

APPENDIX METHODS

Study Population

Data available for analysis arise from 84,514 adults enrolled in the previously-described prospective SCCS.^{1,2} Participants were eligible for enrollment if they were aged 40–79 years, English-speaking, and were not under treatment for cancer within the past year. Participants were recruited during 2002–2009, primarily from community health centers³ (86%) where trained interviewers collected information on lifestyle factors and demographics. The remaining cohort was enrolled using an identical mailed questionnaire sent to stratified random samples of residents in the same 12 states. The SCCS was approved by IRBs at Vanderbilt University and Meharry Medical College. All participants provided written informed consent.

Outcome Ascertainment

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, 2013. Causes of death were grouped according to ICD-10 codes and were classified as cardiovascular diseases (CVD) (I00-I69), cancer (C00-C97), and all other-causes excluding CVD, cancer, and external causes, including accidents and injuries (deaths with codes beginning with the letter V, W, X, or Y).

Exposure Ascertainment

The previously-developed neighborhood deprivation index variable^{4,5} was used as a measure of neighborhood socioeconomic environment. Briefly, the index was constructed through principal components analysis and incorporates 11 census tract-level variables that capture five domains including education, employment, housing, occupation, and poverty, described in more detail in

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Appendix Table 1 and a previous publication.⁴ The variables were obtained from 2000 U.S. Census data⁶ and linked to the geographical coordinates of participant's residential address.⁷

The joint associations of neighborhood socioeconomic environment and the modifiable health behaviors of smoking status, alcohol intake, physical activity, sedentary behavior, and diet quality were evaluated. These five behaviors were chosen due to their strong established associations with risk of premature death. Information on health behaviors was obtained upon entry into the cohort via study questionnaires. The physical activity and sedentary behavior assessments in the SCCS have been described previously.⁸ Briefly, a summary variable for physical activity was created as the sum of all household, leisure, and occupational activity over the course of a week to reflect per day activity and converted to MET estimates of energy expenditure using methods described in the Compendium of Physical Activities.^{9,10} The metabolic equivalent values for specific activity categories were: light household/occupational activity (2.3); moderate household/occupational activity (4.0); vigorous household/occupational activity (6.0); moderate sports/exercise (5.0); vigorous sports/exercise (8.0). A summary sedentary behavior variable was created as the average sitting time per day over the course of the week. Dietary intake was evaluated by an 89-item food frequency questionnaire developed and validated specifically for the diet in the Southeastern U.S.^{11,12} To assess diet quality, Healthy Eating Index (HEI) values (range: 0–100) were calculated where a higher value indicates 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.^{13,14} Also, a healthy lifestyle score was calculated as a composite variable including alcohol intake, physical activity,

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sedentary behavior, and diet quality. For each participant, the healthy lifestyle score was created by counting and summing (0–4) the number of current public health guidelines followed by the participant for the health behaviors of interest (Appendix Table 2).^{14–16} Participants were classified as having met the guideline for alcohol if they were nondrinkers or moderate alcohol drinkers, where moderate alcohol intake was defined as >0 but ≤ 1 drink/day for women or ≤ 2 drink/day for men, according to the 2010 Dietary Guidelines for Americans.¹⁴ Participants were classified as having met the current aerobic physical activity recommendation¹⁵ via sports and exercise if they reported ≥ 150 minutes/week of moderate activity, ≥ 75 minutes/week of vigorous activity or ≥ 150 minutes/week of moderate and vigorous activity combined, where 1 minute of vigorous activity was counted as 2 minutes of moderate activity. The recommendation to “avoid inactivity” was considered met for participants in the tertile for the shortest amount of sedentary time (sedentary time ≤ 6.5 hours). Participants in the upper quartile of HEI (score >65.5) were considered to have a healthy diet, due to their lower mortality risk in a previous study.¹⁷

Population for Analysis

Participants with <1 year of follow-up time (N=364) and those missing data on neighborhood deprivation index (N=1,223), smoking status (N=2,085), alcohol intake (N=2,933), physical activity (N=3,086), and sedentary behavior (N=2,535) were excluded from analysis. Data from 77,896 SCCS participants were available for analysis after these, not mutually exclusive, exclusions.

Statistical Analysis

Frequency distributions of participant characteristics were tabulated for the total sample and stratified by sex and race. Hazard ratios (HRs) and 95% CIs were estimated using Cox

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proportional hazard models for the association between neighborhood deprivation index and mortality with age as the time scale. Cox models included robust variances based on the sandwich estimator to account for the potential of non-independence between participants due to clustering within census tracts. Entry time was defined as age at baseline interview and exit time as age at death or December 31, 2013, whichever came first.¹⁸ Comparison groups for the neighborhood deprivation index were created by dividing participants into quartiles based on the distribution of neighborhood deprivation index values of all census tracts in the 12 states that encompass the SCCS recruitment area. As expected by study design, a large number of SCCS participants fell in the quartile group for the most deprived neighborhood deprivation index. The joint associations of neighborhood deprivation index with five health behaviors and a healthy lifestyle score on all-cause mortality were evaluated. The behavioral variables were categorized as follows: smoking status (never, former, current smoker of <20 years or <20 cigarettes/day, current smoker of ≥ 20 years and ≥ 20 cigarettes/day), alcohol intake (non-drinker, moderate-drinker, heavy-drinker), physical activity (sex-specific tertiles), sedentary behavior (tertiles), and HEI diet quality (quartiles). Participants with missing HEI data (N=4,061) were set to the race, sex, and smoking status-specific medians. Statistical models were stratified by birth year (categorized into 10-year age groups) and adjusted for the following variables selected a priori: enrollment source (community health center, general population), race (black, white, other), education (<9 years, 9–11 years, high school, some college, college graduate and beyond), income (<\$15,000, \$15,000–\$24,999, \$25,000–\$49,999, \geq \$50,000), marital status (married, divorced, widowed, single), and insurance status (insured, not insured). Missing covariate data were set to the race and sex-specific medians (mode for marital status and insurance status). Sample sizes for participants missing covariate data are as follows: education=243, household

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income=239, marital status=347, insurance coverage=47. Analyses were conducted separately by sex because the association between lower neighborhood deprivation index and poorer mortality outcome was stronger in women (p for interaction=0.02). P -values for trend tests were calculated using an ordinal variable representing neighborhood deprivation index quartiles in the model.

The proportional hazards assumption was evaluated graphically and considered met. Interactions between neighborhood deprivation index and factors of interest were assessed by likelihood ratio tests to compare main effects models with and without the addition of cross-product terms.

Statistical analyses were performed using SAS, version 9.4. Data analysis was conducted in the years 2016 and 2017.

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Appendix Table 1. Component Variables of Neighborhood Deprivation Index, the Southern Community Cohort Study

Domain	Variable at census tract level
Education	Individuals with less than a high school education (%)
Employment	Unemployed residents (%)
Housing	Median value of owner-occupied homes (\$)
	Households with more than one person per room (%)
	Household with owner or renter costs >50% of household income (%)
Occupation	Men who worked in managerial jobs (%)
Poverty	Households living below the poverty line (%)
	Households that had an annual income <\$30,000 per year (%)
	Households receiving public assistance (%)
	Households that were headed by women and had dependent children present (%)
	Households without a car (%)

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Appendix Table 2. Public Health Recommendations Used to Operationalize the Healthy Lifestyle Score

Health behavior	Guideline and source
Alcohol intake	Up to one drink per day for women and up to two drinks per day for men (2010 Dietary Guidelines for Americans).
Physical activity	Adults should engage in at least 150 minutes a week of moderate-intensity, 75 minutes a week of vigorous-intensity aerobic physical activity, or an equivalent combination of moderate- and vigorous-intensity aerobic activity. Aerobic activity should be performed in episodes of at least 10 minutes, and preferably, should be spread throughout the week (2008 Physical Activity Guidelines for Americans).
Sedentary behavior	Avoid inactivity. Limit sedentary behaviors (American Cancer Society).
Diet quality	Higher Healthy Eating Index dietary value (USDA's Center for Nutrition Policy and Promotion).

USDA, U.S. Department of Agriculture

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Appendix Table 3. Associations Between Neighborhood Deprivation Index and Cause-Specific Mortality by Sex, the Southern Community Cohort Study

Neighborhood deprivation index	CVD mortality		Cancer mortality		Other-cause mortality ^a	
	Deaths	HR (95% CI) ^b	Deaths	HR (95% CI) ^b	Deaths	HR (95% CI) ^b
Men						
Q1 (least deprived)	133	1 (ref)	109	1 (ref)	142	1 (ref)
Q2	216	1.03 (0.82, 1.28)	141	0.85 (0.66, 1.10)	262	1.14 (0.93, 1.40)
Q3	324	1.08 (0.88, 1.33)	234	1.05 (0.83, 1.32)	338	1.04 (0.85, 1.27)
Q4 (most deprived)	963	1.07 (0.88, 1.31)	769	1.14 (0.91, 1.41)	1,142	1.14 (0.95, 1.38)
<i>p</i> -trend		0.45		0.02		0.27
Women						
Q1 (least deprived)	78	1 (ref)	103	1 (ref)	118	1 (ref)
Q2	206	1.31 (1.01, 1.70)	200	1.10 (0.86, 1.39)	281	1.20 (0.97, 1.49)
Q3	259	1.14 (0.88, 1.48)	261	1.02 (0.81, 1.29)	393	1.22 (0.99, 1.50)
Q4 (most deprived)	826	1.49 (1.17, 1.92)	654	1.07 (0.85, 1.33)	995	1.34 (1.09, 1.64)
<i>p</i> -trend		0.0006		0.82		0.005

^aOther-cause mortality includes deaths from causes other than cardiovascular disease, cancer, or external causes of death.

^bHRs are estimated using Cox models with age as the time scale and stratified by birth year. Statistical models are adjusted for enrollment source, race, education, income, marital status, insurance status, smoking status, alcohol intake, diet quality, physical activity, and sedentary time.

CVD, cardiovascular disease; HR, hazard ratio; Q1–Q4, quartile 1–4

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Appendix Table 4. Distribution of Health Behaviors by Neighborhood Deprivation Index and Sex, the Southern Community Cohort Study

Characteristic	Neighborhood deprivation index							
	Men				Women			
	Quartile 1	Quartile 2	Quartile 3	Quartile 4	Quartile 1	Quartile 2	Quartile 3	Quartile 4
	N=3,458	N=4,554	N=5,978	N=17,482	N=4,917	N=7,962	N=10,322	N=23,524
	%	%	%	%	%	%	%	%
Smoking status								
Never	31.9	27.4	24.1	20.0	47.6	44.9	46.1	43.2
Former	33.0	30.0	28.9	19.9	26.7	23.5	23.2	19.3
Current	35.1	42.6	47.0	60.0	25.7	31.6	30.7	37.5
Alcohol intake								
None	31.4	39.7	39.4	30.1	45.1	56.6	61.7	55.0
Moderate	48.3	39.6	38.2	37.6	44.1	35.6	30.4	31.0
Heavy	20.3	20.7	22.4	32.3	10.8	7.9	7.9	14.0
Diet quality^a (Healthy Eating Index)								
>65.5	29.9	20.6	17.3	13.7	41.6	31.2	31.1	27.3
57.5–65.5	23.9	22.6	23.5	23.0	24.9	25.7	26.6	26.6
49.7–57.4	23.2	25.8	28.1	30.7	17.9	22.4	21.2	24.1
≤49.6	23.0	31.0	31.0	32.6	15.6	20.7	21.1	22.0
Physical activity (meets recommendation)								
Meets	37.2	26.1	24.5	26.3	25.6	18.6	15.4	15.2
Does not meet	62.8	73.9	75.5	73.7	74.4	81.4	84.6	84.8
Sedentary time^b (hours)								
≤6.5	28.0	33.4	33.6	35.6	30.0	32.8	34.4	33.1
6.6–10.5	35.8	33.8	33.2	32.1	35.0	33.6	33.3	32.3
>10.5	36.2	32.8	33.2	32.3	35.0	33.5	32.3	34.6

^aDiet quality categorized in quartiles of Healthy Eating Index.

^bSedentary time categorized in tertiles.

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Appendix Table 5. The Joint Association of Neighborhood Deprivation Index and Smoking Status With All-Cause Mortality by Sex, the Southern Community Cohort Study

NDI (quartiles)	Smoking status ^a								p-value ^c
	Never		Former		Current – Light		Current – Heavy		
	Deaths	HR (95% CI) ^b	Deaths	HR (95% CI) ^b	Deaths	HR (95% CI) ^b	Deaths	HR (95% CI) ^b	
Men									
Q1 (least deprived)	75	1 (ref)	149	1.56 (1.19, 2.05)	107	2.12 (1.57, 2.85)	107	2.33 (1.73, 3.15)	
Q2	121	1.23 (0.92, 1.63)	204	1.43 (1.10, 1.87)	178	2.09 (1.59, 2.75)	194	2.33 (1.78, 3.06)	0.02
Q3	178	1.35 (1.03, 1.77)	282	1.45 (1.12, 1.87)	292	2.08 (1.60, 2.69)	251	2.47 (1.90, 3.22)	
Q4 (most deprived)	483	1.48 (1.15, 1.90)	706	1.73 (1.36, 2.21)	1,331	2.12 (1.66, 2.70)	692	2.29 (1.79, 2.93)	
Women									
Q1 (least deprived)	94	1 (ref)	84	1.34 (1.00, 1.79)	76	2.45 (1.81, 3.32)	81	3.80 (2.83, 5.12)	
Q2	225	1.26 (0.99, 1.60)	187	1.80 (1.40, 2.31)	171	2.87 (2.23, 3.71)	170	3.47 (2.69, 4.49)	0.004
Q3	339	1.28 (1.01, 1.61)	253	1.81 (1.43, 2.29)	232	2.65 (2.08, 3.37)	176	2.93 (2.27, 3.78)	
Q4 (most deprived)	895	1.53 (1.23, 1.90)	563	1.93 (1.54, 2.41)	823	2.86 (2.30, 3.57)	380	3.37 (2.67, 4.26)	

^aLight 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.

^bHRs are estimated using Cox models with age as the time scale and stratified by birth year. Statistical models are adjusted for enrollment source, race, education, income, marital status, insurance status, alcohol intake, diet quality, physical activity, and sedentary time.

^cP-value for interaction between smoking and NDI.

NDI, neighborhood deprivation index; HR, hazard ratio; Q1–Q4, Quartile 1–Quartile 4.

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Appendix Table 6. The Joint Association of Neighborhood Deprivation Index and a Healthy Lifestyle Score With All-Cause Mortality by Sex, the Southern Community Cohort Study

NDI (quartiles)	Lifestyle score (# guidelines met) ^a						<i>p</i> -value ^c
	3 or 4		2		0 or 1		
	Deaths	HR (95% CI) ^b	Deaths	HR (95% CI) ^b	Deaths	HR (95% CI) ^b	
Men							
Q1 (least deprived)	68	1 (ref)	148	1.15 (0.86, 1.52)	222	1.39 (1.06, 1.83)	
Q2	72	0.92 (0.66, 1.28)	235	1.21 (0.92, 1.59)	390	1.39 (1.07, 1.80)	0.28
Q3	92	0.93 (0.68, 1.28)	346	1.27 (0.98, 1.65)	565	1.41 (1.09, 1.83)	
Q4 (most deprived)	294	1.18 (0.90, 1.54)	1,068	1.35 (1.05, 1.73)	1,850	1.43 (1.11, 1.84)	
Women							
Q1 (least deprived)	58	1 (ref)	122	1.17 (0.86, 1.60)	155	1.50 (1.12, 2.03)	
Q2	95	1.07 (0.77, 1.47)	309	1.54 (1.16, 2.04)	349	1.65 (1.25, 2.18)	0.99
Q3	140	1.15 (0.85, 1.56)	387	1.37 (1.04, 1.80)	473	1.60 (1.22, 2.11)	
Q4 (most deprived)	316	1.25 (0.94, 1.65)	1,016	1.62 (1.24, 2.12)	1,329	1.79 (1.37, 2.34)	

^aLifestyle score variable is a summary variable for alcohol intake, physical activity, diet quality, and sedentary time.

^bHRs are estimated using Cox models with age as the time scale and stratified by birth year. Statistical models are adjusted for enrollment source, race, education, income, marital status, insurance status, and smoking status.

^c*P*-value for interaction between Healthy Lifestyle Score and NDI.

NDI, neighborhood deprivation index; HR, hazard ratio; Q1–Q4, Quartile 1–Quartile 4.

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Appendix Table 7. The Joint Association of Neighborhood Deprivation Index and a Healthy Lifestyle Score With All-Cause Mortality by Sex, Among Never Smokers, the Southern Community Cohort Study

NDI (quartiles)	Lifestyle score (# guidelines met) ^a						<i>p</i> -value ^c
	3 or 4		2		0 or 1		
	Deaths	HR (95% CI) ^b	Deaths	HR (95% CI) ^b	Deaths	HR (95% CI) ^b	
Men							
Q1 (least deprived)	22	1 (ref)	26	0.86 (0.48, 1.52)	27	1.05 (0.59, 1.85)	0.78
Q2	18	0.76 (0.40, 1.43)	50	1.23 (0.74, 2.05)	53	1.22 (0.73, 2.05)	
Q3	25	0.86 (0.48, 1.54)	77	1.37 (0.84, 2.23)	76	1.20 (0.73, 1.97)	
Q4 (most deprived)	59	0.93 (0.56, 1.55)	192	1.26 (0.79, 2.02)	232	1.26 (0.79, 2.01)	
Women							
Q1 (least deprived)	26	1 (ref)	28	0.82 (0.48, 1.38)	40	1.52 (0.93, 2.49)	0.37
Q2	44	1.11 (0.68, 1.79)	109	1.50 (0.98, 2.30)	72	1.23 (0.78, 1.92)	
Q3	62	1.10 (0.69, 1.74)	140	1.22 (0.80, 1.85)	137	1.50 (0.98, 2.28)	
Q4 (most deprived)	156	1.24 (0.81, 1.88)	389	1.45 (0.97, 2.16)	350	1.58 (1.06, 2.37)	

^aLifestyle score variable is a summary variable for alcohol intake, physical activity, diet quality, and sedentary time.

^bHRs are estimated using Cox models with age as the time scale and stratified by birth year. Statistical models are adjusted for enrollment source, race, education, income, marital status, and insurance status.

^c*P*-value for interaction between Healthy Lifestyle Score and NDI.

NDI, neighborhood deprivation index; HR, hazard ratio; Q1–Q4, Quartile 1–Quartile 4

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Appendix Table 8. The Association of a Healthy Lifestyle Score and All-Cause Mortality Stratified by Neighborhood Deprivation Index and Sex, the Southern Community Cohort Study

Lifestyle score (# guidelines met) ^a	Neighborhood deprivation index (quartiles)							
	Q1 (least deprived)		Q2		Q3		Q4 (most deprived)	
	Deaths	HR (95% CI) ^b	Deaths	HR (95% CI) ^b	Deaths	HR (95% CI) ^b	Deaths	HR (95% CI) ^b
Men								
3–4	68	1 (ref)	72	1 (ref)	32	1 (ref)	294	1 (ref)
2	148	1.13 (0.84, 1.51)	235	1.34 (1.02, 1.75)	346	1.35 (1.07, 1.70)	1,068	1.15 (1.01, 1.31)
1	184	1.32 (0.98, 1.76)	316	1.46 (1.12, 1.90)	467	1.49 (1.18, 1.87)	1,362	1.18 (1.04, 1.35)
0	38	1.43 (0.94, 2.16)	74	1.79 (1.27, 2.50)	98	1.43 (1.06, 1.91)	488	1.42 (1.23, 1.65)
<i>p</i> -trend	0.03		0.0008		0.005		<0.0001	
Women								
3–4	58	1 (ref)	95	1 (ref)	140	1 (ref)	316	1 (ref)
2	122	1.10 (0.80, 1.51)	309	1.47 (1.16, 1.85)	387	1.19 (1.07, 1.45)	1,016	1.30 (1.15, 1.48)
1	147	1.37 (0.99, 1.88)	323	1.55 (1.22, 1.96)	429	1.38 (1.14, 1.68)	1,128	1.44 (1.26, 1.63)
0	8	0.68 (0.32, 1.45)	26	1.45 (0.93, 2.26)	44	1.71 (1.21, 2.42)	201	1.59 (1.32, 1.91)
<i>p</i> -trend	0.21		0.003		0.0001		<0.0001	

^aLifestyle score variable is a summary variable for alcohol intake, physical activity, diet quality, and sedentary time.

^bHRs are estimated using Cox models with age as the time scale and stratified by birth year. Statistical models are adjusted for enrollment source, race, education, income, marital status, insurance status, and smoking status.

HR, hazard ratio; Q1–Q4, Quartile 1–Quartile 4

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Appendix Table 9. The Association of a Healthy Lifestyle Score and All-Cause Mortality Stratified by Neighborhood Deprivation Index and Sex, Among Participants of the Southern Community Cohort Study who Have Never Smoked Cigarettes

Lifestyle score (# guidelines met) ^a	Neighborhood deprivation index (quartiles)							
	Q1 (least deprived)		Q2		Q3		Q4 (most deprived)	
	Deaths	HR (95% CI) ^b	Deaths	HR (95% CI) ^b	Deaths	HR (95% CI) ^b	Deaths	HR (95% CI) ^b
Men								
3–4	22	1 (ref)	18	1 (ref)	25	1 (ref)	59	1 (ref)
2	26	1.17 (0.87, 1.57)	50	1.40 (1.07, 1.83)	77	1.41 (1.12, 1.77)	192	1.18 (1.04, 1.35)
0–1	27	1.45 (1.09, 1.93)	53	1.66 (1.29, 2.15)	76	1.61 (1.29, 2.02)	232	1.30 (1.15, 1.48)
<i>p</i> -trend	0.005		<0.0001		<0.0001		<0.0001	
Women								
3–4	26	1 (ref)	44	1 (ref)	62	1 (ref)	156	1 (ref)
2	28	1.21 (0.88, 1.66)	109	1.56 (1.24, 1.97)	140	1.22 (1.01, 1.48)	289	1.34 (1.18, 1.52)
0–1	40	1.62 (1.18, 2.21)	72	1.79 (1.42, 2.26)	137	1.53 (1.26, 1.85)	350	1.61 (1.42, 1.83)
<i>p</i> -trend	0.001		<0.0001		<0.0001		<0.0001	

^aLifestyle score variable is a summary variable for alcohol intake, physical activity, diet quality, and sedentary time.

^bHRs are estimated using Cox models with age as the time scale and stratified by birth year. Statistical models are adjusted for enrollment source, race, education, income, marital status, and insurance status.

HR, hazard ratio; Q1–Q4, Quartile 1–Quartile 4