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ORIGINAL RESEARCH

Neighborhood Walkability Is Associated With Lower Burden of Cardiovascular Risk Factors Among Cancer Patients

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ABSTRACT

BACKGROUND Modifiable cardiovascular risk factors constitute a significant cause of cardiovascular disease and mortality among patients with cancer. Recent studies suggest a potential link between neighborhood walkability and favorable cardiovascular risk factor profiles in the general population.

OBJECTIVES This study aimed to investigate whether neighborhood walkability is correlated with favorable cardiovascular risk factor profiles among patients with a history of cancer.

METHODS We conducted a cross-sectional study using data from the Houston Methodist Learning Health System Outpatient Registry (2016-2022) comprising 1,171,768 adults aged 18 years and older. Neighborhood walkability was determined using the 2019 Walk Score and divided into 4 categories. Patients with a history of cancer were identified through International Classification of Diseases-10th Revision-Clinical Modification codes (C00-C96). We examined the prevalence and association between modifiable cardiovascular risk factors (hypertension, diabetes, smoking, dyslipidemia, and obesity) and neighborhood walkability categories in cancer patients.

RESULTS The study included 121,109 patients with a history of cancer; 56.7% were female patients, and 68.8% were non-Hispanic Whites, with a mean age of 67.3 years. The prevalence of modifiable cardiovascular risk factors was lower among participants residing in the most walkable neighborhoods compared with those in the least walkable neighborhoods (76.7% and 86.0%, respectively). Patients with a history of cancer living in very walkable neighborhoods were 16% less likely to have any risk factor compared with car-dependent-all errands neighborhoods (adjusted OR: 0.84, 95% CI: 0.78-0.92). Sensitivity analyses considering the timing of events yielded similar results.

CONCLUSIONS Our findings demonstrate an association between neighborhood walkability and the burden of modifiable cardiovascular risk factors among patients with a medical history of cancer. Investments in walkable neighborhoods may present a viable opportunity for mitigating the growing burden of modifiable cardiovascular risk factors among patients with a history of cancer. (J Am Coll Cardiol CardioOnc 2024;6:421–435) © 2024 The Authors. Published by Elsevier on behalf of the American College of Cardiology Foundation. This is an open access article under the CC BY-NC-ND license (http://creativecommons.org/licenses/by-nc-nd/4.0/).

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ABBREVIATIONS AND ACRONYMS

aOR = adjusted odds ratio

ADI = Area Deprivation Index

EHR = electronic health record

Cardiovascular disease and cancer are leading causes of mortality in the United States.[1] The relationship between these conditions is complex and multifaceted because they share common risk factors,[2] and the presence of 1 condition may indicate an increased risk for the other.[3,4] Notably, compared with the general population, cancer patients face an elevated risk of cardiovascular disease-related mortality.[3] This elevated risk can be attributed in part to the cardiotoxic effects of chemotherapy and radiation therapy as well as the higher prevalence of traditional cardiovascular risk factors among cancer patients.[4-6] Additionally, cancer survivors often undergo lifestyle changes, including reduced physical activity and dietary alterations, further contributing to their cardiovascular disease risk.

Previous research has also shown that social and socioeconomic disadvantages have a detrimental impact on clinical outcomes in cancer patients, mirroring findings from studies on cardiovascular disease.[7-11] However, further exploration is warranted to understand the influence of the built environment on cardiovascular outcomes among cancer patients, particularly in low-income neighborhoods.

Neighborhood walkability, defined as the extent to which a neighborhood facilitates walking, is a vital aspect of the built environment that impacts daily life. Studies have shown an association between neighborhood walkability and cardiovascular risk factors, including obesity,[12] high cholesterol,[13] and high blood pressure.[14] These risk factors, in turn, contribute to an increased risk of cancer and cancer-related mortality.[4] Therefore, investigating the impact of neighborhood walkability in this context can provide valuable insights into how the built environment influences cardiovascular disease risk factors, particularly among patients with a medical history of cancer who are already predisposed to such risks.

Although our previous research identified a negative association between neighborhood walkability and the prevalence of cardiovascular risk factors in the general population of Houston Methodist patients,[15] the present study represents the first investigation into the relationship between neighborhood walkability and various cardiovascular risk factors specifically among cancer patients. Leveraging data from an integrated health system in Houston, Texas, we sought to deepen our understanding of this association to better inform future urban planning strategies and policies. By addressing the unique challenges faced by this vulnerable population, we can work toward mitigating cardiovascular disease risk and advancing the development of more sustainable cities.

METHODS

SETTING AND STUDY DESIGN. This cross-sectional study used data extracted from the Houston Methodist Learning Health System Outpatient Registry, comprising deidentified patient information including demographics, diagnoses, comorbidities, clinical outcomes, and laboratory findings obtained from the electronic health records (EHRs). The registry captures data for patients who had at least 1 outpatient encounter (Supplemental Table 1) between June 2016 and December 2022. To ensure comprehensive and accurate data collection, a series of chart reviews were conducted on randomly selected patients. An Institutional Review Board granted a waiver from Health Insurance Portability and Accountability Act authorization and consent (ID PRO00025790).

STUDY POPULATION. The registry initially comprised data from 1,171,768 adult patients. However, our study focused on a subset of 121,109 cancer patients. This subset was obtained after excluding individuals without a neighborhood Walk Score (n = 187,698) and those without a history of cancer (n = 862,961) (**Figure 1**). Cancer patients were identified using International Classification of Diseases-10th Revision-Clinical Modification codes (C00-C96) (Supplemental Table 2) with a methodology similar to a previous study.[16] Specifically, patients with a documented history of malignant cancer were included, with the presence of a cancer diagnosis International Classification of Diseases-10th Revision code on 2 different visits or encounters serving as the criterion. In addition, manual chart reviews were conducted on a random selection of patient records to confirm the accuracy of their diagnosis codes. Moreover, the patients identified as having a history of cancer by our team were cross-validated against the hospital's

The authors attest they are in compliance with human studies committees and animal welfare regulations of the authors' institutions and Food and Drug Administration guidelines, including patient consent where appropriate. For more information, visit the Author Center.

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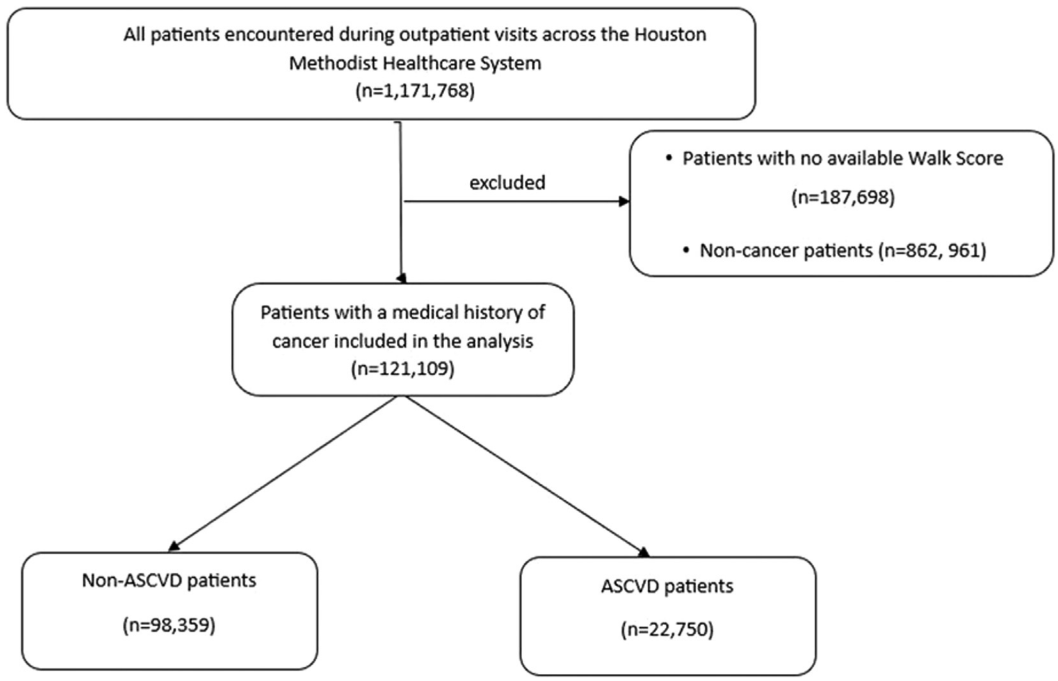
FIGURE 1 Flowchart Showing the Population Included in the Final Analyses



As of December 2022, we had a total of 1,171,768 patients with at least 1 outpatient encounter in our hospital system. After excluding those with no neighborhood Walk Score (n = 187,698) and noncancer patients (n = 862,961), we analyzed data on 121,109 patients with a medical history of cancer. Of this final cohort of patients, 22,750 had atherosclerotic cardiovascular disease (ASCVD), whereas 98,359 did not.

cancer registry to ensure their inclusion in our study cohort.

STUDY VARIABLES. Independent variable: neighborhood walk score. Neighborhood walkability was assessed using the 2019 Walk Score at the zip code level.[17] The Walk Score provides an indication of how walkable a neighborhood is for its residents by considering the proximity to 5 categories of amenities: educational, retail, food, recreational, and entertainment. The Walk Score ranges from 0 to 100, with 0 being the least walkable score and 100 being the maximum walkability score. For example, areas within a 5-minute walk to amenities (<0.25 miles) receive a score of 100, whereas amenities within a 30-minute walk (1 mile) receive a 0. To assess pedestrian friendliness, the score incorporates factors such as block distance and intersection density.

For our study, Walk Scores were categorized into 4 groups: 0 to 24 (car dependent-all errands), 25 to 49 (car dependent-most errands), 50 to 69 (somewhat walkable), and 70 to 100 (very walkable/walkers paradise).[17] Each patient was assigned a Walk Score based on the zip code of their residence. Further methodological details can be found in our previous study.[15] Also, the use of the Walk Score has been validated in several previous studies.[18,19]

Dependent variable: cardiovascular risk factors and cardiovascular disease. Data on cardiovascular diseases and cardiovascular risk factors were collected using a list of International Classification of Diseases-10th Revision-Clinical Modification codes. Variables included hypertension, diabetes, smoking, coronary artery disease, peripheral artery disease, and stroke (Supplemental Tables 3 to 8). Patients were considered to have any of these conditions if they were listed as discharge diagnoses or comorbidities in their EHRs, as indicated by the respective International Classification of Diseases codes.[20,21] Smoking status was defined as either having ever smoked or currently smoking. Patients with coronary artery disease, peripheral artery disease, or stroke were classified as having atherosclerotic cardiovascular disease.

Body mass index was calculated using the height and weight data extracted from the EHR. A patient with a body mass index $\geq$30 kg/m^2 was classified as

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TABLE 1 Demographics and Prevalence of Cardiovascular Risk Factors Among the Total Population (N = 121,109)

		Walkability Group			
	Total Population	Car Dependent All Errands (n = 55,608, 45.9%)	Car Dependent Most Errands (n = 47,992, 39.6%)	Somewhat Walkable (n = 14,438, 11.9%)	Very Walkable/ Walker's Paradise (n = 3,071, 2.5%)
No. of zip codes	704	396	247	54	7
Walk score	27.1 (17.6-37.9)	17.3 (12.3-20.2)	33.3 (28.1-38.2)	62.5 (52.5-67.7)	74.4 (74.4-84.8)
Sex group					
Male	52,463 (43.3)	24,257 (43.6)	20,550 (42.8)	6,235 (43.2)	1,421 (46.3)
Female	68,643 (56.7)	31,349 (56.4)	27,441 (57.2)	8,203 (56.8)	1,650 (53.7)
Unknown	3 (0.0)	2 (0.0)	1 (0.0)	0 (0.0)	0 (0.0)
Age	67.3 (13.6)	66.6 (13.4)	67.6 (13.5)	68.7 (14.3)	67.7 (14.4)
Age group, y					
18-39	4,788 (4.0)	2,188 (3.9)	1,833 (3.8)	600 (4.2)	167 (5.4)
40-64	39,048 (32.2)	18,902 (34.0)	15,118 (31.5)	4,144 (28.7)	884 (28.8)
65-79	56,034 (46.3)	25,816 (46.4)	22,340 (46.5)	6,434 (44.6)	1,444 (47.0)
≥80	21,239 (17.5)	8,702 (15.6)	8,701 (18.1)	3,260 (22.6)	576 (18.8)
Race ethnicity					
Hispanic (H)	12,945 (10.7)	4,592 (8.3)	6,404 (13.3)	1,788 (12.4)	161 (5.2)
Non-Hispanic White	83,381 (68.8)	40,741 (73.3)	29,746 (62.0)	10,329 (71.5)	2,565 (83.5)
Non-Hispanic Black	14,699 (12.1)	5,744 (10.3)	7,696 (16.0)	1,178 (8.2)	81 (2.6)
Non-Hispanic Asian	5,205 (4.3)	2,291 (4.1)	2,267 (4.7)	530 (3.7)	117 (3.8)
Other	4,879 (4.0)	2,240 (4.0)	1,879 (3.9)	613 (4.2)	147 (4.8)
ADI national					
Q1 (least deprived)	29,010 (24.0)	11,660 (21.0)	7,223 (15.1)	7,932 (54.9)	2,195 (71.5)
Q2	35,199 (29.1)	20,387 (36.7)	12,131 (25.3)	2,131 (14.8)	550 (17.9)
Q3	28,426 (23.5)	12,883 (23.2)	13,858 (28.9)	1,454 (10.1)	231 (7.5)
Q4	18,791 (15.5)	7,553 (13.6)	9,575 (20.0)	1,613 (11.2)	50 (1.6)
Q5 (most deprived)	9,252 (7.6)	2,964 (5.3)	5,029 (10.5)	1,249 (8.7)	10 (0.3)
Not available	431 (0.4)	161 (0.3)	176 (0.4)	59 (0.4)	35 (1.1)
Cardiovascular disease risk factors					
Hypertension	80,900 (66.8)	37,388 (67.2)	32,836 (68.4)	8,955 (62.0)	1,721 (56.0)
Diabetes mellitus	32,357 (26.7)	14,862 (26.7)	13,916 (29.0)	3,119 (21.6)	460 (15.0)
Dyslipidemia	47,730 (39.4)	22,921 (41.2)	17,903 (37.3)	5,683 (39.4)	1,223 (39.8)
Obesity	37,360 (30.8)	18,320 (32.9)	15,250 (31.8)	3,255 (22.5)	535 (17.4)
Smoking ever	55,234 (45.6)	25,475 (45.8)	22,869 (47.7)	5,806 (40.2)	1,084 (35.3)
Any cardiovascular disease risk	102,999 (85.0)	47,801 (86.0)	41,223 (85.9)	11,620 (80.5)	2,355 (76.7)
Any cardiovascular disease risk group					
No risk factor, 0	18,110 (15.0)	7,807 (14.0)	6,769 (14.1)	2,818 (19.5)	716 (23.3)
1-2 risk factor, 1-2	57,431 (47.4)	26,280 (47.3)	22,439 (46.8)	7,118 (49.3)	1,594 (51.9)
≥3 risk factors	45,568 (37.6)	21,521 (38.7)	18,784 (39.1)	4,502 (31.2)	761 (24.8)
Cardiovascular disease					
CAD	15,467 (12.8)	7,479 (13.4)	5,792 (12.1)	1,812 (12.6)	384 (12.5)
PAD	4,877 (4.0)	2,362 (4.2)	1,945 (4.1)	499 (3.5)	71 (2.3)
Stroke	8,447 (7.0)	3,888 (7.0)	3,253 (6.8)	1,088 (7.5)	218 (7.1)
Any atherosclerotic cardiovascular disease	22,750 (18.8)	10,767 (19.4)	8,713 (18.2)	2,723 (18.9)	547 (17.8)

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obese. Dyslipidemia was defined as follows: low-density lipoprotein >130 mg/dL; triglycerides >150 mg/dL; or the patient having a history of taking statins, proprotein convertase subtilisin/kexin type 9 inhibitors, bile acid sequestrants, ezetimibe, fibrates, bempedoic acid, omega 3, or inclisiran at any encounter. Furthermore, a dichotomized cardiovascular risk profile was created for each patient (ie, any risk factor if a patient had hypertension, diabetes, dyslipidemia, obesity, or smoking and no risk factor if the patient had none of these risk factors).

Covariates. Our study incorporated various covariates to adjust for demographics (sex, age, and race/ethnicity) and socioeconomic factors represented by the Area Deprivation Index (ADI). For this study, these variables were classified as follows: sex (female and male), age (18-39, 40-64, 65-79, and ≥80 years), and race/ethnicity (Hispanic, non-Hispanic White,

TABLE 1 Continued

		Walkability Group			
	Total Population	Car Dependent All Errands (n = 55,608, 45.9%)	Car Dependent Most Errands (n = 47,992, 39.6%)	Somewhat Walkable (n = 14,438, 11.9%)	Very Walkable/ Walker's Paradise (n = 3,071, 2.5%)
Malignant cancer subtype					
Lip, oral cavity, and pharynx	1,918 (1.6)	893 (1.6)	774 (1.6)	213 (1.5)	38 (1.2)
Digestive organs	12,656 (10.5)	5,621 (10.1)	5,365 (11.2)	1,411 (9.8)	259 (8.4)
Respiratory and intrathoracic	6,447 (5.3)	2,982 (5.4)	2,670 (5.6)	676 (4.7)	119 (3.9)
Bone and articular cartilage	990 (0.8)	446 (0.8)	425 (0.9)	99 (0.7)	20 (0.7)
Skin	18,592 (15.4)	8,933 (16.1)	6,041 (12.6)	2,913 (20.2)	705 (23.0)
Mesothelial and soft tissue	2,030 (1.7)	884 (1.6)	811 (1.7)	280 (1.9)	55 (1.8)
Breast	21,262 (31.0)	9,338 (29.8)	8,730 (31.8)	2,657 (32.4)	542 (17.6)
Female genital organs	7,443 (10.8)	3,164 (10.1)	3,305 (12.0)	833 (10.2)	142 (4.6)
Male genital organs	16,948 (32.3)	7,409 (30.5)	7,036 (34.2)	2,046 (32.8)	457 (14.9)
Urinary tract	7,037 (5.8)	3,143 (5.7)	2,921 (6.1)	814 (5.6)	159 (5.2)
Eye, brain, and CNS	1,978 (1.6)	903 (1.6)	789 (1.6)	221 (1.5)	65 (2.1)
Thyroid and other endocrine Glands	3,452 (2.9)	1,620 (2.9)	1,301 (2.7)	430 (3.0)	101 (3.3)
Ill-defined, other secondary and unspecified sites	62,908 (51.9)	29,343 (52.8)	25,115 (52.3)	6,995 (48.4)	1,455 (47.4)
Neuroendocrine tumors	1,027 (0.8)	456 (0.8)	422 (0.9)	127 (0.9)	22 (0.7)
Secondary neuroendocrine Tumors	353 (0.3)	150 (0.3)	158 (0.3)	35 (0.2)	10 (0.3)
Lymphoid, hematopoietic And related tissue	10,681 (8.8)	4,798 (8.6)	4,286 (8.9)	1,309 (9.1)	288 (9.4)

Values are n, median (Q1-Q3), or n (%).
ADI = Area Deprivation Index; CAD = coronary artery disease; CNS = central nervous system; PAD = peripheral artery disease.

non-Hispanic Black, non-Hispanic Asian, and non-Hispanic others).

We used the 2020 version 3.2 of the ADI developed by the Center for Health Disparities Research at the University of Wisconsin.[22] This measure is a validated index for neighborhood deprivation[23-25] and incorporates 17 different measures that capture data related to housing, housing quality, poverty, income, employment, and education. These measures are derived from U.S. census data and are aggregated to create a composite measure reflecting the socioeconomic context of a given area. ADI was categorized into 5 quintiles, with the first quintile representing the least deprived areas and the fifth quintile representing the most deprived areas, consistent with previous validation efforts.[24]

STATISTICAL ANALYSES. Baseline characteristics are presented as counts and percentages for categoric variables and as medians with first and third quartiles (Q1-Q3) or mean ± SD for continuous variables, both overall and stratified by the neighborhood Walk Score group. Also, cardiovascular risk factors and diseases are reported as frequencies and percentages.

A multicollinearity test was performed for all variables after regression analysis. If the variance inflation factor was >5, it was reported, and the model was adjusted accordingly. Univariable and multivariable logistic regression models were conducted to assess the relationship between the Walk Score and the prevalence of the various cardiovascular risk factors and diseases. The following models were conducted: model 1 was unadjusted; model 2 was adjusted for demographics (age, sex, and race/ethnicity); model 3 was adjusted for demographics and ADI; and model 4, a sensitivity analysis, was adjusted for demographics, ADI, and cardiovascular risk factors.

Also, a multinomial logistic regression test was conducted to examine the relationship between cardiovascular risk profiles (categorized into 3 levels) and the Walk Score. Because of the lack of assessment of proportional OR assumptions using the likelihood ratio test, the multinomial model was chosen instead of the ordinal model ($P < 0.001$).[26] A test for interaction was performed between various factors (age, sex, and race/ethnicity) included in the final model (model 3) and the Walk Score. If significant interaction ($P < 0.05$) was present, it was reported, and stratification was performed. We further performed a subgroup analysis based on atherosclerotic cardiovascular disease status to investigate the effect of the neighborhood Walk Scores among cancer patients with and without existing atherosclerotic cardiovascular disease.

TABLE 2 Univariable and Multivariable Logistic Regression Analyses for All Cardiovascular Risk Factors in the Total Population (N = 121,109)

	Model 1[a]	Model 2[b]	Model 3[c]	Model 4[d]
Hypertension				
Car dependent-all errands	Reference	Reference	Reference	Reference
Car dependent-most errands	1.06 (1.03-1.08)	0.95 (0.93-0.98)	0.90 (0.87-0.93)	0.95 (0.92-0.98)
Somewhat walkable	0.80 (0.77-0.83)	0.70 (0.67-0.73)	0.78 (0.74-0.81)	0.85 (0.81-0.89)
Very walkable and paradise	0.62 (0.58-0.67)	0.58 (0.54-0.63)	0.71 (0.65-0.77)	0.79 (0.73-0.87)
Diabetes mellitus				
Car dependent-all errands	Reference	Reference	Reference	Reference
Car dependent-most errands	1.12 (1.09-1.15)	1.01 (0.98-1.03)	0.94 (0.92-0.97)	1.00 (0.97-1.04)
Somewhat walkable	0.76 (0.72-0.79)	0.71 (0.68-0.75)	0.79 (0.75-0.83)	0.84 (0.79-0.90)
Very walkable and paradise	0.48 (0.44-0.53)	0.51 (0.46-0.57)	0.64 (0.58-0.71)	0.67 (0.59-0.77)
Obesity				
Car dependent-all errands	Reference	Reference	Reference	Reference
Car dependent-most errands	0.95 (0.92-0.97)	0.93 (0.90-0.95)	0.89 (0.87-0.92)	0.91 (0.88-0.93)
Somewhat walkable	0.59 (0.57-0.62)	0.61 (0.59-0.64)	0.69 (0.66-0.72)	0.72 (0.69-0.76)
Very walkable and paradise	0.43 (0.39-0.47)	0.46 (0.42-0.50)	0.56 (0.51-0.62)	0.60 (0.54-0.66)
Dyslipidemia				
Car dependent-all errands	Reference	Reference	Reference	Reference
Car dependent-most errands	0.85 (0.83-0.87)	0.86 (0.83-0.88)	0.87 (0.85-0.89)	0.90 (0.87-0.92)
Somewhat walkable	0.93 (0.89-0.96)	0.92 (0.89-0.96)	0.93 (0.89-0.97)	1.00 (0.96-1.04)
Very walkable and paradise	0.94 (0.88-1.02)	0.93 (0.86-1.00)	0.92 (0.86-1.00)	1.02 (0.94-1.10)
Smoking ever				
Car dependent-all errands	Reference	Reference	Reference	Reference
Car dependent-most errands	1.08 (1.05-1.10)	1.02 (0.99-1.04)	0.95 (0.92-0.97)	0.99 (0.96-1.03)
Somewhat walkable	0.80 (0.77-0.83)	0.76 (0.73-0.79)	0.85 (0.82-0.89)	0.98 (0.93-1.03)
Very walkable and paradise	0.65 (0.60-0.70)	0.64 (0.59-0.70)	0.82 (0.76-0.89)	1.06 (0.96-1.17)
Any risk factor (vs no risk factor)				
Car dependent-all errands	Reference	Reference	Reference	Reference
Car dependent-most errands	0.98 (0.97-0.99)	0.92 (0.91-0.93)	0.85 (0.84-0.86)	0.98 (0.95-1.01)
Somewhat walkable	0.62 (0.62-0.63)	0.63 (0.62-0.64)	0.69 (0.68-0.70)	0.85 (0.81-0.89)
Very walkable and paradise	0.41 (0.40-0.42)	0.49 (0.48-0.51)	0.58 (0.57-0.60)	0.84 (0.78-0.92)

Values are OR (95% CI). [a]Crude model. [b]Adjusted for age + sex + race/ethnicity. [c]Adjusted for age + sex + race/ethnicity + Area Deprivation Index. [d]Adjusted for age + sex + race/ethnicity + Area Deprivation Index + smoking + atherosclerotic cardiovascular disease status + diabetes + hypertension + obesity + dyslipidemia.

Stata/MP 17.0 analytical software (StataCorp) was used for all statistical analyses. A 2-sided P value < 0.05 was considered statistically significant. Additional sensitivity analyses were performed, restricting the timing of cardiovascular risk factors to pre-existing (before cancer diagnosis) and incident (after cancer diagnosis). Moreover, analyses were limited to patients with at least 2 years of follow-up within the health system.

RESULTS

NEIGHBORHOOD CHARACTERISTICS ACROSS WALK SCORE GROUPS. The study population was composed of 121,109 participants distributed across 704 neighborhoods defined by residential zip codes. The median Walk Score was 27 (Q1-Q3: 18-38). Participants had a mean age of 67.3 ± 14 years, with women accounting for 56.7% of the population. Additionally, 68.8% of the participants identified as non-Hispanic White, and the majority (76.6%) of the study population belonged to the top 3 ADI quintile groups. Among the specified cancer subtypes, cancer of the male genital organs had the highest prevalence at 32.3% followed by breast cancer at 31.0%. Notably, the prevalence of atherosclerotic cardiovascular disease was 18.8% (**Table 1**). Among those with atherosclerotic cardiovascular disease, 98.0% had at least 1 cardiovascular risk factor, whereas 82.1% of those without atherosclerotic cardiovascular disease had at least 1 cardiovascular risk factor (Supplemental Table 9).

About 85.5% of the study population resided in the 2 least walkable (car-dependent) neighborhoods (**Table 1**). Populations with and without atherosclerotic cardiovascular disease showed a similar distribution across walkability groups, with 85.6% and 85.4% of cancer patients, respectively, residing in the

TABLE 3 Association Between Walkability and Cardiovascular Risk Factors in Specific Subpopulations

	Hypertension	Diabetes	Obesity	Dyslipidemia	Smoking	Any Cardiovascular Disease Risk Factor
Interaction *P* value for sex	$P = 0.43$	$P = 0.46$	$P = 0.068$	$P = 0.063$	$P = 0.007$	$P = 0.63$
Male	0.76 (0.67-0.85)	0.70 (0.61-0.81)	0.57 (0.50-0.66)	0.83 (0.74-0.93)	0.78 (0.70-0.87)	0.57 (0.55-0.59)
Female	0.67 (0.60-0.75)	0.57 (0.48-0.67)	0.54 (0.47-0.62)	1.01 (0.91-1.12)	0.86 (0.77-0.96)	0.59 (0.57-0.61)
Interaction *P* value for age	$P = 0.77$	$P = 0.29$	$P = 0.75$	$P = 0.043$	$P = 0.010$	$P = 0.51$
18-39 y	0.60 (0.35-1.04)	0.48 (0.17-1.34)	0.32 (0.19-0.53)	0.51 (0.31-0.83)	0.55 (0.32-0.92)	0.55 (0.53-0.57)
40-64 y	0.70 (0.61-0.81)	0.62 (0.49-0.79)	0.58 (0.49-0.68)	1.03 (0.90-1.19)	0.85 (0.73-1.00)	0.60 (0.57-0.62)
65-79 y	0.71 (0.63-0.79)	0.64 (0.56-0.74)	0.54 (0.47-0.62)	0.89 (0.80-0.99)	0.80 (0.71-0.89)	0.58 (0.54-0.63)
80+ y	0.73 (0.58-0.91)	0.63 (0.51-0.79)	0.68 (0.52-0.88)	0.93 (0.78-1.11)	0.82 (0.68-0.97)	0.92 (0.77-1.10)
Interaction *P* value for race/ethnicity	$P = 0.006$	$P < 0.001$	$P = 0.015$	$P = 0.54$	$P = 0.11$	$P = 0.003$
Hispanic	0.73 (0.51-1.03)	0.65 (0.44-0.97)	0.70 (0.48-1.01)	0.77 (0.55-1.08)	0.81 (0.57-1.14)	0.59 (0.54-0.65)
Non-Hispanic White	0.71 (0.65-0.78)	0.63 (0.56-0.71)	0.55 (0.50-0.61)	0.93 (0.85-1.01)	0.81 (0.74-0.88)	0.60 (0.58-0.62)
Non-Hispanic Black	0.96 (0.56-1.64)	0.66 (0.39-1.11)	0.65 (0.40-1.04)	1.10 (0.69-1.73)	0.92 (0.58-1.46)	0.63 (0.56-0.71)
Non-Hispanic Asian	0.58 (0.38-0.90)	0.63 (0.38-1.03)	0.85 (0.48-1.51)	0.91 (0.62-1.35)	0.74 (0.48-1.16)	0.63 (0.57-0.69)
Non-Hispanic others	0.64 (0.44-0.92)	1.00 (0.63-1.59)	0.29 (0.17-0.51)	0.91 (0.63-1.32)	1.06 (0.72-1.55)	0.45 (0.41-0.49)
Interaction *P* value for ADI Quintiles	$P < 0.001$	$P < 0.001$	$P < 0.001$	$P = 0.67$	$P = 0.43$	$P = 0.93$
Q1 (least deprived)	0.73 (0.66-0.81)	0.65 (0.57-0.74)	0.57 (0.50-0.64)	0.91 (0.83-1.00)	0.92 (0.83-1.02)	0.65 (0.63-0.68)
Q2	0.61 (0.50-0.73)	0.56 (0.44-0.71)	0.52 (0.42-0.65)	0.79 (0.66-0.94)	0.69 (0.57-0.83)	0.51 (0.48-0.54)
Q3	0.56 (0.42-0.76)	0.57 (0.40-0.80)	0.34 (0.23-0.48)	0.96 (0.73-1.27)	0.49 (0.37-0.65)	0.43 (0.39-0.46)
Q4	0.73 (0.40-1.36)	0.38 (0.17-0.85)	0.73 (0.39-1.37)	1.32 (0.75-2.33)	0.50 (0.27-0.91)	0.49 (0.43-0.57)
Q5 (most deprived)	0.92 (0.19-4.56)	0.47 (0.10-2.24)	0.97 (0.23-3.99)	0.44 (0.09-2.10)	0.52 (0.14-1.86)	0.33 (0.20-0.56)

Values are adjusted OR (95% CI) unless otherwise indicated. aORs adjusted for age + sex + race/ethnicity + ADI.
ADI = Area Deprivation Index.

2 least walkable (car-dependent) neighborhoods (Supplemental Tables 9 and 10). In our sample, 24% of participants resided in the least deprived areas (lowest ADI score), whereas only 8% resided in the most deprived areas. Overall, residents living in the least walkable areas compared with those living in the most walkable areas were predominantly non-White and belonged to the most deprived areas (Table 1). Similar demographic patterns were observed in populations with and without atherosclerotic cardiovascular disease, as evidenced in atherosclerotic cardiovascular disease-stratified groups (Supplemental Tables 9 and 10).

CARDIOVASCULAR RISK FACTORS. The prevalence of hypertension was higher in the least walkable neighborhood (67.2%) compared with the most walkable neighborhood (56.0%) (OR: 0.62; 95% CI: 0.58-0.67) (Table 1). This relationship persisted even after adjusting for age, sex, race/ethnicity, and ADI (adjusted OR [aOR]: 0.71; 95% CI: 0.65-0.77) (Table 2). In sex-stratified groups ($P_{\text{interaction}} = 0.43$), women and men living in the most walkable neighborhoods were approximately 33% (aOR: 0.67; 95% CI: 0.60-0.75) and 24% (aOR: 0.76; 95% CI: 0.67-0.85) less likely to be hypertensive, respectively, compared with those living in the least walkable neighborhoods (Table 3). Differences were also observed in age ($P_{\text{interaction}} = 0.770$), race/ethnicity ($P_{\text{interaction}} = 0.006$), and ADI groups ($P_{\text{interaction}} < 0.001$) (Table 3). Notably, individuals aged 40 to 64 years (aOR: 0.7; 95% CI: 0.61-0.81), Whites (aOR: 0.71; 95% CI: 0.65-0.78), and those in the second ADI quintile group (aOR: 0.61; 95% CI: 0.50-0.73) showed the most significant connection between hypertension and walkability within their respective demographic groups. After stratifying by atherosclerotic cardiovascular disease groups, we observed a lower prevalence of hypertension in populations residing in the most walkable neighborhoods, both without (49.4%) and with (86.8%) atherosclerotic cardiovascular disease. These associations persisted even after adjusting for age, sex, race/ethnicity, and ADI groups (aOR: 0.71; 95% CI: 0.65-0.77 and aOR: 0.71; 95% CI: 0.54-0.93) (Table 4).

For diabetes, the prevalence was lower in the most walkable neighborhoods (15.0%) compared to the least walkable neighborhoods (26.7%; OR: 0.48; 95% CI: 0.44-0.53) (Tables 1 and 2). Similar findings were found after adjusting for age, sex, race/ethnicity, and ADI groups (aOR: 0.64; 95% CI: 0.58-0.71) (Table 2). After stratifying by sex ($P_{\text{interaction}} = 0.46$), women living in the most walkable neighborhoods were 43% less likely to have diabetes compared to those in the least walkable neighborhoods (aOR: 0.57; 95% CI:

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TABLE 4 Multivariable Analysis With Stratification Based on the Atherosclerotic Cardiovascular Disease Status

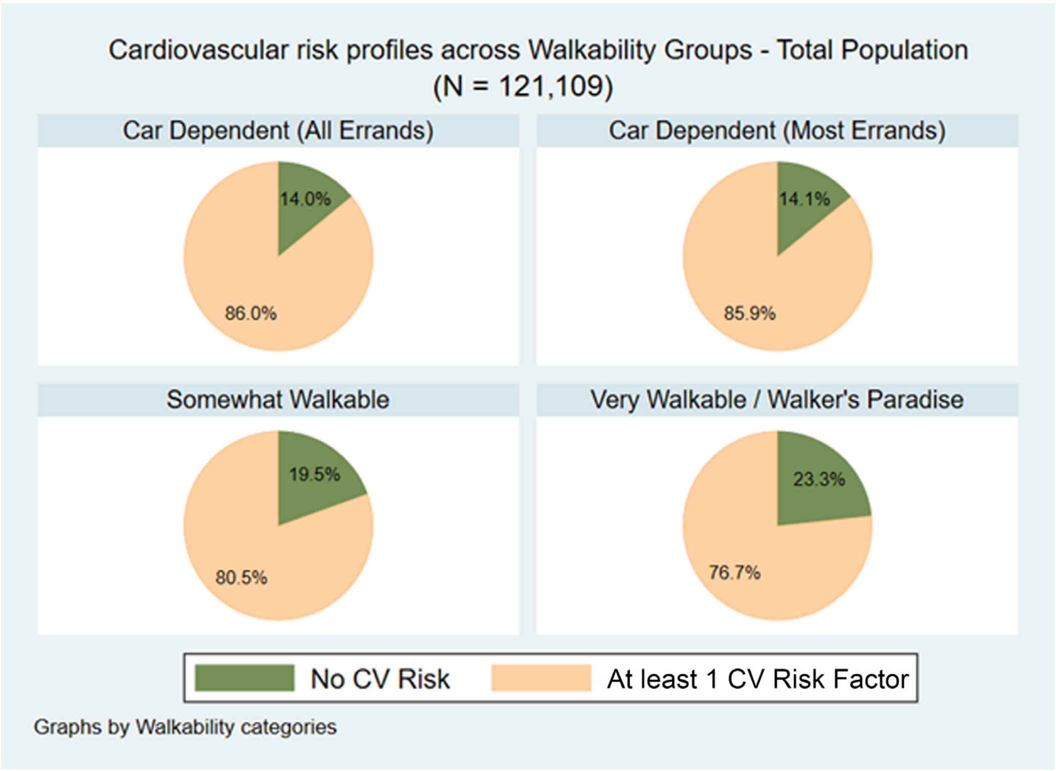
	With Atherosclerotic Cardiovascular Disease (n = 22,750)		Without Atherosclerotic Cardiovascular Disease (n = 98,359)	
	OR (95% CI)	aOR[a] (95% CI)	OR (95% CI)	aOR[a] (95% CI)
Hypertension				
Car dependent-all errands	Reference	Reference	Reference	Reference
Car dependent-most errands	1.08 (0.96-1.20)	0.92 (0.82-1.03)	1.08 (1.05-1.11)	0.92 (0.89-0.95)
Somewhat walkable	0.73 (0.63-0.84)	0.78 (0.66-0.91)	0.79 (0.76-0.83)	0.78 (0.74-0.81)
Very walkable and paradise	0.53 (0.41-0.69)	0.71 (0.54-0.93)	0.62 (0.57-0.67)	0.71 (0.65-0.77)
Diabetes mellitus				
Car dependent-all errands	Reference	Reference	Reference	Reference
Car dependent-most errands	1.10 (1.04-1.17)	0.96 (0.91-1.02)	1.15 (1.12-1.19)	0.96 (0.93-1.00)
Somewhat walkable	0.74 (0.68-0.81)	0.83 (0.75-0.91)	0.76 (0.72-0.80)	0.78 (0.74-0.83)
Very walkable and paradise	0.55 (0.46-0.67)	0.76 (0.63-0.92)	0.45 (0.40-0.51)	0.60 (0.53-0.68)
Obesity				
Car dependent all errands	Reference	Reference	Reference	Reference
Car dependent most errands	0.96 (0.90-1.02)	0.94 (0.88-1.00)	0.95 (0.92-0.97)	0.89 (0.86-0.91)
Somewhat walkable	0.66 (0.60-0.73)	0.77 (0.69-0.85)	0.58 (0.55-0.60)	0.68 (0.64-0.71)
Very walkable and paradise	0.56 (0.46-0.69)	0.66 (0.53-0.82)	0.40 (0.36-0.45)	0.54 (0.48-0.60)
Dyslipidemia				
Car dependent-all errands	Reference	Reference	Reference	Reference
Car dependent-most errands	0.89 (0.84-0.95)	0.94 (0.89-1.00)	0.84 (0.82-0.87)	0.87 (0.84-0.90)
Somewhat walkable	1.04 (0.95-1.13)	1.09 (1.00-1.20)	0.90 (0.86-0.94)	0.90 (0.86-0.95)
Very walkable and paradise	1.05 (0.88-1.25)	1.04 (0.87-1.24)	0.94 (0.86-1.02)	0.91 (0.83-1.00)
Smoking ever				
Car dependent-all errands	Reference	Reference	Reference	Reference
Car dependent-most errands	1.04 (0.98-1.10)	0.92 (0.87-0.98)	1.11 (1.08-1.14)	0.98 (0.95-1.00)
Somewhat walkable	0.72 (0.66-0.78)	0.83 (0.75-0.91)	0.81 (0.78-0.84)	0.87 (0.83-0.91)
Very walkable and paradise	0.64 (0.54-0.76)	0.86 (0.72-1.03)	0.64 (0.59-0.70)	0.81 (0.74-0.89)
Any risk factor				
Car dependent-all errands	Reference	Reference	Reference	Reference
Car dependent-most errands	1.14 (1.05-1.23)	0.94 (0.86-1.02)	0.98 (0.97-0.99)	0.85 (0.84-0.86)
Somewhat walkable	0.73 (0.66-0.82)	0.80 (0.71-0.90)	0.62 (0.61-0.63)	0.69 (0.68-0.70)
Very walkable and paradise	0.52 (0.43-0.63)	0.71 (0.58-0.87)	0.42 (0.40-0.43)	0.58 (0.56-0.60)

[a]Adjusted for age + sex + race/ethnicity + socioeconomic status (Area Deprivation Index).

0.48-0.67). Variations were observed across age ($P_{\text{interaction}} = 0.29$), race/ethnicity ($P_{\text{interaction}} < 0.001$), and ADI groups ($P_{\text{interaction}} < 0.001$). Specifically, individuals aged 40 to 64 years (aOR: 0.62; 95% CI: 0.49-0.79), non-Hispanic Whites (aOR: 0.63; 95% CI: 0.56-0.71), and those in the second ADI quintile group (aOR: 0.56; 95% CI: 0.44-0.71) living in the most walkable neighborhoods demonstrated the lowest likelihood of having diabetes compared to those living in the least walkable neighborhoods within their respective demographic groups (Table 3). Similar observations were noted across populations with and without atherosclerotic cardiovascular disease. In populations with atherosclerotic cardiovascular disease, the prevalence of diabetes was lower in the most walkable neighborhoods compared to the least walkable neighborhoods (31% and 44%, respectively; OR: 0.55: 95% CI: 0.46-0.67). Likewise, in populations without atherosclerotic cardiovascular disease, the prevalence of diabetes was also lower in the most walkable neighborhoods compared to the least walkable neighborhoods (12% and 22%, respectively; OR: 0.45; 95% CI: 0.40-0.51) (Table 4). This relationship persisted after adjusting for age, sex, race/ethnicity, and ADI groups in populations with (aOR: 0.76; 95% CI: 0.63-0.92) and without (aOR: 0.60; 95% CI: 0.53-0.68) atherosclerotic cardiovascular disease (Table 4).

In the total population, the prevalence of obesity was lower in the most walkable neighborhoods compared to the least walkable neighborhoods (17.4% and 32.9%, respectively; OR: 0.43; 95% CI: 0.39-0.47) (Tables 1 and 2). This trend persisted when stratified into populations with and without atherosclerotic cardiovascular disease. In the most walkable neighborhoods compared to the least walkable neighborhoods, the prevalence of obesity was lower for those with atherosclerotic cardiovascular disease (21.8% and 33.0%, respectively; OR: 0.56; 95% CI: 0.46-0.69)

FIGURE 2 Cardiovascular Risk by Walkability Groups, Total Population (N = 121,109)



More patients (86.0%) in the car-dependent (CD) group had at least 1 cardiovascular (CV) risk factor compared to 76.7% in the very walkable (VW) group. Conversely, less patients (14.0%) in the CD group had no cardiovascular risk factor compared to 23.3% in the VW group. Additionally, as walkability improved across groups, the presence of any risk factor decreased.

and for those without atherosclerotic cardiovascular disease (16.5% and 32.9%, respectively; OR: 0.40; 95% CI: 0.36-0.45). Furthermore, this observation persisted even after adjusting for age, sex, race/ethnicity, and ADI groups for both the total population (aOR: 0.56; 95% CI: 0.51-0.62) and the populations with (aOR: 0.66; 95% CI: 0.53-0.82) and without atherosclerotic cardiovascular disease (aOR: 0.54; 95% CI: 0.48-0.60) (Table 4).

In sex ($P_{\text{interaction}} = 0.068$), age ($P_{\text{interaction}} = 0.75$), race/ethnicity ($P_{\text{interaction}} = 0.015$), and ADI ($P_{\text{interaction}} < 0.001$) stratified groups, females (aOR: 0.54; 95% CI: 0.47-0.62), individuals aged 18 to 39 years (aOR: 0.32; 95% CI: 0.19-0.53), non-Hispanic Whites (aOR: 0.55; 95% CI: 0.50-0.61), and those in the second ADI quintile group living in the most walkable neighborhoods (aOR: 0.52; 95% CI: 0.42-0.65) demonstrated the lowest likelihood of obesity compared to those living in the least walkable neighborhoods within their respective demographic groups (Table 3).

In the total population, a slightly lower prevalence of dyslipidemia was shown in patients living in the most walkable neighborhoods compared to the least walkable neighborhoods (39.8% and 41.2%, respectively; OR: 0.94; 95% CI: 0.88-1.02) (Tables 1 and 2). After stratifying by atherosclerotic cardiovascular disease, patients in the most walkable neighborhoods showed a lower prevalence of dyslipidemia compared to those in the least walkable neighborhoods regardless of atherosclerotic cardiovascular disease status. Specifically, the prevalence of dyslipidemia was 35.3% in the most walkable neighborhoods and 36.9% in the least walkable neighborhoods among patients with atherosclerotic cardiovascular disease. In contrast, among patients with atherosclerotic cardiovascular disease, a higher prevalence of dyslipidemia was shown in those living in the most walkable neighborhoods compared to those in the least walkable neighborhoods (60.5% and 59.3%, respectively). However, these associations were not statistically significant in either crude

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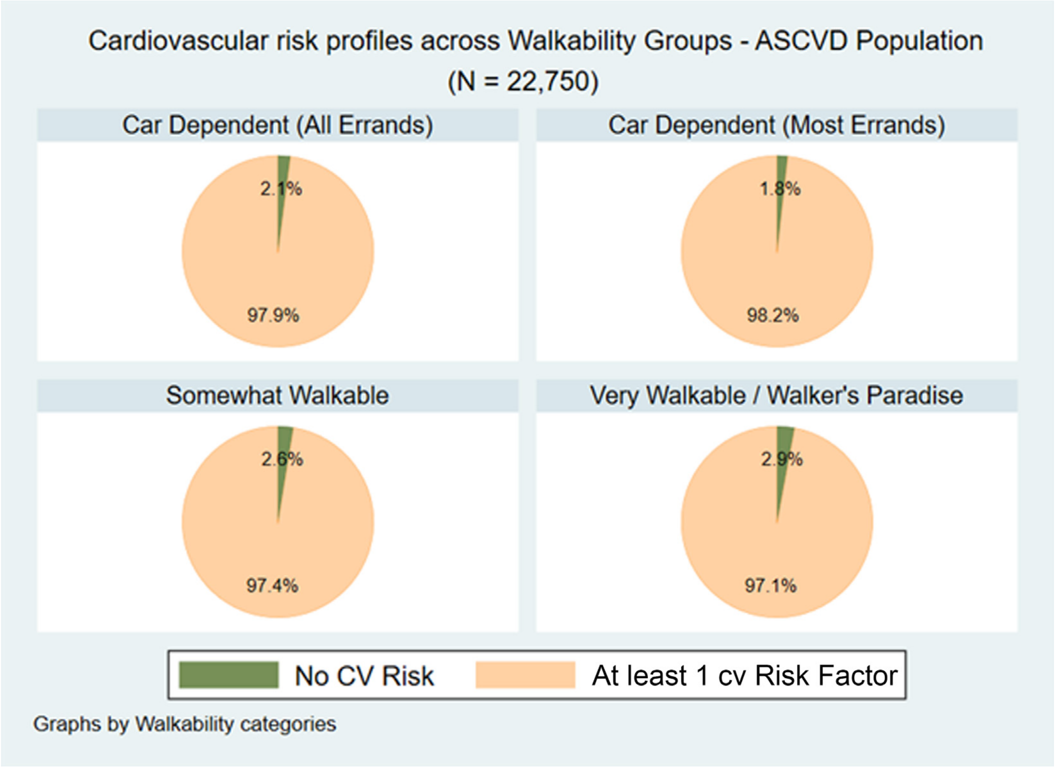
FIGURE 3 **Cardiovascular Risk by Walkability Groups, Atherosclerotic Cardiovascular Disease Population (N = 22,750)**



More patients (97.9%) in the CD group had at least 1 CV risk factor compared to 97.1% in the VW group. Conversely, less patients (2.1%) in the CD group had no cardiovascular risk factor compared to 2.9% in the VW group. Additionally, as walkability improved across groups, the presence of any CV risk factor also decreased in the atherosclerotic cardiovascular disease population. Abbreviations as in Figures 1 and 2.

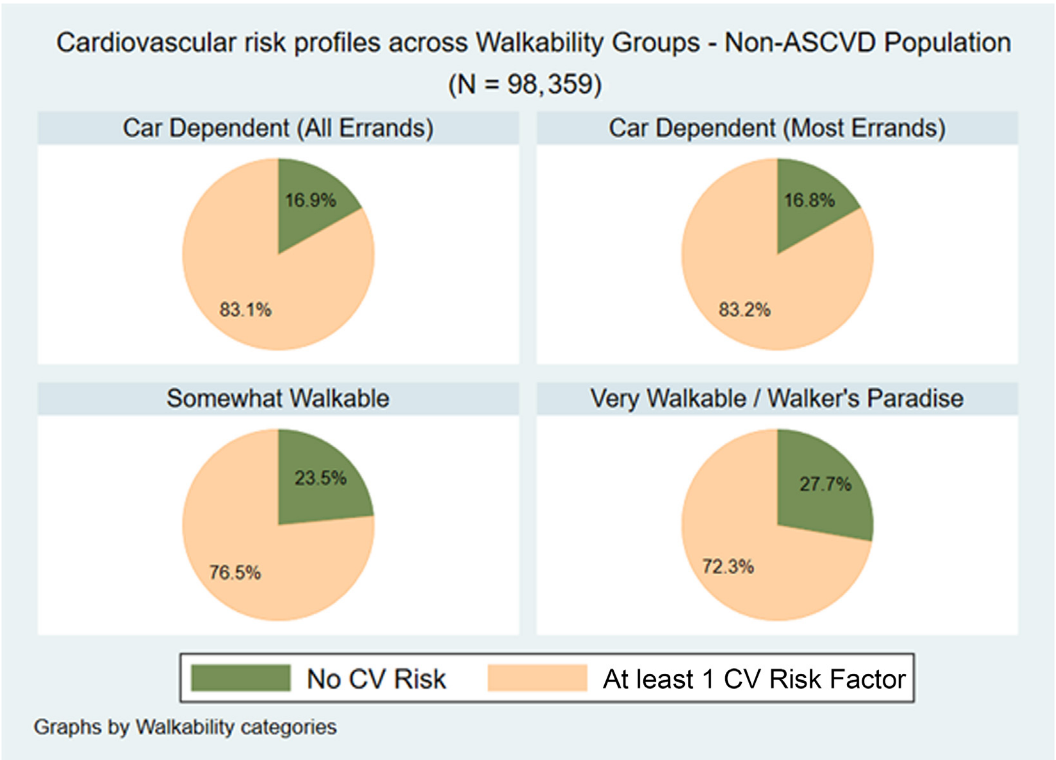
or adjusted regression models for the total population or after stratifying by atherosclerotic cardiovascular disease (Table 4).

After stratifying by sex ($P_{interaction}$ = 0.063), age ($P_{interaction}$ = 0.043), race/ethnicity ($P_{interaction}$ = 0.54), and ADI groups ($P_{interaction}$ = 0.67), only men (aOR: 0.83; 95% CI: 0.74-0.93), Hispanics (aOR: 0.77; 95% CI: 0.55-1.08), and individuals in the second ADI quintile group (aOR: 0.79; 95% CI: 0.66-0.94) living in the most walkable neighborhoods were less likely to have dyslipidemia compared to those in the least walkable neighborhoods (Table 3).

In the total population, a lower prevalence of ever smoking was observed in the most walkable neighborhoods compared to the least walkable neighborhoods (35.3% and 45.8%, respectively; OR: 0.65; 95% CI: 0.60-0.70). In the most walkable neighborhoods compared to the least walkable neighborhoods, the prevalence of ever smoking was lower for those with atherosclerotic cardiovascular disease (58.7% and 68.9%, respectively; OR: 0.64; 95% CI: 0.54-0.76) and for those without atherosclerotic cardiovascular disease (30.2% and 40.3%, respectively; OR: 0.64; 95% CI: 0.59-0.70) (Tables 1 and 2).

After adjusting for age, sex, race/ethnicity, and ADI groups, similar findings were found in both the total population (aOR: 0.80; 95% CI: 0.73-0.88) and the population without atherosclerotic cardiovascular disease (aOR: 0.81; 95% CI: 0.74-0.89). However, this association was not evident in patients with atherosclerotic cardiovascular disease (aOR: 0.86; 95% CI: 0.72-1.03) (Table 4). Differences were also noted in sex ($P_{interaction}$ = 0.007), age ($P_{interaction}$ = 0.010), race/ethnicity ($P_{interaction}$ = 0.11), and ADI groups ($P_{interaction}$ = 0.43). In certain demographic groups, including men (aOR: 0.78; 95% CI: 0.70-0.87), individuals aged 18 to 39 years (aOR 0.55; 95% CI: 0.32-0.92), non-Hispanic Whites (aOR: 0.81; 95% CI: 0.74-0.88), and those in the third ADI quintile group (aOR: 0.49; 95% CI: 0.37-0.65), residents of the most walkable neighborhoods demonstrated the lowest

FIGURE 4 **Cardiovascular Risk by Walkability Groups, Nonatherosclerotic Cardiovascular Disease Population (N = 98,359)**



More patients (83.1%) in the CD group had at least 1 CV risk factor compared to 72.3% in the VW group. Conversely, less patients (16.9%) in the CD group had no CV risk factor compared to 27.7% in the VW group. Additionally, as walkability improved across groups, the presence of any CV risk factor decreased in the population without ASCVD. Abbreviations as in Figures 1 and 2.

likelihood of having a history of smoking compared to those in the least walkable neighborhoods (Table 3).

CARDIOVASCULAR RISK FACTOR PROFILES. In the overall study population, an improvement in neighborhood walkability was associated with a consistent reduction in the prevalence of any cardiovascular risk factor, decreasing from 86% in the least walkable neighborhoods to 77% in the most walkable neighborhoods (Table 1, Figure 2). Similarly, consistent findings were observed after stratification by atherosclerotic cardiovascular disease status (Figures 3 and 4, Supplemental Table 8).

After adjusting for age, sex, race/ethnicity, and ADI groups, adults with cancer residing in the most walkable neighborhoods were less likely to have any cardiovascular risk factor compared with those in the least walkable neighborhoods (aOR: 0.58; 95% CI: 0.57-0.60) (Table 2). Similar findings were found after stratifying by atherosclerotic cardiovascular disease status (for those with atherosclerotic cardiovascular disease, aOR: 0.71, 95% CI: 0.58-0.87; for those without it, aOR: 0.58; 95% CI: 0.56-0.60) (Table 4). Additionally, after stratifying by sex ($P_{interaction}$ = 0.625), age ($P_{interaction}$ = 0.509), race/ethnicity ($P_{interaction}$ = 0.003), and ADI groups ($P_{interaction}$ = 0.928), specific categories showed notable differences. Male patients (aOR: 0.57; 95% CI: 0.55-0.591), individuals aged 18 to 39 years (aOR: 0.55; 95% CI: 0.530-0.57), Hispanics (aOR: 0.59; 95% CI: 0.54-0.65), and those in the fifth ADI quintile group (aOR: 0.33; 95% CI: 0.20-0.56) residing in the most walkable neighborhoods demonstrated the lowest likelihood of having any cardiovascular risk factor compared with those in the least walkable neighborhoods (Table 3).

SENSITIVITY ANALYSES. The results of sensitivity analyses, which were conducted by limiting the analysis to cardiovascular risk factors before or after cancer diagnosis and by focusing on patients with at least 2 years of health care contact with our health system, showed findings consistent with the main

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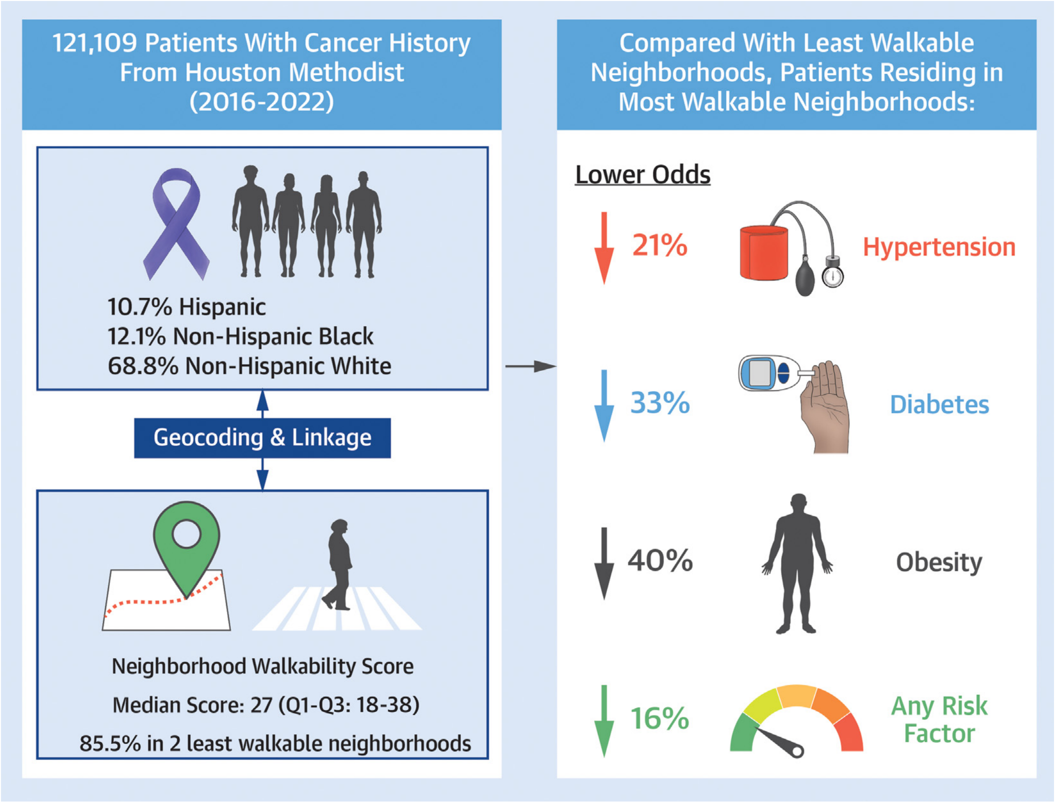
CENTRAL ILLUSTRATION Relationship Between Walkability and Cardiovascular Risk Factors



Nwana N, et al. J Am Coll Cardiol CardioOnc. 2024;6(3):421-435.

Neighborhood walkability (NW) had the strongest relationship with obesity; patients living in very walkable neighborhoods (VWNs) were 40% less likely to be obese compared to patients living in car-dependent neighborhoods (CDNs). Similar associations were found between NW and other cardiovascular risk factors (diabetes mellitus and hypertension). Patients living in VWNs were also less likely to have any cardiovascular risk factor compared to patients living in more CDNs, which are less walkable.

results. These findings are presented in Supplemental Tables 11 to 14.

DISCUSSION

To our knowledge, we present the findings of the first investigation into the association between neighborhood walkability and the prevalence of cardiovascular risk factors among cancer patients. Conducted within the diverse population served by Houston Methodist Hospital, this large-scale observational study revealed a notable trend—the prevalence of all cardiovascular risk factors decreased as neighborhood walkability increased. Importantly, even after controlling for demographic and socioeconomic variables, the influence of neighborhood walkability on cardiovascular risk factors persisted (**Central Illustration**). These findings contribute significantly to the growing body of evidence linking area-level built environmental factors to the burden of cardiovascular risk factors. This association is highly relevant for specific populations, such as cancer patients, who often share similar risk factors with individuals affected by cardiovascular disease.

Specifically, in our study, we found that patients living in neighborhoods with higher walkability scores were less likely to exhibit hypertension, diabetes, obesity, and a history of smoking than those in less walkable areas. Additionally, we observed a reduced likelihood of having any cardiovascular risk factor associated with living in neighborhoods with higher walkability compared to less walkable neighborhoods. These findings were consistent with a recent study[15] examining the relationship between neighborhood walkability and cardiovascular risk factors in a general population. In that study, patients living in neighborhoods with favorable walkability similarly showed a decreased likelihood of hypertension, diabetes, obesity, smoking history, or any cardiovascular risk factor.

Furthermore, our findings demonstrated generalizability across all patient groups regardless of atherosclerotic cardiovascular disease status, age, sex, race, ethnicity, and socioeconomic status. By including demographics and ADI groups as confounding variables, we were able to disentangle the direct impact of neighborhood walkability on cardiovascular disease risk factors from the influence of socioeconomic and demographic disparities.

Our finding of the positive impact of neighborhood walkability on cardiovascular risk factors among cancer patients underscores the crucial role of neighborhood factors in promoting cardiovascular health, particularly in a population already facing heightened vulnerabilities. Cancer patients are increasingly susceptible to cardiovascular disease.[6] Cancer treatments, including chemotherapy and radiation therapy, as well as metabolic changes and chronic inflammation from cancer can inflict damage on the heart and blood vessels, thereby elevating the risk of cardiovascular disease.[6] Consequently, cancer patients are strongly advised to prioritize lifestyle modifications, such as regular exercise including activities such as walking, to mitigate their risk.

The concept of "place" and its influence on health has been extensively discussed within the research community,[27] with cancer patients proving no exception to its significance. Our study reveals that neighborhood attributes, such as walkability, have the potential to mitigate cardiovascular risk factors in this population. Furthermore, these factors may offer additional benefits, potentially contributing to the reduction of future cancer incidence given the overlap between risk factors for cardiovascular disease and cancer.

The mechanism through which walkable neighborhoods influence cardiovascular disease risk factors in this subpopulation warrants further investigation in future studies. Nevertheless, we hypothesize that walkable neighborhoods encourage people to opt for walking and biking, as opposed to driving, thereby reducing cardiovascular disease risk factors and potentially lowering the incidence and prevalence of cardiovascular disease. Moreover, walkable neighborhoods often feature more vibrant social and economic environments, fostering increased social interactions and opportunities for local businesses to thrive. This sense of community can mitigate feelings of isolation and loneliness while regulating mood and symptoms of depression and anxiety.[28] Additionally, walkable neighborhoods typically offer greater access to fresh, healthy food options available in farmer's markets and grocery stores, promoting a healthier diet and aiding in the reduction of cardiovascular disease.[29-31] Furthermore, the presence of green spaces and pleasant scenery in walkable neighborhoods can also help reduce stress levels, ultimately positively impacting overall health.[32] In essence, the built environment plays a significant role in determining the extent to which people engage in walking, thereby positively affecting their cardiovascular health.[27]

Unfortunately, the built environment has not always encouraged the incorporation of physical activities into the lifestyle of all Americans. Research has shown that people of color and low-income communities are adversely affected because of the lack of infrastructure designed to promote healthy lifestyles.[33,34] Specifically, people of color tend to live in socioeconomically disadvantaged neighborhoods that notably lack sidewalks and safety measures, thus discouraging walking. As observed in our study, the lack of incentives for leading physically active lives contributes to residents from these neighborhoods being at a disproportionate risk of a higher prevalence of cardiovascular risk factors and disease.

The findings from our study, along with other studies highlighting the disproportionate burden of cardiovascular risk factors in low-income communities caused by inadequate environmental infrastructure, serve as a call to action for policymakers. It urges them to change the narrative and prioritize the implementation of policies aimed at improving the built environment, particularly the walkability of low-income neighborhoods. Such initiatives have the potential to improve the cardiovascular health of residents in these neighborhoods, including those living with cancer.

STUDY LIMITATIONS. The inclusion of patients solely from 1 health care system within a specific geographic location limits the generalizability of our findings to other geographic settings and the broader population of the United States. However, the substantial sample size and diversity of our study sample, encompassing age, sex, race/ethnicity, and socioeconomic status, provide a solid foundation for reporting our findings with a high level of confidence.

Additionally, the observational cross-sectional design of our study presents limitations in establishing causality or determining the direction of the relationship between neighborhood walkability and cardiovascular risk factors. To enhance the statistical power and confidence in our findings, future studies using randomized or longitudinal time series designs would be beneficial.

In addition, future studies could explore this relationship at a more granular level by examining other cancer subtypes. This approach would enhance our collective understanding of the relationship between neighborhood walkability and cardiovascular risk factors within specific cancer populations. Another limitation of our study pertains to the characteristics of the cancer patients, particularly their active cancer status. Our study focused on all patients with a history of cancer. However, future studies could focus solely on patients with active cancers to gain insights into the impact of neighborhood walkability on cardiovascular disease risk within this population. In addition, conducting a prospective trial that follows patients without a history of cancer to understand how their cancer status may change based on neighborhood walkability could offer valuable insights for the scientific community.

Our neighborhood Walk Score data had certain limitations. It was obtained from a singular point in time (year 2019), whereas patient data spanned multiple years (2016-2022). However, this discrepancy is unlikely to significantly affect our findings because the average change in Walk Score across years is approximately 0.2 points. Additionally, the absence of using patient-level data to determine whether patients are actually engaging in walking presents a significant limitation. This limitation hinders the precision and validity of assessing the impact of walkability on health outcomes. Relying solely on neighborhood-level data overlooks potential variations in physical activity levels among patients, which could lead to inaccurate conclusions regarding the relationship between walkability and health. To address these limitations, future studies could focus on examining how individuals' actual walking behavior, influenced by neighborhood factors, affects cardiovascular disease risk.

Lastly, the method of identifying the cohort for analyses using International Classification of Diseases-10th Revision codes may not be robust enough to capture all relevant patients because it may overlook those with undiagnosed or subclinical conditions. To enhance this method, future studies could include additional criteria such as laboratory results and medication usage. Furthermore, using advanced techniques such as machine learning algorithms and natural language processing could improve the accuracy of identifying patient cohorts.

Despite the limitations inherent in our study, the preliminary findings regarding the relationship between neighborhood walkability and cardiovascular disease risk in patients with a history of cancer present a promising hypothesis for future prospective trials. These trials could aim to characterize the potential causal link by which neighborhood walkability may reduce cardiovascular disease risk factors among patients with a history of cancer. Such research may yield valuable insights into tailored interventions for this vulnerable group and contribute to a holistic approach to managing cardiovascular disease risk.

CONCLUSIONS

Our findings demonstrate a significant association between neighborhood walkability and the burden of modifiable cardiovascular risk factors among patients with a history of cancer. The findings suggest that investments in neighborhood infrastructure to enhance walkability could offer a promising opportunity for mitigating the burden of modifiable cardiovascular risk factors in this population.

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PERSPECTIVES

COMPETENCY IN PATIENT CARE: The study highlights the significance of evaluating and managing patients' neighborhood environmental factors within comprehensive patient care plans. Neighborhood walkability emerges as a crucial factor influencing cardiovascular disease risk factors in patients with a history of cancer. By integrating interventions at the neighborhood level, health care providers can contribute to more holistic patient care approaches, potentially leading to improved outcomes in this population.

TRANSLATIONAL OUTLOOK: Further research should focus on assessing how neighborhood walkability affects the incidence of cardiovascular disease risk factors among patients with active cancer, both during and after cancer treatment.

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KEY WORDS cancer, cardiovascular risk, walkability, Walk Score

APPENDIX For supplemental tables, please see the online version of this paper.