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Original Contribution

Examining the Relationship Between Multilevel Resilience Resources and Cardiovascular Disease Incidence, Overall and by Psychosocial Risks, Among Participants in the Jackson Heart Study, the Multi-Ethnic Study of Atherosclerosis, and the Mediators of Atherosclerosis in South Asians Living in America (MASALA) Study

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We examined relationships between resilience resources (optimism, social support, and neighborhood social cohesion) and cardiovascular disease (CVD) incidence and assessed potential effect-measure modification by psychosocial risk factors (e.g., stress, depression) among adults without CVD in 3 cohort studies (2000–2018): the Jackson Heart Study, the Multi-Ethnic Study of Atherosclerosis, and the Mediators of Atherosclerosis in South Asians Living in America (MASALA) Study. We fitted adjusted Cox models accounting for within-neighborhood clustering while censoring at dropout or non-CVD death. We assessed for effect-measure modification by psychosocial risks. In secondary analyses, we estimated standardized risk ratios using inverse-probability–weighted Aalen-Johansen estimators to account for confounding, dropout, and competing risks (non-CVD deaths) and obtained 95% confidence intervals (CIs) using cluster bootstrapping. For high and medium (versus low) optimism ($n = 6{,}243$), adjusted hazard ratios (HRs) for incident CVD were 0.94 (95% CI: 0.78, 1.13) and 0.90 (95% CI: 0.75, 1.07), respectively. Corresponding HRs were 0.88 (95% CI: 0.74, 1.04) and 0.92 (95% CI: 0.79, 1.06) for social support ($n = 7{,}729$) and 1.10 (95% CI: 0.94, 1.29) and 0.99 (95% CI: 0.85, 1.16) for social cohesion ($n = 7{,}557$), respectively. Some psychosocial risks modified CVD HRs. Secondary analyses yielded similar findings. For optimism and social support, an inverse relationship was frequently most compatible with the data, but a positive relationship was also compatible. For neighborhood social cohesion, positive and null relationships were most compatible. Thus, specific resilience resources may be potential intervention targets, especially among certain subgroups.

cardiovascular disease; optimism; psychological resilience; psychosocial factors; social cohesion; social support

Abbreviations: CI, confidence interval; CVD, cardiovascular disease; EMM, effect-measure modification; HR, hazard ratio; JHS, Jackson Heart Study; MASALA, Mediators of Atherosclerosis in South Asians Living in America; MESA, Multi-Ethnic Study of Atherosclerosis.

Cardiovascular disease (CVD) is one of the leading causes of death in the United States, and the US government has prioritized efforts to reduce and prevent adverse CVD outcomes (1). However, racial/ethnic disparities in CVD incidence and mortality rates persist (2, 3), as African-American adults have a higher CVD mortality rate than White non-Hispanic adults (4). Further, the underlying cause of such persistent disparities may be rooted in structural racism, leading to disparities in exposure to adversities that negatively affect health (5, 6). These adversities, or psychosocial risk factors (e.g., anger, perceived discrimination, and neighborhood deprivation)—henceforth referred to as psychosocial

risks—may be experienced at multiple levels disproportionately across populations. For example, individuals with a low socioeconomic position may experience greater psychosocial risk than those with a higher socioeconomic position (7–10). However, although it is important to address psychosocial risks in the context of CVD, resilience resources may be more malleable targets for interventions to reduce CVD incidence.

Resilience has been defined as the ability of individuals to cope positively and adapt to adversity (11, 12). Based on the reserve capacity model, resilience is a dynamic process wherein individuals may utilize resources at different levels (10, 13). Examples of potential resilience resources are optimism (individual level), social support (interpersonal level), and neighborhood social cohesion (neighborhood level) (14, 15). Prior studies examining the relationship between resilience resources and CVD incidence suggested that having greater resources may reduce numbers of adverse CVD events (16–21). Although some studies have accounted for psychosocial risks (e.g., depression) as potential confounders, there is limited evidence on how the relationship is modified by the levels of psychosocial risks experienced. For instance, resilience resources may only be beneficial in the presence of challenges such as exposure to psychosocial risks.

Thus, our study examined the relationship between resilience resources (i.e., optimism, social support, and neighborhood social cohesion, assessed separately) and incident CVD events in a racially/ethnically diverse population. To investigate whether this relationship differed by psychosocial risks, for each resilience resource, we assessed potential effect-measure modification (EMM) one psychosocial risk at a time.

METHODS

Study population

The study population included adults from 3 US cohort studies: the Jackson Heart Study (JHS; $n = 5{,}306$), the Multi-Ethnic Study of Atherosclerosis (MESA; $n = 6{,}814$), and the Mediators of Atherosclerosis in South Asians Living in America (MASALA) Study ($n = 1{,}164$). Data from the 3 studies were harmonized. JHS and MESA participants were included in the optimism analysis, while JHS, MESA, and MASALA participants were included in the social support and neighborhood social cohesion analyses.

The cohort studies have been described in detail elsewhere (22–24), but briefly, the JHS is a study of African-American adults aged 21 years or older residing in Jackson, Mississippi. Examination 1 was conducted from September 2000 to March 2004, and participants are followed up every 4–5 years. Annual follow-up interviews have been conducted approximately every year following the participants' first examination. MESA includes White non-Hispanic, African-American, Asian, and Hispanic adults aged 45–84 years without a CVD history at enrollment from 6 US sites (New York, New York; Baltimore, Maryland; Chicago, Illinois; Los Angeles, California; Minneapolis-St. Paul, Minnesota; and Winston-Salem, North Carolina). Examination 1 was conducted from July 2000 to August 2002, and participants have been followed up every 2–5 years. MASALA is a study of South Asian adults over the age of 40 years without a CVD history from the San Francisco Bay and Chicago areas. The first examination was conducted in 2010–2013, with a follow-up examination during 2015–2018.

The institutional review boards at each study site approved the parent cohort study, and all study participants provided written informed consent. This secondary data analysis was approved by the Brown University (Providence, Rhode Island) Institutional Review Board.

Measures

Exposures evaluated included optimism, social support, and neighborhood social cohesion. Optimism was measured using the Revised Life Orientation Test during the second annual follow-up interview in the JHS and at examination 2 in MESA. Optimism was assessed at MASALA examination 2, but information was unavailable in the harmonized data set. The Revised Life Orientation Test had an acceptable level of reliability (Cronbach's $\alpha = 0.69$). Social support was measured at examination 1 using the Interpersonal Social Support Evaluation List in the JHS and the Social Support Inventory in MASALA and MESA. Although different, scores from the 2 scales were harmonized by averaging the sums of similar items within both scales and standardizing on a 0–1 scale. The harmonized scale showed an acceptable level of internal reliability (Cronbach's $\alpha = 0.79$). Neighborhood social cohesion was measured using the 5-item Neighborhood Social Cohesion Scale during the third annual follow-up interview in the JHS (25) and examination 1 in MASALA and MESA. The 4-point scale used in the JHS was rescaled to match the 5-point scale used in MASALA and MESA (26). Cronbach's α was 0.73. All 3 resilience resources were time-fixed, self-reported, and examined as tertiles (low/medium/high).

The outcome variable was an incident CVD event. Details on adjudication of a CVD event have been published previously (24, 27–29). Briefly, eligible CVD events included coronary heart disease (definite/probable myocardial infarction, death, resuscitated cardiac arrest, and coronary revascularization), heart failure (definite/probable), and stroke (fatal/nonfatal). In the JHS, eligible CVD events were identified during annual telephone interviews and through monitoring of medical records and death registries. In MASALA and MESA, eligible CVD events were identified primarily through self-reports (or next-of-kin/proxy reports for deaths) during annual telephone interviews. In all 3 cohorts, independent physician reviewers adjudicated the identified events using medical records, and disagreements were resolved by a third independent reviewer or the full review committee.

Potential confounding variables included age (years; continuous), sex/gender (male/female), race/ethnicity (White non-Hispanic/Asian/African-American/Hispanic), geographic region (West/South/Midwest/Northeast), nativity (US-born/non–US-born), marital status (married/never married, separated, divorced, widowed), self-rated health (good/not good), health insurance (public or private/none), family history of CVD (yes/no), and religiosity (high/not high;

optimism analysis only). All confounding variables were time-fixed, self-reported, and assessed concurrently with or before exposure assessment. In addition, all confounders were identified a priori and considered potential sources of selection bias (30). When a resilience resource was not the exposure of interest, it was treated as a confounder if assessed concurrently with or before the exposure.

Potential effect modifiers included psychosocial risk factors for CVD (7–9): education, employment, income, anger, chronic stress, depressive symptoms, perceived everyday discrimination, neighborhood deprivation, and neighborhood safety. Education was categorized as less than high school, high school or some college, and college degree or more. Annual family income was adjusted for inflation using the value of the US dollar in the year 2000 and was categorized as ≤$19,999, $20,000–$49,999, and ≥$50,000. Employment was dichotomized into employed at least part-time and unemployed. Anger was measured using the harmonized measure of Anger-Out in the JHS and State-Trait in MASALA and MESA from the Spielberger State-Trait Anger Expression Inventory (31). A binary variable for depressive symptoms was created using the Center for Epidemiologic Studies Depression Scale (32), where a cutoff value of 16 or higher indicates the presence of depressive symptoms. Chronic stress was measured by summing similar items from the Global Perceived Stress Scale developed for the JHS and the Chronic Burden Scale for MASALA and MESA (33). Perceived everyday discrimination was measured by the Everyday Discrimination Scale (34). Neighborhood deprivation was a neighborhood-level (census-tract) summary score of socioeconomic factors estimated using principal component factor analysis from the 2000 US Census and the American Community Survey (2005–2009 and 2007–2013) (35). Socioeconomic factors, such as household income and housing value, were summarized into a combined z score, with higher scores representing better neighborhood socioeconomic context. Neighborhood safety was categorized as safe or not safe using a 1-item question on how safe the neighborhood was from crime. All psychosocial risk measures were time-fixed, ascertained at examination 1, examined as tertiles (low, medium, and high, unless otherwise stated), and considered as potential sources of confounding and selection bias.

Statistical analyses

From a total of 13,284 JHS, MASALA, and MESA participants, we excluded participants from the analysis of the resilience resource of interest if they did not have data on the relevant exposure assessment, had not had the relevant confounders or effect modifiers measured at examinations concurrent with or before exposure assessment, or either had a CVD event concurrent with or before exposure assessment or refused to release medical records for CVD adjudication during the relevant time periods.

Descriptive analyses (Pearson's χ^2 and Wilcoxon-Mann-Whitney tests) examined characteristics comparing persons included in each analysis and a subset of those excluded—that is, JHS, MESA, and/or MASALA participants with a CVD event at or before exposure assessment or who refused to release medical records. For our primary analyses, we fitted unadjusted and adjusted Cox proportional hazards models for each resilience resource. Adjusted Cox models included all measured potential sources of confounding and selection bias. The time scale was number of days from exposure assessment to a minimum of 1) a CVD event, 2) study dropout, 3) non-CVD death, or 4) the administrative end of follow-up. Therefore, follow-up was censored at dropout, non-CVD death, or administrative end of follow-up. In the JHS, dropout was 12 months after the last contact, because events were captured outside of study interviews. In MASALA and MESA, dropout was the time of the last contact, because events were measured primarily during study interviews/examinations (24, 28, 36, 37). Additional details are provided in Web Appendix 1 (available at https://doi.org/10.1093/aje/kwad159). Each Cox model accounted for within-neighborhood clustering (i.e., census tract at examinations 1 (JHS) and 2 (MESA) for optimism; examination 1 for social support and neighborhood social cohesion) using the robust variance estimator. The proportional hazards assumption was satisfied after inclusion of relevant exposure and time-product terms in our adjusted models (38). Product terms that were a function of log-time also satisfied the assumption.

Further, to assess the presence of EMM, we altered our adjusted Cox models to include relevant product terms between the resilience resource and psychosocial risk. Only 1 psychosocial risk was considered a potential effect modifier in each Cox model. P values were estimated from a global χ^2 test to indicate whether at least 1 of the coefficients of the relevant exposure and psychosocial risk product terms was different from 0.

For our secondary analyses that examined the overall relationship, we repeated the primary analyses but estimated standardized risk ratios for CVD incidence at 4, 8, and 12 years since origin using Aalen-Johansen estimators fitted with combined stabilized inverse probability weights. Further details on the secondary analyses are presented in Web Appendix 2. Briefly, the Aalen-Johansen estimator was used to obtain cumulative incidence functions for CVD while accounting for competing risks due to non–CVD-related deaths (39, 40). Combined stabilized inverse probability weights (for exposure and dropout) were used to minimize potential confounding and selection bias due to dropout. We considered all combined weights to be well-behaved (41).

To assess potential EMM, we repeated the secondary analyses by modifying the exposure numerator weight to be estimated as a function of the relevant effect modifier and obtaining the Aalen-Johansen estimate by level of the relevant effect modifier, thus requiring different weights for each EMM assessment (42). As part of the sensitivity analyses, assessment of EMM in the secondary analyses was also conducted without estimating the exposure numerator weight as a function of the relevant effect modifier, as well as using the relevant effect modifier to estimate both the dropout and exposure numerator weights. All combined weights for the EMM assessments were well-behaved.

To account for within-neighborhood clustering of CVD events in the secondary analyses, we used cluster bootstrapping with 200 repetitions to obtain the 95% confidence intervals (CIs) (40, 43, 44). Specifically, we resampled census tracts, not individuals, at examinations 1 (JHS) and 2 (MESA) for optimism and at examination 1 for social support and neighborhood social cohesion, with replacement with equal probability 200 times and included all of the participants in the resampled census tracts as our bootstrapped data.

For all of our analyses, we used restricted quadratic splines to model the continuous age variable with 4 knots at unequal intervals (5th, 35th, 65th, and 95th percentiles) and indicators to model categorical variables in all relevant models to facilitate correct model specification (45). We performed sensitivity analyses by repeating primary and secondary analyses restricted to MESA and/or MASALA (Web Appendix 3). Following the recent hypothesis-testing literature (46–48), we interpreted our study findings in terms of data compatibility rather than statistical significance. We determined evidence for an association or EMM using the point estimates, 95% CIs, and *P* values, not solely on the basis of the 95% CIs' excluding the null value or *P* values' being less than 0.05. All statistical analyses were performed using SAS 9.4 (SAS Institute, Inc., Cary, North Carolina).

RESULTS

Optimism

Web Figure 1 shows the 6,243 participants included in the optimism analysis, with 789 incident CVD events (12.6%). Table 1 shows characteristics of the included and excluded JHS and MESA participants. The included participants' median age was 59 (25th–75th percentiles, 51–68) years, and the median length of follow-up was 4,575 (25th–75th percentiles, 3,896–4,736) days. Most included participants in the optimism analysis were female (56.8%), African-American (44.5%), US-born (77.1%), and married (61.4%), resided in the South (37.2%), reported good self-rated health (88.5%), had either public or private health insurance (90.7%), and reported a family history of CVD (56.3%). In addition, most included participants had a high school diploma or some college education (46.6%), were employed at least part-time (53.6%), had an annual family income or $50,000 or more (41.6%), were not depressed (85.9%), and reported their neighborhood as safe (78.3%).

Based on the adjusted primary analyses, a lower hazard of CVD among persons with high or medium (versus low) optimism was most compatible with the data (hazard ratio (HR) = 0.94 (95% CI: 0.78, 1.13) and HR = 0.90 (95% CI: 0.75, 1.07), respectively) (Table 2). However, as evidenced by the 95% CIs, a higher hazard of CVD was also compatible. Further, there was evidence for EMM of the relationship between optimism and CVD by several psychosocial risks, such as employment, income, depression, stress, and neighborhood deprivation (Table 3). For example, focusing on the most compatible estimates, high (versus low) optimism was associated with a higher hazard of CVD among persons living in neighborhoods with high deprivation (HR = 1.24, 95% CI: 0.92, 1.67) but was associated with a lower hazard of CVD among those in neighborhoods with medium (HR = 0.84, 95% CI: 0.59, 1.20) or low (HR = 0.82, 95% CI: 0.62, 1.08) deprivation.

Regarding the secondary analyses, the standardized risk ratios for CVD at 4, 8, and 12 years and the corresponding 95% CIs are shown in Web Tables 1 and 2. Findings from the secondary analyses and corresponding sensitivity analyses (results not shown) were similar to the findings from the primary analyses.

Social support

Web Figure 2 shows the 7,729 participants included in the social support analysis, with 995 incident CVD events (12.9%). The characteristics among the included and excluded JHS, MASALA, and MESA participants were similar to those for the optimism analysis, and the median length of the included participants' follow-up was 5,114 (25th–75th percentiles, 3,870–5,390) days (Table 4).

The primary analysis using adjusted Cox models showed that an inverse relationship between high or medium (versus low) social support and the hazard of CVD was most compatible with the data (HR = 0.88 (95% CI: 0.74, 1.04) and HR = 0.92 (95% CI: 0.79, 1.06), respectively) (Table 2). Evidence for EMM by psychosocial risks, including depression, chronic stress, and discrimination, was observed (Table 5). For instance, focusing on the most compatible estimates, high (versus low) social support was associated with a higher hazard of CVD among persons who were depressed (HR = 1.17, 95% CI: 0.78, 1.78) but was associated with a lower hazard of CVD among those who were not depressed (HR = 0.86, 95% CI: 0.72, 1.02).

The secondary analyses (Web Table 1 and Web Table 3) and corresponding sensitivity analysis results (not shown) were similar to those of our primary analyses.

Neighborhood social cohesion

Web Figure 3 shows the 7,557 participants included in the neighborhood social cohesion analysis, with 968 incident CVD events (12.8%). The characteristics of included and excluded participants were similar to those of the optimism analysis, and the median length of the included participants' follow-up was 4,967 (25th–75th percentiles, 3,653–5,275) days (Table 6).

Table 2 shows the results of the primary analyses for the overall relationship. Both a positive and a null relationship between high or medium (versus low) neighborhood social cohesion and CVD were most compatible with the data (HR = 1.10 (95% CI: 0.94, 1.29) and HR = 0.99 (95% CI: 0.85, 1.16), respectively). There was evidence of EMM by psychosocial risks, such as income, chronic stress, and neighborhood deprivation. Particularly, a positive association for medium (versus low) neighborhood social cohesion was most compatible among persons reporting low chronic stress (HR = 1.26, 95% CI: 1.00, 1.60);

Table 1. Characteristics at Examinations Concurrent With or Before Exposure Assessment Comparing the Included and a Subset of the Excluded JHS and MESA Participants From the Primary Analysis, 2000–2013

Characteristic	Included Participants (*n* = 6,243)		Excluded Participants[a] (*n* = 436)		*P* Value[b]
	No.	%	No.	%	
Optimism[c] at MESA exam 2 or JHS AFI2					0.62
Low	2,281	36.6	167	38.3	
Medium	2,054	32.9	145	33.3	
High	1,908	30.6	124	28.4	
Length of follow-up since exposure assessment, days[d]	4,575 (3,896–4,736)				
Age at exam 1, years[d]	59 (51–68)		61 (50–68)		0.83
Sex/gender at exam 1					0.66
Female	3,547	56.8	243	55.7	
Male	2,696	43.2	193	44.3	
Race/ethnicity at exam 1					<0.01
White non-Hispanic	1,864	29.9	37	8.5	
Asian	512	8.2	6	1.4	
African-American	2,776	44.5	366	83.9	
Hispanic	1,091	17.5	27	6.2	
Nativity at exam 1					<0.01
Non–US-born	1,431	22.9	25	5.7	
US-born	4,812	77.1	411	94.3	
Region at exam 1					<0.01
West	918	14.7	19	4.4	
South	2,321	37.2	360	82.6	
Midwest	1,574	25.2	39	8.9	
Northeast	1,430	22.9	18	4.1	
Marital status at exam 1					0.01
Never married, separated/divorced, or widowed	2,413	38.7	197	45.2	
Married	3,830	61.4	239	54.8	
Self-rated health[e] at exam 1					<0.01
Not good	721	11.6	149	34.2	
Good	5,522	88.5	287	65.8	
Health insurance at exam 1					0.05
None	583	9.3	53	12.2	
Public or private	5,660	90.7	383	87.8	
Family history of CVD or stroke at exam 1					<0.01
No	2,727	43.7	148	33.9	
Yes	3,516	56.3	288	66.1	
Education at exam 1					0.39
College degree or more	2,422	38.8	155	35.6	
High school or some college	2,911	46.6	216	49.5	
Less than high school	910	14.6	65	14.9	
Employment at exam 1					<0.01
Employed (part-time or full-time)	3,346	53.6	189	43.3	
Unemployed	2,897	46.4	247	56.7	

Table continues

Table 1. Continued

Characteristic	Included Participants (n = 6,243)		Excluded Participants[a] (n = 436)		P Value[b]
	No.	%	No.	%	
Annual family income at exam 1, dollars					<0.01
≥50,000	2,594	41.6	143	32.8	
20,000–49,999	2,289	36.7	167	38.3	
≤19,999	1,360	21.8	126	28.9	
Anger[c] at exam 1					<0.01
Low	2,385	38.2	133	30.5	
Medium	1,986	31.8	122	28.0	
High	1,872	30.0	181	41.5	
Depression at exam 1					<0.01
No	5,360	85.9	324	74.3	
Yes	883	14.1	112	25.7	
Chronic stress[c] at exam 1					<0.01
Low	2,576	41.3	97	22.3	
Medium	2,106	33.7	173	39.7	
High	1,561	25.0	166	38.1	
Discrimination[c] at exam 1					<0.01
Low	2,213	35.5	129	29.6	
Medium	2,045	32.8	133	30.5	
High	1,985	31.8	174	39.9	
Neighborhood deprivation[c] at exam 1					<0.01
Low	2,505	40.1	111	25.5	
Medium	2,099	33.6	149	34.2	
High	1,639	26.3	176	40.4	
Neighborhood safety at exam 1					<0.01
Safe	4,890	78.3	296	67.9	
Not safe	1,353	21.7	140	32.1	
Religiosity at MESA exam 2 or JHS AFI2					<0.01
Not high	3,063	49.1	161	36.9	
High	3,180	50.9	275	63.1	
Social support at exam 1					0.67
Not high	3,056	49.0	218	50.0	
High	3,187	51.1	218	50.0	

Abbreviations: AFI2, second annual follow-up interview; CVD, cardiovascular disease; exam, examination; JHS, Jackson Heart Study; MASALA, Mediators of Atherosclerosis in South Asians Living in America; MESA, Multi-Ethnic Study of Atherosclerosis.

[a] Participants who had a CVD event at or before exposure assessment or refused the release of medical records for CVD adjudication.

[b] Pearson's χ^2 test or Wilcoxon-Mann-Whitney test.

[c] Tertiles are not exact thirds because of ties at boundaries and because no participants with the same values were included in different tertiles.

[d] Values are presented as median (25th–75th percentiles).

[e] A binary self-rated health variable was used to indicate "good" and "not good" categories from the harmonization of different self-rated health measures across the JHS, MESA, and MASALA cohort studies.

however, an inverse association was most compatible among those with high (HR = 0.72, 95% CI: 0.50, 1.04) and medium (HR = 0.83, 95% CI: 0.64, 1.08) chronic stress (Table 7).

Findings from the secondary analyses (Web Table 1 and Web Table 4) and corresponding sensitivity analyses (results not shown) did not differ meaningfully from those of the primary analyses.

Table 2. Hazard Ratios[a] for Cardiovascular Disease Events Comparing Resilience Resource Levels Among Cohort Study Participants (JHS, MASALA, and MESA) Included in the Final Primary Analysis, 2000–2018

Resilience Resource	Total No. of Participants	Unadjusted Results		Adjusted Results	
		HR	95% CI	HR	95% CI
Optimism[b]	6,243				
High		0.78	0.65, 0.94	0.94[c]	0.78, 1.13
Medium		0.76	0.64, 0.91	0.90[c]	0.75, 1.07
Low		1.00	Referent	1.00	Referent
Social support	7,729				
High		0.83	0.71, 0.96	0.88[d]	0.74, 1.04
Medium		0.91	0.79, 1.04	0.92[d]	0.79, 1.06
Low		1.00	Referent	1.00	Referent
Neighborhood social cohesion	7,557				
High		1.05	0.90, 1.23	1.10[e]	0.94, 1.29
Medium		0.99	0.84, 1.15	0.99[e]	0.85, 1.16
Low		1.00	Referent	1.00	Referent

Abbreviations: CI, confidence interval; CVD, cardiovascular disease; HR, hazard ratio; JHS, Jackson Heart Study; MASALA, Mediators of Atherosclerosis in South Asians Living in America; MESA, Multi-Ethnic Study of Atherosclerosis.

[a] Each outcome model accounted for observations clustered within neighborhoods (i.e., census tracts) at examinations 1 (JHS) and 2 (MESA) for optimism and at examination 1 for social support and neighborhood social cohesion.

[b] MASALA participants were excluded.

[c] HRs were adjusted for age, sex/gender, race, nativity, geographic region, marital status, self-rated health, insurance, family history of CVD and stroke, education, income, employment, anger, depression, chronic stress, discrimination, neighborhood deprivation, neighborhood safety, religiosity, and social support.

[d] HRs were adjusted for age, sex/gender, race, nativity, geographic region, marital status, self-rated health, insurance, family history of CVD and stroke, education, income, employment, anger, depression, chronic stress, discrimination, neighborhood deprivation, and neighborhood safety.

[e] HRs were adjusted for age, sex/gender, race, nativity, geographic region, marital status, self-rated health, insurance, family history of CVD and stroke, education, income, employment, anger, depression, chronic stress, discrimination, neighborhood deprivation, neighborhood safety, and social support.

Sensitivity analysis entailing restriction of harmonized data to MESA and/or MASALA

Our inferences did not meaningfully change after the harmonized data were restricted to the MESA and MASALA cohorts (Web Tables 5 and 6).

DISCUSSION

In our prospective analysis using harmonized data from 3 US cohort studies, we showed that an inverse relationship between higher optimism and social support and CVD was frequently most compatible with the data, but a positive relationship was also compatible. For neighborhood social cohesion, a positive and null relationship was most compatible with the data. In our assessments for EMM, several psychosocial risks appeared to modify the relationship between resilience resources and CVD (e.g., neighborhood deprivation for optimism, depression for social support, and chronic stress for neighborhood social cohesion). However, modification was typically not in the expected direction. Our findings based on the standardized risk ratios were consistent with the findings based on the HRs.

Optimism and social support results for the overall relationship suggested that greater resilience resources may be associated with lower CVD incidence. These findings are consistent with prospective CVD studies comparing high and low optimism and social support levels (16–19, 49–57). Moreover, a meta-analytical study showed that optimism was associated with a reduced CVD risk and lower all-cause mortality (58). Regarding higher neighborhood social cohesion, most studies have suggested a negative association with the occurrence of CVD events (20, 21, 59, 60); however, a null relationship with greater frequency of CVD events has also been documented in past work, as well as in the current study. For example, 1 prospective study (61) and 1 cross-sectional study (62) showed that higher neighborhood social cohesion was not associated with incident CVD or ideal cardiovascular health outcomes, respectively. Thus, additional prospective studies of neighborhood-level resilience resources are warranted.

One potential mechanism through which having greater resilience resources may reduce CVD incidence is provided by the reserve capacity model, which posits that individuals may utilize capacities or resilience resources at different levels to offset the harmful effects of adversity on health (10).

Table 3. Assessment of Effect-Measure Modification Through Examination of Adjusted Hazard Ratios[a] for Cardiovascular Disease Events Based on Comparing Optimism Level Within Levels of Psychosocial Risk Measures Among JHS and MESA Participants Included in the Primary Analysis Sample (*n* = 6,243), 2000–2013

Psychosocial Risk Measure	Association Between Optimism and Incident CVD				*P* Value[b]
	High Versus Low Optimism		Medium Versus Low Optimism		
	aHR	95% CI	aHR	95% CI	
Education at exam 1					0.56
College degree or more	0.78	0.56, 1.08	0.73	0.55, 0.99	
High school or some college	1.00	0.77, 1.28	0.98	0.77, 1.25	
Less than high school	1.07	0.72, 1.58	0.98	0.65, 1.48	
Employment at exam 1					0.20
Employed (part-time or full-time)	0.77	0.57, 1.03	0.86	0.65, 1.12	
Unemployed	1.05	0.84, 1.30	0.92	0.73, 1.15	
Annual family income at exam 1, dollars					0.11
≥50,000	0.84	0.61, 1.16	0.70	0.51, 0.97	
20,000–49,999	0.86	0.66, 1.13	0.86	0.66, 1.11	
≤19,999	1.17	0.82, 1.66	1.25	0.90, 1.73	
Anger at exam 1					0.56
Low	0.86	0.67, 1.12	0.86	0.66, 1.12	
Medium	0.92	0.69, 1.24	0.79	0.59, 1.08	
High	1.12	0.78, 1.61	1.10	0.80, 1.51	
Depression at exam 1					0.18
No	0.89	0.73, 1.08	0.86	0.71, 1.03	
Yes	1.38	0.84, 2.26	1.10	0.72, 1.69	
Chronic stress at exam 1					0.09
Low	0.86	0.67, 1.11	0.81	0.63, 1.03	
Medium	0.92	0.67, 1.26	1.10	0.82, 1.48	
High	1.23	0.85, 1.78	0.80	0.56, 1.15	
Discrimination at exam 1					0.78
Low	0.86	0.67, 1.11	0.87	0.65, 1.16	
Medium	1.12	0.82, 1.52	0.96	0.72, 1.29	
High	0.89	0.61, 1.30	0.87	0.64, 1.18	
Neighborhood deprivation at exam 1					0.04
Low	0.82	0.62, 1.08	0.68	0.50, 0.92	
Medium	0.84	0.59, 1.20	1.05	0.78, 1.40	
High	1.24	0.92, 1.67	1.11	0.82, 1.49	
Neighborhood safety at exam 1					0.50
Safe	0.90	0.74, 1.10	0.90	0.74, 1.09	
Not safe	1.13	0.76, 1.70	0.88	0.59, 1.30	

Abbreviations: aHR, adjusted hazard ratio; CI, confidence interval; CVD, cardiovascular disease; exam, examination; JHS, Jackson Heart Study; MESA, Multi-Ethnic Study of Atherosclerosis.

[a] Hazard ratios were adjusted for age, sex/gender, race, nativity, geographic region, marital status, self-rated health, insurance, family history of CVD and stroke, education, income, employment, anger, depression, chronic stress, discrimination, neighborhood deprivation, neighborhood safety, religiosity, and social support. Each outcome model accounted for observations clustered within neighborhoods (i.e., census tracts) at examination 1 in the JHS and at examination 2 in MESA.

[b] Global χ^2 test.

Table 4. Characteristics at Examinations Concurrent With Exposure Assessment Comparing the Included and a Subset of the Excluded Cohort Study Participants (JHS, MASALA, and MESA) From the Primary Analysis, 2000–2018

Characteristic	Included Participants (*n* = 7,729)		Excluded Participants[a] (*n* = 369)		*P* Value[b]
	No.	%	No.	%	
Social support[c] at exam 1					0.04
Low	2,724	35.2	120	32.5	
Medium	2,513	32.5	107	29.0	
High	2,492	32.2	142	38.5	
Length of follow-up since exposure assessment, days[d]	5,114 (3,870–5,390)				
Age at exam 1, years[d]	59 (51–68)		59 (48–66)		<0.01
Sex/gender at exam 1					0.01
Female	4,230	54.7	228	61.8	
Male	3,499	45.3	141	38.2	
Race/ethnicity at exam 1					<0.01
White non-Hispanic	2,285	29.6	3	0.8	
Asian	1,091	14.1	5	1.4	
African-American	3,097	40.1	360	97.6	
Hispanic	1,256	16.3	1	0.3	
Nativity at exam 1					<0.01
Non–US-born	2,155	27.9	5	1.4	
US-born	5,574	72.1	364	98.6	
Region at exam 1					<0.01
West	1,126	14.6	0	0	
South	2,508	32.5	359	97.3	
Midwest	2,330	30.2	10	2.7	
Northeast	1,765	22.8	0	0	
Marital status at exam 1					<0.01
Never married, separated/divorced, or widowed	2,859	37.0	166	45.0	
Married	4,870	63.0	203	55.0	
Self-rated health[e] at exam 1					<0.01
Not good	893	11.6	152	41.2	
Good	6,836	88.5	217	58.8	
Health insurance at exam 1					0.09
None	719	9.3	44	11.9	
Public or private	7,010	90.7	325	88.1	
Family history of CVD or stroke at exam 1					<0.01
No	3,412	44.2	125	33.9	
Yes	4,317	55.9	244	66.1	
Education at exam 1					0.06
College degree or more	3,189	41.3	130	35.2	
High school or some college	3,442	44.5	184	49.9	
Less than high school	1,098	14.2	55	14.9	
Employment at exam 1					<0.01
Employed (part-time or full-time)	4,162	53.9	161	43.6	
Unemployed	3,567	46.2	208	56.4	

Table continues

Table 4. Continued

Characteristic	Included Participants (n = 7,729)		Excluded Participants[a] (n = 369)		P Value[b]
	No.	%	No.	%	
Annual family income at exam 1, dollars					<0.01
≥50,000	3,301	42.7	122	33.1	
20,000–49,999	2,781	36.0	140	37.9	
≤19,999	1,647	21.3	107	29.0	
Anger[c] at exam 1					<0.01
Low	2,907	37.6	102	27.6	
Medium	2,485	32.2	92	24.9	
High	2,337	30.2	175	47.4	
Depression at exam 1					<0.01
No	6,667	86.3	266	72.1	
Yes	1,062	13.7	103	27.9	
Chronic stress[c] at exam 1					<0.01
Low	3,348	43.3	57	15.5	
Medium	2,577	33.3	148	40.1	
High	1,804	23.3	164	44.4	
Discrimination[c] at exam 1					<0.01
Low	2,786	36.1	99	26.8	
Medium	2,572	33.3	109	29.5	
High	2,371	30.7	161	43.6	
Neighborhood deprivation[c] at exam 1					<0.01
Low	2,162	28.0	186	50.4	
Medium	2,790	36.1	117	31.7	
High	2,777	35.9	66	17.9	
Neighborhood safety at exam 1					<0.01
Safe	6,162	79.7	237	64.2	
Not safe	1,567	20.3	132	35.8	

Abbreviations: CVD, cardiovascular disease; exam, examination; JHS, Jackson Heart Study; MASALA, Mediators of Atherosclerosis in South Asians Living in American; MESA, Multi-Ethnic Study of Atherosclerosis.

[a] Participants who had a CVD event at or before exposure assessment or refused the release of medical records for CVD adjudication.

[b] Pearson's χ^2 test or Wilcoxon-Mann-Whitney test.

[c] Tertiles are not exact thirds because of ties at boundaries and because no participants with the same values were included in different tertiles.

[d] Values are presented as median (25th–75th percentiles).

[e] A binary self-rated health variable was used to indicate "good" and "not good" categories from the harmonization of different self-rated health measures across the JHS, MESA, and MASALA cohort studies.

Thus, individuals with greater access to available resources may exhibit lower CVD incidence. Furthermore, resilience resources may act directly or indirectly through behavioral or physiological pathways to reduce CVD incidence (63). Such behavioral pathways refer to a process wherein individuals with higher resilience resources engage in healthier behaviors (e.g., healthier diet and increased physical activity) associated with better cardiovascular health (30, 64, 65). Physiological pathways include lower inflammation and hypothalamic-pituitary-adrenal function that may contribute to better cardiovascular outcomes (58, 63). However, our findings for the neighborhood-level resource suggested that higher resources at times increased the occurrence of CVD. Interestingly, there are suggestions in the literature that the neighborhood environment is a dynamic and intertwining system, which may potentially be protective but simultaneously harmful to individuals' health outcomes (66, 67). Nevertheless, the evidence supporting a positive association between higher resilience resources and better CVD outcomes is growing (68, 69).

Table 5. Assessment of Effect-Measure Modification Through Examination of Adjusted Hazard Ratios[a] for Cardiovascular Disease Events Based on Comparing Social Support Level Within Levels of Psychosocial Risk Measures Among JHS, MASALA, and MESA Participants Included in the Primary Analysis Sample (*n* = 7,729), 2000–2018

Psychosocial Risk Measure	Association Between Social Support and Incident CVD				*P* Value[b]
	High Versus Low Social Support		Medium Versus Low Social Support		
	aHR	95% CI	aHR	95% CI	
Education at exam 1					0.57
College degree or more	0.84	0.66, 1.08	0.99	0.75, 1.30	
High school or some college	0.84	0.65, 1.07	0.83	0.68, 1.02	
Less than high school	1.06	0.75, 1.49	1.02	0.71, 1.47	
Employment at exam 1					0.44
Employed (part-time or full-time)	0.79	0.61, 1.02	0.82	0.64, 1.04	
Unemployed	0.94	0.76, 1.15	0.98	0.81, 1.19	
Annual family income at exam 1, dollars					0.41
≥50,000	0.92	0.70, 1.21	1.12	0.84, 1.49	
20,000–49,999	0.80	0.62, 1.02	0.84	0.68, 1.04	
≤19,999	1.00	0.72, 1.39	0.84	0.63, 1.12	
Anger at exam 1					0.43
Low	0.77	0.59, 0.99	0.84	0.66, 1.07	
Medium	0.89	0.68, 1.18	1.01	0.76, 1.34	
High	1.06	0.79, 1.43	0.92	0.68, 1.25	
Depression at exam 1					0.03
No	0.86	0.72, 1.02	0.96	0.82, 1.12	
Yes	1.17	0.78, 1.78	0.64	0.41, 0.99	
Chronic stress at exam 1					0.10
Low	0.86	0.68, 1.10	1.01	0.80, 1.28	
Medium	0.87	0.67, 1.13	0.70	0.54, 0.90	
High	0.98	0.69, 1.37	1.14	0.85, 1.52	
Discrimination at exam 1					0.17
Low	0.79	0.61, 1.02	0.79	0.62, 1.01	
Medium	0.96	0.73, 1.26	0.90	0.69, 1.17	
High	0.91	0.66, 1.25	1.19	0.91, 1.56	
Neighborhood deprivation at exam 1					0.30
Low	0.83	0.63, 1.09	0.96	0.74, 1.24	
Medium	0.88	0.66, 1.18	1.02	0.82, 1.27	
High	0.93	0.71, 1.21	0.76	0.58, 1.00	
Neighborhood safety at exam 1					0.32
Safe	0.86	0.72, 1.04	0.95	0.81, 1.11	
Not safe	0.95	0.67, 1.35	0.78	0.56, 1.08	

Abbreviations: aHR, adjusted hazard ratio; CI, confidence interval; CVD, cardiovascular disease; exam, examination; JHS, Jackson Heart Study; MASALA, Mediators of Atherosclerosis in South Asians Living in America; MESA, Multi-Ethnic Study of Atherosclerosis.

[a] Hazard ratios were adjusted for age, sex/gender, race, nativity, geographic region, marital status, self-rated health, insurance, family history of CVD and stroke, education, income, employment, anger, depression, chronic stress, discrimination, neighborhood deprivation, and neighborhood safety. Each outcome model accounted for observations clustered within neighborhoods (i.e., census tracts) at examination 1.

[b] Global χ^2 test.

Table 6. Characteristics at Examinations Concurrent With or Before Exposure Assessment Comparing the Included and a Subset of the Excluded Cohort Study Participants (JHS, MASALA, and MESA) From the Primary Analysis, 2000–2018

Characteristic	Included Participants (*n* = 7,557)		Excluded Participants[a] (*n* = 331)		*P* Value[b]
	No.	%	No.	%	
Neighborhood social cohesion[c] at MASALA/MESA exam 1 or JHS AFI3					<0.01
Low	3,352	44.4	116	35.1	
Medium	1,958	25.9	57	17.2	
High	2,247	29.7	158	47.7	
Length of follow-up since exposure assessment, days[d]	4,967 (3,653–5,275)				
Age at exam 1, years[d]	59 (51–68)		59 (48–66)		<0.01
Sex/gender at exam 1					0.03
Female	4,098	54.2	200	60.4	
Male	3,459	45.8	131	39.6	
Race/ethnicity at exam 1					<0.01
White non-Hispanic	2,285	30.2	3	0.9	
Asian	1,091	14.4	5	1.5	
African-American	2,925	38.7	322	97.3	
Hispanic	1,256	16.6	1	0.3	
Nativity at exam 1					<0.01
Non–US-born	2,155	28.5	5	1.5	
US-born	5,402	71.5	326	98.5	
Region at exam 1					<0.01
West	1,126	14.9	0	0	
South	2,336	30.9	321	97.0	
Midwest	2,330	30.8	10	3.0	
Northeast	1,765	23.4	0	0	
Marital status at exam 1					0.01
Never married, separated/divorced, or widowed	2,771	36.7	145	43.8	
Married	4,786	63.3	186	56.2	
Self-rated health[e] at exam 1					<0.01
Not good	851	11.3	138	41.7	
Good	6,706	88.7	193	58.3	
Health insurance at exam 1					0.01
None	699	9.3	44	13.3	
Public or private	6,858	90.8	287	86.7	
Family history of CVD or stroke at exam 1					<0.01
No	3,323	44.0	114	34.4	
Yes	4,234	56.0	217	65.6	
Education at exam 1					0.03
College degree or more	3,124	41.3	113	34.1	
High school or some college	3,354	44.4	167	50.5	
Less than high school	1,079	14.3	51	15.4	
Employment at exam 1					<0.01
Employed (part-time or full-time)	4,050	53.6	140	42.3	
Unemployed	3,507	46.4	191	57.7	

Table continues

Table 6. Continued

Characteristic	Included Participants (n = 7,557)		Excluded Participants[a] (n = 331)		P Value[b]
	No.	%	No.	%	
Annual family income at exam 1, dollars					<0.01
≥50,000	3,242	42.9	106	32.0	
20,000–49,999	2,710	35.9	129	39.0	
≤19,999	1,605	21.2	96	29.0	
Anger[c] at exam 1					<0.01
Low	2,850	37.7	93	28.1	
Medium	2,440	32.3	79	23.9	
High	2,267	30.0	159	48.0	
Depression at exam 1					<0.01
No	6,524	86.3	240	72.5	
Yes	1,033	13.7	91	27.5	
Chronic stress[c] at exam 1					<0.01
Low	3,317	43.9	56	16.9	
Medium	2,519	33.3	135	40.8	
High	1,721	22.8	140	42.3	
Discrimination[c] at exam 1					<0.01
Low	2,744	36.3	84	25.4	
Medium	2,519	33.3	99	29.9	
High	2,294	30.4	148	44.7	
Neighborhood deprivation[c] at exam 1					<0.01
Low	2,742	36.3	53	16.0	
Medium	2,718	36.0	107	32.3	
High	2,097	27.8	171	51.7	
Neighborhood safety at exam 1					<0.01
Safe	6,071	80.3	209	63.1	
Not safe	1,486	19.7	122	36.9	
Social support at exam 1					0.34
Not high	3,788	50.1	157	47.4	
High	3,769	49.9	174	52.6	

Abbreviations: AFI3, third annual follow-up interview; CVD, cardiovascular disease; exam, examination; JHS, Jackson Heart Study; MASALA, Mediators of Atherosclerosis in South Asians Living in America; MESA, Multi-Ethnic Study of Atherosclerosis.

[a] Participants who had a CVD event at or before exposure assessment or refused the release of medical records for CVD adjudication.

[b] Pearson's χ^2 test or Wilcoxon-Mann-Whitney test.

[c] Tertiles are not exact thirds because of ties at boundaries and because no participants with the same values were included in different tertiles.

[d] Values are presented as median (25th–75th percentiles).

[e] A binary self-rated health variable was used to indicate "good" and "not good" categories from the harmonization of different self-rated health measures across the JHS, MESA, and MASALA cohort studies.

In our study, several psychosocial risks showed evidence for EMM. This finding may be due to the fact that resilience is a complex and dynamic process that interacts across multiple levels and acts in the presence of adversities (67, 70). However, because of the limited resilience resources available to individuals depending on their capacity, trade-offs may exist in a dynamic environment with multilevel adversities, where resilience may operate against some adversities but not others (67).

Our study found that when evidence for modification was present, modification was typically not in the expected direction (i.e., resilience was not increasingly protective with increasing adversity). This unexpected finding may be due to "wear and tear" on the body resulting from

Table 7. Assessment of Effect-Measure Modification Through Examination of Adjusted Hazard Ratios[a] for Cardiovascular Disease Events Based on Comparing Neighborhood Social Cohesion Level Within Levels of Psychosocial Risk Measures Among JHS, MASALA, and MESA Participants Included in the Primary Analysis Sample (*n* = 7,557), 2000–2018

Psychosocial Risk Measure	Association Between Neighborhood Social Cohesion and Incident CVD				*P* Value[b]
	High Versus Low Neighborhood Social Cohesion		Medium Versus Low Neighborhood Social Cohesion		
	aHR	95% CI	aHR	95% CI	
Education at exam 1					0.81
College degree or more	1.17	0.89, 1.53	1.13	0.87, 1.46	
High school or some college	1.07	0.84, 1.36	0.92	0.73, 1.16	
Less than high school	1.08	0.76, 1.53	0.94	0.64, 1.38	
Employment at exam 1					0.88
Employed (part-time or full-time)	1.06	0.82, 1.37	1.01	0.78, 1.30	
Unemployed	1.12	0.93, 1.36	0.98	0.80, 1.20	
Annual family income at exam 1, dollars					0.09
≥50,000	1.20	0.92, 1.56	1.28	0.96, 1.70	
20,000–49,999	1.00	0.78, 1.27	0.75	0.58, 0.98	
≤19,999	1.20	0.89, 1.61	1.11	0.81, 1.51	
Anger at exam 1					0.74
Low	1.08	0.85, 1.37	1.10	0.86, 1.40	
Medium	1.08	0.84, 1.40	0.92	0.71, 1.21	
High	1.16	0.88, 1.54	0.91	0.67, 1.24	
Depression at exam 1					0.51
No	1.06	0.89, 1.26	0.96	0.81, 1.14	
Yes	1.35	0.89, 2.05	1.18	0.75, 1.85	
Chronic stress at exam 1					0.06
Low	1.24	1.00, 1.54	1.26	1.00, 1.60	
Medium	1.00	0.75, 1.32	0.83	0.64, 1.08	
High	1.01	0.73, 1.41	0.72	0.50, 1.04	
Discrimination at exam 1					0.69
Low	1.15	0.90, 1.48	1.10	0.86, 1.42	
Medium	1.01	0.76, 1.33	0.93	0.71, 1.23	
High	1.15	0.87, 1.51	0.87	0.63, 1.21	
Neighborhood deprivation at exam 1					0.39
Low	0.94	0.71, 1.23	1.06	0.80, 1.40	
Medium	1.25	0.97, 1.62	0.98	0.77, 1.24	
High	1.13	0.86, 1.47	0.91	0.66, 1.24	
Neighborhood safety at exam 1					0.57
Safe	1.12	0.94, 1.33	0.98	0.82, 1.17	
Not safe	0.94	0.62, 1.42	1.09	0.76, 1.57	

Abbreviations: aHR, adjusted hazard ratio; CI, confidence interval; CVD, cardiovascular disease; exam, examination; JHS, Jackson Heart Study; MASALA, Mediators of Atherosclerosis in South Asians Living in America; MESA, Multi-Ethnic Study of Atherosclerosis.

[a] Hazard ratios were adjusted for age, sex/gender, race, nativity, geographic region, marital status, self-rated health, insurance, family history of CVD and stroke, education, income, employment, anger, depression, chronic stress, discrimination, neighborhood deprivation, neighborhood safety, and social support. Each outcome model accounted for observations clustered within neighborhoods (i.e., census tracts) at examination 1.

[b] Global χ^2 test.

repeated activation of physiological systems to maintain balance in cardiovascular health during repeated exposure to adversities, which may lead to adverse health outcomes because of the chronic burden of adversities that can overload an individual's capacity to cope (71). Further, the reserve capacity model suggests that low–socioeconomic-position individuals may be exposed to more adversities (64), may overrespond, or may have allostatic overload in response to stressors (72). Thus, the chronic exposure and response to adversities may be too overwhelming for resilience resources to attenuate the adverse health effects of these adversities (10, 73). Therefore, future studies should include multilevel psychosocial risks when examining the association between resilience resources and incident CVD.

Our study had limitations. We analyzed data harmonized from 3 different cohort studies, but other methods, such as meta-analysis, may have been possible. In addition, our sample was not representative of the US population; that is, we did not include other racial/ethnic groups experiencing CVD-related disparities (e.g., American Indian/Alaska Native populations) (74, 75). Thus, gaps in resilience-CVD research among diverse racial/ethnic groups still exist, and our findings may not be generalizable to populations with different distributions of effect modifiers, which potentially include psychosocial risks.

Optimism and neighborhood social cohesion were assessed during the JHS second and third annual follow-up interviews, respectively. The exact date of each interview was unknown. Based on the JHS study design, we assumed that optimism and neighborhood social cohesion were assessed 2 and 3 years, respectively, after the participants' examination 1 date. However, we believe that our assumption of 2 and 3 years for the second and third annual follow-up interviews based on the JHS study design is reasonable, and any CVD events that we may have missed would not have meaningfully altered our inferences. Moreover, census tract data were only available for examinations 1 and 2; hence, we used census tract at JHS examination 1 for the optimism analysis. Further, most CVD events in MASALA in 2020 were underrepresented, most likely because of difficulty in obtaining medical records during the coronavirus disease 2019 (COVID-19) pandemic.

Additionally, because of the temporal ordering of assessments for resilience resources, some measures could not be used to control for potential confounding and selection bias; for example, we did not adjust for optimism and religiosity in the social support analysis because those variables were measured temporally after social support. In addition, the EMM assessments by psychosocial risk levels may have been underpowered. Because most measures were self-reported, there may have been measurement bias. Moreover, some of the original measures were not validated in racial/ethnic minority populations. Therefore, in future studies, researchers should examine the construct validity of the measures within various racial/ethnic groups and complete other psychometric analyses.

Although we used restricted quadratic splines for continuous age and indicators for categorical variables, there may still have been bias due to model misspecification. Our secondary analysis for social support and neighborhood social cohesion did not include MASALA participants in the risk set at 12 years. Lastly, our within-neighborhood clustering approach did not account for outcomes' being correlated because participants moved to different neighborhoods (i.e., census tracts) after examination 1 or 2 for optimism and after examination 1 for social support and neighborhood social cohesion. However, 74.0% of the included JHS participants for optimism resided in the same neighborhood after examination 1 (i.e., examination 2). The corresponding numbers after examination 1 (i.e., examination 2) for social support and neighborhood social cohesion were 86.1% and 86.5%, respectively.

Our study had several notable strengths. We assessed the overall relationships between multilevel resilience resources and CVD events and EMM by psychosocial risks for each resilience resource. Further, the harmonized data set yielded a larger, racially/ethnically and socioeconomically diverse population, which likely improved our statistical power. Lastly, we performed secondary analyses to estimate standardized risk ratios using inverse probability weights and the Aalen-Johansen estimator for comparison with our primary analysis results, which were noncollapsible HRs with a built-in selection bias and treated competing risks as a censoring event (76–78).

Our findings suggest that higher levels of certain resilience resources are associated with a lower hazard of CVD. Several psychosocial risks appear to be modifiers of the relationship between resilience resources and CVD; however, modification was typically not in the expected direction. Future prospective studies or clinical trials should examine interventions targeting resilience resources, at multiple levels, to evaluate resilience resources in relation to CVD incidence or mortality, and as a potential health equity strategy in a more racially/ethnically diverse population.

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