reduce random measurement error in each PEDS item. Although perceived measures can be informative, identifying aspects of the environment that can be directly intervened on is crucial for support from public officials and urban planners. Obesity was objectively measured, which is the preferred measurement method for large epidemiologic studies. Furthermore, the stratified sampling design enabled us to compare associations by neighborhood characteristics.

Nevertheless, this study had some limitations. First, the study was cross-sectional which limits the ability to make causal statements about observed associations. Second, census tract boundaries were used to approximate neighborhoods, which creates the potential for measurement error in environmental attributes located in a participant's neighborhood. Third, the length of exposure to certain neighborhood characteristics is unknown, thus, associations may not reflect the walkability characteristics measured in this study. However, it is unlikely that mobile individuals move to drastically resource-different neighborhoods because of financial limitations and social preferences.[45] Fourth, physical activity was self-reported for only a few HANDLS participants. Nevertheless, because the physical activity

TABLE 3—Adjusted Associations Between Walkability and Obesity: HANDLS Study, Baltimore, MD, 2004–2008

Walkability Score	Overall, PR (95% CI)	Neighborhood Race, PR (95% CI): White (n = 10)	Neighborhood Race, PR (95% CI): Black (n = 24)	Neighborhood SES, PR (95% CI): High (n = 16)	Neighborhood SES, PR (95% CI): Low (n = 18)
Low	1.00	1.00	1.00	1.00	1.00
Medium	1.05 (0.90, 1.23)	1.09 (0.92, 1.29)	1.00 (0.87, 1.14)	0.89 (0.76, 1.00)	1.14 (0.98, 1.32)
High	0.88 (0.75, 1.03)	0.58 (0.46, 0.73)	1.00 (0.88, 1.14)	0.80 (0.68, 0.93)	0.83 (0.68, 1.00)

Note. CI = confidence interval; HANDLS = Healthy Aging in Neighborhoods of Diversity across the Life Span; PR = prevalence ratio; SES = socioeconomic status. Adjusted for individual-level age, gender, race, poverty status, education, and self-reported health. Sample size was n = 2541.

measure did not capture utilitarian walking, an important factor in this line of research, a separate transportation question was used as a proxy for information on walking habits. Fifth, there may be other population-level factors that influence obesity but were not accounted for in these analyses. For example, variation between neighborhoods in the availability of healthy food may impact obesity status in this population. Given increases in total energy consumption[46] and the low prevalence of physical activity among adults,[47] it is important to understand how neighborhood walkability and healthy food availability interact and influence obesity in neighborhoods of varying characteristics. Finally, the use of multilevel models makes conclusions on possible intermediate variables difficult given that the variance structures of the neighborhood- and individual-level variables are different; caution should be taken when interpreting potential mediating pathways.

The literature on walkability and obesity continues to grow. Although early work is promising, there are methodological issues that should be challenged in the future. First, the environmental determinants of obesity are numerous and few studies have incorporated comprehensive models to account for both energy expenditure and energy intake (i.e., environmental supports for physical activity and healthy dietary intake). Second, most previous studies were cross-sectional, which severely limits the ability to imply causal associations; experimental or longitudinal studies are needed. Third, formative research should be used to establish the most appropriate neighborhood spatial scale for varying demographic and geographic populations. Fourth, few studies have explored walkability beyond the scope of neighborhoods (e.g., workplace). Finally, improvements in the conceptualization of walkability are warranted. Numerous attributes of walkability have been associated with obesity; future work should further define walkability for varying populations and geographic areas.

In our population, high walkability was associated with lower obesity among individuals living in high-SES and predominately White neighborhoods. A thorough understanding of the underlying mechanisms in which these associations operate is needed. At the very least, individual physical activity recommendations and weight-management guidelines should recognize neighborhood walkability as an important enabler or inhibitor to meeting these guidelines. ■

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Contributors

S. Stark Casagrande designed the study, supervised all aspects of implementation, performed data analyses, and led the writing. J. Gittelsohn, A.B. Zonderman, and M.K. Evans contributed to the study design and supervision. T.L. Gary-Webb contributed to the study design, supervised the study, and assisted with the writing. All authors conceptualized ideas, interpreted findings and reviewed drafts of the manuscript.

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Human Participant Protection

This project was approved by the Johns Hopkins Bloomberg School of Public Health institutional review board.

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