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Authors

Joseph, Joshua

Williams, Amaris

Azap, Rosevine

et al.

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ORIGINAL RESEARCH

Role of Sex in the Association of Socioeconomic Status With Cardiovascular Health in Black Americans: The Jackson Heart Study

Joshua J. Joseph, MD, MPH*; Amaris Williams, PhD*; Rosevine A. Azap, BS; Songzhu Zhao, MS; Guy Brock, PhD; David Kline, PhD; James B. Odei, PhD; Randi Foraker, PhD, MA; Mario Sims, PhD, MS; LaPrincess C. Brewer, MD, MPH; Darrell M. Gray II, MD, MPH; Timiya S. Nolan, PhD

BACKGROUND: Socioeconomic status (SES) is associated with cardiovascular health (CVH). Potential differences by sex in this association remain incompletely understood in Black Americans, where SES disparities are posited to be partially responsible for cardiovascular inequities. The association of SES measures (income, education, occupation, and insurance) with CVH scores was examined in the Jackson Heart Study.

METHODS AND RESULTS: American Heart Association CVH components (non–high-density-lipoprotein cholesterol, blood pressure, diet, tobacco use, physical activity, sleep, glycemia, and body mass index) were scored cross-sectionally at baseline (scale: 0–100). Differences in CVH and 95% CIs (Estimate, 95% CI) were calculated using linear regression, adjusting for age, sex, and discrimination. Heterogeneity by sex was assessed. Participants had a mean age of 54.8 years (SD 12.6 years), and 65% were women. Lower income, education, occupation (non-management/professional versus management/professional occupations), and insurance status (uninsured, Medicaid, Veterans Affairs, or Medicare versus private insurance) were associated with lower CVH scores (all $P<0.01$). There was heterogeneity by sex, with greater magnitude of associations of SES measures with CVH in women versus men. The lowest education level (<high school) versus highest (>high school) was associated with 8.8-point lower (95% CI: −10.2 to −7.3) and 5.4-point lower (95% CI: −7.2 to −3.6) CVH scores in women and men, respectively (interaction $P=0.003$). The lowest (<25 000) versus highest level of income (≥$75 000) was associated with a greater reduction in CVH scores in women than men (interaction $P=0.1142$).

CONCLUSIONS: Among Black Americans, measures of SES were associated with CVH, with a greater magnitude in women compared with men for education and income. Interventions aimed to address CVH through SES should consider the role of sex.

Key Words: Black American ■ socioeconomic status ■ education ■ income ■ cardiovascular health ■ Life's Essential 8 ■ health equity

Racial and ethnic minority groups in the United States have a higher prevalence of chronic diseases and premature mortality compared with non-Hispanic White (NHW) populations.[1–3] In particular, there exists an excess burden of cardiovascular disease (CVD) and CVD mortality in non-Hispanic Black Americans (Black Americans).[4] From 2017 to 2020, the prevalence of CVD in Black

Correspondence to: Joshua J. Joseph, MD, MPH, Department of Medicine, The Ohio State University Wexner Medical Center, 579 McCampbell Hall, 1581 Dodd Dr, Columbus, OH 43210. Email: joseph.117@osu.edu

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*J. J. Joseph and A. Williams contributed equally.

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CLINICAL PERSPECTIVE

What Is New?

- In Black Americans, lower levels of multiple measures of socioeconomic status were associated with lower levels of cardiovascular health measures.
- In Black Americans, lower levels of income and education had a greater magnitude of association with cardiovascular health in women compared with men.

What Are the Clinical Implications?

- Interventions aimed to address cardiovascular health through socioeconomic status should consider the role of sex in intervention development and evaluation, because improvements in socioeconomic status alone may be associated with less benefit in Black American men, thus emphasizing the potential importance of multilevel interventions in Black American men to advance health equity.

Nonstandard Abbreviations and Acronyms

AHA	American Heart Association
CVH	cardiovascular health
JHS	Jackson Heart Study
LE8	Life's Essential 8
NHW	non-Hispanic White

Americans was 59% in men and women, compared with 51% and 45% in NHW men and women, respectively.[5] In 2019, CVD mortality was 1.3-fold higher in 2019 for Black compared with NHW Americans (age-adjusted CVD mortality rates among Black men, Black women, NHW men, and NHW women were 526.3, 351.8, 396.0, and 267.5 per 100 000 people, respectively).[6] One component of the excess burden of CVD is an excess of modifiable cardiovascular risk factors in Black Americans and higher prevalence of adverse socioeconomic factors and social determinants of health.[2,3] Socioeconomic status (SES) influences CVD risk factors and outcomes and is posited to partially explain CVD racial and ethnic disparities.[4,7–11] Interestingly, Black Americans with high SES may still have higher risk for poor health outcomes, compared with NHW Americans.[12,13] In fact, other social determinants of health, including racism and discrimination, impact health and health behaviors in Black Americans and may mitigate health gains from advancements in SES.[14,15]

In 2022, the American Heart Association (AHA) updated its cardiovascular health (CVH) metric, Life's Essential 8 (LE8).[16] The 8 components of LE8 are healthful sleep, reducing blood glucose, controlling cholesterol, managing blood pressure, stopping smoking, getting physically active, eating healthfully, and maintaining (or achieving) a healthy body mass index (BMI).[16] Since the inception of LE8's predecessor, Life's Simple 7,[17] numerous studies have shown an association between attainment of higher levels of CVH with lower risk of diabetes, CVD, cancer, heart failure, and cognitive impairment.[18–21] Black American populations, including those represented within the Jackson Heart Study (JHS), have a lower attainment of higher levels of CVH compared with NHW populations.[22,23] However, there exists a scarcity of literature determining the association of SES measures with CVH in Black American populations and examining differences by sex.

In Black American men in the African American Male Wellness Walks, higher annual income ≥$75 k versus <$20 k and private insurance versus Medicare or no insurance was positively associated with attainment of CVH scores,[24] but there was no association of education or employment with attainment of CVH scores.[24] A previous JHS study evaluated the association of income and education with a 14-point total CVH score using the AHA metrics, revealing a positive association of income and education with the CVH score.[25] The authors did not test for heterogeneity by sex, nor evaluate the role of occupation or insurance in attainment of CVH. While there is limited evidence in regard to differences in the association of SES with attainment of CVH scores by sex, a recent meta-analysis did show potential sex differences in the association of SES with incident CVD and mortality worldwide.[26] In the meta-analysis, women were more sensitive to income and education in terms of CVD incidence, while men were more sensitive to income and education in terms of CVD mortality.[26]

Based on the extant literature, it is unclear whether the benefit of SES on CVH is consistent among various surrogate measures of SES and across sexes, particularly in Black American populations. Thus we will examine 4 components of SES with CVH attainment, including health insurance status, occupational roles, annual income, and highest education achieved in addition to testing for heterogeneity by sex. We hypothesize a lower magnitude of association of SES measures with CVH in men compared with women.

METHODS

Study Sample

The JHS is a prospective cohort study of CVD among 5306 Black American adults, aged 21 to 96 years, from the tri-county area of metropolitan Jackson,

Mississippi. Enrollment and baseline examinations were performed from 2000 to 2004. Details about the study design, recruitment, and methods have been described elsewhere.[27] Data from the baseline visit were analyzed cross-sectionally. Participants were excluded for missing data on outcomes (LE8 metrics [n=1152]) exposures (education [n=8] and insurance [n=12]), and important covariates (everyday discrimination [n=60]) with a final analytic sample of 4074, as shown in Figure S1. The study was approved by the institutional review boards of University of Mississippi Medical Center, Jackson State University, and Tougaloo College, and the participants gave written informed consent. This analysis of secondary data was exempted from approval by The Ohio State University Institutional Review Board, because the use of de-identified secondary data does not constitute human subjects research. This report followed the Strengthening the Reporting of Observational Studies in Epidemiology (STROBE) reporting guidelines for cohort studies. The data, analytic methods, and study materials are available to other researchers for purposes of reproducing the results or replicating the procedure by following the JHS publication procedures and data use agreements guidelines.[28]

Assessments

Baseline information was obtained using standardized questionnaires including demographics, annual income, educational level, occupation, insurance status, and current prescription medication use. Fasting blood samples were processed and stored using a standardized protocol.[27,29] The Everyday Discrimination Scale (9 items) measures perceptions of everyday discrimination of being treated with less respect and less courtesy than NHW Americans, among other factors. Scores range from 1 (never) to 7 (several times a day), with higher scores indicating greater perceived discrimination.[30]

Exposures

The exposures were annual income (<$25 k, $25 k–$34 k, $35 k–$74 k, and ≥$75 k), educational attainment (<high school, high school/general education development certificate, or >high school [attended vocational school, trade school, or college]), occupation (management/professional versus not), and insurance (private, Medicare\Medicaid, Veteran Affairs, dual-enrolled, and uninsured). Due to uncertainty about the types of insurance held, results from dual-enrolled participants were not reported.

Outcome

The primary outcome was LE8 score assessed using 8 metrics: tobacco use status, diet, physical activity, BMI, total cholesterol, blood pressure, sleep, and blood glucose.[16] LE8 score was calculated by averaging participants' scores for each metric (0–100). The secondary outcome was created by categorizing the LE8 scores as low (0–49), moderate (50–79), and high (80–100, Table S1).[16]

Tobacco Use

Self-reported tobacco use was categorized as current (0 points) and never (100 points). Former tobacco users were categorized as described in Table S1.[16]

Dietary Intake

The Dietary Approaches to Stop Hypertension (DASH) diet score was assessed using the methods of Fung et al.[31] Dietary components included fruits, vegetables, nuts and legumes, whole grains, low-fat dairy, sodium, red and processed meats, and sweetened beverages. LE8 diet score was then derived by comparing the DASH score in our study with percentile of DASH score based on 2017 to 2018 National Health and Nutrition Examination Survey data (Table S1).

Physical Activity

Physical activity was assessed using the validated JHS Physical Activity Cohort survey,[32] and defined according to the AHA categorization (Table S1).[16]

Serum Cholesterol, BMI, Blood Pressure, Glycemia, and Sleep

Participants' non–high-density lipoprotein cholesterol was scored as 100 points for <130 mg/dL and 0 points for ≥220 mg/dL. Intermediate values were scored according to Table S1. Calibrated devices were used to measure participants' weight and height to calculate BMI as weight (kilograms)/height^2 (meters^2). BMI was scored as follows: 0 points for ≥40 kg/m^2 and 100 points for <25 kg/m^2. Intermediate values were scored according to Table S1. Resting, seated blood pressure (BP) was measured twice at 5-minute intervals using an appropriately sized cuff with standard Hawksley random-zero instruments and measurements were averaged. BPs were scored as follows: 0 points for systolic BP ≥160 or diastolic BP ≥100 mm Hg and 100 points for <120/<80 mm Hg. Intermediate values were scored according to Table S1. Fasting glucose was measured on a Vitros 950 or 250, Ortho-Clinical Diagnostics analyzer (Raritan, NJ) using standard procedures that met the College of American Pathologists accreditation requirement.[29] Glycemia was scored as follows: 0 points for ≥10% glycated hemoglobin and 100 points for blood glucose <100 mg/dL or <5.7% glycated hemoglobin in the absence of self-reported diabetes. Intermediate values were scored according

to Table S1. Actual hours of sleep were scored as 100 points for 7 to <9 hours of sleep and 0 points for <4 hours of sleep. Other sleep durations were scored according to Table S1.

Covariates

Models were adjusted for age, sex, and daily discrimination.

Statistical Analysis

Descriptive statistics were used to compare the baseline characteristics of participants by categories of LE8 scores (low [0–49], moderate [50–79], and high [80–100]; Table 1), and by sex (Table S2) using ANOVA for normally distributed continuous variables, Kruskal–Wallis tests for non-normally distributed continuous variables, and χ^2 tests for categorical variables. Linear regression models were used to examine the associations of SES measures with continuous LE8 scores, and multinomial logistic regression models were used to examine the associations of SES measures with LE8 categories (0–49, 50–79, and 80–100). Each of the analyses utilizing health insurance, education, income, and occupation were performed in separate analytic models. Sequential multivariable adjustment modeling was performed: Model 1: unadjusted; Model 2: Model 1+age, sex, and everyday discrimination; and Model 3: included age, sex, everyday discrimination, and all 4 SES measures. Odds ratios were estimated comparing 50 to 79 or 80 to 100 LE8 score to 0 to 49. Heterogeneity by sex was assessed by placing an interaction term in the model. Two figures were used to visualize the interaction effect between SES measures and sex: (1) Predicted LE8 (95% CI) were plotted by SES measures and sex, and (2) odds ratios (50–79 versus 0–49 and 80–100 versus 0–49) and 95% CI were displayed graphically by SES measures and sex. Two sensitivity analyses were performed to confirm the robustness of the analyses. First, multiple imputation was used to handle missing data, which included 3 steps: (1) 10 imputed data sets were created using fully conditional method including discriminant function for categorical variables and predictive mean matching method for continuous variables; (2) linear regression modeling between SES and LE8 was fitted for each imputed data set; and (3) the parameter estimates (beta-coefficients and standard errors in linear regression models) obtained from each imputed data set were then combined for inference (Tables S3 and S4). Second, linear regression models were used to examine the associations of SES measures with continuous Life's Simple 7 scores using the 0 to 14 scoring (Tables S5 and S6).[33] All analyses were performed using SAS 9.4 (SAS Institute Inc., Cary, NC) and R version 4.2.0. Statistical significance was defined as a 2-sided $P<0.05$ for main effects and <0.10 for interaction terms, as has been done previously.[34,35]

Role of the Funding Source

The funding sources had no role in the design and conduct of the study; collection, management, analysis, and interpretation of the data; preparation, review, or approval of the manuscript; and decision to submit the manuscript for publication.

RESULTS

Baseline Characteristics

The baseline characteristics stratified by CVH categories and sex are presented in Table 1 and Table S2. Among 4074 participants, the mean age was 54.8 years (SD 12.6), and 65% were women. Participants with higher LE8 scores had higher levels of education, higher income, and were more likely to have management/professional occupational roles and private insurance (all $P<0.001$). Men had a lower prevalence of managerial/professional occupations (34% versus 40%), diabetes medication use, and BP medication use and lower total cholesterol and BMI. Men had higher BP, and everyday discrimination (all $P<0.05$).

Figure 1 shows the predicted LE8 scores and 95% CI for SES measures, stratified by sex, with age and everyday discrimination held constant at the mean. For income and education, the gap between men's and women's LE8 scores widened as these SES measures increased, with women having the highest scores. No differences existed by sex in the magnitude of association of occupation or insurance with LE8.

Association of SES Measures With LE8

The association of SES measures with LE8 is shown in Table 2, Model 2 and Table S7, Model 2, with adjustment for age, sex, and everyday discrimination. The lowest (<25 k) versus highest level of income (≥$75 k) was associated with an 8.7-point lower LE8 score (CI, −10.0 to −7.4). The lowest level of education (<high school) versus highest (>high school) was associated with a 7.5-point lower LE8 score (CI, −8.7 to −6.3). The lowest (non-management/professional) versus highest level of occupational role (management/professional) was associated with a 5.5-point lower LE8 score (CI, −6.4 to −4.7). The lowest (uninsured) versus highest level of insurance (private) was associated with a 7.1-point lower LE8 score (CI, −8.3 to −5.8).

Association of SES Measures With CVH Scores, Adjusting for all 4 SES Measures

All 4 SES measures were included in the same model with age, sex, and everyday discrimination

Table 1. Baseline Characteristics by Life's Essential 8 Category

Variable	Level*	Low (0–49) (n=1289)	Moderate (50–79) (n=2602)	High (80–100) (n=183)	Total (n=4074)	*P* value
Age	Mean (SD)	57.3 (11.4)	54.1 (12.9)	47.1 (12.3)	54.8 (12.6)	<0.001‡
Sex	Women	760 (59%)	1735 (66.7%)	132 (72.1%)	2627 (64.5%)	<0.001‡
	Men	529 (41%)	867 (33.3%)	51 (27.9%)	1447 (35.5%)	
Education	<High school	342 (26.5%)	338 (13%)	4 (2.2%)	684 (16.8%)	<0.001‡
	High school graduate/GED	307 (23.8%)	470 (18.1%)	15 (8.2%)	792 (19.4%)	
	>High school	640 (49.7%)	1794 (68.9%)	164 (89.6%)	2598 (63.8%)	
Income	Missing	196 (15.2%)	360 (13.8%)	25 (13.7%)	581 (14.3%)	<0.001‡
	<$25 000	507 (39.3%)	710 (27.3%)	22 (12%)	1239 (30.4%)	
	$25 000–$34 000	147 (11.4%)	292 (11.2%)	13 (7.1%)	452 (11.1%)	
	$35 000–$74 000	328 (25.4%)	807 (31%)	71 (38.8%)	1206 (29.6%)	
	$75 000 and above	111 (8.6%)	433 (16.6%)	52 (28.4%)	596 (14.6%)	
Occupation	Management/ professional	328 (25.4%)	1106 (42.5%)	109 (59.6%)	1543 (37.9%)	<0.001‡
	Non-management/ professional	961 (74.6%)	1496 (57.5%)	74 (40.4%)	2531 (62.1%)	
Insurance†	Private	503 (39%)	1503 (57.8%)	147 (80.3%)	2153 (52.8%)	<0.001‡
	Medicare	144 (11.2%)	204 (7.8%)	4 (2.2%)	352 (8.6%)	
	Medicaid	55 (4.3%)	51 (2%)	0 (0%)	106 (2.6%)	
	VA	21 (1.6%)	27 (1%)	1 (0.5%)	49 (1.2%)	
	Dual enrolled	336 (26.1%)	543 (20.9%)	15 (8.2%)	894 (21.9%)	
	Uninsured	230 (17.8%)	274 (10.5%)	16 (8.7%)	520 (12.8%)	
Glucose, mg/dL	Median [IQR]	98 [90–112]; missing=1	90 [84–97]	85 [81–89]	91 [85–100]; missing=1	<0.001‡
HbA1c	Median [IQR]	6 [5.6–6.7]; missing=16	5.5 [5.2–5.9]; missing=44	5.2 [5–5.5]; missing=3	5.7 [5.3–6.1]; missing=63	<0.001‡
Total cholesterol, mg/dL	Mean (SD)	212 (42)	194.9 (36.8)	176.9 (30.7)	199.5 (39.4)	<0.001‡
Systolic blood pressure, mm Hg	Mean (SD)	134.3 (17)	124.8 (15.4)	113.3 (11.4)	127.3 (16.7)	<0.001‡
Diastolic blood pressure, mm Hg	Mean (SD)	77.7 (9.2)	75.3 (8.2)	72.3 (7.1)	75.9 (8.6)	<0.001‡
Body mass index, kg/m^2	Mean (SD)	34.4 (7.6)	30.8 (6.7)	26 (3.2)	31.7 (7.2)	<0.001‡
Diabetes medications	Yes	288 (22.3%)	223 (8.6%)	0 (0%)	511 (12.5%)	<0.001‡
Blood pressure Medications	Yes	833 (64.6%)	1221 (46.9%)	28 (15.3%)	2082 (51.1%)	<0.001‡
Lipid-lowering medications	Yes	228 (17.7%)	312 (12%)	12 (6.6%)	552 (13.5%)	<0.001‡
Everyday discrimination	Median [IQR]	1.8 [1.2–2.7]	1.9 [1.2–2.6]	1.9 [1.3–2.6]	1.9 [1.2–2.6]	0.616
Life's Essential 8 Metrics§	Score					
Body mass index	0	252 (19.6%)	221 (8.5%)	1 (0.5%)	474 (11.6%)	<0.001‡
	15	283 (22%)	328 (12.6%)	1 (0.5%)	612 (15%)	
	30	397 (30.8%)	649 (24.9%)	12 (6.6%)	1058 (26%)	
	70	273 (21.2%)	1001 (38.5%)	91 (49.7%)	1365 (33.5%)	
	100	84 (6.5%)	403 (15.5%)	78 (42.6%)	565 (13.9%)	
Blood pressure	0	101 (7.8%)	71 (2.7%)	1 (0.5%)	173 (4.2%)	<0.001
	5	224 (17.4%)	203 (7.8%)	1 (0.5%)	428 (10.5%)	
	25	119 (9.2%)	115 (4.4%)	2 (1.1%)	236 (5.8%)	
	30	290 (22.5%)	374 (14.4%)	7 (3.8%)	671 (16.5%)	
	50	170 (13.2%)	353 (13.6%)	19 (10.4%)	542 (13.3%)	
	55	127 (9.9%)	258 (9.9%)	6 (3.3%)	391 (9.6%)	
	75	64 (5%)	262 (10.1%)	15 (8.2%)	341 (8.4%)	
	80	120 (9.3%)	338 (13%)	14 (7.7%)	472 (11.6%)	
	100	74 (5.7%)	628 (24.1%)	118 (64.5%)	820 (20.1%)	

(*Continued*)

Table 1. Continued

Variable	Level*	Low (0–49) (n=1289)	Moderate (50–79) (n=2602)	High (80–100) (n=183)	Total (n=4074)	*P* value
Physical activity	0	966 (74.9%)	954 (36.7%)	7 (3.8%)	1927 (47.3%)	<0.001
	20	148 (11.5%)	340 (13.1%)	6 (3.3%)	494 (12.1%)	
	40	52 (4%)	166 (6.4%)	4 (2.2%)	222 (5.4%)	
	60	58 (4.5%)	374 (14.4%)	24 (13.1%)	456 (11.2%)	
	80	18 (1.4%)	130 (5%)	16 (8.7%)	164 (4%)	
	90	11 (0.9%)	118 (4.5%)	12 (6.6%)	141 (3.5%)	
	100	36 (2.8%)	520 (20%)	114 (62.3%)	670 (16.4%)	
Smoking status	0	369 (28.6%)	212 (8.1%)	1 (0.5%)	582 (14.3%)	<0.001
	5	75 (5.8%)	30 (1.2%)	0 (0%)	105 (2.6%)	
	25	61 (4.7%)	59 (2.3%)	1 (0.5%)	121 (3%)	
	30	37 (2.9%)	27 (1%)	0 (0%)	64 (1.6%)	
	50	26 (2%)	35 (1.3%)	1 (0.5%)	62 (1.5%)	
	55	47 (3.6%)	72 (2.8%)	1 (0.5%)	120 (2.9%)	
	75	63 (4.9%)	162 (6.2%)	14 (7.7%)	239 (5.9%)	
	80	203 (15.7%)	540 (20.8%)	28 (15.3%)	771 (18.9%)	
	100	408 (31.7%)	1465 (56.3%)	137 (74.9%)	2010 (49.3%)	
Non-HDL cholesterol	0	131 (10.2%)	75 (2.9%)	1 (0.5%)	207 (5.1%)	<0.001
	20	224 (17.4%)	221 (8.5%)	4 (2.2%)	449 (11%)	
	40	355 (27.5%)	553 (21.3%)	19 (10.4%)	927 (22.8%)	
	60	336 (26.1%)	764 (29.4%)	32 (17.5%)	1132 (27.8%)	
	80	67 (5.2%)	167 (6.4%)	6 (3.3%)	240 (5.9%)	
	100	176 (13.7%)	822 (31.6%)	121 (66.1%)	1119 (27.5%)	
Diet	0	486 (37.7%)	471 (18.1%)	9 (4.9%)	966 (23.7%)	<0.001
	25	453 (35.1%)	825 (31.7%)	25 (13.7%)	1303 (32%)	
	50	234 (18.2%)	605 (23.3%)	33 (18%)	872 (21.4%)	
	80	104 (8.1%)	513 (19.7%)	79 (43.2%)	696 (17.1%)	
	100	12 (0.9%)	188 (7.2%)	37 (20.2%)	237 (5.8%)	
Sleep	0	50 (3.9%)	20 (0.8%)	0 (0%)	70 (1.7%)	<0.001
	20	147 (11.4%)	112 (4.3%)	1 (0.5%)	260 (6.4%)	
	40	332 (25.8%)	398 (15.3%)	7 (3.8%)	737 (18.1%)	
	70	369 (28.6%)	777 (29.9%)	55 (30.1%)	1201 (29.5%)	
	90	34 (2.6%)	84 (3.2%)	8 (4.4%)	126 (3.1%)	
	100	357 (27.7%)	1211 (46.5%)	112 (61.2%)	1680 (41.2%)	
Glycemia	0	62 (4.8%)	19 (0.7%)	0 (0%)	81 (2%)	<0.001
	10	33 (2.6%)	15 (0.6%)	0 (0%)	48 (1.2%)	
	20	65 (5%)	47 (1.8%)	0 (0%)	112 (2.7%)	
	30	106 (8.2%)	74 (2.8%)	0 (0%)	180 (4.4%)	
	40	208 (16.1%)	199 (7.6%)	1 (0.5%)	408 (10%)	
	60	568 (44.1%)	838 (32.2%)	18 (9.8%)	1424 (35%)	
	100	247 (19.2%)	1410 (54.2%)	164 (89.6%)	1821 (44.7%)	
Life's Essential 8 Score	Median [IQR]	42.5 [36.9–46.3]	61.3 [55.6–68.1]	83.8 [81.3–86.9]	56.3 [46.9–65.6]	<0.001

GED indicates general education development certificate; and VA, US Department of Veterans Affairs.

*Mean (SD), median [IQR], or frequency (percent) are listed, *P* values calculated using χ^2 (categorical variables), ANOVA (normally distributed continuous variables) and Kruskal–Wallis test (non-normally distributed continuous variables).

†The dual-enrolled category includes: private insurance & Medicare; private insurance & Medicaid; private insurance & VA; VA & Medicare; VA & Medicaid; Medicare & Medicaid; private insurance & VA & Medicare; private insurance & VA & Medicaid; private insurance & Medicare & Medicaid; Medicare & Medicaid & VA; private insurance & Medicare & Medicaid & VA.

‡*P* values are <0.05.

§Scoring for Life's Essential 8 is provided in Table S1.

to assess the association of SES measures with LE8 scores (Table 2, Model 3). The association for income with LE8 scores remained significant at *P*<0.001 for all levels of income. In multivariable models, education remained significant at *P*<0.05 for high school graduate/general education development certificate versus >high school education and *P*<0.001 for <high school education versus >high school education. The association of the lowest (non-management/professional) versus

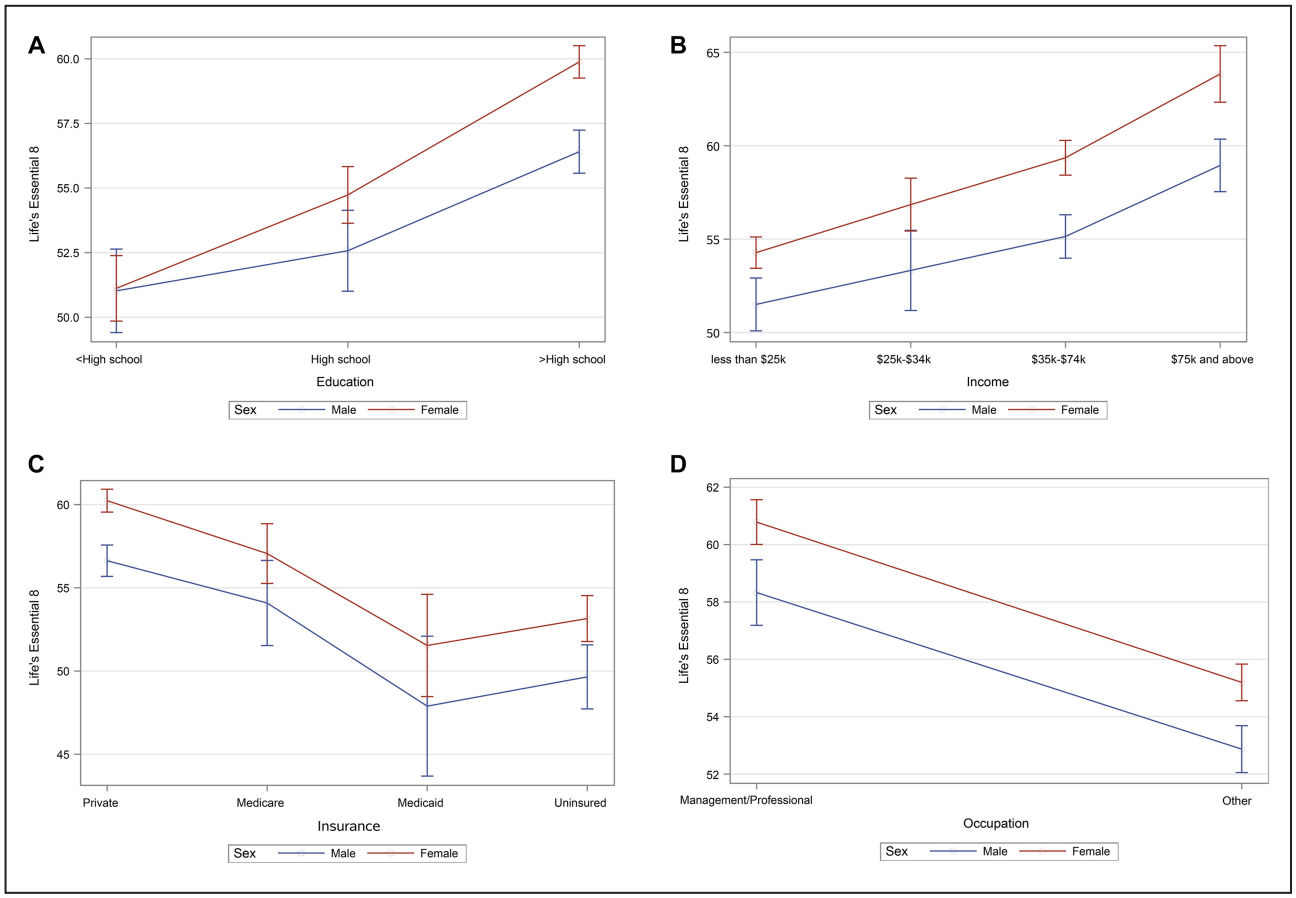

Figure 1. Predicted Life's Essential 8 scores (95% CI) for socioeconomic status measures, stratified by sex.
Error bars are 95% confidence limits. **A**, Predicted Life's Essential 8 scores for each level of education with age and everyday discrimination held constant at the mean. **B**, Income. **C,** Insurance. **D,** Occupation. Interpretation: the association of education with Life's Essential 8 is of greater magnitude in women than men, because the trend in Life's Essential 8 scores increases more sharply with increasing education in women than men. There is little difference between men and women of lower education levels, but a significant gap appears, with women having higher scores at higher education levels.

highest level of occupational role (management/professional) with LE8 scores remained significant ($P<0.001$). All insurance associations became non-significant except uninsured and Medicaid versus private (both $P<0.001$).

Association of SES Measures With LE8 by Sex

In Figure 2, Table 3, and Table S8, the magnitude and significance of associations were generally greater among women. The lowest (<25 k) versus highest level of income (≥$75 k) was associated with 9.6-point lower (–11.3, –7.8) and 7.4-point lower (–9.4, –5.4) LE8 scores in women and men, respectively (P for interaction=0.114), in age- and discrimination-adjusted models. In models that included all 4 SES variables, age, and discrimination, the sex*income interaction P value for <25 k compared with ≥$75 k was significant ($P$=0.085). The lowest level of education (<high school) versus highest (>high school) was associated with 8.8-point lower (–10.2, –7.3) and 5.4-point lower (–7.2, –3.6) LE8 scores in women and men, respectively (P for interaction=0.003). There were no significant sex differences in the associations of occupation or health insurance with LE8 scores.

Sensitivity Analyses

There were similar findings of the association of SES with CVH and differences by sex in the association of SES measures with CVH using a data set with less missingness after multiple imputation (Tables S3 and S4). Similar findings were shown for the association of SES measures with CVH in directionality and significance using AHA's Life's Simple 7 in comparison to Life's Essential 8. Lower levels of income, education, occupation, and insurance (Medicaid or uninsured vs private) were associated with lower Life's Simple 7 scores (0–14) (Tables S5 and S6). There were sex differences in the Life's Simple 7–based analysis, with greater magnitude of association in women for the

Table 2. Association of Socioeconomic Status Measures With Continuous Life's Essential 8 Scores

Socioeconomic status levels	Estimate Model 1	95% CI	*P* value	Estimate Model 2	95% CI	*P* value	Estimate Model 3	95% CI	*P* value
Income									
<$25 k	−8.83	(−10.11 to −7.54)	<0.001*	−8.72	(−10.01 to −7.42)	<0.001*	−4.62	(−6.10 to −3.14)	<0.001*
$25 k–$34 k	−5.88	(−7.49 to −4.26)	<0.001*	−6.32	(−7.91 to −4.74)	<0.001*	−4.30	(−5.91 to −2.70)	<0.001*
$35 k–$74 k	−3.47	(−4.77 to −2.18)	<0.001*	−4.06	(−5.33 to −2.80)	<0.001*	−3.04	(−4.30 to −1.78)	<0.001*
$75 k and above	Referent								
Education									
<High school	−9.24	(−10.34 to −8.14)	<0.001*	−7.51	(−8.69 to −6.33)	<0.001*	−3.30	(−4.76 to −1.85)	<0.001*
High school graduate/GED	−5.23	(−6.27 to −4.19)	<0.001*	−4.69	(−5.73 to −3.65)	<0.001*	−1.30	(−2.52 to −0.08)	0.037*
>High school	Referent								
Occupation									
Non-management/ professional	−6.17	(−7.01 to −5.34)	<0.001*	−5.54	(−6.37 to −4.72)	<0.001*	−2.76	(−3.76 to −1.76)	<0.001*
Management/professional	Referent								
Insurance									
Medicare	−7.00	(−8.48 to −5.51)	<0.001*	−3.66	(−5.28 to −2.03)	<0.001*	−0.78	(−2.58 to 1.02)	0.395
Medicaid	−10.22	(−12.79 to −7.65)	<0.001*	−8.97	(−11.50 to −6.44)	<0.001*	−4.97	(−7.86 to −2.07)	<0.001*
VA	−7.32	(−11.05 to −3.59)	<0.001*	−4.68	(−8.36 to −1.00)	0.013*	−3.38	(−7.42 to 0.66)	0.101
Uninsured	−6.98	(−8.24 to −5.72)	<0.001*	−7.05	(−8.29 to −5.81)	<0.001*	−4.35	(−5.76 to −2.94)	<0.001*
Private	Referent								

Model 1: unadjusted model, Model 2: adjusted for age, sex, and everyday discrimination; Model 3: adjusted for age, sex, everyday discrimination, and 4 socioeconomic status exposures together. Example Interpretation: In Model 2, The Life's Essential 8 score among participants with income <$25 k was 8.72 points lower than those with income $75 k and above (estimate: −8.72 [95% CI, −10.01 to −7.42], *P*<0.001) with adjustment for age, sex, and everyday discrimination. GED indicates general education development certificate, and VA, US Department of Veterans Affairs.

**P* values are <0.05.

associations of income, education, and Medicare versus private insurance with Life's Simple 7.

DISCUSSION

In this large, prospective, community-based cohort study of Black Americans, lower levels of income and education, non-management/professional occupational roles versus management/professional occupational roles, and uninsured or Medicaid versus private insurance were associated with lower LE8 scores. To examine the relative importance of various correlated SES measures on LE8, adjustment for all 4 measures of SES simultaneously fully attenuated the associations of most insurance types with LE8. Importantly, there were significant differences of the association SES with CVH scores by sex, with women having a greater effect size for many of the SES measures, including education and income. Evaluation of the predicted LE8 scores reveals that the widest gaps between men and women (with women having the highest scores) come at higher levels of income and education. The ≈5-point gaps between men and women of high SES are clinically significant, because a 6-point difference in LE8 score is associated with a 16% difference in major adverse cardiovascular event risk.[36] We also demonstrated that men and women of high SES are more likely to have high CVH. High CVH, as defined by LE8 score ≥80, in men and women is associated with 7 and 9 years longer disease-free life expectancy than men and women with low CVH (LE8 scores <50), respectively.[37]

The study is consistent with the extant literature that in the United States and around the world, SES has a significant association with CVD.[9,10,38] In US- and foreign-born White, Asian, and Latino adults in California, participants with higher educational attainment had higher levels of individual components of CVH as assessed by Life's Simple 7, except for Asian participants.[39] In Europeans, higher education levels were associated with higher levels of CVH as compared with those with low or medium education.[40] MacDonald et al also conducted a cross-sectional study of middle-aged workers in the United States and demonstrated differences in the prevalence of CVH between occupations, with sales and low status office workers having a low prevalence of optimal CVH.[41] A study by McClurkin et al demonstrated that lack of health insurance may be a barrier to attaining CVH for US adults.[42] Among Black Americans in the JHS, higher levels of income and education were associated with higher CVH score using a 14-point scale.[25]

A major limitation of the extant literature is the limited evaluation of potential differences in the association of SES with CVH by sex. Black American men who

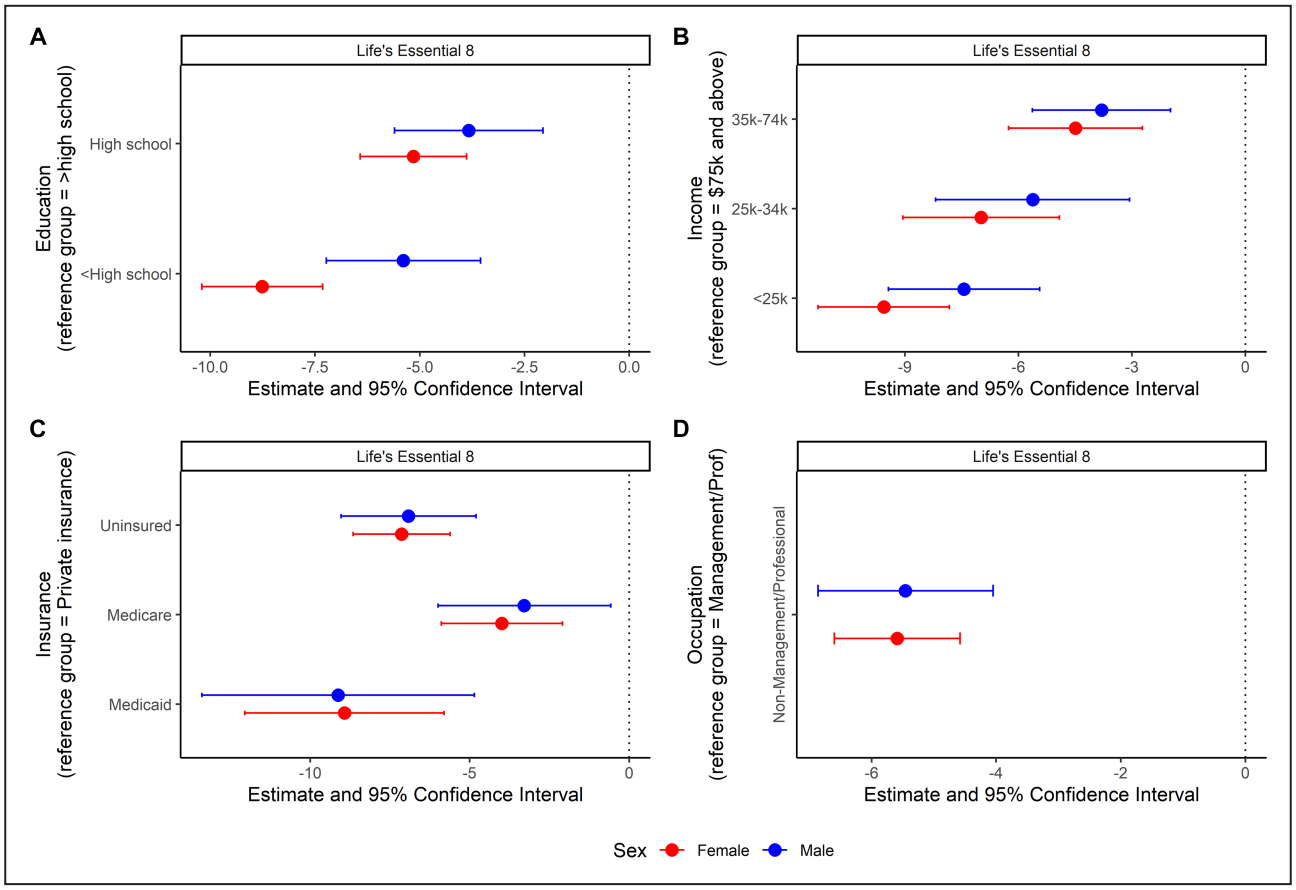

Figure 2. Association of socioeconomic status measures with Life's Essential 8 Score by sex.
Estimates come from models adjusted for age and everyday discrimination. **A**, Difference in Life's Essential 8 scores between the referent group (>high school education) and the education levels indicated on the *y* axis. **B**, Difference in Life's Essential 8 scores between the referent group (≥$75 000) and the income levels indicated on the *y* axis. **C**, Difference in Life's Essential 8 scores between the referent group (private insurance) and the types of health insurance listed on the *y* axis. **D**, Difference in Life's Essential 8 scores between those with a management/professional occupation and those with a non-management/non-professional occupation.

attended African American Male Wellness Walks had a positive association between income and attainment of ideal cardiovascular health, but there was no association of education or employment with attainment of CVH.[24] The sex-stratified findings in this analysis reveal greater magnitudes of association of SES with CVH in women compared with men. These findings of CVH in Black men are similar to the findings in Black men attending community walks.[24] Interestingly, higher levels of education and income were associated with higher attainment of CVH in Chinese women, but not in Chinese men, consistent with some of the findings in Black men.[43]

The literature on sex differences in socioeconomic mobility is similarly limited. Others have found evidence of sex differences in the health effects of socioeconomic mobility, but results are mixed.[44,45] This cross-sectional analysis did not consider how change in SES may affect CVH, which is an important area for future research. Previously, we discussed the potential role of allostatic load from the cumulative stress associated with discrimination and racism in Black populations as an explanation of some differences in SES between Black and White American populations.[24] Thus, in this analysis, we adjusted for everyday discrimination. Everyday discrimination was noted to be higher in men, but adjustment in the models did not decrease the magnitude of sex differences among Black men and women. No differences existed in baseline education between men and women. While there were no statistically significant differences in income, numerical differences did exist with 35% of women in the <25 k group, compared with 22% of men and 11% of women in the ≥75 k group compared with 22% of men. Insurance was similar across sex, except Veterans Affairs insurance, which was higher in men. The median LE8 score was 57.5 in women and 55 in men. The authors would expect other built environment factors that may influence the association of SES with CVH to be similar across sexes, but confirming this through examining factors such as racial residential segregation and area deprivation index is another important area for further inquiry given the significant association of these

Table 3. Association of Socioeconomic Status Measures With Continuous Life's Essential 8 by Sex

Socioeconomic status levels	Sex	Model 1				Model 2				Model 3			
		Estimate	95% CI	*P* value	Interaction *P* value	Estimate	95% CI	*P* value	Interaction *P* value	Estimate	95% CI	*P* value	Interaction *P* value
Income													
<$25 000 vs 75 000 and above	Women	−10.88	(−12.63 to −9.12)	<0.001*	0.093	−9.56	(−11.30 to −7.83)	<0.001*	0.114	−5.56	(−7.42, −3.70)	<0.001*	0.085
$25 000–$34 000 vs 75 000 and above	Women	−7.50	(−9.61 to −5.39)	<0.001*	0.437	−6.99	(−9.06 to −4.92)	<0.001*	0.415	−5.11	(−7.18, −3.04)	<0.001*	0.319
$35 000–$74 000 vs 75 000 and above	Women	−4.64	(−6.45 to −2.84)	<0.001*	0.423	−4.49	(−6.26 to −2.72)	<0.001*	0.599	−3.61	(−5.36, −1.86)	<0.001*	0.443
<$25 000 vs 75 000 and above	Men	−8.58	(−10.61 to −6.55)	<0.001*		−7.44	(−9.44 to −5.44)	<0.001*		−3.28	(−5.39, −1.17)	0.002*	
$25 000–$34 k vs 75 000 and above	Men	−6.17	(−8.78 to −3.55)	<0.001*		−5.62	(−8.19 to −3.06)	<0.001*		−3.46	(−6.02, −0.89)	0.008*	
$35 000–$74 k vs 75 000 and above	Men	−3.59	(−5.44 to −1.73)	<0.001*		−3.80	(−5.63 to −1.98)	<0.001*		−2.63	(−4.44, −0.82)	0.004*	
Education													
Less than high school vs >high school	Women	−10.49	(−11.87 to −9.11)	<0.001*	0.003*	−8.76	(−10.20 to −7.32)	<0.001*	0.003*	−4.56	(−6.28, −2.84)	<0.001*	0.006*
High school graduate/GED vs >high school	Women	−5.97	(−7.24 to −4.70)	<0.001*	0.088	−5.15	(−6.42 to −3.88)	<0.001*	0.236	−1.27	(−2.75, 0.21)	0.093	0.918
Less than high school vs >high school	Men	−7.00	(−8.80 to −5.19)	<0.001*		−5.39	(−7.23 to −3.55)	<0.001*		−1.16	(−3.25, 0.94)	0.280	
High school graduate/GED vs >high school	Men	−4.06	(−5.85 to −2.27)	<0.001*		−3.83	(−5.60 to −2.06)	<0.001*		−1.39	(−3.32, 0.54)	0.157	
Occupation													
Non- vs management/professional	Women	−6.22	(−7.25 to −5.19)	<0.001*	0.553	−5.59	(−6.60 to −4.58)	<0.001*	0.881	−2.60	(−3.79, −1.41)	<0.001*	0.636
Non- vs management/professional	Men	−5.69	(−7.12 to −4.25)	<0.001*		−5.46	(−6.86 to −4.05)	<0.001*		−3.04	(−4.58, −1.50)	<0.001*	
Insurance													
Medicare vs private	Women	−7.51	(−9.28 to −5.73)	<0.001*	0.465	−3.99	(−5.89 to −2.09)	<0.001*	0.661	−1.38	(−3.48, 0.71)	0.196	0.367
Medicaid vs private	Women	−9.83	(−12.99 to −6.67)	<0.001*	0.693	−8.92	(−12.05 to −5.80)	<0.001*	0.942	−5.20	(−8.82, −1.57)	0.005*	0.868
VA vs Private	Women	−5.15	(−12.91 to 2.62)	0.194	0.867	−2.99	(−10.65 to 4.67)	0.444	0.704	0.26	(−8.50, 9.03)	0.953	0.411
Uninsured vs private	Women	−7.22	(−8.76 to −5.67)	<0.001*	0.631	−7.13	(−8.65 to −5.61)	<0.001*	0.873	−4.39	(−6.10, −2.69)	<0.001*	0.999
Medicare vs private	Men	−6.32	(−8.97 to −3.67)	<0.001*		−3.29	(−5.99 to −0.58)	0.017*		0.15	(−2.74, 3.03)	0.920	
Medicaid vs private	Men	−10.91	(−15.23 to −6.59)	<0.001*		−9.12	(−13.39 to −4.85)	<0.001*		−4.71	(−9.31, −0.10)	0.045*	
VA vs private	Men	−5.91	(−10.17 to −1.64)	0.007*		−4.68	(−8.89 to −0.47)	0.029*		−3.87	(−8.42, 0.69)	0.096	
Uninsured vs private	Men	−6.57	(−8.72 to −4.43)	<0.001*		−6.92	(−9.03 to −4.80)	<0.001*		−4.39	(−6.70, −2.08)	<0.001*	

Model 1: unadjusted model; Model 2: adjusted for age, everyday discrimination; Model 3: adjusted for age, everyday discrimination, and 4 socioeconomic status exposures together. Example Interpretation: in Model 2, for women, Life's Essential 8 was 8.76 points lower among participants with <high school degree compared with those with >high school degree (estimate, −8.76 [95% CI, −10.20 to −7.32], *P*<0.001); For men, Life's Essential 8 was 5.39 points lower among participants with <high school degree compared with those with > high school degree (estimate, −5.39 [95% CI, −7.23 to −3.55], *P*<0.001). The sex × education interaction *P* value for <high school compared with >high school was 0.003, indicating a significant difference in association of education with Life's Essential 8 between women and men. GED indicates general education development certificate; and VA, US Department of Veterans Affairs.

**P* values are <0.05.

measures with SES, CVH, and CVD.[46–49] A sex difference relevant to the current results is the lower utilization of the health care system in Black men compared with women,[50] which may explain the lower scores among men. Further research to determine mediators of the differential association in men versus women is critical given that Black men have the shortest life expectancy of any US racial/sex group, and CVD remains the leading cause of death in Black men.[51]

Strengths and Limitations

Strengths of the study include a large, socioeconomically diverse, Black American cohort, along with validated questionnaires and a comprehensive ascertainment of AHA CVH categories. Furthermore, we assessed 4 surrogate measures for SES, and assessed strength of associations by including multiple SES measures simultaneously in models, which has seldom been performed. We analyzed heterogeneity by sex. Despite these strengths, our study should be considered in light of some limitations. First, JHS participants are from a major metropolitan area in the southeastern United States, and thus, findings may not be generalizable to all Black Americans. Geography may interact with the observed results, such that findings may not be generalizable to all regions of the United States. Despite this limitation, this cohort's calculated LE8 score (56.3) is 3 points lower than the calculated LE8 score for Black Americans in the National Health and Nutrition Examination Survey (59.7),[23] suggesting that the JHS population is less healthy than a nationally representative sample of Black Americans. Studies of other cohorts are necessary to confirm these findings. Second, self-reported physical activity and dietary intake were used, which although validated, have the potential for misclassification and residual confounding due to lack of precision compared with objective measures. Finally, while we did have >1400 men in the analysis; the men only represented one-third of the sample, potentially impacting the significance of the sex-stratified findings.

CONCLUSIONS

Among Black Americans in the JHS, multiple measures of SES were associated with attainment of CVH, with greater magnitudes of association for income and education in women. Thus, policies and practices that improve income and education should have a beneficial impact on CVH in Black women. Further research is needed to address the potential pathways leading to the diminished impact of SES on attainment of CVH in Black men. The findings indicate that advancements in overall SES measures in Black Americans are 1 route to improve CVD risk factors, but among Black men, addressing additional factors concurrently with SES may be important to improve CVH attainment. Thus, multilevel interventions and programming are needed to improve CVH in Black men. These interventions should include factors such as trust in the health care system, patient–provider engagement, and health education.[33,52] Additionally, interventions that address public health and the approach of health care to engaging with communities and populations, specifically Black men, are essential to improve CVD risk factors.[53–55]

ARTICLE INFORMATION

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Affiliations

The Ohio State University College of Medicine, Columbus, OH (J.J.J., A.W., R.A.A., S.Z., G.B.); Department of Biostatistics and Data Science, Division of Public Health Sciences, Wake Forest School of Medicine, Winston-Salem, NC (D.K.); The Ohio State University College of Public Health, Columbus, OH (J.B.O.); Department of Internal Medicine and Institute for Informatics, Washington University in St. Louis School of Medicine, St. Louis, MO (R.F.); University of California, Riverside, CA (M.S.); Department of Cardiovascular Medicine, Center for Health Equity and Community Engagement Research, Mayo Clinic, Rochester, MN (L.C.B.); Now with Elevance Health (formerly of The Ohio State University Wexner Medical Center), Indianapolis, IN (D.M.G.); and The Ohio State University College of Nursing, Columbus, OH (T.S.N.).

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Supplemental Material

Tables S1–S8
Figure S1
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