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ORIGINAL RESEARCH

Neighborhood Archetypes and Cardiovascular Health in Black Breast Cancer Survivors

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ABSTRACT

BACKGROUND Maintaining cardiovascular health (CVH) is critical for breast cancer (BC) survivors, particularly given the potential cardiotoxic effects of cancer treatments. Poor CVH among Black BC survivors may be influenced by various area-level social determinants of health, yet the impact of neighborhood archetypes in CVH among this population remains understudied.

OBJECTIVES This study aimed to characterize the neighborhood archetypes where Black BC survivors resided at diagnosis and evaluate their associations with CVH.

METHODS We assessed CVH 24 months post-diagnosis in 713 participants diagnosed between 2012 and 2017 in the Women's Circle of Health Follow-Up Study, a population-based study of Black BC survivors in New Jersey. Neighborhood archetypes, identified via latent class analysis based on 16 social and built environment features, were categorized into tertiles. Associations between neighborhood archetypes and CVH scores were estimated using polytomous logistic regression.

RESULTS CVH scores were assessed categorically (low, moderate, and optimal) and as continuous variables. On average, Black BC survivors achieved only half of the recommended score for optimal CVH. Among the 4 identified archetypes, women in the Mostly Culturally Black and Hispanic/Mixed Land Use archetype showed the lowest CVH scores. Compared to this archetype, Black BC survivors in the Culturally Diverse/Mixed Land Use archetype were nearly 3 times as likely to have optimal CVH (relative risk ratio: 2.92; 95% CI: 1.58-5.40), with a stronger association observed in younger or premenopausal women. No significant CVH differences were noted for the other 2 archetypes with fewer built environment features.

CONCLUSIONS Neighborhood archetypes, integrating social and built environment factors, may represent crucial targets for promoting CVH among BC survivors. (J Am Coll Cardiol CardioOnc 2024;6:405-418) © 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

AHA = American Heart Association

AJCC = American Joint Committee on Cancer

BC = breast cancer

BMI = body mass index

BP = blood pressure

CVH = cardiovascular health

LE8 = Life's Essential 8

LS7 = Life's Simple 7

NJSCR = New Jersey State Cancer Registry

nSES = neighborhood socioeconomic status

WCHFS = Women's Circle of Health Follow-Up Study

The increasing number of breast cancer (BC) survivors in the United States[1] underscores the importance of understanding the multilevel and complex factors affecting survivorship, which has become a public health priority.[2] BC and cardiovascular disease are major contributors to morbidity and mortality among women, particularly affecting Black women, who face a 40% higher BC mortality and a 32% higher cardiovascular disease mortality than White women.[1,3,4] BC survivors also face an increased risk of cardiovascular disease and related mortality compared to women without a history of BC,[5,6] primarily because of the cardiotoxic effects of several cancer treatments and shared risk factors between BC and cardiovascular disease such as obesity, diet, and smoking. These factors can further exacerbate the adverse effects of cardiotoxic treatments.[6-8] Therefore, the emerging field of cardio-oncology has seen increased clinical attention directed toward cardiovascular health (CVH) after a BC diagnosis, recognizing the essential role of optimal CVH in reducing the burden of cardiovascular disease and improving BC survivorship.[8,9]

The American Heart Association (AHA) developed Life's Simple 7 (LS7),[8] a CVH metric that quantifies 7 modifiable cardiovascular disease precursors: body mass index (BMI), diet, smoking, physical activity, blood pressure (BP), total cholesterol, and blood glucose. Recently, this metric was expanded to include sleep in the new Life's Essential 8 (LE8).[10] Adhering to optimal CVH reduces the lifetime risk of cardiovascular disease among Black individuals, improves quality of life, and reduces financial burden after a BC diagnosis.[7]

Despite the benefits of optimal CVH for BC survivors, adopting and maintaining healthy behaviors and factors may be challenging because of social, physical activity, food, and health care environments that are generally beyond their control.[11-13] BC survivors, facing constraints in time, energy, and workforce participation after diagnosis,[14] may be particularly vulnerable to the impact of their residential environments compared to individuals without cancer.[15] Moreover, compared to White survivors, Black BC survivors, who are more likely to live in disadvantaged neighborhoods because of structural racism, may be especially susceptible.[16,17] However, there remains a lack of understanding regarding how neighborhood social and built environments influence CVH among Black BC survivors. Failing to adequately consider this important context may hinder the development of intervention strategies for this underserved population and the identification of cancer survivors at higher risk of poor CVH.

Furthermore, prior research assessing neighborhood environments and cancer outcomes often relies on single measures or indexes that cannot capture the complex interplay of neighborhood features. Evaluating neighborhood archetypes, which develop multidimensional classifications incorporating social and built environment measures, has emerged as a promising approach to characterize neighborhoods for identifying susceptible and desirable communities.[18,19] This method may stimulate the development and implementation of more effective targeted interventions.[20]

In a large prospective study of Black BC survivors, we characterized the neighborhood archetypes where women resided at diagnosis and evaluated their associations with CVH approximately 24 months after diagnosis.

METHODS

STUDY POPULATION. Participants were enrolled in the Women's Circle of Health Follow-Up Study (WCHFS), a population-based cohort of Black BC survivors. Detailed study methods have been described previously.[21] Briefly, participants were identified through rapid case ascertainment in 10 New Jersey counties by the New Jersey State Cancer Registry (NJSCR). Eligible participants self-identified as Black or African American, were aged between 20 and 75 years at the time of diagnosis, had a histologically confirmed diagnosis of ductal carcinoma in situ or invasive BC, were able to speak English, and had no history of cancer other than nonmelanoma skin

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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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TABLE 1 Cardiovascular Health Score Components; Data Source; and Definition of Poor, Intermediate, and Ideal Scores

Components[a]	Data Source	Definitions and Levels of CVH for Each Component (Adapted to WCHFS)		
		Poor (Score = 0)	Intermediate (Score = 1)	Ideal (Score = 2)
Body mass index	Measured or self-reported at F/U1	≥30 kg/m^2	25-29.9 kg/m^2	<25 kg/m^2
Physical activity[b]	Godin Exercise Questionnaire at F/U1	None	1-149 min/wk	≥150 min/wk
Healthy dietary pattern[c]	Short frequency questionnaire at F/U1 + FFQ	<2 components	2-3 components	4-5 components
Smoking	Smoking history questionnaire at F/U1	Current smoking	Former (quit since diagnosis)	Never or quit before diagnosis
Blood pressure	Measured at F/U1 + questionnaire for treatment information	SBP ≥140 mm Hg or DBP ≥90 mm Hg	SBP 120-139 mm Hg or DBP 80-89 or treated to goal	SBP <120 mm Hg and DBP <80 mm Hg
Total cholesterol	Medical records (approximately F/U1) + plasma samples + questionnaire	≥240 mg/dL or not taking medication for high cholesterol as prescribed	200-239 mg/dL or treated to goal or taking medication for high cholesterol as prescribed	<200 mg/dL
HbA1c or FPG	Medical records (approximately F/U1) + questionnaire	HbA1c ≥6.5% or FPG ≥126 mg/dL or not taking medication for diabetes as prescribed	HbA1c 5.7%-6.4% or FPG 100-125 mg/dL, treated to goal, or taking medication for diabetes as prescribed	HbA1c <5.7% or FPG <100 mg/dL
Sleep duration	Self-reported at F/U1	≤5 or ≥10 h	6 and 9 h	7-8 h

[a]Definitions primarily followed the American Heart Association 2020 Goals for adults ≥20 years of age. All components except sleep are based on Life's Simple 7, with sleep duration additionally included in Life's Essential 8. [b]Calculated as moderate + 2 * vigorous. [c]Minor modifications based on the following American Heart Association–defined healthy diet pattern: 1) ≥4.5 times/d of fresh fruits and vegetables, 2) ≥3 times/wk of fish, 3) ≥3 times/d of whole grains; 4) ≤3 times/wk of nondiet sodas, and 5) ≤1,500 mg/d of sodium based on the average between baseline and F/U2 FFQs.

CVH = cardiovascular health; FFQ = food frequency questionnaire; FPG = fasting plasma glucose; F/U = follow-up; HbA1c = hemoglobin A1c; WCHFS = Women's Circle of Health Follow-Up Study.

cancer. A total of 720 WCHFS participants were diagnosed between May 2012 and November 2017. After excluding 7 because of invalid residential addresses, our analytical sample consisted of 713 BC survivors. All participants provided written informed consent, and the study was approved by the Institutional Review Boards at all participating institutions.

Data collection involved a baseline interview approximately 10 months after diagnosis followed by annual follow-up interviews conducted through home visits (Supplemental Figure 1). During these home visits, participants underwent anthropometric measurements, BP measurements, and biospecimen collection. They also completed interviewer-administered questionnaires that covered sociodemographic, reproductive, lifestyle, and medical history information. Clinicopathologic factors of BC, including American Joint Committee on Cancer (AJCC) stage, tumor grade, and subtypes, were retrieved from pathology reports or files from the NJSCR. Information on BC treatments was primarily obtained from medical records. In cases in which data were missing, they were supplemented from the NJSCR or through self-report. Previous studies have shown high concordance between self-reported treatment and medical records (eg, kappa values of 0.91 and 0.74 for chemotherapy and radiation therapy, respectively).[22]

CARDIOVASCULAR HEALTH. Data on CVH components were collected approximately 24 months after diagnosis. Descriptions of CVH measures are provided in Table 1. BMI was calculated as kg/m^2 measured by trained interviewers using a standardized protocol[21,22] or derived from self-reports if measurements were unavailable (2.1%). High concordance (intraclass correlation = 0.97) between BMI derived from self-reported and measured weight and height has been previously observed in a separate study.[23]

Dietary intake over the past year was assessed using an 18-item food frequency questionnaire, whereas physical activity was evaluated using the Godin Leisure-Time Exercise Questionnaire.[24] Cigarette smoking history since diagnosis was also assessed during the interviewer-administered interview.

BP was measured during the home visit and recorded after at least 5 minutes of rest using a clinically validated automated BP monitor (IntelliSense model HEM-907XL, Omron) following the AHA protocol.[25] Total cholesterol, hemoglobin A1c, and fasting plasma glucose levels were retrieved from medical records. For participants with unavailable medical records, cholesterol levels were measured from blood samples collected during the home visit (36.0%). Information on BP-lowering, glucose-lowering, and lipid-lowering treatments was collected through the interviewer-administered

questionnaire. Average sleep hours over the past month were assessed as part of the Pittsburgh Sleep Quality Index questionnaire.[26]

The total CVH scores were derived using AHA definitions for ideal, intermediate, and poor health components with slight modifications.[8] The LS7 scores range from 0 to 14, and the LS7 + sleep scores range from 0 to 16. Higher scores indicate better CVH.

NEIGHBORHOOD CHARACTERISTICS. The social and built environment characteristics of participants' neighborhoods were determined based on their residences at diagnosis. A detailed description of these characteristics has been published previously[27-29] and is provided in Supplemental Table 1. In brief, participants' addresses were geocoded and linked to 2010 census tracts.

We have previously shown that breast tumor phenotypes may be influenced by social environmental factors,[30] specifically the National Cancer Institute neighborhood socioeconomic (nSES) index, which includes education, household income, poverty level, unemployment, working class, home value and rent value,[31] and residential racial composition. Therefore, these measures were included in our study. Census tract-level racial, ethnic, and non-U.S. born composition data were obtained from the 2010 Census and the 2010-2014 American Community Survey.

Given previous findings suggesting associations between several built environment features and adiposity among Black BC survivors,[14] we included various neighborhood environment characteristics in our analysis. These included densities of supermarkets, other food stores, fast food restaurants, and other restaurants within the food environment, as well as physical activity environments such as densities of physical activity facilities and walkable destinations. Additionally, we considered green space and health care environment densities, such as ambulatory care and hospital-based inpatient care, along with the presence and density of religious institutions. These built environment measures were primarily derived from the National Establishment Time Series Data of 2014[27-29] corresponding to the median year of diagnosis. Estimates of green space density were obtained using the National Land Cover Database.

NEIGHBORHOOD ARCHETYPE ANALYSIS. We used 16 tract-level social and built environment characteristics to conduct latent class analysis and identify distinct neighborhood archetypes where Black BC survivors in our study reside. Latent class analysis involves identifying subgroups within a sample by examining patterns of responses to observed variables. Following the methods described in previous studies,[18,32] we dichotomized these indicators based on whether they exceeded or fell below the median among unique census tracts in our study (n = 410). Features exhibited by fewer than 50% of neighborhoods were categorized as present or absent. The optimal number of classes was determined by evaluating statistical model fit indexes, including a small Bayesian information criterion value, the highest entropy value (0.904), and the Vuong-Lo-Mendell-Rubin likelihood ratio test, while ensuring interpretability. To meet the assumption of local independence in the latent class model, population density was excluded, which did not alter the identified archetypes.

Additionally, to evaluate whether our model adequately captured the additional value of social and built environment features beyond nSES, we conducted a sensitivity analysis by excluding nSES and observed no substantial changes in our findings. Detailed methods for the latent class analysis are provided in the Supplemental Methods and further illustrated in Supplemental Figure 2.

STATISTICAL ANALYSES. Data are presented using mean ± SD for continuous variables or percentages (%) for categoric variables. We used multiple imputations by chained equations to impute missing values in CVH components and covariates, and Rubin's rule was used to pool estimates from 10 imputed data sets.[33] Regarding sensitivity analyses, we compared the distribution of each CVH component between imputed data and complete cases without imputation, and estimates were derived from 20 imputed data sets.

CVH scores were evaluated categorically as low, moderate, and optimal and as continuous variables. We used multivariable polytomous logistic regression models and linear regression models to estimate the relative risk ratios and the β coefficients (ie, difference in CVH score), respectively, along with 95% CIs to assess the associations of archetypes with categoric and continuous CVH scores. Robust sandwich estimators were used to account for clustering of participants within census tracts.[34]

We selected the following covariates based on prior knowledge: sociodemographic factors (age at diagnosis, education, household income, health insurance status, non-U.S. born status, and marital status), menopausal status, a health behavior factor not included in the CVH scores (ie, alcohol intake), tumor characteristics (AJCC stage, tumor grade, and BC subtypes [luminal A, human epidermal growth factor receptor 2+, and triple negative]), and cancer

treatments received (surgery type, chemotherapy, radiotherapy, and endocrine therapy). A parsimonious set of covariates was identified using backward elimination ($P < 0.10$).

We stratified the analysis by age group, menopausal status, education level, and tumor subtypes and conducted separate tests for additive interactions using Wald tests. Additionally, we performed a separate analysis among stage I to III BC cases. To identify the most influential CVH components in the associations between neighborhood archetypes and overall CVH, we repeated the analyses by excluding each CVH component individually. Furthermore, we conducted an additional analysis adjusting for CVH components measured at baseline. Statistical significance was defined as a 2-sided P value <0.05. Latent class analysis was conducted using Mplus 8.4 (Muthen & Muthen),[35] and statistical analyses were performed using Stata version 18.0 (StataCorp LLC).

DATA AVAILABILITY. Deidentified data for this study are available upon approval from the Women's Circle of Health Follow-up Study Scientific Committee and with human subjects research approval and data transfer agreement.

RESULTS

In this population-based study of Black BC survivors, the mean age at diagnosis was 55.4 ± 10.8 years, with 66% being postmenopausal. Approximately one-third (33%) of participants reported a household income of <$25,000 per year. The mean CVH scores for LS7 and LS7 + sleep were 7.5 ± 2.1 and 8.5 ± 2.3 points, respectively. Notably, no participant met all ideal metrics. The distributions of poor, intermediate, and ideal scores were consistent between imputed and complete case analyses (Supplemental Table 2).

Four distinct neighborhood archetypes were identified from the latent class analysis and were named after their racial/ethnic compositions and land use features (**Figure 1**). The Mostly Culturally Black and Hispanic/Mixed Land Use archetype, which accounted for 42% of participants, was the most prevalent archetype. It exhibited a high proportion of Black and Hispanic residents along with high densities of food stores (excluding supermarkets), walkable destinations, and religious institutions.

The Culturally Diverse/Mixed Land Use archetype, which accounted for 16% of participants, was characterized by a high nSES; diverse racial and ethnic groups; a high percentage of non-US born residents; and high densities of food stores, restaurants, physical activity facilities, walkable destinations, and ambulatory care locations. The Mostly Culturally Black/Green-centric archetype, which accounted for 17% of participants, featured a high proportion of Black residents and high densities of green space and religious institutions.

Finally, the Culturally Diverse/Green-centric archetype, which accounted for 25% of participants, exhibited a high nSES and high proportions of White and Asian residents along with green space. Although the proportion of Black residents was not a defining feature of this archetype, its mean was 15.8%, close to the New Jersey average (data not shown).

Black BC survivors in the Mostly Culturally Black and Hispanic/Mixed Land Use archetype exhibited the lowest CVH scores, whereas those in the Culturally Diverse/Mixed Land Use neighborhoods showed the highest scores, with a mean LS7 of 7.3 ± 2.0 and 8.0 ± 2.3, respectively (**Table 2**). Participants in the former archetype were more likely to have lower levels of education and household income compared to those in the other 3 archetypes, whereas women in the latter neighborhoods were most likely to be postmenopausal. Women in the Mostly Culturally Black/Green-centric archetype were predominantly native-born. Women in the Culturally Diverse/Green-centric archetype were characterized by having high education and household income levels, being married or cohabiting, and having private health insurance.

Given the well-established association between LS7 scores and cardiovascular disease and considering our scoring criteria's close alignment with LS7, we present our primary findings based on LS7 scores. Although the data we collected did not allow us to follow the new LE8 scoring criteria, we conducted additional analyses using LS7 + sleep CVH scores because sleep is a newly added component of LE8, and our previous research indicated a high prevalence of sleep disturbance in this population.[36] The results of these additional analyses are provided in Supplemental Table 3 and are consistent with the primary findings.

Compared to women in the Mostly Culturally Black and Hispanic/Mixed Land Use archetype, Black BC survivors in the Culturally Diverse/Mixed Land Use neighborhoods exhibited significantly better CVH scores. The multivariable-adjusted relative risk ratios for moderate and optimal LS7 scores were 1.77 (95% CI: 0.96-3.24) and 2.92 (95% CI: 1.58-5.40), respectively, compared to low scores (**Table 3**). Notably, the 2 green-centric archetypes did not show significant associations with CVH scores.

The results for continuous CVH scores consistently showed that Black BC survivors residing only in the

FIGURE 1 Neighborhood Archetypes Identified in the WCHFS

Tract-level indicators[a] (0 – 1)	Neighborhood Archetypes: Mostly Culturally Black and Hispanic / Mixed Land Use	Culturally Diverse / Mixed Land Use	Mostly Culturally Black / Green-Centric	Culturally Diverse / Green-Centric
	42%[b]	16%[b]	17%[b]	25%[b]
	Item-response membership probabilities[c]			
nSES index	0.05	0.7	0.49	0.89
non-Hispanic Black	0.84	0.18	0.97	0.12
Hispanic	0.63	0.82	0.44	0.17
non-Hispanic White	0.02	0.77	0.24	0.97
non-Hispanic Asian	0.12	0.78	0.24	0.85
Foreign born	0.52	0.8	0.39	0.34
Supermarkets	0.17	0.32	0.25	0.37
Food stores other than supermarkets	0.93	0.79	0.11	0
Fast-food restaurants	0.66	0.86	0.19	0.23
Restaurants other than fast-food restaurants	0.78	0.88	0.09	0.12
All physical activity facilities	0.49	0.76	0.35	0.42
Religious institutions	0.94	0.45	0.54	0.02
Ambulatory care locations	0.57	0.79	0.27	0.34
Hospital based inpatient care	0.22	0.49	0.21	0.41
Green space proportion	0.11	0.29	0.72	0.96
Walkable destinations	0.95	0.78	0.09	0

[a]Each indicator was dichotomized as above (*vs.* below) the median value among unique census tracts (n=410) in our study, except for supermarkets and inpatient care, which were any (*vs.* none) since fewer than 50% of the neighborhoods possessed that feature.

[b]Percentage of WCHFS participants in each archetype.

[c]Numbers represent the item-response membership probabilities for each neighborhood indicator. A value close to 1 suggests that the indicator is a strong predictor of the neighborhood archetype. Stronger predictors of the neighborhood archetypes are shown in darker green.

The results of latent class analysis identifying 4 neighborhood archetypes across 410 unique census tracts in the study. Item-response membership probabilities of 16 social and built environment indicators are depicted using a heat map, indicating the strengths of these probabilities for each neighborhood archetype. Darker shades of green indicate stronger neighborhood features associated with each archetype. nSES = neighborhood socioeconomic status; WCHFS = Women's Circle of Health Follow-Up Study.

Culturally Diverse/Mixed Land Use archetype had significantly better CVH, with scores that were 0.67 points higher (95% CI: 0.25-1.10) than those living in the Mostly Culturally Black and Hispanic/Mixed Land Use archetype. The exclusion of women with in situ and stage 4 cancers did not materially change our results.

To identify the most influential CVH components in the observed associations, we repeated the linear regression models, removing each component individually from the overall CVH score. When comparing estimates from the overall score to those excluding individual components, we found that the strong positive associations between the Culturally Diverse/Mixed Land Use archetype and CVH were mainly driven by physical activity, BP, and smoking (results not shown).

Significant additive interactions were observed for age (P for interaction = 0.05) and menopausal status (P for interaction = 0.01). Among younger and premenopausal women, residing in Culturally Diverse/Mixed Land Use neighborhoods, compared to residing in Mostly Culturally Black and Hispanic/Mixed Land Use neighborhoods, was associated with higher CVH scores of 1.37 (95% CI: 0.68-2.06) and 1.43 (95% CI: 0.74-2.11) points, respectively, and the associations were close to null among their respective counterparts (Figure 2). The significant association was also observed only in women with higher educational attainment. Additionally, adjusting for physical

TABLE 2 Distribution of Participant Characteristics Across Neighborhood Archetypes

Characteristic[a]	Total (N = 713)	Neighborhood Archetypes: Mostly Culturally Black and Hispanic/Mixed Land Use 42%	Culturally Diverse/Mixed Land Use 16%	Mostly Culturally Black/Green-Xentric 17%	Culturally Diverse/Green-Centric 25%
CVH score					
LS 7, range 0-14	7.5 ± 2.1	7.3 ± 2.0	8.0 ± 2.3	7.6 ± 1.9	7.6 ± 2.1
LS 7 + sleep, range 0-16	8.5 ± 2.3	8.1 ± 2.3	8.9 ± 2.5	8.6 ± 2.2	8.6 ± 2.4
CVH components, poor level, %					
BMI	58	58	55	64	58
Physical activity	32	35	26	24	34
Dietary pattern	69	68	67	73	69
Smoking	11	15	6	8	7
Blood pressure	29	34	26	33	20
Total cholesterol	10	11	7	9	12
Blood glucose	18	19	16	18	15
Sleep[b]	40	44	42	37	35
Age at diagnosis, y	55.4 ± 10.8	55.7 ± 10.7	55.9 ± 11.3	54.5 ± 11.4	55.2 ± 10.4
Foreign-born, %					
No	84	86	81	90	78
Yes	16	14	19	10	22
Marital status, %					
Married/living as married	35	31	35	38	41
Divorced/separated/widowed	34	35	30	35	34
Single/never married	31	34	36	27	24
Household income, %					
<$25,000	33	40	40	21	24
$25,000-$69,999	35	34	29	46	31
≥$70,000	33	26	30	33	45
Insurance status, %					
Private	53	45	46	57	67
Medicaid	14	19	14	5	12
Medicare	19	20	22	22	15
Uninsured	4	5	4	6	2
Other	10	11	13	10	5
Education, %					
≤High school graduate	35	41	37	39	23
Some college	33	35	32	30	34
≥College	31	24	31	31	43
Menopausal status, %					
Premenopausal	34	33	30	38	36
Postmenopausal	66	67	70	63	64
Alcohol drinking before diagnosis, %					
Nondrinker	58	59	64	52	58
>0-≤1 drinks/d	37	34	33	44	39
>1 drink/d	5	7	3	4	3
AJCC stage, %					
0	20	23	22	15	16
I	39	33	48	40	42
II	32	36	22	34	30
III/IV	10	9	9	11	12
Grade, %					
I	14	18	17	8	12
II	42	37	47	48	44
III	44	45	37	44	44

Continued on the next page

TABLE 2 Continued

Characteristic[a]	Total (N = 713)	Neighborhood Archetypes: Mostly Culturally Black and Hispanic/Mixed Land Use 42%	Culturally Diverse/Mixed Land Use 16%	Mostly Culturally Black/Green-Xentric 17%	Culturally Diverse/Green-Centric 25%
Chemotherapy, %					
No	48	46	60	44	44
Yes	52	55	40	56	56
Radiation therapy, %					
No	28	32	30	31	20
Yes	72	68	70	69	80
Endocrine therapy, %					
No	33	34	33	30	32
Yes	67	66	67	70	68
Type of surgery, %					
No surgery	3	4	2	4	2
Lumpectomy	52	50	52	46	61
Mastectomy	44	46	46	50	37
Subtypes, %					
Luminal A	63	61	67	66	61
HER2+	19	19	14	17	23
Triple negative	18	20	19	18	16

Values are % or mean ± SD. [a]Percent unknown and thus imputed for participant characteristics were as follows: <0.3% for marital status, education, and tumor stage, respectively; 1% to 5.5% for health insurance, tumor grade, and income; 9.7% for alcohol intake; and 14.9% for tumor subtypes. Refer to Supplemental Table 2 for CVH component data before and after imputation. [b]All components except sleep are part of LS7, with sleep duration additionally included in LS7 + sleep.

AJCC = American Joint Committee on Cancer; BMI = body mass index; CVH = cardiovascular health; HER2+ = human epidermal growth factor receptor 2+; LS7 = Life's Simple 7.

activity, BP, and smoking measured at baseline revealed no substantive differences in the association of neighborhood archetypes with CVH at approximately 2 years post-diagnosis (Supplemental Table 4).

DISCUSSION

To our knowledge, this study represents the first comprehensive investigation of CVH in a large population-based study of Black BC survivors. It focuses on identifying neighborhood archetypes associated with CVH within this disproportionately affected population, which experiences higher rates of cardiovascular disease mortality after a BC diagnosis compared to other racial groups.[37,38] On average, Black BC survivors in this study achieved only half of the recommended score for optimal CVH, and none met all ideal metrics. This observed CVH score is notably lower than the national average for women across all racial groups, consistent with the finding that <1% of Black individuals meet all ideal CVH components.[39] This finding is concerning given that poor CVH is a known predictor of cancer treatment-related cardiotoxicity[40] and cardiovascular disease risk and mortality among cancer patients.[41,42]

Our analysis revealed that the neighborhood archetype associated with better CVH post-diagnosis (ie, Culturally Diverse/Mixed Land Use) was characterized by diverse racial and ethnic populations; higher nSES; and greater densities of restaurants, food stores, physical activity facilities, walkable destinations, and ambulatory care locations. Notably, only 16% of our study participants lived in this type of neighborhood (**Central Illustration**).

Our findings demonstrate the interconnected nature of neighborhoods as complex systems[18] in which neighborhood archetypes characterized by both social and built environment factors influence CVH among Black BC survivors. Although nSES is the most studied neighborhood factor,[11,43] our study shows that nSES alone is not the sole driver. Interestingly, despite both the Culturally Diverse/Mixed Land Use and Culturally Diverse/Green-centric archetypes exhibiting high nSES, Black BC survivors in the latter archetype exhibited worse CVH. Notable differences between these 2 archetypes primarily relate to built environment features.

Importantly, these findings are independent of individual-level SES. In fact, participants residing in the Culturally Diverse/Green-centric neighborhoods exhibited the highest levels of education and

TABLE 3 Associations Between Neighborhood Archetypes and Cardiovascular Health Scores in Black Breast Cancer Survivors

Neighborhood Archetype	Tertiles of CVH Score[a] T1 (Low: 0-6)	T2 (Moderate: 7-8) RRR (95% CI)	T3 (Optimal: 9-14) RRR (95% CI)	Continuous CVH Score[b] (Score Range: 0-14) β (95% CI)
		Model 1[c]		
Mostly Culturally Black and Hispanic/Mixed Land Use	Ref	Ref	Ref	Ref
Culturally Diverse/Mixed Land Use	Ref	1.75 (0.97-3.16)	2.98 (1.66-5.35)	0.76 (0.32-1.20)
Mostly Culturally Black/Green-centric	Ref	1.10 (0.61-1.98)	1.47 (0.81-2.64)	0.22 (−0.20 to 0.64)
Culturally Diverse/Green-centric	Ref	1.10 (0.67-1.74)	1.32 (0.79-2.20)	0.27 (−0.11 to 0.64)
		Model 2[d,e]		
Mostly Culturally Black and Hispanic/Mixed Land Use	Ref	Ref	Ref	Ref
Culturally Diverse/Mixed Land Use	Ref	1.77 (0.96-3.24)	2.92 (1.58-5.40)	0.67 (0.25-1.10)
Mostly Culturally Black/Green-centric	Ref	1.00 (0.54-1.87)	1.37 (0.74-2.54)	0.15 (−0.26 to 0.57)
Culturally Diverse/Green-centric	Ref	0.84 (0.51-1.40)	1.01 (0.59-1.72)	0.05 (−0.32 to 0.42)

[a]Polytomous logistic regression models with robust SEs were used for the analysis. The CVH scores were based on Life's Simple 7. See Supplemental Table 3 for the results including CVH plus sleep. [b]Linear regression models with robust SEs were used for the analysis. [c]Model 1 was adjusted for age. [d]Model 2 was adjusted for age, household income, non-US born status, menopausal status, and tumor stage. [e]Other covariates such as education, marital status, tumor subtypes, and breast cancer treatment were considered but were not included in the final parsimonious model. Details of covariate selection strategies are provided in the Methods.

CVH = cardiovascular health; RRR = relative risk ratio.

household income, underscoring the significant role of health-promoting physical infrastructure and community resources in achieving optimal and equitable CVH among cancer survivors.

Land use and destination mix, key features of the Culturally Diverse/Mixed Land Use archetype associated with the best CVH outcomes in our study, have been linked to increased physical activity,[44] healthier weight status,[45] and a reduced risk of cardiovascular disease risk in noncancer populations.[46]

The 2020 American Cancer Society lifestyle guidelines for cancer prevention now emphasize the importance of diversifying local destinations and adopting initiatives and zoning policies that promote mixed land use environments.[47] Our findings further endorse the applicability of these recommendations not only for cancer prevention but also for survivorship, particularly considering the critical role of CVH in BC survivorship.

We did not observe comparable improvements in CVH among participants living in the 2 green-centric neighborhoods compared to those living in the Culturally Diverse/Mixed Land Use neighborhoods. However, caution is advised in interpreting these results because we did not specifically evaluate the independent association of green space with CVH apart from other neighborhood features.

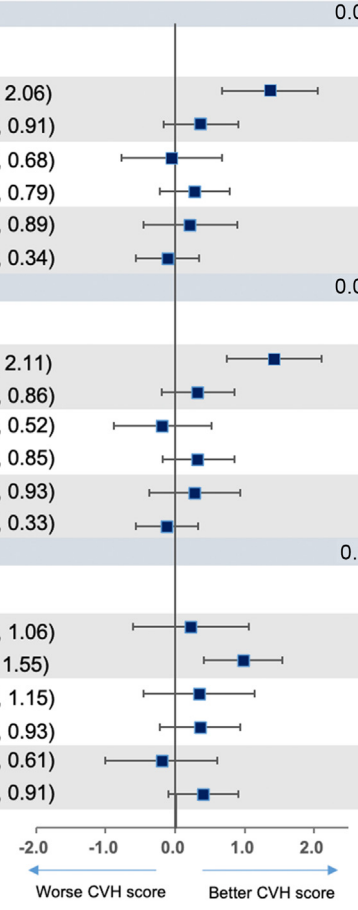
In addition, our analysis revealed that among 2 mixed land-use archetypes, Black BC survivors living in culturally diverse environments exhibited higher CVH scores compared to those in neighborhoods with higher proportions of Black and Hispanic populations. This difference is mainly driven by 3 key CVH components: physical activity, BP, and smoking. The observed contrast could stem from variations in the social environment, including differences in community infrastructure and facilities. Additionally, it may be linked to neighborhood disinvestment, which is prevalent in segregated and socially disadvantaged neighborhoods because of long-term structural racism.[48,49]

Notably, the association between Culturally Diverse/Mixed Land Use neighborhoods and better CVH was stronger among younger, premenopausal, and highly educated women. This stronger association is likely because of fewer constraints from preexisting health behaviors or conditions and increased use of community health-promoting resources.[50]

Given that the racial disparity in cardiovascular disease mortality among BC survivors is most pronounced among younger women,[37,51] with younger Black BC survivors facing nearly 4 times the risk compared to their White counterparts,[37] our findings are particularly relevant in addressing and reducing this racial disparity in cardiovascular disease mortality after BC diagnosis. Moreover, the stronger association observed among Black women with higher education suggests the need for additional interventions to ensure that women with lower education levels benefit from living in heart-healthy neighborhoods. This approach may be required to

FIGURE 2 Associations Between Neighborhood Archetypes and CVH: Stratified Analysis Results

Neighborhood Archetypes	Individual-level Characteristics	CVH Score β (95% CI)	*P* for interaction
	Age		0.051
Mostly Culturally Black and Hispanic / Mixed Land Use		Ref	
Culturally Diverse / Mixed Land Use	≤50	1.37 (0.68, 2.06)	
	>50	0.37 (-0.17, 0.91)	
Mostly Culturally Black / Green-centric	≤50	-0.05 (-0.77, 0.68)	
	>50	0.28 (-0.22, 0.79)	
Culturally Diverse / Green-centric	≤50	0.22 (-0.46, 0.89)	
	>50	-0.11 (-0.56, 0.34)	
	Menopausal status		0.006
Mostly Culturally Black and Hispanic / Mixed Land Use		Ref	
Culturally Diverse / Mixed Land Use	Pre-	1.43 (0.74, 2.11)	
	Post-	0.33 (-0.20, 0.86)	
Mostly Culturally Black / Green-centric	Pre-	-0.18 (-0.88, 0.52)	
	Post-	0.33 (-0.18, 0.85)	
Culturally Diverse / Green-centric	Pre-	0.28 (-0.37, 0.93)	
	Post-	-0.12 (-0.57, 0.33)	
	Education		0.84
Mostly Culturally Black and Hispanic / Mixed Land Use		Ref	
Culturally Diverse / Mixed Land Use	≤High school	0.23 (-0.60, 1.06)	
	≥Some college	0.98 (0.42, 1.55)	
Mostly Culturally Black / Green-centric	≤High school	0.35 (-0.45, 1.15)	
	≥Some college	0.36 (-0.22, 0.93)	
Culturally Diverse / Green-centric	≤High school	-0.19 (-1.00, 0.61)	
	≥Some college	0.41 (-0.10, 0.91)	



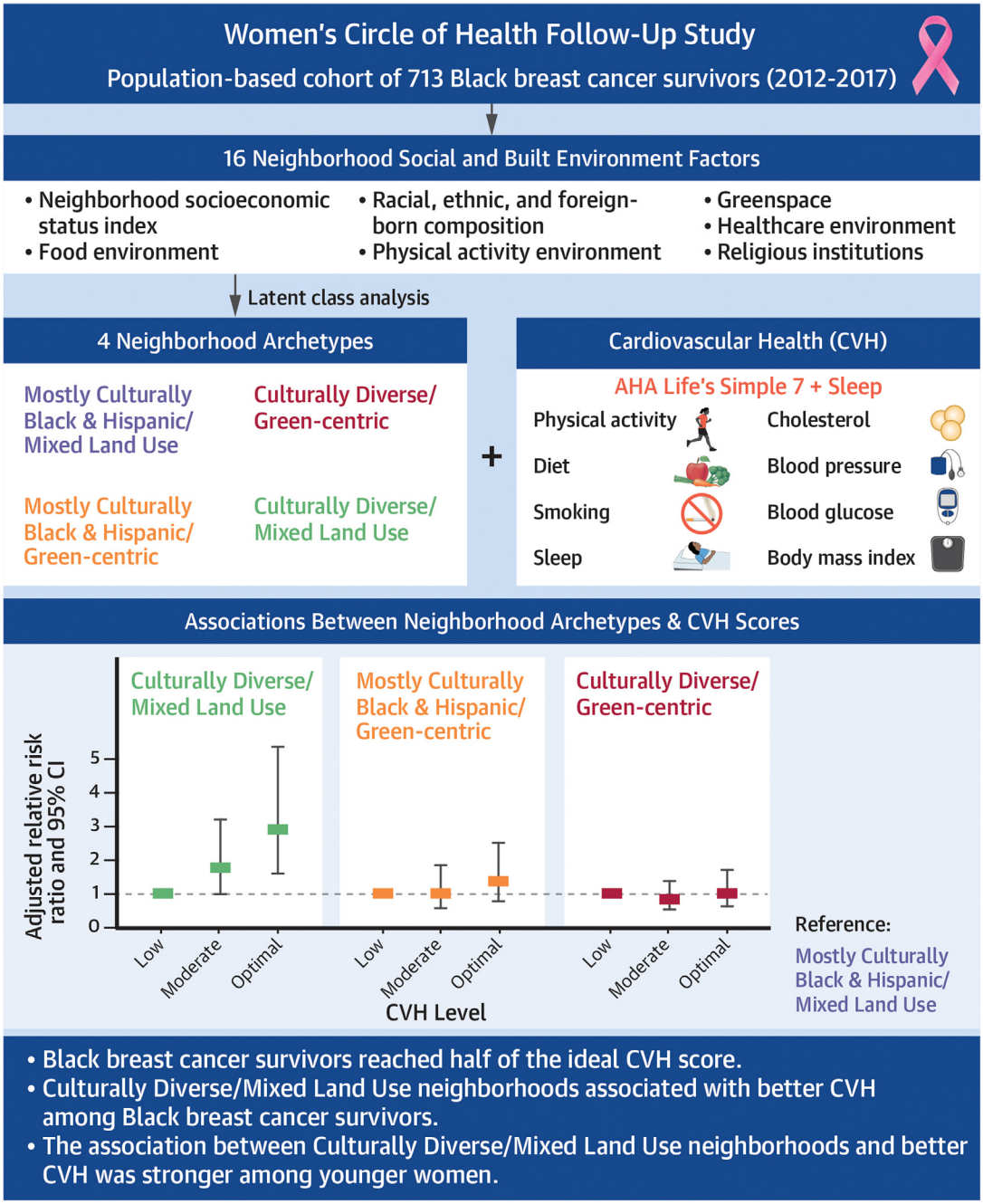
This figure presents the associations between neighborhood archetypes and cardiovascular health (CVH) scores among Black breast cancer survivors stratified by age groups, menopausal status, and education levels. Linear regression models with robust SEs were used, adjusting for age, household income, non-U.S. born status, menopausal status, and tumor stage where appropriate.

prevent unintentional widening of cancer health disparities resulting from community actions.

STUDY STRENGTHS AND LIMITATIONS. Our study has several strengths and limitations worth noting. One potential limitation is the possibility of residential self-selection bias in which health-conscious women may choose neighborhoods with better health resources. However, this is unlikely to fully explain our findings, especially given that no significant association was observed with the Culturally Diverse/Green-centric archetype where participants had the highest education levels—a proxy for health consciousness. Moreover, the main associations observed between neighborhood archetypes and CVH at approximately 2 years post-diagnosis remain robust even when accounting for baseline CVH component measures. Furthermore, we characterized participants' neighborhoods at the time of diagnosis, and excluding those who had moved when CVH was measured (9% of participants) did not alter our results.

This study has several strengths. By linking well-defined social and built environment data to a

CENTRAL ILLUSTRATION **Neighborhood Archetypes and Cardiovascular Health Among Black Breast Cancer Survivors**



Sánchez-Díaz CT, et al. J Am Coll Cardiol CardioOnc. 2024;6(3):405–418.

This figure shows that Black breast cancer survivors living in Culturally Diverse and Mixed Land Use neighborhoods were more likely to have better cardiovascular health (CVH), especially among younger women. It visually summarizes the key findings, highlighting the importance of considering neighborhood archetypes that integrate both social and built environment factors as crucial targets for improving CVH and reducing cardiovascular disease mortality among Black breast cancer survivors.

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population-based prospective cohort containing detailed information on all CVH components, we are uniquely suited to investigate neighborhood archetypes for CVH among Black BC survivors. Moreover, we have identified consistent characteristics between participants in the WCHFS and Black BC patients in New Jersey,[21] which enhances the credibility of our findings within our target area. Although New Jersey shows comparable age-adjusted BC mortality rates to the national average and similar racial disparities in BC mortality,[52] further research is needed to determine the generalizability of our findings to Black BC survivors in other geographic areas.

CONCLUSIONS

In summary, our study shows that, on average, Black BC survivors achieved only half of the recommended score for optimal CVH. Moreover, those living in diverse, affluent neighborhoods with mixed land use and destinations are more likely to attain better CVH. Our findings underscore the importance of considering neighborhood archetypes, encompassing both social and built environment factors, to identify modifiable neighborhood elements that promote CVH and prevent cardiovascular disease mortality among BC survivors. This identification process is essential for advocating policy evaluations targeting neighborhood attributes, such as promoting mixed land use. By identifying these neighborhood-level determinants, tailored policies and interventions can more effectively support the CVH needs of Black BC survivors and reduce the burden of cardiovascular disease mortality within this population.

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PERSPECTIVES

COMPETENCY IN MEDICAL KNOWLEDGE: In this population-based prospective study of Black BC survivors, women in Mostly Culturally Black and Hispanic/Mixed Land Use neighborhoods exhibited the lowest CVH scores. Compared to them, women in Culturally Diverse/Mixed Land Use neighborhoods were nearly 3 times as likely to achieve optimal CVH, whereas women in neighborhoods with fewer built environment features showed no significant CVH differences.

TRANSLATIONAL OUTLOOK: This study underscores the importance of considering neighborhood archetypes, which encompass both social and built environment factors, as essential targets for promoting CVH and preventing cardiovascular disease mortality among Black BC survivors.

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KEY WORDS breast cancer, cancer health disparities, cancer survivorship, cardiovascular health, neighborhoods and health, social determinants of health

APPENDIX For an expanded Methods section and supplemental tables and figures, please see the online version of this paper.