American Journal of
Preventive Medicine

RESEARCH ARTICLE

Social and Economic Differences in Neighborhood Walkability Across 500 U.S. Cities

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Introduction: Neighborhood walkability has been established as a potentially important determinant of various health outcomes that are distributed inequitably by race/ethnicity and sociodemographic status. The objective of this study is to assess the differences in walkability across major urban centers in the U.S.

Methods: City- and census tract−level differences in walkability were assessed in 2020 using the 2019 Walk Score across 500 large cities in the U.S.

Results: At both geographic levels, high-income and majority White geographic units had the lowest walkability overall. Walkability was lower with increasing tertile of median income among majority White, Latinx, and Asian American and Native Hawaiian and Pacific Islander neighborhoods. However, this association was reversed within majority Black neighborhoods, where tracts in lower-income tertiles had the lowest walkability. Associations varied substantially by region, with the strongest differences observed for cities located in the South.

Conclusions: Differences in neighborhood walkability across 500 U.S. cities provide evidence that both geographic unit and region meaningfully influence associations between sociodemographic factors and walkability. Structural interventions to the built environment may improve equity in urban environments, particularly in lower-income majority Black neighborhoods.

INTRODUCTION

The prevalence of numerous chronic conditions, including obesity and diabetes, has been increasing in the U.S., and researchers have observed persistent disparities in these conditions by sociodemographic factors, such as race/ethnicity and poverty.[1] Regular physical activity reduces the risk for these chronic conditions,[2] and a growing body of research suggests that neighborhood walkability or the extent to which the built environment supports walking is associated both with higher physical activity[3−5] and with lower prevalence of chronic conditions.[5,6]

Because walkability is a potentially important health determinant and because there are significant disparities in health outcomes associated with it, researchers have explored whether there are corresponding differences in neighborhood-level characteristics that would influence the walkability of these environments.[7−13] However, studies that have examined the sociodemographic differences in neighborhood walkability have provided inconsistent results, with some having observed lower walkability levels among high-poverty or predominantly non-White neighborhoods,[7−11] whereas others have observed higher walkability levels among more disadvantaged neighborhoods.[9,12,13]

These disparate results across studies may in part reflect the lack of consensus on how to measure and

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0749-3797/$36.00
https://doi.org/10.1016/j.amepre.2021.03.014

define walkability. Studies have used a wide variety of variables to define walkability, with evidence suggesting that both built environmental factors, such as street connectivity or proximity to amenities,[14–18] and social factors, such as perceived safety,[19,20] are associated with higher physical activity. In general, studies using walkability measures that incorporate elements of safety or quality, such as rates of felony complaints or sidewalk unevenness, have observed lower walkability levels among higher-poverty or non-White neighborhoods.[7–9,12] By contrast, studies that have used accessibility-focused measures that are derived from objective measures of the built environment, such as intersection density and retail floor area ratio, have observed higher walkability levels among higher-poverty or non-White neighborhoods.[9,12,13] Walk Score, a proprietary metric quantifying multiple dimensions of the built environment including walking routes, distances to different categories of amenities, population density, road segment lengths, and intersection density,[21] is one commonly used accessibility-focused measure of walkability that has been validated previously.[22–26]

In addition, most existing studies have been conducted within a single city or have been inconsistent in their selection of geographic levels, leading to a lack of comparability. Previous research has shown that the geographic unit of an analysis can influence the magnitude or direction of the observed spatial association.[27–29] This issue, known as the modifiable areal unit problem,[30] highlights the importance of selecting the appropriate geographic unit for a given analysis. Multiple studies that have explored the differences in walkability across small samples of cities also suggest that the associations may not be uniform across geographic areas.[11,12,31,32] In particular, a study that compared the associations between social vulnerability and walkability found that differences were highly variable across 3 U.S. cities, with stronger associations observed in the city in the South than in those in the Northeast and West.[11] However, with only 3 cities included in this study, a clear pattern by geographic region cannot be discerned.

Given the limitations of previous research and in light of the remaining unaddressed questions regarding health inequity and walkability, this study seeks to address several limitations of previous studies by:

1. using a nationally standardized measure of neighborhood walkability to examine univariable and multivariable associations between sociodemographic factors and walkability across 500 major urban centers in the U.S., allowing for consistent inferences that are representative of all large cities across the nation;
2. contrasting the associations observed at the city level versus those observed at the census tract level to understand the potential variations in the associations by geographic unit; and
3. comparing the associations observed across different geographic regions of the U.S. to understand the potential variations in the associations by geographic area.

The primary hypothesis is that larger differences in walkability will be observed when using census tract definitions of neighborhoods because these smaller geographic areas will better capture granular variation in walkability levels within cities. The secondary hypothesis is that the associations will not be uniform across U.S. regions because regions have distinct urban infrastructures, histories, and cultures that could influence these associations.[33,34]

METHODS

Study Sample

In this cross-sectional study, 2 levels of analysis were incorporated: neighborhoods (defined as census tracts), and cities (defined as census incorporated places, whose boundaries correspond to municipal government jurisdictions). Data were analyzed on the 497 of the most populous cities in the U.S. and the 3 highest population cities in Vermont, West Virginia, and Wyoming as of 2010 to allow for representation from all 50 states.[35]

Measures

Walkability was measured at the city and census tract level using the 2019 Walk Score.[21,24] Walkability data were acquired through a data use agreement between Walk Score and the City Health Dashboard, a free online resource providing 37 public health−related measures for U.S. cities.[35] Walk Score considers ratings from 0 to 49 to be car dependent and scores from 50 to 100 to be somewhat walkable to highly walkable.[21] To calculate city walkability, Walk Score divides cities into blocks of roughly 500 feet on each side and calculates a population density−weighted average for all blocks within the city.[21,30] To calculate neighborhood walkability, Walk Score calculates walkability across the entirety of each census tract, removing places where people do not live.[36] Walkability was analyzed on a continuous scale ranging from 0 to 100.

Sociodemographic factors explored in these analyses (income and majority race/ethnicity) were measured using the 2018 American Community Survey 5-year estimates. Both income and majority race/ethnicity were measured at the city and census tract level, and these were classified as categorical variables. Income was categorized as low, middle, and high using tertiles of median household income for the geographic area (from Table DP03: Selected Economic Characteristics). Majority race/ethnicity was defined by whether a racial/ethnic group comprised >50% of the total resident population for the geographic area (from Table DP05: American Community Survey Demographic and Housing Estimates). Majority race/ethnicity was categorized as non-Hispanic Asian American (AA) and Native Hawaiian and Pacific Islander (NH&PI), non-Hispanic Black (Black), Hispanic/Latino

(Latinx), and non-Hispanic White (White) or None. Owing to small population sizes, areas identified as AA and NH&PI majority included both AA and NH&PI residents in the AA and NH&PI category, which limits the ability to distinguish patterns across heterogeneous Asian subgroups. Areas listed as None majority reflected areas with no racial/ethnic group representing >50% of the resident population. To analyze the potential geographic variation in the associations between sociodemographic factors and walkability, cities were classified into the 4 Census Bureau−designated regions of the U.S.: the Northeast, Midwest, South, and West.[37]

Statistical Analysis

Descriptive statistics of walkability by income tertile, majority race/ethnicity, and the region at the city and census tract level were analyzed. Next, univariable associations between the sociodemographic factors and walkability at the city level using linear regression models were assessed. Because walkability and sociodemographic factors are likely to vary across neighborhoods within a given city, univariable associations at the census tract level were assessed using random-intercept multilevel linear regression models to account for the clustering of census tracts within cities. Using census tract−level data, adjusted associations were assessed using a random-intercept multilevel linear regression model, including terms for income level, majority race/ethnicity, and the interaction of income level and majority race/ethnicity ($F_{[828,492]}$=13.3, p<0.01). This multivariable model was replicated, including terms for the interaction of income level and U.S. region ($F_{[628,096]}$=40.6, p<0.01) and the interaction of majority race/ethnicity and U.S. region ($F_{[928,181]}$=6.7, p<0.01), to assess whether there was significant regional variation in these associations. Regional models excluded AA and NH&PI majority census tracts given small cell sizes. Census tracts that were missing data were excluded from these analyses. All analyses were conducted using SAS, version 9.4.2.

RESULTS

Of the 500 cities included in this study, 93 (18.6%) were located in the Midwest, 54 (10.8%) were located in the Northeast, 158 (31.6%) were located in the South, and 195 (39.0%) were located in the West. Of the 29,305 census tracts within these cities, 115 were missing Walk Score data, 203 were missing majority race/ethnicity data, and 380 were missing income data. As a result, 28,130 census tracts (98%) were included in the final sample, with an average number of census tracts per city of 62.1 in the Midwest, 78.7 in the Northeast, 61.5 in the South, and 50.3 in the West.

Cities within the Northeast had, on average, higher city Walk Scores than those in the other regions of the U.S. Cities located within the South had lower variability in city Walk Scores, with >90% of Southern cities classified as car dependent (scores from 0 to 49). There was an inverse relationship between income and mean Walk Score, with low-income cities having the highest average Walk Score and high-income cities having the lowest average Walk Score (Table 1). This inverse relationship between income level and Walk Score was more pronounced at the neighborhood level than at the city level, with low-income neighborhoods having an average Walk Score of 55.5 (SD=22.6) compared with 40.6 (SD=27.9) for high-income neighborhoods. On average, majority

Table 1. Mean Walk Score by Income Level, Majority Race/Ethnicity, and Region at the City- and Neighborhood-Level for 500 U.S. Cities in 2019

	City level		Neighborhood level	
Metrics	***n***	**Mean (SD)**	***n***	**Mean (SD)**
Total	500	42.9 (15.79)	28,791	47.6 (26.2)
Income				
Low	166	44.2 (16.0)	9,632	55.5 (22.6)
Mid	167	42.6 (15.4)	9,628	46.6 (25.8)
High	167	41.8 (16.3)	9,631	40.6 (27.9)
Majority race/ethnicity				
AA and NH&PI	6	57.3 (9.7)	562	61.4 (25.7)
Black	23	41.5 (14.7)	3,929	55.9 (23.3)
Latino	63	50.1 (17.8)	4,946	55.9 (23.3)
White	245	39.0 (13.8)	13,600	41.2 (26.6)
None	163	45.6 (16.7)	5,854	49.7 (25.6)
Region				
Midwest	93	40.5 (12.2)	5,527	47.2 (23.9)
Northeast	54	65.6 (13.3)	4,250	78.7 (18.8)
South	158	34.4 (11.8)	9,464	36.6 (22.5)
West	195	44.7 (14.4)	9,650	44.9 (23.0)

AA, Asian American; NH&PI, Native Hawaiian and Pacific Islander.

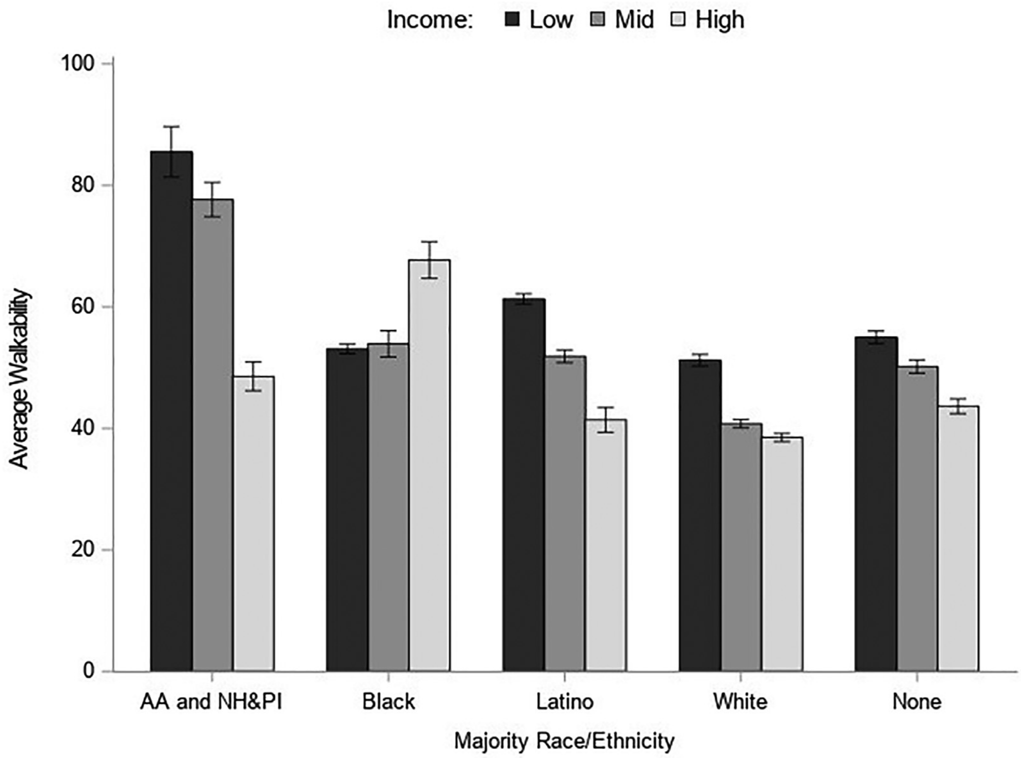

Figure 1. Average neighborhood-level walkability by income and majority race/ethnicity for 500 U.S. cities in 2019.

AA and NH&PI cities had the highest average Walk Score, whereas majority White cities had the lowest average Walk Score at both the city and neighborhood level.

When neighborhoods were stratified by majority race/ethnicity, the inverse relationship between income level and Walk Score was observed for majority AA and NH&PI, White, and Latinx neighborhoods and for neighborhoods with no racial/ethnic majority, but this relationship was reversed for majority Black neighborhoods. High-income, majority Black neighborhoods had an average Walk Score of 67.7 (SD=22.5) compared with 53.1 (SD=21.9) for low-income, majority Black neighborhoods (Figure 1).

In the univariable city-level model, there were minor differences in city walkability by income (Table 2). Majority White cities had the lowest estimated Walk Score. Majority AA and NH&PI cities had a mean Walk Score that was 18.3 units higher than that of majority White cities (95% CI=5.9, 30.8), and majority Latinx cities had a mean Walk Score that was 11.1 units higher than that of majority White cities (95% CI=6.8, 15.3). Differences between majority Black and majority White cities were minor (β=2.5, 95% CI= −4.1, 9.0).

In the univariable tract-level model with random intercepts for cities, there was a more pronounced inverse association between Walk Score and median household income (Table 2). Low-income neighborhoods had an 18.2-unit higher mean Walk Score than high-income neighborhoods (95% CI=17.7, 18.8), and

Table 2. City- and Neighborhood-Level Model Coefficients and 95% CIs From Univariable Regression Models for 500 U.S. Cities in 2019

Metrics	City level	Neighborhood level
Income		
Low	2.4 (−1.0, 5.8)	18.2 (17.7, 18.8)
Mid	0.8 (−2.6, 4.2)	9.0 (8.5, 9.5)
High	ref	ref
Majority race/ethnicity		
AA and NH&PI	18.3 (5.9, 30.8)	6.5 (4.7, 8.2)
Black	2.5 (−4.1, 9.0)	2.4 (1.7, 3.1)
Latino	11.1 (6.8, 15.3)	11.1 (10.4, 11.9)
White	ref	ref
None	6.6 (3.6, 9.7)	4.7 (4.1, 5.3)
Region		
Midwest	−4.2 (−7.4, −0.9)	−2.1 (−5.4, 1.2)
Northeast	20.9 (16.9, 24.9)	25.7 (21.7, 29.7)
South	−10.3 (−13.1, −7.5)	−7.8 (−10.6, −5.0)
West	ref	ref

AA, Asian American; NH&PI, Native Hawaiian and Pacific Islander.

middle-income neighborhoods had a 9.0-unit higher mean Walk Score than high-income neighborhoods (95% CI=8.5, 9.5). Majority Latinx neighborhoods had the highest estimated neighborhood Walk Score (48.4, 95% CI=46.9, 49.8) than other racial/ethnic groups. Majority White and majority Black neighborhoods had the lowest mean Walk Score (White: 37.2, 95% CI=35.8, 38.6; Black: 39.6, 95% CI=38.1, 41.1).

In the multilevel, tract-level model, the inverse relationship between income level and Walk Score was observed within all racial/ethnic groups. The largest differences by income were observed for majority AA and NH&PI and majority White neighborhoods, with low-income neighborhoods having a mean Walk Score 23 units higher than high-income neighborhoods. The smallest differences by income were observed for majority Black neighborhoods, with low-income neighborhoods having a mean Walk Score 13.4 units higher than high-income neighborhoods.

Within each tertile of neighborhood median income, majority Black neighborhoods had lower mean Walk Scores than other majority racial/ethnic neighborhoods. For low-income neighborhoods, majority Black neighborhoods had an estimated 10.6-unit lower mean Walk Score than majority White neighborhoods. For high-income neighborhoods, majority Black neighborhoods had an estimated 1.5-unit lower mean Walk Score than majority White neighborhoods. Low-income majority Latinx neighborhoods also had lower mean Walk Scores than low-income majority White neighborhoods (White/low-income: 54.3, 95% CI=52.7, 55.9; Latinx/low-income: 51.8, 95% CI=50.2, 53.3).

The magnitude of the associations between these sociodemographic factors and walkability varied by U.S. region. Cities within the South had the largest differences in estimated Walk Score by majority race/ethnicity, and cities within the South and West had the largest differences by income level. Cities within the Northeast had the smallest differences in estimated Walk Scores by both majority race/ethnicity and income (Figure 2).

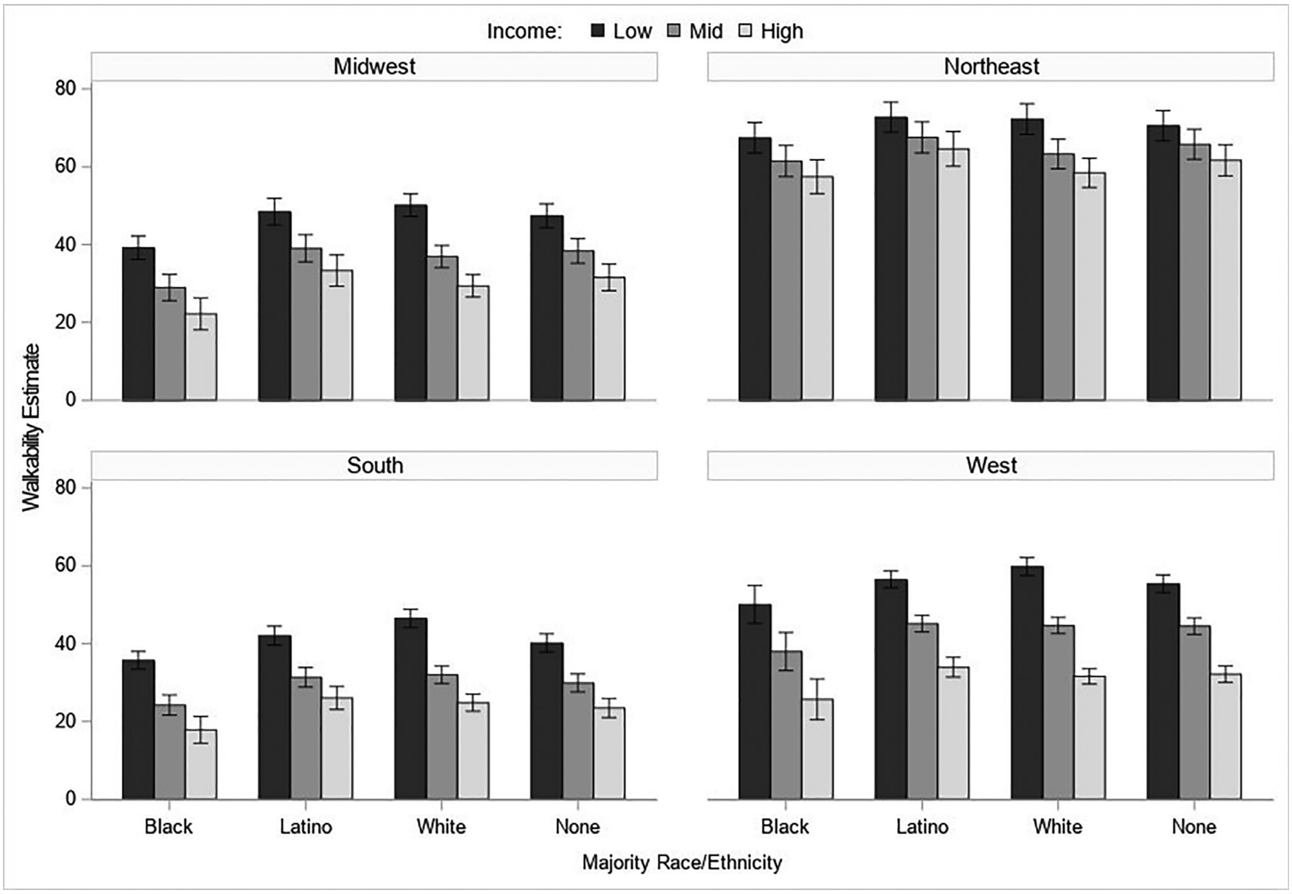

Figure 2. Neighborhood-level Walk Score estimates by income, majority race/ethnicity, and region of the U.S. for 500 U.S. cities in 2019, multivariable linear regression.

DISCUSSION

In this study, cross-sectional city- and census tract–level data were used to describe the differences in neighborhood walkability by income, racial/ethnic composition, and geographic region of the U.S. This is the first study that examines urban walkability at this scale across 500 cities from all regions of the U.S. Large differences were observed in neighborhood walkability by both income level and majority race/ethnicity across the regions. In particular, an inverse relationship was found between income level and walkability, with low-income neighborhoods associated with higher average Walk Scores than high-income neighborhoods. Overall, majority White neighborhoods had, on average, lower Walk Scores than other racial/ethnic majority neighborhoods or neighborhoods with no racial/ethnic majority.

Evidence suggests that people whose incomes are below the federal poverty threshold tend to live in dense urban areas that are more walkable. One practical reason for this may be to have access to public transit owing to the costs of car ownership.[38] Indeed, there are large racial gaps in car ownership owing to reduced access to resources.[39] This may contribute to the overall higher walkability of low-income and non-White majority neighborhoods. However, within majority Black neighborhoods, a reversed association was observed between income and walkability compared with the relationship within other racial/ethnic majority neighborhoods where tracts in low-income neighborhoods had the lowest walkability. This association may be due to the geographic distribution of high-income majority Black neighborhoods because the association reversed after accounting for city and regional effects in the multilevel model (i.e., in adjusted models, low-income neighborhoods were also associated with higher walkability in majority Black neighborhoods). In addition, after accounting for these effects, both majority Black and Latinx low-income neighborhoods had estimated Walk Scores that were lower than those of majority White low-income neighborhoods.

To explore how the associations are influenced by geographic unit and place, city-level to census tract–level models were compared, and regional interaction terms were included in the models. In these analyses, city-level models showed no significant association between income level and walkability. These results highlight the importance of the modifiable areal unit problem, specifically that larger geographic aggregations may cause spatial smoothing that reduces variation and unpredictably biases the results of multiple regression analyses.[30] Therefore, smaller geographic areas may provide a better representation of neighborhoods than city or county boundaries, particularly because many community-level variables vary significantly within these larger geographic areas.[40]

In addition, the magnitude of the associations varied significantly by U.S. region, with cities in the Northeast having the weakest association between walkability and these sociodemographic factors and cities in the South and West having the strongest associations. These differences in associations by geographic region may support previous studies that found stronger differences in walkability for a city in the South[11] and found no significant differences for a city located in the Northeast.[10] Regions of the U.S. generally correspond with historical periods in urban development and immigration, which may contribute to the differences in social composition and street infrastructure by region.[33,34] However, further research is needed to understand the underlying reason for these regional differences in sociodemographic disparities in walkability.

Limitations

This study leverages Walk Score to measure walkability, which has the strengths of being an established measure of walkability that is regularly used in the literature and is standardized across the nation.[24] However, there are limitations to this measure that may influence the results. Walk Score is an accessibility-focused measure that incorporates distances to amenities, intersection density, block length, land use, and walking routes into their index.[21] However, this index does not include the physical condition or safety elements, such as sidewalks or lighting, which would influence a pedestrian's willingness or ability to walk in a neighborhood.[19,20,41] As seen in previous studies, the use of accessibility-focused walkability measures has generally provided researchers with the counterintuitive result of higher walkability scores in lower-income neighborhoods.[9,12,13] The results were consistent with these previous findings. In many cities, lower-income neighborhoods may be located in close proximity to downtown areas that have higher intersection densities, whereas higher-income neighborhoods may be located in outer portions of the city that have a more suburban infrastructure.[42,43] Accessibility-focused walkability measures would be greatly influenced by these infrastructure differences and may overlook the differences in quality or aesthetics that would be important to the neighborhood's residents. Although objectively built environment factors are important indicators of walkability,[14–18] an improved walkability measure would also account for the physical condition of roads and sidewalks or crime because these factors have been shown to influence pedestrian walking habits.[19,20,41]

Another key limitation of this study was that census tracts were the smallest geography used for defining neighborhoods in the available walkability data. Census tracts represent administrative boundaries of approximately 2,500−8,000 people and are commonly used to serve as neighborhood proxies.[7,10,13] However, research suggests that census tracts may not always align with natural neighborhoods[44] and may represent too large of geographic areas for walkability studies, particularly for less densely populated areas.[24] Refining definitions of neighborhood boundaries or using smaller administrative units (i.e., census blocks or address-based Walk Score) may improve the validity of these results.

CONCLUSIONS

Significant differences in neighborhood walkability across 500 U.S. cities were observed, and evidence was suggestive that both geographic unit and geographic place meaningfully influence the associations between sociodemographic factors and walkability. City leaders increasingly aspire to enact data-driven policies to improve equity in their jurisdictions. Although structural interventions to the built environment, such as modifying street layouts, may be difficult to change, interventions such as Open Streets[45] or changes in zoning codes may prove valuable and attainable public health solutions for addressing health disparities related to worse neighborhood environments.[46] City leaders and policymakers can leverage neighborhood walkability data on the City Health Dashboard website to better plan and allocate resources for these sorts of interventions.[35] On the basis of these observations, future studies should use small geographic areas when analyzing walkability measures. It is also warranted to explore the inclusion of elements such as safety and the condition of sidewalks and the examination of how car ownership influences the relationship between sociodemographic factors and walkability.

ACKNOWLEDGMENTS

The authors would like to thank Miriam Gofine, Taylor Lampe, and Pei Yang Hsieh on the City Health Dashboard team for their contributions to this work.

This work was supported by the Robert Wood Johnson Foundation (Grant Number 794S43).

No financial disclosures were reported by the authors of this paper.

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