Associations Between Neighborhood Environment, Health Behaviors, and Mortality

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Introduction: Considering the joint association of neighborhood socioeconomic environment and individual-level health behaviors with health outcomes may help officials design effective disease prevention strategies. This study evaluates the joint influences of neighborhood socioeconomic environment and individual health behaviors on mortality in a cohort primarily comprising people with low individual-level SES.

Methods: The prospective Southern Community Cohort Study includes 77,896 white and African American participants recruited in the years 2002–2009; 55% of participants had a household income <$15,000 at baseline interview. Mortality from cancer (n=2,471), cardiovascular diseases (n=3,005), and all-causes (n=10,099) was identified from the National Death Index through December 31, 2013 (median follow-up, 8 years). Data were analyzed in 2016 and 2017. Associations were assessed between mortality, a neighborhood deprivation index composed of 11 census tract-level variables, five health behaviors, and a composite healthy lifestyle score.

Results: Living in a neighborhood with the greatest socioeconomic disadvantage was associated with higher all-cause mortality in both men (hazard ratio=1.41, 95% CI=1.27, 1.57) and women (hazard ratio=1.77, 95% CI=1.57, 2.00). Associations were attenuated after adjustment for individual-level SES and major risk factors (hazard ratio for men=1.09, 95% CI=0.98, 1.22, and hazard ratio for women=1.26, 95% CI=1.12, 1.42). The dose–response association between neighborhood disadvantage and mortality was less apparent among smokers. Nevertheless, individuals who lived in disadvantaged neighborhoods and had the unhealthiest lifestyle scores experienced the highest mortality.

Conclusions: Disadvantaged neighborhood socioeconomic environments are associated with increased mortality in a cohort of individuals of low SES. Positive individual-level health behaviors may help negate the adverse effect of disadvantage on mortality.

INTRODUCTION

Epidemiologic studies report associations between disadvantaged neighborhood socioeconomic environments and mortality.1–7 The relations between neighborhood socioeconomic environment and individual-level health outcomes may reflect correlations with individual-level SES, residents’ self-selection into neighborhoods, resident health behaviors, access to health care, or the social environment, including neighborhood violence.8 Studies show residents of...
disadvantaged neighborhood socioeconomic environments report that they have less social support\(^4\) and their neighborhoods have lower social capital,\(^5\) both of which are associated with higher mortality.\(^6\) Proposed mechanisms by which neighborhoods may affect health behaviors include the influence of social and cultural norms around health behaviors; the ease of access to alcohol, energy-dense foods, and tobacco; and the level of difficulty in engaging in outdoor physical activity.\(^7\)–\(^11\)

Few published studies have evaluated potential interactions between neighborhood socioeconomic environment and individual-level health behaviors in association with mortality. Previous studies conducted using data from the NIH-AARP Diet and Health Study found the association between neighborhood socioeconomic environment and mortality is not modified by smoking status or consumption of red or processed meat.\(^12\)–\(^14\) No previous study has evaluated the combined influence of health behaviors and neighborhood socioeconomic environment on mortality, in African American or socioeconomically disadvantaged populations. Considering the joint influence of neighborhood socioeconomic environment and individual-level health behavior on health may help health officials design effective disease prevention strategies to reduce mortality.

The Southern Community Cohort Study (SCCS) provides a unique opportunity to evaluate associations between neighborhood socioeconomic environment, individual-level health behavior, and mortality in a racially diverse low-SES population. A previous SCCS publication reported higher mortality associated with low individual SES and disadvantaged neighborhood socioeconomic environment.\(^2\) Herein, the mortality follow-up time is expanded, increasing the numbers of deaths by more than 65%, and the joint associations of neighborhood disadvantage with five behavioral (and one composite) health indicators on mortality are assessed.

**METHODS**

**Study Population**

Data available for analysis come from 84,514 adults enrolled in the previously described prospective SCCS.\(^2,3\) 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 centers\(^4\) (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 states. The SCCS 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, 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).

The previously developed neighborhood deprivation index variable\(^2,3\) 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 Appendix Table 1 (available online) and a previous publication.\(^2\) The variables were obtained from 2000 U.S. Census data\(^4\) and linked to the geographic coordinates of each participant’s residential address.\(^5\)

Joint associations were evaluated between neighborhood socioeconomic environment and self-reported health behaviors at cohort entry for smoking status, alcohol intake, physical activity, sedentary behavior, diet quality, and a healthy lifestyle variable. 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 alcohol intake, physical activity, sedentary behavior, and diet quality (Appendix Table 2, available online).\(^6,7\) These behaviors were chosen due to their strong established associations with risk of premature death. Detailed information on health behavior ascertainment and variable categorization in statistical models can be found in Appendix Methods (available online).

**Statistical Analysis**

Frequency distributions of participant characteristics were tabulated for the total sample and stratified by sex and race. Hazard ratios and 95% CIs were estimated using Cox 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 because of 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.\(^8\) 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 Healthy Eating Index diet quality (quartiles). Participants with missing Healthy Eating Index data
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