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Combined Impact of Health Behaviors on Mortality in Low-Income Americans

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Abstract

Introduction—African Americans and low-income whites have higher mortality than the U.S. general population. This study prospectively investigated the combined influence of major lifestyle factors and poverty on mortality in this vulnerable population.

Methods—Data were collected in 2002–2009 from 79,101 Southern Community Cohort Study participants, of which 67% were African American and 55% had household incomes <\$15,000. Mortality outcomes were identified from the National Death Index through December 31, 2011 (data analyzed in 2014–2015). Healthy behavior scores were created based on tobacco smoking, alcohol intake, diet, physical activity, and sedentary time. The primary analysis was performed based on the score created by counting each participant as having met/not met public health guidelines for each behavior.

Results—Healthy behavior scores were associated with reduced cancer, cardiovascular disease, and all-cause mortality. Associations were stronger for whites than African Americans: hazard ratios for all-cause mortality comparing participants meeting four or five guidelines versus participants meeting zero were 0.41 (95% CI=0.30, 0.55) for African American men, 0.36 (95%

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CI=0.24, 0.55) for white men, 0.46 (95% CI=0.36, 0.59) for African American women, and 0.27 (95% CI=0.18, 0.43) for white women. The association between healthy lifestyle and all-cause mortality was weaker among those with incomes <\$15,000 than those with higher income, particularly in men ($p<0.05$ for interaction).

Conclusions—This study demonstrates the importance of health behaviors on mortality among all groups, but highlights the need for additional research to identify factors contributing to high risk of mortality among low-income and African American populations.

Introduction

Epidemiologic studies have reported that healthy lifestyles, as measured by combinations of non-smoking, moderate alcohol intake, higher diet quality, regular physical activity, and less sedentary time, are inversely associated with mortality.^{1–6} However, it is unclear whether the magnitude of the healthy lifestyle and mortality association can be generalized to all populations. Virtually all previous studies were conducted in European-ancestry samples, and individuals, particularly African Americans, with low SES were not represented in these studies.

The strength of the association between healthy lifestyle and mortality may differ by SES and race. Low SES characterizes an inadequate access to health resources, including financial means, social support, medical care, and knowledge of best health practices.⁷ Additionally, as a group, African Americans are more often of low SES, have a higher prevalence of chronic disease, and may experience additional barriers to longevity such as historic and present social inequality.^{8,9} Social and medical determinants are important contributors to mortality outcomes and it may be through these mechanisms that SES and race modify the association between healthy lifestyle and mortality.⁷ It is plausible that when social and medical determinants are unmet, the beneficial effects of healthy lifestyle on mortality are not optimized. Herein, in a cohort of low-income Americans, the hypothesis that the combined association of modifiable lifestyle factors with all-cause and cause-specific mortality may vary by race and household income is evaluated.

Methods

Study Population

Data were from 84,731 participants enrolled from 2002 to 2009 in the Southern Community Cohort Study (SCCS), a previously described prospective cohort study designed to assess racial disparities in health outcomes, conducted in 12 southeastern U.S. states.^{10,11} Eligible participants were aged 40–79 years at enrollment, spoke English, and were not under treatment for cancer within the prior year. Participants were recruited from community health centers (CHCs, 86%),¹² or from stratified random samples of residents in the same 12 states (14%). All participants completed interviews on lifestyle factors. Participants with <1 year of follow-up time or missing data for smoking status, alcohol intake, physical activity, and sedentary behavior were excluded from analysis. After these exclusions (not mutually exclusive), data from 79,101 SCCS participants were available for analysis. The study was

approved by IRBs at Vanderbilt University and Meharry Medical College. All participants provided written informed consent.

Measures

Vital status was obtained via linkage to the Social Security Administration's Death Master File. Cause of death was ascertained from the National Death Index through December 31, 2011. Cause-specific mortality categories were grouped according to the ICD-10 codes and were classified as cardiovascular diseases (I00–I69), cancer (C00–C97), and all other-causes.

Data on health behaviors, prior medical history, and demographic characteristics were ascertained upon entry into the cohort. Information was obtained via study questionnaires about lifetime smoking history, alcohol intake, physical activity, and diet during the previous year. The physical activity and sedentary behavior assessments in the SCCS have been described previously.¹³ Briefly, participants were asked to comprehensively assess active behaviors done at work, home, and during leisure time (sports/exercise). Sedentary behavior was assessed by asking about the amount of time/day spent sitting. Dietary intake was evaluated by an 89-item Food Frequency Questionnaire developed and validated specifically for the diet in the Southeastern U.S.^{14,15} Data for the potential confounding variable, neighborhood deprivation index, was obtained from the 2000 U.S. Census and linked to participants' residential addresses. The neighborhood deprivation index variable incorporates 11 Census tract-level variables that capture domains of education, employment, housing, occupation, and poverty.¹⁶

Two healthy lifestyle scores were created to assess the combined associations between health behaviors with mortality. The first score was a composite of the relative effects on all-cause mortality of smoking, alcohol, physical activity, sedentary behavior, and diet. Both smoking duration (years) and quantity of cigarettes smoked/day were taken into account. For Score 1, participants with alcohol intake reported as more than zero but one or fewer drinks/day for women or two or fewer drinks/day for men were used as the reference owing to the potential beneficial health effects of moderate alcohol consumption, especially in respect to risk of cardiovascular disease and all-cause mortality.¹⁷ To evaluate physical activity, a summary variable was created as the sum of all household, leisure, and occupational activity over the course of a week to reflect daily activity and converted to MET estimates of energy expenditure using methods described in the Compendium of Physical Activities.^{18,19} A summary sedentary behavior variable was created as the average sitting time/day over the course of the week. To assess diet quality, Healthy Eating Index (HEI) values (range, 0–100) were calculated, where a higher value indicated a healthier diet, based on 12 dietary components: total fruits; whole fruits; total vegetables; greens and beans; whole and refined grains; dairy; total protein foods; seafood and plant proteins; fatty acids; sodium; and calories from solid fats, alcohol, and added sugars.^{20,21} The HEI is a diet quality measure that assesses adherence to the Dietary Guidelines for Americans.¹⁷ Compared with typical food consumption patterns in the U.S., the HEI suggests eating more vegetables and fruits.¹⁷ Score 2 was created by counting and summing (0–5) the number of

current public health guidelines (no/yes) the participant met for the five health behaviors of interest, as outlined in Appendix Table 1.^{17,20,22,24}

Statistical Analysis

Frequency distributions of participant characteristics were tabulated for the total sample and by race and sex (Appendix Table 2). Hazard ratios and 95% CIs were estimated using Cox proportional hazard models for the association between lifestyle factors and mortality using age as the time scale with entry time defined as age at baseline interview and exit time as age at death or December 31, 2011.²⁵ Statistical models included the following potential confounding variables selected a priori based on their established associations with mortality and at least one exposure variable selected for this analysis: enrollment source, race, sex, education, income, marital status, neighborhood deprivation index, and BMI. State of residence was evaluated as a potential confounder a posteriori and was not included in the final analysis because the inclusion of residence state in statistical models did not affect point estimates or CIs for the associations between healthy lifestyle scores and mortality. Missing covariate data were set to the race- and sex-specific medians (mode for marital status). Participants missing HEI data were set to the race-, sex-, and smoking status-specific medians. Excluded participants or participants missing data on model covariates were more likely to be male or recruited from the general population than included participants without imputed data.

Score 1 was formed by calculating adjusted risk estimates for the whole cohort, as categorized in Table 1, for levels of the five health behaviors. Models were adjusted for race, gender, enrollment source, income, education, marital status, neighborhood deprivation index, and BMI. For each variable, the reference group was assigned a value of zero and for other categories of the variable, point estimates were used as weighted values. The weights were summed and grouped by quartiles. Individuals in the highest 25% of scores were placed in Quartile 1 (least healthy lifestyle) and used as the reference group for comparisons.

Adjusted hazard ratios and 95% CIs were estimated between scores and all- and cause-specific mortality. The proportional hazards assumption was evaluated graphically and considered met. For trend tests, *p*-values were calculated by treating ordinal score variables as continuous in models. Sensitivity analyses were conducted by evaluating associations between scores and mortality with exclusion of participants with < 2 years of follow-up, participants recruited from the general population, or participants with missing covariate data. Associations were evaluated between scores and all-cause mortality in subgroups defined by baseline household income, chronic disease status, or BMI. Possible interactions between scores and factors of interest were assessed by likelihood ratio tests to compare main effects models with and without the addition of cross-product terms. Population attributable risk (PAR) estimates of all-cause mortality were calculated in association with each health behavior and with Score 2. PAR estimates the proportion of deaths associated

with not having by using the formula: $\sum_{i=0}^k P * (RR_i - 1) / RR_i * 100$, where *p* = proportion of cases in the *i*th exposure level, and *RR_i* = relative risk for participants at each level of the health factor. Covariate categorization and sample sizes of excluded and imputed

data are available in Appendix Methods. Data analysis was conducted in 2014 and 2015. Statistical analyses were performed using SAS, version 9.3.

Results

At baseline, current smoking was more frequent among men than women, and white current smokers smoked more cigarettes/day than African American current smokers (Table 1). Former and current smoking was associated with increased mortality and the association was strongest in white participants. Alcohol intake was generally low among all demographic subgroups and was the public health recommendation most commonly met. The physical activity guideline was met the least (19.7%). Independently, moderate alcohol intake, higher diet quality, higher physical activity, and less daily sedentary time were associated with decreased mortality.

Individuals with scores indicating more healthy behaviors were at lower mortality risk (Table 2). Significant interactions in the association between scores and all-cause mortality by race and sex were observed, thus stratified analyses are presented. Within each race, the sex difference in the associations of lifestyle scores with all-cause mortality was less apparent. Point estimates for the associations between scores and all-cause mortality were similar in analyses with and without adjustment for BMI. For example, hazard ratios for all-cause mortality without adjustment for BMI comparing participants meeting four or more guidelines versus meeting zero were 0.38 (95% CI=0.29, 0.52) for African American men, 0.36 (95% CI=0.24, 0.54) for white men, 0.40 (95% CI=0.32, 0.52) for African American women, and 0.27 (95% CI=0.17, 0.42) for white women. The PAR for all-cause mortality associated with not meeting four or more public health guidelines was 49.2% for African American men, 46.5% for white men, 34.3% for African American women, and 57.0% for white women (Appendix Figure 1).

Stratified results for the association between scores and mortality due to cardiovascular disease, cancer, and other-causes of death were similar to all-cause mortality findings (Table 3). With the exception of other-cause mortality among men, stronger associations with lifestyle scores were found in analyses of cause-specific mortality for whites than African Americans, although not all tests for interactions were significant. Point estimates for the associations between lifestyle scores with all-cause mortality were minimally changed when participants with 2 years of follow-up or missing covariate data were excluded from analyses (Appendix Table 3). In analyses restricted to participants enrolled at CHCs, the relationships between lifestyle scores and all-cause mortality were unchanged for African American participants and white women. In white men enrolled via CHCs, the associations between lifestyle scores and all-cause mortality were diminished and interactions between lifestyle scores and race in men was no longer significant (Appendix Table 3).

The inverse association between Lifestyle Score 2 and all-cause mortality was observed among subgroups classified by baseline chronic disease status: individuals with severe diseases (cancer, stroke, or heart diseases), individuals with diabetes or hypertension, and healthy individuals (without HIV infection or the diseases listed above) (Appendix Figure 2). Significant interactions between whites and African Americans were noted for all except

the female severe disease and male healthy groups. Significant inverse trends were observed between Lifestyle Score 2 and all-cause mortality in all BMI subgroups (Appendix Table 4). The association between Lifestyle Score 2 and mortality was weaker among men with household income <\$15,000 (Table 4). Significant interaction between household income and Lifestyle Score 2 was not observed among women.

Discussion

This study demonstrates the substantial impact of healthy lifestyle on mortality in low-SES whites and African Americans and provides strong support for lifestyle modification measures to reduce mortality in this underserved population. Previous studies conducted primarily in European-ancestry samples and individuals with higher SES also show an inverse trend between healthy lifestyle and mortality.^{1–4,26–30} In the SCCS, the association between lifestyle scores and mortality was weaker in African Americans than whites. Current smoking prevalence is highest in African American men, but white current smokers smoked more cigarettes/day and thus had higher total cigarette consumption. Heavier current smoking by white than African American participants may contribute to their higher smoking PARs and the stronger associations observed between lifestyle scores and mortality (Appendix Figure 1). Another potential explanation of these findings is that there are additional mortality risk factors to be identified in African American populations. Potential risk factors may be individual health behaviors or risk factors associated with social support, social cohesion, the physical environment and racial bias in the form of real and perceived discrimination. Perceived discrimination has been linked to poor mental and physical health,³¹ through conditions such as depression and hypertension, potentially leading to premature mortality. Additionally, in interactions with the healthcare system, African Americans report lower quality of care and may suffer from implicit racial bias of their providers.³² In general and within the cohort, African Americans are more often of low SES (Appendix Table 2), which is known to adversely affect mortality outcomes,³³ even after adjustment for individual lifestyle behaviors.^{34,35} Additionally, in comparison with white Americans, on average, African Americans have less wealth, defined as total monetary assets minus debts.³⁶ In analyses restricted to participants enrolled via CHCs, the racial difference in the all-cause mortality associations dissipated among men, indicating that when African American and white men's social circumstances are comparable, the association between lifestyle and mortality is similar (Appendix Table 3). The male CHC results are in agreement with a study by LaVeist et al.,³⁷ who found health outcomes are generally similar among African Americans and whites who live in the same low-income Census tract. In CHC-restricted analyses, white women with the healthiest lifestyle experienced a greater mortality risk reduction than African American women, indicating differences between these two populations persist even when both groups have limited resources and a similar type of medical care (Appendix Table 3). The reasons for this disparity are unclear. Other determinants for mortality, such as stress, depression, and discrimination may have different impact on mortality between African American and white women.

The study's results also show evidence of effect modification of the association between healthy lifestyle and mortality by household income among male participants. The study design of the SCCS focused primarily on recruitment of low-SES participants and

approximately 55% of study participants have household income <\$15,000. Income of \$15,000 is the approximate poverty guideline for a two-person adult household, and is the approximate annual wage of a full-time federal minimum wage employee. Low SES is theorized to affect health through lack of resources, health knowledge, social support, and access to quality medical care.⁷ Lack of knowledge of best health practices may keep individuals from participating in routine cancer screening, and other practices that can optimize health. Moreover, low-SES individuals more frequently report exposures to stressors such as poor social networks and job insecurity.³⁸ Chronic stress may be linked to mortality through mechanisms of increased coronary heart disease, hypertension, and cancer.^{31,39} However, the finding of substantial reduced mortality risk associated with a greater healthy lifestyle score in participants with household income <\$15,000 provides support to attend to individual health behaviors as well as socioeconomic issues to improve mortality outcomes in low-income African Americans and whites.

Limitations

Self-reported health behaviors are susceptible to measurement error. Because of the prospective study design, misclassification is expected to be non-differential and likely will attenuate study results. Additionally, validation studies found physical activity and sedentary behavior questionnaires used in the SCCS to correlate with relevant criterion measures,⁴⁰ and food frequency questionnaire estimates significantly correlate with biochemical indicators of micronutrient levels.¹⁵ Both validation studies found the performance of the SCCS questionnaire in regard to physical activity, sedentary behavior, and diet to be consistent across racial subgroups. Nevertheless, it is possible that social desirability bias could contribute to some of the differences observed in this study. Reverse causation is another concern in lifestyle and mortality studies. Reverse causation was addressed by conducting analyses that excluded participants with <2 years of follow-up, and found similar results. Additionally, the inverse association between healthy lifestyle and all-cause mortality is consistently observed in subgroups defined by chronic disease status at baseline, suggesting that reverse causation is not substantially affecting the conclusions.

The HEI was chosen as a measure of diet quality because of its applicability to low-income populations.⁴¹ However, the constitution of a healthy diet is still debated. Moreover, HEI is an inherently relative measure, as individual's HEI value may vary depending on the food frequency questionnaire used in a particular study, and thus it is difficult to compare the value of HEI across studies. No sedentary behavior guidelines have been established. The decision to operationalize the recommendation to "avoid inactivity"⁴² as the upper quartile of reported sitting time in this study may have affected the strength of the associations between scores and mortality. Lastly, individuals who agree to participate in epidemiologic studies are often healthier than the general population, a phenomenon termed the "healthy volunteer" effect. Possible influence of this effect on our study results is unclear. Lastly, individuals who agree to participate in epidemiologic studies may differ from those who did not participate. However, information was not collected about characteristics of non-participants in the study to assess how non-participation may have influenced the study results.

Conclusions

Results from this study show individuals with the healthiest lifestyle scores have twofold to threefold decreased mortality compared with those with less healthy scores in all studied race–sex groups; however associations of healthy lifestyle and mortality are weaker among low-SES whites and African Americans. These findings highlight the importance of meeting public health recommendations to reduce mortality. Implementation of policies that aim to remove structural barriers to optimal health in low-income and African American populations, such as policies that address opportunities to make healthy choices, increase educational attainment, and decrease racial bias, may help to decrease health disparities by race and class.

Supplementary Material

Refer to Web version on PubMed Central for supplementary material.

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Table 1
Associations Between Health Behaviors and Mortality by Sex and Race, the Southern Community Cohort Study

All participants										Men				Women					
Characteristic	Cohort	Deaths	HR (95% CI) ^a	African American				White				African American				White			
				Deaths	HR (95% CI) ^b	Deaths	HR (95% CI) ^b	Deaths	HR (95% CI) ^b	Deaths	HR (95% CI) ^b	Deaths	HR (95% CI) ^b	Deaths	HR (95% CI) ^b				
Smoking status																			
Never	28,462	1,710	1 (ref.)	443	1 (ref.)	168	1 (ref.)	805	1 (ref.)	244	1 (ref.)	1 (ref.)	1 (ref.)						
Former	18,060	1,774	1.31 (1.22–1.40)	618	1.16 (1.03–1.31)	330	1.22 (1.01–1.47)	481	1.28 (1.14–1.44)	259	1.51 (1.27–1.80)	1.51 (1.27–1.80)							
Current ^c Light	21,443	2,376	1.73 (1.61–1.85)	1199	1.35 (1.20–1.52)	204	1.92 (1.54–2.39)	659	1.65 (1.47–1.85)	244	2.70 (2.23–3.26)	2.70 (2.23–3.26)							
Current-Heavy	11,136	1,504	1.95 (1.80–2.11)	490	1.43 (1.25–1.64)	409	1.98 (1.62–2.41)	212	1.84 (1.56–2.16)	325	2.91 (2.42–3.49)	2.91 (2.42–3.49)							
Alcohol consumption																			
Nondrinker	36,871	3,626	1.22 (1.15–1.29)	934	1.15 (1.05–1.27)	518	1.29 (1.12–1.49)	1294	1.17 (1.05–1.30)	715	1.23 (1.06–1.43)	1.23 (1.06–1.43)							
Moderate ^d	28,155	2,162	1 (ref.)	941	1 (ref.)	341	1 (ref.)	541	1 (ref.)	268	1 (ref.)	1 (ref.)							
Heavy	14,075	1,576	1.21 (1.13–1.29)	875	1.18 (1.07–1.30)	252	1.35 (1.14–1.59)	322	1.26 (1.09–1.45)	89	1.26 (0.99–1.61)	1.26 (0.99–1.61)							
Physical activity (MET-hrs/day) ^e																			
High	25,897	1,590	1 (ref.)	562	1 (ref.)	211	1 (ref.)	528	1 (ref.)	226	1 (ref.)	1 (ref.)							
Mid	24,433	1,990	1.23 (1.15–1.31)	740	1.37 (1.23–1.53)	296	1.20 (1.00–1.44)	615	1.10 (0.97–1.23)	263	1.17 (0.98–1.40)	1.17 (0.98–1.40)							
Low	26,086	3,221	1.58 (1.48–1.68)	1181	1.76 (1.58–1.96)	467	1.41 (1.18–1.67)	918	1.36 (1.22–1.52)	532	1.68 (1.43–1.97)	1.68 (1.43–1.97)							
None	2,685	563	2.10 (1.90–2.32)	267	2.07 (1.78–2.41)	137	2.08 (1.66–2.61)	96	2.13 (1.70–2.65)	51	2.92 (2.14–3.97)	2.92 (2.14–3.97)							
Sedentary time (hours/day, quartiles)																			
5.75	19,907	1,863	1 (ref.)	733	1 (ref.)	279	1 (ref.)	528	1 (ref.)	262	1 (ref.)	1 (ref.)							
5.76–8.5	20,648	1,935	1.07 (1.00–1.14)	707	1.06 (0.95–1.17)	308	1.06 (0.90–1.25)	545	1.06 (0.94–1.20)	320	1.10 (0.94–1.30)	1.10 (0.94–1.30)							
8.6–12	19,994	1,888	1.18 (1.11–1.26)	696	1.20 (1.08–1.33)	278	1.09 (0.92–1.29)	561	1.21 (1.07–1.37)	279	1.16 (0.97–1.37)	1.16 (0.97–1.37)							
>12	18,552	1,678	1.25 (1.16–1.33)	614	1.16 (1.04–1.29)	246	1.31 (1.10–1.56)	523	1.30 (1.15–1.47)	211	1.10 (0.91–1.33)	1.10 (0.91–1.33)							
Healthy Eating Index (quartiles)																			
>66.7	19,775	1,500	1 (ref.)	396	1 (ref.)	157	1 (ref.)	607	1 (ref.)	265	1 (ref.)	1 (ref.)							
59.3–66.7	19,777	1,836	1.16 (1.08–1.24)	652	1.10 (0.97–1.24)	228	1.21 (0.98–1.49)	612	1.13 (1.01–1.27)	275	1.25 (1.05–1.48)	1.25 (1.05–1.48)							
51.8–59.2	19,774	1,989	1.11 (1.03–1.19)	844	1.07 (0.94–1.21)	288	1.15 (0.93–1.41)	535	1.11 (0.98–1.25)	255	1.17 (0.98–1.40)	1.17 (0.98–1.40)							
51.7	19,775	2,039	1.12 (1.04–1.20)	858	1.08 (0.96–1.23)	438	1.23 (1.01–1.50)	403	1.04 (0.91–1.19)	277	1.14 (0.95–1.37)	1.14 (0.95–1.37)							

HR, hazard ratio; MET-hrs, metabolic equivalent-hours; Ref., reference

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^a Adjusted for sex, race, enrollment source, education, income, marital status, neighborhood deprivation, BMI, and the individual lifestyle factors included in the table.

^b Adjusted for enrollment source, education, income, marital status, neighborhood deprivation, BMI, and the individual lifestyle factors included in the table.

^c Light current smoking is defined as smoking for < 20 years or < 20 cigarettes/day. Heavy current smoking is defined as smoking for ≥ 20 years and ≥ 20 cigarettes/day.

^d Moderate alcohol intake is defined as > 0 but < 1 drink/day for women or < 2 drink/day for men.

^e Physical activity categories are defined high: > 23.8 for women, > 30.6 for men; mid: 12.7–23.8 for women, 12.7–30.6 for men; low: 0.1–12.6 for women and men; none: 0 MET-hrs/day.

Table 2

Associations Between Composite Lifestyle Scores and All-Cause Mortality, the Southern Community Cohort Study

Women																
African American						White			African American			White				
Cohort	Deaths	HR (95% CI) ^a	Cohort	Deaths	HR (95% CI) ^a	Cohort	Deaths	HR (95% CI) ^a	Cohort	Deaths	HR (95% CI) ^a	Cohort	Deaths	HR (95% CI) ^a	p-value ^b	
Lifestyle score 1 (quartiles)																
Q1	7,336	1279	1 (ref.)	0.76	2,814	544	1 (ref.)	0.69	5,644	609	1 (ref.)	0.76	3,273	444	1 (ref.)	0.60
Q2	6,546	811	(0.69–0.83)	0.59	2,408	296	(0.59–0.79)	0.49	6,747	560	(0.67–0.85)	0.55	3,247	267	(0.51–0.70)	0.41
Q3	4,613	450	(0.53–0.66)	0.47	2,228	185	(0.41–0.59)	0.35	8,110	508	(0.48–0.62)	0.46	3,863	218	(0.35–0.49)	0.27
Q4	3,155	210	(0.40–0.54)	1,674	86	(0.28–0.44)			9,800	480	(0.41–0.52)		4,231	143	(0.22–0.32)	
p-trend			<0.001				<0.001				<0.001				<0.001	
Lifestyle score 2 (# guidelines met)																
0	2,772	422	1 (ref.)	0.86	687	130	1 (ref.)	0.79	1,646	151	1 (ref.)	0.91	457	44	1 (ref.)	0.89
1	7,858	1098	(0.76–0.96)	0.76	3,362	501	(0.65–0.96)	0.60	7,631	691	(0.76–1.09)	0.69	4,303	440	(0.65–1.22)	0.61
2	7,165	864	(0.68–0.86)	0.70	3,058	332	(0.48–0.73)	0.49	11,089	770	(0.58–0.83)	0.52	5,418	384	(0.45–0.84)	0.43
3	3,008	316	(0.60–0.81)	0.41	1,486	119	(0.38–0.64)	0.36	7,419	423	(0.43–0.64)	0.46	3,208	168	(0.31–0.61)	0.27
4+	847	50	(0.30–0.55)	531	29	(0.24–0.55)			2,516	122	(0.36–0.59)		1,228	36	(0.18–0.43)	
p-trend			<0.001				<0.001				<0.001				<0.001	

HR, hazard ratio; Ref., reference

Note: Boldface indicates statistical significance ($p < 0.05$).^a Adjusted for enrollment source, education, income, marital status, neighborhood deprivation, and BMI.^b p-value for interaction between race and lifestyle score.

Lifestyle score 1 – All-cause mortality p-interactionSex for cohort=0.20, African Americans=0.02, whites=0.02.

Lifestyle score 2 – All-cause mortality p-interactionSex for cohort <0.001, African Americans <0.001, whites=0.02.

Table 3
Associations Between Composite Lifestyle Scores and Cause-Specific Mortality, the Southern Community Cohort Study

Men					Women				
		African American			White				
	Deaths	HR (95% CI) ^a	Deaths	HR (95% CI) ^a	Deaths	HR (95% CI) ^a	Deaths	HR (95% CI) ^a	p-value ^b
Cardiovascular diseases mortality									
Lifestyle score 1 (quartiles)									
Q1	357	1 (ref.)	158	1 (ref.)	164	1 (ref.)	117	1 (ref.)	
Q2	247	0.79 (0.67–0.94)	78	0.60 (0.45–0.78)	158	0.77 (0.62–0.96)	67	0.55 (0.40–0.74)	
Q3	151	0.65 (0.54–0.79)	62	0.51 (0.37–0.69)	155	0.58 (0.46–0.73)	48	0.33 (0.23–0.46)	<0.001
Q4	73	0.52 (0.40–0.68)	18	0.23 (0.14–0.38)	157	0.54 (0.43–0.67)	39	0.26 (0.18–0.38)	
p-trend		<0.001		<0.001		<0.001		<0.001	
Lifestyle score 2 (# guidelines met)									
0	104	1 (ref.)	33	1 (ref.)	38	1 (ref.)	9	1 (ref.)	
1	330	0.99 (0.79–1.24)	150	0.84 (0.57–1.23)	185	0.90 (0.63–1.28)	115	0.98 (0.49–1.94)	
2	258	0.84 (0.67–1.06)	90	0.54 (0.36–0.81)	246	0.78 (0.55–1.12)	103	0.67 (0.34–1.34)	0.02
3	113	0.91 (0.69–1.19)	34	0.46 (0.28–0.75)	134	0.58 (0.40–0.85)	35	0.36 (0.17–0.76)	
4+	23	0.66 (0.42–1.05)	9	0.36 (0.17–0.77)	31	0.41 (0.25–0.66)	9	0.29 (0.11–0.74)	
p-trend		0.04		<0.001		<0.001		<0.001	
Cancer mortality									
Lifestyle score 1 (quartiles)									
Q1	317	1 (ref.)	121	1 (ref.)	158	1 (ref.)	110	1 (ref.)	
Q2	178	0.69 (0.57–0.83)	72	0.73 (0.54–0.98)	124	0.64 (0.50–0.81)	67	0.57 (0.42–0.77)	
Q3	82	0.43 (0.33–0.55)	37	0.37 (0.25–0.54)	134	0.54 (0.42–0.68)	63	0.41 (0.30–0.57)	0.01
Q4	49	0.44 (0.32–0.60)	20	0.28 (0.17–0.46)	127	0.45 (0.35–0.57)	39	0.23 (0.16–0.34)	
p-trend		<0.001		<0.001		<0.001		<0.001	
Lifestyle score 2 (# guidelines met)									
0	122	1 (ref.)	30	1 (ref.)	46	1 (ref.)	11	1 (ref.)	
1	243	0.64 (0.51–0.80)	115	0.78 (0.52–1.17)	162	0.67 (0.48–0.93)	109	0.93 (0.50–1.74)	
2	188	0.57 (0.45–0.72)	71	0.52 (0.34–0.81)	184	0.51 (0.36–0.71)	96	0.61 (0.32–1.14)	0.25

	Men						Women					
	African American			White			African American			White		
	Deaths	HR (95% CI) ^a	Deaths	HR (95% CI) ^a	Deaths	p-value ^b	Deaths	HR (95% CI) ^a	Deaths	HR (95% CI) ^a	Deaths	p-value ^b
3	64	0.48 (0.35–0.65)	29	0.45 (0.26–0.76)	115		115	0.43 (0.30–0.61)	51	0.48 (0.25–0.92)		
4+	9	0.24 (0.12–0.48)	5	0.20 (0.08–0.52)	36		36	0.39 (0.25–0.62)	12	0.30 (0.13–0.69)		
p-trend		<0.001		<0.001				<0.001		<0.001		
Other-cause mortality^c												
Lifestyle score 1 (quartiles)												
Q1	542	1 (ref.)	256	1 (ref.)	259		259	1 (ref.)	205	1 (ref.)		
Q2	359	0.80 (0.70–0.91)	137	0.70 (0.57–0.87)	245		245	0.81 (0.68–0.97)	122	0.63 (0.50–0.79)		
Q3	196	0.65 (0.55–0.77)	83	0.55 (0.43–0.72)	192	0.43	192	0.52 (0.43–0.63)	95	0.44 (0.34–0.56)		0.02
Q4	81	0.45 (0.36–0.57)	45	0.47 (0.34–0.65)	167		167	0.41 (0.33–0.50)	58	0.28 (0.20–0.37)		
p-trend		<0.001		<0.001				<0.001		<0.001		
Lifestyle score 2 (# guidelines met)												
0	184	1 (ref.)	60	1 (ref.)	60		60	1 (ref.)	22	1 (ref.)		
1	469	0.89 (0.75–1.05)	231	0.84 (0.63–1.12)	311		311	1.11 (0.84–1.47)	205	0.87 (0.56–1.36)		
2	385	0.84 (0.70–1.00)	161	0.70 (0.52–0.95)	298	0.28	298	0.75 (0.57–1.00)	170	0.60 (0.38–0.94)		0.08
3	124	0.70 (0.55–0.88)	54	0.59 (0.40–0.86)	150		150	0.54 (0.40–0.74)	71	0.43 (0.26–0.69)		
4+	16	0.35 (0.21–0.58)	15	0.55 (0.31–0.97)	44		44	0.49 (0.33–0.73)	12	0.22 (0.11–0.45)		
p-trend		<0.001		0.001				<0.001		<0.001		

HR, hazard ratio; Ref., reference

Note: Boldface indicates statistical significance ($p < 0.05$).^a Adjusted for enrollment source, education, income, marital status, neighborhood deprivation and BMI.^b p-value for interaction between race and lifestyle score.^c Other-cause mortality includes all deaths from causes other than cardiovascular diseases and cancer.

Table 4
Association Between Lifestyle Score 1 and All-Cause Mortality by Race, Income, and Sex

African American										White					
< \$15000										\$15000		< \$15000		\$15000	
Lifestyle score 2	Deaths	HR (95%CI) ^a	Deaths	HR (95%CI) ^b	p-value ^c	Deaths	HR (95%CI) ^a	Deaths	HR (95%CI) ^b	p-value ^c	Deaths	HR (95%CI) ^a	Deaths	HR (95%CI) ^b	p-value ^c
# guidelines met															
Men															
0	312	1 (ref.)	110	1 (ref.)		94	1 (ref.)	36	1 (ref.)		36	1 (ref.)	36	1 (ref.)	
1	829	0.93 (0.83–1.06)	269	0.66 (0.53–0.83)		312	0.78 (0.62–0.99)	189	0.78 (0.54–1.12)		189	0.78 (0.54–1.12)	189	0.78 (0.54–1.12)	
2	639	0.86 (0.75–0.99)	225	0.52 (0.41–0.66)	0.002	213	0.66 (0.52–0.85)	119	0.47 (0.32–0.69)	0.04	119	0.47 (0.32–0.69)	119	0.47 (0.32–0.69)	0.04
3	207	0.78 (0.65–0.93)	109	0.52 (0.39–0.68)		49	0.47 (0.33–0.68)	70	0.46 (0.31–0.70)		70	0.46 (0.31–0.70)	70	0.46 (0.31–0.70)	
4+	32	0.50 (0.34–0.72)	18	0.27 (0.16–0.45)		15	0.58 (0.33–1.00)	14	0.24 (0.13–0.44)		14	0.24 (0.13–0.44)	14	0.24 (0.13–0.44)	
p-trend		<0.001		<0.001			<0.001		<0.001			<0.001		<0.001	
# guidelines met															
Women															
0	121	1 (ref.)	30	1 (ref.)		35	1 (ref.)	9	1 (ref.)		9	1 (ref.)	9	1 (ref.)	
1	536	0.93 (0.76–1.13)	155	0.84 (0.57–1.25)		319	0.83 (0.58–1.18)	121	1.14 (0.57–2.25)		121	1.14 (0.57–2.25)	121	1.14 (0.57–2.25)	
2	566	0.71 (0.58–0.87)	204	0.64 (0.43–0.94)		266	0.58 (0.41–0.84)	118	0.72 (0.37–1.43)		118	0.72 (0.37–1.43)	118	0.72 (0.37–1.43)	
3	313	0.55 (0.44–0.69)	110	0.46 (0.30–0.70)	0.89	113	0.42 (0.29–0.62)	55	0.49 (0.24–1.00)	0.49	55	0.49 (0.24–1.00)	55	0.49 (0.24–1.00)	0.49
4+	77	0.45 (0.33–0.60)	45	0.48 (0.30–0.76)		18	0.25 (0.14–0.45)	18	0.35 (0.15–0.78)		18	0.35 (0.15–0.78)	18	0.35 (0.15–0.78)	
p-trend		<0.001		<0.001			<0.001		<0.001			<0.001		<0.001	

HR, hazard ratio; Ref., reference

Note: Boldface indicates statistical significance ($p < 0.05$).

^a Adjusted for enrollment source, education, marital status, neighborhood deprivation, and BMI.

^b Models additionally adjusted for income.

^c p-value for interaction between income and lifestyle score.

p-interaction Race, lifestyle score and income for men=0.12

p-interaction Race, lifestyle score and income for women=0.33