

Socioeconomic Status, Race, and Mortality: A Prospective Cohort Study

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From birth through approximately age 85 years, there is a mortality rate disparity between Blacks and Whites in the United States that peaks in early adulthood and slowly narrows thereafter.¹⁻⁴ Most of the excess deaths among Blacks occur in middle-aged adults, given the confluence of rising mortality rates and the disparity at those ages. During much of the 20th century, this disparity was unyielding,⁴⁻⁶ but recent data point to some narrowing of the gap beginning in the 1990s.⁷⁻⁹ Still, in 2011 the highest age-standardized death rate in the United States was that among non-Hispanic Blacks (877.4 per 100 000 standard population), followed by non-Hispanic Whites (738.1 per 100 000 standard population).¹⁰ Also, average life expectancies at birth in 2011 were 4.5 years shorter for Black than White men and 3.1 years shorter for Black than White women.¹⁰

Although national mortality data are routinely reported by race/ethnicity, their interpretation must consider the determinants of race-specific mortality rates, including behavioral, social, economic, and political factors that determine the resources available to maintain health and prolong life.³ Whether socioeconomic status (SES) completely accounts for mortality differences between Blacks and Whites is not clear. Previous studies have reported that SES alone cannot fully account for the disparity, although in settings where Blacks and Whites are drawn from considerably different SES strata, confounding by SES may be difficult to overcome.¹¹⁻¹⁴ By contrast, in settings where race-specific SES differences are minimal (including the current study), it has been suggested that important health indicators are quite similar by race.¹⁵⁻¹⁷ Individual-level SES aside, neighborhood-level SES has also been reported to influence mortality rates,¹⁸ but fewer investigations have assessed the joint contribution of individual and neighborhood SES,¹⁹⁻²² and analyses

Objectives. We evaluated the independent and joint effects of race, individual socioeconomic status (SES), and neighborhood SES on mortality risk.

Methods. We conducted a prospective analysis involving 52 965 non-Hispanic Black and 23 592 non-Hispanic White adults taking part in the Southern Community Cohort Study. Cox proportional hazards modeling was used to determine associations of race and SES with all-cause and cause-specific mortality.

Results. In our cohort, wherein Blacks and Whites had similar individual SES, Blacks were less likely than Whites to die during the follow-up period (hazard ratio [HR] = 0.78; 95% confidence interval [CI] = 0.73, 0.84). Low household income was a strong predictor of all-cause mortality among both Blacks and Whites (HR = 1.76; 95% CI = 1.45, 2.12). Being in the lowest (vs highest) category with respect to both individual and neighborhood SES was associated with a nearly 3-fold increase in all-cause mortality risk (HR = 2.76; 95% CI = 1.99, 3.84). There was no significant mortality-related interaction between individual SES and neighborhood SES among either Blacks or Whites.

Conclusions. SES is a strong predictor of premature mortality, and the independent associations of individual SES and neighborhood SES with mortality risk are similar for Blacks and Whites. (*Am J Public Health.* 2014;104:e98-e107. doi:10.2105/AJPH.2014.302156)

assessing the interplay of these 2 SES domains with race are rare.^{19,21}

We thus took the opportunity, within a large prospective study of non-Hispanic Black and White adults (residing in a large area of the United States, enrolled mainly in low-income settings but also non-low-income settings, and representing a range of SES levels), to evaluate the independent and joint contributions of race, individual SES, and neighborhood SES to overall and cause-specific mortality risk.

METHODS

The Southern Community Cohort Study (SCCS), a prospective cohort study designed to investigate racial disparities in cancer, enrolled more than 85 000 men and women across 12 southeastern states from 2002 to 2009. Comprehensive study details are provided elsewhere.²³ Briefly, individuals were eligible for enrollment if they were 40 to 79 years of

age, they were English speaking, and they had not been under treatment for cancer within the preceding year. Recruitment took place primarily (86%) at community health centers (CHCs), which provide health services in medically underserved, lower-income areas. The remainder of the SCCS participants (14%) enrolled through the mail in response to population-based mass mailings. Of 85 689 SCCS cohort members, 80 641 (94%) self-reported their race/ethnicity as either non-Hispanic Black or non-Hispanic White and served as the study base for this analysis.

At CHCs, trained interviewers administered a computer-assisted personal interview to collect baseline data on demographic characteristics, body size, medical history, and a wide range of lifestyle factors (e.g., diet, smoking, exercise). Participants who enrolled through the mail completed an identical survey on a scannable, self-administered form (available at <http://www.southerncommunitystudy.org>).

Mortality Follow-Up

The cohort was followed prospectively for mortality via linkage to the National Death Index through 2010 and the Social Security Administration's Death Master File through February 2011. Cause of death was ascertained from the National Death Index. Use of these national mortality registries was expected to lead to minimal loss to follow-up, particularly given that Social Security numbers were available for more than 95% of the participants.^{24,25} Participants were followed from enrollment until their date of death or February 2011, whichever came first. In the case of those whose vital status was reported as unknown by the Social Security Administration in 2011, person-time accrued to the final known date they were confirmed alive. The average length of follow-up was 5.4 years (SD = 2.0), and the maximum was 8.9 years.

Individual and Neighborhood Socioeconomic Status

Annual household income was reported in categories of less than \$15 000, \$15 000 to \$24 999, \$25 000 to \$49 999, \$50 000 to \$99 999, and \$100 000 or more, with the 2 highest categories combined owing to small numbers. Educational attainment was classified as less than 9 years; 9 to 11 years; high school, general educational development (GED), or vocational school; some college or junior college; and college graduate or beyond. Marital status was classified as married or living as married with a partner, separated or divorced, widowed, and single or never married.

In addition, health insurance coverage was classified as none, Medicaid, Medicare (in 2 categories for those aged 65 years or older and those younger than 65 years to distinguish individuals who aged into coverage from individuals who achieved eligibility through disability at younger ages), private insurance, military insurance, and "other." Participants also reported the type of job they held for the longest period of time during their adult life in 20 categories. We applied Nam-Powers-Boyd occupational status scores,²⁶ which fall on a scale from 1 (lowest) to 100 (highest) and represent the socioeconomic standing of an occupation, to our occupational categories by assigning each the average of the scores for the individual job examples in that category.

Finally, we considered data on household size, the number of close friends or relatives that participants reported would help with their emotional problems or feelings, and the number of close friends or relatives they could ask for help in an emergency or with lending them money.

To estimate neighborhood SES, we computed a neighborhood deprivation index (NDI) using methods described previously²⁷; the index was based on 20 tract-level US census variables in the 7 domains of poverty, housing, occupation, employment, education, residential stability, and racial composition (Table A, available as a supplement to the online version of this article at <http://www.ajph.org>). The variables were obtained from 2000 US census data²⁸ and linked to the geographical coordinates of SCCS participants' residential addresses.²⁹ Also, we used Federal Information Processing Standards codes to link county of residence to the 9-level 2003 rural-urban continuum code created by the US Office of Management and Budget.³⁰ We then collapsed this 9-level measure into a dichotomous variable indicating urban (metropolitan) or rural (nonmetropolitan) residence.

We performed an initial principal components analysis involving all census tracts of the SCCS participants, overall as well as by strata of urban or rural residence. Twelve census variables with loadings greater than the root mean square of all loading values in the loading matrix in either the combined population or the rural or urban subsets were initially chosen for retention in the final analysis. One of the 12 variables was percentage of non-Hispanic Blacks, which we subsequently forced out of the analysis to avoid undue influence over Black participants' deprivation index assignment, a decision that had negligible impact on the variance explained.

Thus, the final principal components analysis was based on 11 census tract-level variables: the percentage of individuals who had less than a high school education; the percentage of individuals who were unemployed; the percentage of men who worked in managerial jobs; the percentages of households with more than one person per room and with renter or owner costs greater than 50% of household income; the percentage of households living below the poverty line; the percentage of

households that were headed by women and had dependent children present; the percentages of households that had an annual income below \$30 000 per year, that were receiving public assistance, and that had no car; and the median value of owner-occupied homes. The first principal component was retained (explaining 60% of the total variance), and we determined quartiles of this tract-level measure (the NDI) and applied those values to the participant-level data. The first (lowest) quartile of the NDI represents the least deprived areas.

Statistical Analysis

Among the 80 641 SCCS participants eligible for this analysis, we excluded 4084 (5.1%) who had missing information on one or more of the variables of a priori interest. This left 76 557 participants available for our analysis (52 965 Blacks and 23 592 Whites).

We calculated race- and gender-specific crude mortality rates as the number of deaths divided by the corresponding person-time, and we used 5-year age increments to age standardize these rates according to the US 2000 standard population. We used Cox proportional hazards models to estimate hazard ratios (HRs) and 95% confidence intervals (CIs) for all-cause mortality and cause-specific mortality (divided into 3 groups reflecting death from cardiovascular disease [CVD], cancer, and all other nonexternal causes combined), with age used as the underlying time metric. To account for clustering of participants within census tracts and guard against biased variance estimates and confidence intervals if data within each tract were not independent, we computed robust variances based on the sandwich estimator in the Cox models.³¹ However, the resulting confidence intervals for all exposures of interest were minimally different from those observed with standard maximum likelihood variances, so only the latter are presented.

We constructed multivariate models considering all of the covariates shown in Table 1. Seven categories were used to model smoking (never, former smoker in tertiles of pack-year exposure, current smoker in tertiles of pack-year exposure). Occupational scores were categorized in approximate quartiles based on the entire study population distribution, with Nam-Powers-Boyd score cutoffs of 22, 37.3, and 49. We found that calendar year of enrollment,

TABLE 1—Baseline Characteristics and Crude and Age-Standardized Mortality Rates, by Race, Gender, and Enrollment Type: 76 557 Southern Community Cohort Study Participants, Southeastern United States, 2002–2009

	Community Health Center Women		Community Health Center Men		General Population Women		General Population Men	
	Black (n = 28 639)	White (n = 12 092)	Black (n = 20 577)	White (n = 6476)	Black (n = 2186)	White (n = 2408)	Black (n = 1563)	White (n = 2616)
No. of deaths	1749	813	2289	809	78	93	111	172
Crude mortality rate (per 100 000 person-years)	1056.0	1380.3	1983.0	2701.9	662.4	725.5	1330.9	1241.7
Age standardized mortality rate ^a (per 100 000 person-years)	1373.9	2126.6	2848.0	3762.1	599.9	667.1	1330.7	1073.9
Age at enrollment, y, no. (%)								
40–49	13 904 (48.6)	4835 (40.0)	10 928 (53.1)	2971 (45.9)	741 (33.9)	675 (28.0)	410 (26.2)	502 (19.2)
50–59	9458 (33.0)	4127 (34.1)	6877 (33.4)	2060 (31.8)	987 (45.2)	1047 (43.5)	701 (44.9)	1056 (40.4)
60–69	3885 (13.6)	2358 (19.5)	2176 (10.6)	1069 (16.5)	395 (18.1)	589 (24.5)	381 (24.4)	885 (33.8)
70–79	1392 (4.9)	772 (6.4)	596 (2.9)	376 (5.8)	63 (2.9)	97 (4.0)	71 (4.5)	173 (6.6)
Annual household income, \$, no. (%)								
< 15 000	17 805 (62.2)	6851 (56.7)	13 083 (63.6)	3742 (57.8)	627 (28.7)	408 (16.9)	301 (19.3)	165 (6.3)
15 000–24 999	6624 (23.1)	2470 (20.4)	4474 (21.7)	1358 (21.0)	454 (20.8)	364 (15.1)	269 (17.2)	215 (8.2)
25 000–49 999	3220 (11.2)	1673 (13.8)	2290 (11.1)	894 (13.8)	641 (29.3)	658 (27.3)	443 (28.3)	666 (25.5)
≥ 50 000	990 (3.5)	1098 (9.1)	730 (3.6)	482 (7.4)	464 (21.2)	978 (40.6)	550 (35.2)	1570 (60.0)
Education, no. (%)								
< 9 y	2212 (7.7)	1067 (8.8)	1900 (9.2)	743 (11.5)	44 (2.0)	48 (2.0)	52 (3.3)	49 (1.9)
9–11 y	6881 (24.0)	2372 (19.6)	5354 (26.0)	1239 (19.1)	174 (8.0)	101 (4.2)	148 (9.5)	69 (2.6)
High school/GED/vocational	11 289 (39.4)	4913 (40.6)	8624 (41.9)	2575 (39.8)	675 (30.9)	725 (30.1)	483 (30.9)	616 (23.6)
Some college/junior college	5720 (20.0)	2389 (19.8)	3363 (16.3)	1213 (18.7)	562 (25.7)	578 (24.0)	398 (25.5)	536 (20.5)
College	2537 (8.9)	1351 (11.2)	1336 (6.5)	706 (10.9)	731 (33.4)	956 (39.7)	482 (30.8)	1346 (51.5)
Marital status, no. (%)								
Married/living as married	7526 (26.3)	5206 (43.1)	5899 (28.7)	2634 (40.7)	720 (32.9)	1302 (54.1)	1035 (66.2)	2168 (82.9)
Divorced	9864 (34.4)	4278 (35.4)	7092 (34.5)	2385 (36.8)	817 (37.4)	659 (27.4)	329 (21.1)	272 (10.4)
Widowed	4044 (14.1)	1650 (13.7)	765 (3.7)	269 (4.2)	253 (11.6)	273 (11.3)	40 (2.6)	53 (2.0)
Single, never married	7205 (25.2)	958 (7.9)	6821 (33.2)	1188 (18.3)	396 (18.1)	174 (7.2)	159 (10.2)	123 (4.7)
No. of household members, no. (%)								
1	6705 (23.4)	3139 (26.0)	6298 (30.6)	2149 (33.2)	573 (26.2)	656 (27.2)	295 (18.9)	319 (12.2)
2	8702 (30.4)	4723 (39.1)	5965 (29.0)	2333 (36.0)	706 (32.3)	1055 (43.8)	611 (39.1)	1506 (57.6)
3–4	9478 (33.1)	3277 (27.1)	6081 (29.6)	1532 (23.7)	696 (31.8)	580 (24.1)	503 (32.2)	656 (25.1)
5–6	2888 (10.1)	751 (6.2)	1717 (8.3)	361 (5.6)	159 (7.3)	101 (4.2)	127 (8.1)	120 (4.6)
> 6	866 (3.0)	202 (1.7)	516 (2.5)	101 (1.6)	52 (2.4)	16 (0.7)	27 (1.7)	15 (0.6)
Occupational status score, no. (%)								
Quartile 1 (lowest status)	5993 (22.2)	2717 (23.4)	7583 (39.0)	2171 (35.4)	288 (14.4)	396 (17.4)	298 (19.9)	245 (9.8)
Quartile 2	8683 (32.1)	2667 (22.9)	5298 (27.3)	1433 (23.3)	354 (17.7)	167 (7.3)	272 (18.2)	274 (10.9)
Quartile 3	5085 (18.8)	3206 (27.6)	4563 (23.5)	1562 (25.4)	444 (22.2)	526 (23.1)	376 (25.1)	499 (19.9)
Quartile 4 (highest status)	7301 (27.0)	3039 (26.1)	1988 (10.2)	976 (15.9)	911 (45.6)	1185 (52.1)	552 (36.9)	1493 (59.5)

Continued

TABLE 1—Continued

Neighborhood deprivation index, no. (%)										
Quartile 1 (least deprived)	1475 (5.2)	2052 (17.0)	1008 (4.9)	1065 (16.5)	255 (11.7)	775 (32.2)	232 (14.9)	980 (37.5)		
Quartile 2	2942 (10.3)	3596 (29.7)	1742 (8.5)	1673 (25.9)	338 (15.5)	716 (29.7)	278 (17.8)	729 (27.9)		
Quartile 3	5096 (17.8)	3768 (31.2)	3089 (15.0)	1827 (28.3)	548 (25.1)	625 (26.0)	385 (24.7)	602 (23.0)		
Quartile 4 (most deprived)	19 124 (66.8)	2675 (22.1)	14 726 (71.6)	1901 (29.4)	1045 (47.8)	292 (12.1)	667 (42.7)	305 (11.7)		
No. of people to help with emotional problems, ^b no. (%)										
0	2316 (8.1)	886 (7.3)	1964 (9.6)	805 (12.5)	148 (7.0)	113 (4.8)	142 (9.6)	156 (6.1)		
1-2	8668 (30.4)	3435 (28.5)	5950 (29.0)	2015 (31.2)	489 (23.2)	424 (17.8)	308 (20.8)	495 (19.4)		
3-4	6807 (23.8)	2903 (24.1)	4545 (22.2)	1411 (21.8)	490 (23.2)	538 (22.6)	282 (19.0)	612 (24.0)		
≥ 5	10 765 (37.7)	4842 (40.1)	8047 (39.2)	2229 (34.5)	982 (46.6)	1303 (54.8)	752 (50.7)	1284 (50.4)		
Missing	83	26	71	16	77	30	79	69		
No. of people to help with emergencies/lending money, ^c no. (%)										
0	3075 (10.8)	1273 (10.6)	2335 (11.4)	875 (13.6)	233 (10.9)	208 (8.8)	140 (9.5)	203 (8.0)		
1	5205 (18.2)	2212 (18.4)	3392 (16.5)	1172 (18.2)	270 (12.7)	232 (9.8)	164 (11.1)	243 (9.6)		
2	6287 (22.0)	2731 (22.7)	4152 (20.2)	1335 (20.7)	482 (22.6)	447 (18.9)	267 (18.1)	415 (16.3)		
3	3999 (14.0)	1552 (12.9)	2751 (13.4)	791 (12.3)	305 (14.3)	319 (13.5)	190 (12.9)	261 (10.3)		
4	2648 (9.3)	1088 (9.0)	1815 (8.9)	517 (8.0)	192 (9.0)	244 (10.3)	139 (9.4)	267 (10.5)		
≥ 5	7323 (25.7)	3195 (26.5)	6073 (29.6)	1765 (27.3)	647 (30.4)	920 (38.8)	577 (39.1)	1151 (45.3)		
Missing	102	41	59	21	57	38	86	76		
Health insurance coverage, no. (%)										
None	11 229 (39.2)	5031 (41.6)	10 231 (49.8)	3119 (48.2)	388 (18.4)	312 (13.2)	234 (15.8)	162 (6.3)		
Medicaid	3432 (12.0)	1489 (12.3)	2539 (12.4)	1019 (15.7)	255 (12.1)	190 (8.1)	187 (12.6)	167 (6.5)		
Medicare < age 65 y	6251 (21.8)	1920 (15.9)	2963 (14.4)	814 (12.6)	187 (8.9)	116 (4.9)	77 (5.2)	77 (3.0)		
Medicare ≥ age 65 y	1367 (4.8)	1114 (9.2)	596 (2.9)	527 (8.1)	109 (5.2)	226 (9.6)	134 (9.0)	427 (16.6)		
Private	5900 (20.6)	2341 (19.4)	3234 (15.7)	713 (11.0)	1064 (50.5)	1406 (59.6)	710 (47.8)	1580 (61.4)		
Military	144 (0.5)	91 (0.8)	732 (3.6)	231 (3.6)	45 (2.1)	56 (2.4)	98 (6.6)	121 (4.7)		
Other	303 (1.1)	101 (0.8)	263 (1.3)	51 (0.8)	60 (2.9)	55 (2.3)	45 (3.0)	41 (1.6)		
Missing	13	5	19	2	78	47	78	41		
Baseline smoking status, no. (%)										
Current	9714 (34.0)	4768 (39.5)	12 314 (59.9)	3418 (52.8)	422 (20.2)	495 (20.9)	388 (26.1)	403 (15.8)		
Former	5433 (19.0)	2957 (24.5)	3914 (19.0)	1798 (27.8)	547 (26.2)	722 (30.5)	590 (39.7)	1181 (46.3)		
Never	13 466 (47.1)	4359 (36.1)	4336 (21.1)	1257 (19.4)	1122 (53.7)	1148 (48.5)	507 (34.1)	968 (37.9)		
Missing	26	8	13	3	95	43	78	64		
Baseline health history, no. (%)										
Diabetes	7143 (25.0)	2626 (21.7)	3623 (17.6)	1261 (19.5)	473 (21.6)	324 (13.5)	323 (20.7)	388 (14.8)		
Heart attack/bypass surgery	1478 (5.2)	908 (7.5)	1303 (6.3)	951 (14.7)	97 (4.6)	105 (4.5)	107 (7.2)	293 (11.6)		
Hypertension	17 902 (62.5)	6207 (51.4)	10 168 (49.5)	3262 (50.4)	1292 (59.1)	926 (38.5)	882 (56.4)	1120 (42.8)		

Continued

TABLE 1—Continued

BMI at enrollment (kg/m^2), mean (SD)	32.5 (8.0)	31.1 (8.2)	27.6 (6.0)	28.8 (6.7)	32.8 (8.1)	28.8 (7.4)	28.9 (5.9)	28.4 (5.4)
BMI at age 21 y (kg/m^2), mean (SD)	23.1 (5.3)	22.7 (5.7)	23.8 (4.5)	24.0 (4.8)	22.9 (5.1)	22.1 (4.9)	23.5 (3.8)	23.6 (3.7)
Physical activity expenditure (MET hours per day), mean (SD)	21.0 (15.9)	20.7 (16.1)	26.4 (23.5)	23.7 (22.6)	21.3 (15.8)	21.5 (15.3)	24.7 (21.3)	22.0 (16.3)
No. of sedentary h/d, mean (SD)	9.4 (5.1)	8.7 (4.5)	9.3 (5.3)	8.8 (4.9)	11.6 (5.8)	9.7 (4.5)	10.7 (5.4)	10.0 (4.8)

Note. BMI = body mass index; GED = general educational development (high school equivalent); MET = metabolic equivalent.

^aAge standardized according to the US 2000 standard population (5-year age increments).

^bParticipants were asked the following question: "How many close friends or relatives would help you with your emotional problems or feelings if you needed it?"

^cParticipants were asked the following question: "How many people could you ask for help in an emergency or with lending you money?"

household size, and number of people participants could ask for help in an emergency or with lending them money (the latter 2 had null associations with mortality) did not affect the results, and thus we omitted these variables from our final models. In addition, adjustment for comorbidities (history of heart disease, diabetes, and hypertension) changed the hazard ratio for race by only 2.3%, the hazard ratio for the highest level of household income by 6.3%, and the hazard ratio for the lowest NDI quartile by 1.5%, and these variables were potentially in the causal pathway; thus, they were also excluded from the final models.

We examined models excluding the first 1, 2, and 3 years of follow-up to identify evidence of reverse causation with regard to SES (i.e., that underlying fatal disease resulted in poverty). We verified the proportionality assumptions of the Cox models by dividing the period of follow-up into the first 4 and subsequent years and comparing hazard ratios for the 2 time periods. As a means of comparing models with and without the relevant interaction terms, we used the likelihood ratio test to assess interactions. All *P* values are 2-tailed, and SAS/STAT version 9.3 (SAS Institute Inc, Cary, NC) was used in conducting the statistical analyses.

RESULTS

A total of 6114 deaths occurred during a follow-up period representing 416 677 person-years, for a crude mortality rate of 1467 per 100 000 person-years. The gender- and race-specific mortality rates for CHC-enrolled participants were markedly higher than those for participants who enrolled in the SCCS through the mail, reflecting the different demographic characteristics of the 2 study bases (Table 1). Among CHC-enrolled participants, household income was similarly distributed across race and gender strata, suggesting only minor racial differences in individual SES; despite these similarities, Blacks tended to reside in communities with higher NDI values. Among the mail-enrolled participants with income distributions more reflective of a general volunteer sample, Blacks were also more likely (relative to their individual SES level) than Whites to reside in areas of high deprivation.

Overall, Blacks were less likely than Whites to die during the follow-up period (HR = 0.78; 95% CI = 0.73, 0.84; Table 2). The absence of excess mortality among Blacks was evident at each level of household income, within each quartile of neighborhood deprivation, and among those enrolled from the general population and from CHCs alike (Table B, available as a supplement to the online version of this article at <http://www.ajph.org>). Associations between individual- and neighborhood-level SES factors and all-cause mortality are shown in Table 2. These results were not modified by race, gender, or source of participant enrollment (Table 2).

Household income was a strong predictor of mortality (as shown in the survival curve in Figure A, available as a supplement to the online version of this article at <http://www.ajph.org>). Those in the lowest income group (<\$15 000) were about 75% as likely to die during the follow-up period as those with incomes of \$50 000 or more, an association that was even larger among those who had never smoked (HR = 2.52; 95% CI = 1.75, 3.63). After adjustment for household income, education and occupational status were not significantly associated with mortality. Independent of household income, however, there was a significant (*P* < .001) trend of increasing mortality risk with increasing NDI quartile. We also observed a significantly elevated mortality risk among individuals who had never married and who had any type of health insurance other than private insurance; individuals who had 3 or more close friends exhibited a significantly reduced mortality risk.

The combined effect of being in the least (vs most) advantageous category with respect to both individual and neighborhood SES was a striking increase in mortality risk (HR = 2.76; 95% CI = 1.99, 3.84; Table 3), an effect that was similar for Blacks and Whites (data not shown). We detected no significant interaction between individual SES and neighborhood SES, with the effect of one being similar across categories of the other for both Blacks (interaction *P* = .98) and Whites (interaction *P* = .58).

The adverse impact of low individual SES was observed for mortality from CVD and other nonmalignant diseases but not for cancer mortality (Table 4). By contrast, the highest

TABLE 2—Multivariate Hazard Ratios for Associations Between Race, Socioeconomic Status Indicators, and All-Cause Mortality: Southern Community Cohort Study, Southeastern United States, 2002–2009

	Model 1, Adjusted HR ^a (95% CI)	Model 2, Adjusted HR ^b (95% CI)
Race^c		
Black	0.84 (0.79, 0.89)	0.78 (0.73, 0.84)
White (Ref)	1.00	1.00
Annual household income, \$^d		
< 15 000	3.79 (3.26, 4.41)	1.76 (1.45, 2.12)
15 000–24 999	2.46 (2.10, 2.89)	1.48 (1.22, 1.78)
25 000–49 999	1.61 (1.36, 1.90)	1.20 (0.99, 1.45)
≥ 50 000 (Ref)	1.00	1.00
Neighborhood deprivation index^e		
Quartile 4 (most deprived)	1.73 (1.55, 1.92)	1.26 (1.12, 1.42)
Quartile 3	1.42 (1.27, 1.59)	1.19 (1.06, 1.35)
Quartile 2	1.34 (1.19, 1.51)	1.17 (1.03, 1.33)
Quartile 1 (least deprived) (Ref)	1.00	1.00
Education		
< 9 y	1.20 (1.10, 1.30)	0.97 (0.88, 1.07)
9–11 y	1.22 (1.15, 1.30)	1.06 (0.98, 1.13)
High school/GED/vocational (Ref)	1.00	1.00
Some college/junior college	0.91 (0.85, 0.99)	0.98 (0.91, 1.07)
College	0.63 (0.57, 0.70)	0.95 (0.84, 1.07)
Marital status		
Married/living as married (Ref)	1.00	1.00
Separated/divorced	1.50 (1.41, 1.60)	1.16 (1.07, 1.24)
Widowed	1.53 (1.39, 1.67)	1.18 (1.07, 1.30)
Single, never married	1.67 (1.55, 1.80)	1.21 (1.11, 1.32)
NPB occupational status score		
Quartile 4 (highest) (Ref)	1.00	1.00
Quartile 3	1.20 (1.10, 1.30)	0.99 (0.90, 1.08)
Quartile 2	1.27 (1.17, 1.38)	0.98 (0.89, 1.07)
Quartile 1 (lowest)	1.39 (1.28, 1.51)	1.01 (0.93, 1.11)
No. of close friends^f		
0 (Ref)	1.00	1.00
1–2	0.87 (0.79, 0.95)	0.96 (0.87, 1.06)
≥ 3	0.71 (0.66, 0.77)	0.88 (0.81, 0.97)

Continued

NDI quartile was associated with an approximate 30% increase in mortality risk regardless of cause. Relative to Whites, Blacks had an equivalent risk of cancer mortality but a lower risk of mortality from CVD and other nonmalignant diseases during follow-up.

Results excluding the first 1, 2, and 3 years of follow-up were similar to those presented in the tables. For example, after exclusion of the first 3 years, the hazard ratio for low income

(< \$15 000) was 1.66 (95% CI = 1.28, 2.15), the hazard ratio for NDI quartile 4 was 1.25 (95% CI = 1.07, 1.47), and the hazard ratio for Black race was 0.77 (95% CI = 0.70, 0.85). Also, among participants who were relatively healthy at baseline (i.e., no self-reported history of myocardial infarction, coronary artery bypass surgery, stroke, diabetes, or cancer), household income (< \$15 000 vs ≥ \$50 000; HR = 1.55; 95% CI = 1.19, 2.02) and NDI (quartile 4 vs quartile 1; HR = 1.30; 95%

CI = 1.10, 1.54) were still significantly associated with mortality.

DISCUSSION

This is among the first and largest investigations to examine race, individual SES, and neighborhood SES jointly as determinants of mortality. We did not find evidence that individual and neighborhood SES acted synergistically; rather, both played an independent role in predicting mortality, with a particularly strong link between household income and longevity. We did not observe a higher mortality risk among Blacks (vs Whites) in any stratum of SES, and in fact we observed an overall better mortality profile for Blacks. This was apparent in both segments of SCCS participants (i.e., those drawn from CHCs and those drawn from the general population). We had expected mortality parity for Blacks and Whites among the CHC-enrolled participants (with these groups having similar individual SES and arguably similar access to medical care) and would not have been surprised to also find mortality parity in the general population participants (a group for which we had detailed information on demographic and lifestyle factors that would allow for good control of confounding).

The reason for the lower risk of mortality from CVD and other nonmalignant causes among Blacks in the SCCS is unclear. The observed mortality deficit among Blacks persisted despite adjustment for additional factors that might benefit Blacks in the South, such as church-based social or spiritual support (data not shown). A possibility is the influence of confounding from unmeasured factors, perhaps even those related to resiliency in US Black communities,^{34–36} or residual confounding from factors included in the analysis (e.g., cigarette smoking). Despite similar smoking prevalence, White SCCS smokers had an average smoking history of 33.7 pack-years (SD = 23.7), as compared with 18.8 pack-years (SD = 16.2) among Black SCCS smokers, consistent with national figures showing higher numbers of cigarettes per day smoked among White than Black smokers.³⁷ The makeup of the SCCS may be another factor. According to standardized mortality ratios (SMRs) comparing SCCS participants with the general US

TABLE 2—Continued

Health insurance coverage		
Private (Ref)	1.00	1.00
None	2.12 (1.92, 2.34)	1.38 (1.24, 1.55)
Medicare < age 65 y	3.55 (3.20, 3.94)	2.17 (1.92, 2.45)
Medicaid	3.29 (2.96, 3.65)	1.90 (1.68, 2.14)
Medicare ≥ age 65 y	1.90 (1.64, 2.18)	1.36 (1.16, 1.59)
Military	2.29 (1.91, 2.76)	1.72 (1.41, 2.10)
Other	1.83 (1.40, 2.40)	1.38 (1.03, 1.86)

Note. CI = confidence interval; GED = general educational development (high school equivalent); HR = hazard ratio; NPB = Nam-Powers-Boyd.

^aHazard ratio from a Cox proportional hazards model adjusting for gender, race, and enrollment type (community health center or general population).

^bHazard ratio from a Cox proportional hazards model adjusting for gender, race, and enrollment type (community health center or general population), plus all of the covariates shown in Table 2, smoking, body mass index (BMI), BMI at age 21 years, physical activity (in metabolic equivalent hours per day), and sedentary time (number of hours sitting per day).

^cFor race, there were no statistically significant interactions with enrollment source (interaction $P = .92$), household income (interaction $P = .31$), or neighborhood deprivation (interaction $P = .65$).

^dFor household income, there were no statistically significant interactions with enrollment source (interaction $P = .13$), race (interaction $P = .31$), or neighborhood deprivation (interaction $P = .6$).

^eFor neighborhood deprivation, there were no statistically significant interactions with enrollment source (interaction $P = .8$), race (interaction $P = .65$), or household income (interaction $P = .6$).

^fParticipants were asked the following question: "How many close friends or relatives would help you with your emotional problems or feelings if you needed it?"

population of the same race, gender, and calendar year period within the 12 enrollment states, CHC-enrolled SCCS participants had, as expected, higher mortality rates than their general population counterparts, although this excess was relatively greater among Whites (SMRs of 2.36 for men and 1.77 for women) than among Blacks (SMRs of 1.45 for men and 1.13 for women). Volunteer participants from the general population are typically a select, healthier group, and standardized mortality ratios for the SCCS general population participants reflect this situation; however, this

"healthy volunteer" effect was somewhat stronger for Blacks (SMRs of 0.80 for men and 0.88 for women) than for Whites (SMRs of 0.81 for men and 0.96 for women).

The link between low SES and premature mortality is well established.^{11,19,38-42} In our analyses, the effect of low income on all-cause mortality was on par with that of heavy smoking, with a hazard ratio of 1.75 (95% CI = 1.60, 1.92) for current smokers with 27 or more pack-years of exposure (vs those who had never smoked). The reason SES is such a strong predictor of mortality, independent of

proximate risk factors such as smoking and obesity, is less understood and may involve life resources that escape quantification in epidemiologic analyses. Link and Phelan⁴³ postulated that such key resources may include money, knowledge, power, prestige, and beneficial social connections; moreover, the advantages provided by higher SES are not only wide ranging and broadly applicable to overall health enhancement but are also "adaptable to changing health-related conditions and can be used to protect health no matter...the current risks, treatments, or diseases."^{3(p267)} Within the SCCS, we can show empirically that education is associated with health insurance benefits (8% of individuals with less than a high school education vs 33% of individuals with a college education reported having private health insurance). However, it is impossible to capture the full scope of relevant advantages, some of which may be quite subtle, in any study.

In line with some previous reports,^{19,21} we found that individual SES was a stronger predictor of all-cause mortality than neighborhood SES. We did not, however, find an interaction between individual and neighborhood SES, in contrast to a few prior reports suggesting that those of low individual SES exhibit the highest mortality rates in areas of high neighborhood SES.^{20,22} It is important to understand how residential communities can influence mortality, particularly given that mortality inequalities between deprived and nondeprived US communities appeared to increase from 1969 to 1998.⁴⁴ The general living environment may influence or shape health exposures and outcomes through its infrastructure, values placed

TABLE 3—Hazard Ratios for the Joint Effects of Household Income and Neighborhood Deprivation on All-Cause Mortality: Southern Community Cohort Study, Southeastern United States, 2002–2009

Annual Household Income, \$	Neighborhood Deprivation Index			
	Quartile 4 (Most Deprived), HR ^a (95% CI)	Quartile 3, HR ^a (95% CI)	Quartile 2, HR ^a (95% CI)	Quartile 1 (Least Deprived), HR ^a (95% CI)
< 15 000	2.76 (1.99, 3.84)	2.68 (1.92, 3.74)	2.54 (1.81, 3.56)	2.40 (1.69, 3.42)
15 000–24 999	2.37 (1.69, 3.31)	2.16 (1.52, 3.06)	2.18 (1.53, 3.12)	1.79 (1.20, 2.68)
25 000–49 999	1.93 (1.36, 2.74)	1.76 (1.21, 2.56)	1.79 (1.23, 2.62)	1.41 (0.93, 2.13)
≥ 50 000	1.86 (1.22, 2.82)	1.31 (0.82, 2.10)	1.69 (1.13, 2.55)	1.00 (Ref)

Note. CI = confidence interval; HR = hazard ratio.

^aHazard ratio for combinations of household income and neighborhood deprivation derived from a single Cox proportional hazards model adjusting for race, gender, education, marital status, occupational status, number of close friends, health insurance type, enrollment type, smoking, body mass index (BMI), BMI at age 21 years, physical activity (in metabolic equivalent hours per day), and sedentary time (number of hours sitting per day).

TABLE 4—Multivariate Hazard Ratios for Associations Between Individual- and Neighborhood-Level Socioeconomic Status and Cause-Specific Mortality: Southern Community Cohort Study, Southeastern United States, 2002–2009

	Cardiovascular Disease Mortality (n = 1869), HR ^a (95% CI)	Cancer Mortality (n = 1435), HR ^a (95% CI)	Mortality From All Other Nonexternal Causes (n = 2076), HR ^a (95% CI)
Race			
Black	0.88 (0.78, 1.00)	1.00 (0.87, 1.16)	0.70 (0.62, 0.78)
White (Ref)	1.00	1.00	1.00
Annual household income, \$			
< 15 000	2.08 (1.45, 2.98)	1.08 (0.78, 1.50)	2.38 (1.62, 3.49)
15 000–24 999	1.87 (1.30, 2.68)	1.00 (0.72, 1.38)	1.79 (1.22, 2.64)
25 000–49 999	1.53 (1.06, 2.20)	0.80 (0.57, 1.11)	1.43 (0.96, 2.12)
≥ 50 000 (Ref)	1.00	1.00	1.00
Education			
< 9 y	0.99 (0.84, 1.18)	1.01 (0.82, 1.22)	1.00 (0.85, 1.18)
9–11 y	1.03 (0.90, 1.17)	1.09 (0.94, 1.27)	1.10 (0.97, 1.23)
High school/GED/vocational (Ref)	1.00	1.00	1.00
Some college/junior college	0.99 (0.85, 1.14)	1.04 (0.88, 1.24)	0.96 (0.84, 1.11)
College	0.82 (0.66, 1.03)	1.02 (0.80, 1.31)	0.89 (0.71, 1.10)
Marital status			
Married/living as married (Ref)	1.00	1.00	1.00
Separated/divorced	1.09 (0.96, 1.24)	1.02 (0.87, 1.18)	1.26 (1.11, 1.43)
Widowed	1.03 (0.87, 1.23)	1.18 (0.98, 1.43)	1.29 (1.08, 1.53)
Single, never married	1.13 (0.97, 1.31)	1.12 (0.93, 1.35)	1.36 (1.18, 1.58)
NPB occupational status score			
Quartile 4 (highest) (Ref)	1.00	1.00	1.00
Quartile 3	0.91 (0.77, 1.07)	1.17 (0.97, 1.41)	0.89 (0.76, 1.05)
Quartile 2	0.89 (0.76, 1.04)	1.12 (0.93, 1.36)	0.93 (0.80, 1.09)
Quartile 1 (lowest)	0.88 (0.75, 1.04)	1.18 (0.97, 1.43)	1.00 (0.86, 1.17)
No. of close friends^b			
0 (Ref)	1.00	1.00	1.00
1–2	0.95 (0.80, 1.14)	1.08 (0.86, 1.36)	0.96 (0.81, 1.13)
≥ 3	0.81 (0.69, 0.96)	1.14 (0.92, 1.41)	0.87 (0.75, 1.02)
Health insurance coverage			
Private (Ref)	1.00	1.00	1.00
None	1.57 (1.27, 1.93)	1.35 (1.09, 1.68)	1.37 (1.11, 1.69)
Medicare < age 65 y	2.43 (1.94, 3.04)	1.49 (1.16, 1.91)	2.75 (2.21, 3.44)
Medicaid	2.08 (1.66, 2.61)	1.40 (1.10, 1.78)	2.35 (1.88, 2.93)
Medicare ≥ age 65 y	1.64 (1.24, 2.17)	1.10 (0.82, 1.47)	1.46 (1.08, 1.96)
Military	1.83 (1.26, 2.65)	1.48 (1.00, 2.20)	2.03 (1.42, 2.91)
Other	1.66 (0.98, 2.80)	0.94 (0.48, 1.85)	1.70 (1.03, 2.80)
Neighborhood deprivation index			
Quartile 4 (most deprived)	1.28 (1.03, 1.58)	1.29 (1.01, 1.64)	1.31 (1.06, 1.61)
Quartile 3	1.23 (0.98, 1.54)	1.32 (1.02, 1.69)	1.20 (0.96, 1.49)
Quartile 2	1.19 (0.94, 1.51)	1.15 (0.88, 1.50)	1.20 (0.95, 1.50)
Quartile 1 (least deprived) (Ref)	1.00	1.00	1.00

Note. HR = hazard ratio; CI = confidence interval; GED = general educational development (high school equivalent); NPB = Nam-Powers-Boyd. Cardiovascular disease (CVD) death was defined as *International Classification of Diseases* (9th edition; *ICD-9*) codes 390–459 and 798 and *ICD-10* codes I00–I9.^{32,33} Cancer death was defined as *ICD-9* codes 140–239 and *ICD-10* codes C00–C97. All other nonexternal causes of death were non-CVD and noncancer deaths that excluded external causes.

^aHazard ratios derived from 3 separate Cox proportional hazards models (one for each cause of death) adjusting for all covariates shown in Table 2 in addition to gender, race, enrollment type (community health center or general population), smoking, body mass index (BMI), BMI at age 21 years, physical activity (in metabolic equivalent hours per day), and sedentary time (number of hours sitting per day).

^bParticipants were asked the following question: “How many close friends or relatives would help you with your emotional problems or feelings if you needed it?”

on health and health-associated factors, availability of health care, exposure to pollutants, and stress related to crime, transportation options, or lack of social cohesion.^{19,45}

Some studies have documented, longitudinally, detrimental changes in physical functioning and in self-rated health among adults living in socioeconomically disadvantaged or otherwise burdened (e.g., excessive noise, heavy traffic) neighborhoods.^{46,47} In our study, it is noteworthy that whereas associations between individual income and mortality were limited to CVD and other nonmalignant diseases, trends in risk associated with the NDI were similar regardless of cause of death. Reasons for the differences by cause of death are not clear but raise the possibility of neighborhood environmental influences on cancer risk above those associated with low SES.

In analyses involving US vital statistics that could not account for individual-level characteristics such as SES, it has been estimated that a substantial proportion of the higher mortality among Blacks than Whites nationally arises from mortality that is “medical care amenable” or “avoidable,” that is, mortality from conditions that can often be controlled with quality health care and appropriate therapies.^{7,8,48} Examples of these conditions include CVD, type 2 diabetes, and intestinal and respiratory infections. On the basis of our cause-specific mortality findings and evidence that low SES, as opposed to race, is a primary barrier to obtaining preventive health services,⁴⁹ we surmise that these reported observations are due predominantly to SES.

Strengths and Limitations

This study has a number of strengths, including its base in a large, diverse, well-characterized cohort with essentially complete follow-up for mortality. Despite the generally low SES of many SCCS participants, our study had sufficient numbers of both Black and White individuals across SES strata to enable well-powered analyses in an SES range relevant to the general US population. The simultaneous examination of race, individual SES, and neighborhood SES also provided needed insights and clarification into questions of interaction between individual and neighborhood SES and whether SES was a stronger

mediator of mortality for Blacks than for Whites. In addition, the SCCS was unique in that there was substantial SES overlap between Blacks and Whites, affording opportunities for racial comparisons less confounded by SES than in other studies.

Our assessment of individual and neighborhood SES was limited by data at one point in time, and a life-course assessment may have provided richer insights into the impact of SES on adult mortality risk. In addition, poor health can contribute to loss of jobs, income, and private health insurance. The same dynamic may also shift those in poor health into poor neighborhoods. Although this was a prospective study, these phenomena, if they occurred prior to enrollment, may have created spurious associations between SES and mortality. We have some evidence, however, that our results did not stem from such bias: restricting analyses to individuals with more than 3 years of follow-up did not change the findings, and participants residing in the most deprived areas reported having lived in their current home for an average of nearly 9 years prior to enrollment (the average was identical for those who subsequently died and those who did not die). Finally, although we aimed to characterize “neighborhood” SES, census tracts were not devised to delineate neighborhood boundaries; however, the census tract is a widely used metric of convenience for this purpose.^{19,20,38,50,51}

Conclusions

Our data support the strong role of SES in predicting premature mortality in the United States. Our findings also suggest that individual and community SES act independently to affect mortality risk in a similar manner for Blacks and Whites. Because they are new, our findings of lower mortality from noncancer causes among Blacks than Whites require replication in other studies before conclusive interpretations can be made. ■

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Contributors

L. B. Signorello originated and designed the study, oversaw the data analysis, and drafted the article. S. S. Cohen participated in study design, carried out statistical analyses, and participated in critical interpretation and editing of the article. D. R. Williams contributed to analyses and participated in critical interpretation and editing of the article. H. M. Munro carried out statistical analyses and participated in critical interpretation and editing of the article. M. K. Hargreaves participated in critical interpretation and editing of the article. W. J. Blot participated in designing the study and in critical interpretation and editing of the article.

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Human Participant Protection

The Southern Community Cohort Study was approved by the Vanderbilt University and Meharry Medical College institutional review boards. All participants provided written informed consent.

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