Original article

The joint contribution of neighborhood poverty and social integration to mortality risk in the United States

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ARTICLE INFO

ABSTRACT

Purpose: A well-established literature has shown that social integration strongly patterns health, including mortality risk. However, the extent to which living in high-poverty neighborhoods and having few social ties jointly pattern survival in the United States has not been examined.
Methods: We analyzed data from the Third National Health and Nutrition Examination Survey (1988 —1994) linked to mortality follow-up through 2006 and census-based neighborhood poverty. We fit Cox proportional hazards models to estimate associations between social integration and neighborhood poverty on all-cause mortality as independent predictors and in joint-effects models using the relative excess risk due to interaction to test for interaction on an additive scale.
Results: In the joint-effects model adjusting for age, gender, race/ ethnicity, and individual-level socioeconomic status, exposure to low social integration alone was associated with increased mortality risk (hazard ratio [HR]: 1.42, 95% confidence interval [CI]: 1.28—1.59) while living in an area of high poverty alone did not have a significant effect (HR: 1.10; 95% CI: 0.95—1.28) when compared with being jointly unexposed. Individuals simultaneously living in neighborhoods characterized by high poverty and having low levels of social integration had an increased risk of mortality (HR: 1.63; 95% CI: 1.35—1.96). However, relative excess risk due to interaction results were not statistically significant.
Conclusions: Social integration remains an important determinant of mortality risk in the United States independent of neighborhood poverty.

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Introduction

Several decades of research has shown that social relationships have a profound effect on health [1—8], and social integration, defined as engagement with others through social ties and institutional connections, has been associated with a range of chronic health conditions and mortality [1,7,9,10]. Berkman and colleagues [11] developed a conceptual framework for understanding how social relationships influence health and described a cascading effect of social contexts on relationships, health behaviors, and ultimately population health.

A similarly robust literature links neighborhood of residence to health showing that living in deprived areas increases risk of cardiovascular disease, physiological stress, health-damaging behaviors, and mortality [12—17]. Moreover, there has been an increased interest in elucidating how neighborhood contexts shape the formation and maintenance of social relationships [4,18—22] and how they interact with individual-level exposures to potentially modify the development of disease [15,23,24].

Despite the consistent and large body of evidence on neighborhoods and social integration as independent predictors of health, fewer studies have explicitly examined how social integration is patterned by broader neighborhood contexts [25—29]. Investigations of whether neighborhood conditions and social integration may have a synergistic effect on health seem to be missing entirely. Evidence from the Whitehall cohort study [30] showed that men with higher socioeconomic position (SEP) had

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better quality social relationships and better health than those with lower SEP; the association between SEP and mortality was partly explained by social integration. However, this and other research investigating social integration's impact on mortality did not include neighborhood socioeconomic condition [30,31].

Informed by the evidence base, we examined if neighborhood poverty and social integration synergistically influenced mortality risk in a national sample of the US population. We used the conceptual framework proposed by Berkman et al. [11] to guide the study and hypothesized that individuals living in impoverished neighborhoods and having low levels of social integration have a mortality risk greater than what may be expected from the additive effects of exposure to each factor alone.

Material and methods

Data sources

Data are drawn from the Third National Health and Nutrition Examination Survey (NHANES III). The survey, conducted by the Centers for Disease Control and Prevention, used a complex, multistage, stratified sampling design intended to recruit a nationally representative sample of the non-institutionalized, civilian US population. NHANES III was conducted from October 1988–1994 and included individuals from age 2 months. Data collection consisted of an in-home interview and a series of examinations [32]. The data for the present study were taken from the household interviews.

The NHANES III Linked Mortality File contains follow-up data for NHANES III participants through December 31, 2006. Mortality status was identified using the National Death Index, primarily through probabilistic record matching. This is considered to be a reliable source of mortality follow-up [33].

NHANES III participants' home addresses were geocoded and matched to 1990 Census tracts. Data were geocoded by the Westat Geocoding Service Center for the National Center for Health Statistics (NCHS) [34] Geocoded NHANES III data are available for restricted use which assures confidentiality of the study participants. The 1990 Census file used for this study was compiled by The Public Health Disparities Geocoding Project at the Harvard School of Public Health [35,36]. It contains a measure of the percent of residents in each census tract living below the poverty line. In addition to review and approval by the Research Data Center at NCHS, the study protocol was approved by the authors' University Institutional Review Board.

Measures

Social integration

Previously published studies [9,37,38] have used items from NHANES III to create a modified Social Network Index (SNI) that captures the four domains first assessed by Berkman and Syme [1]. This index was chosen for use in the present study to allow our work to be placed within the context of the research that has already been done that uses this modified SNI with the NHANES III [9,37–39]. It is computed as follows: 1 point was assigned for married or living as married, 1 point was assigned for >156 contacts with friends and family in the past year, 1 point was assigned if at least four religious services were attended in the past year, and participation in a voluntary organization was assigned 1 point. A total score, ranging from 0 to 4, was created by summing the four items. This approach has been shown to have good predictive validity in that it is associated with health outcomes in a similar manner to the original SNI [1,9,37,38]. The SNI was dichotomized into high (2–4) and low (0–1), where the high-score category

represented a favorable level of social integration. This categorization is consistent with other studies where 0 and 1 have been combined to create a low social integration group and compared with the remaining categories [9,10,38]. We also conducted sensitivity analyses to assess if results differed based on our choice of categorization (data not shown). We found minor differences in risk across the original categories of 2, 3, and 4 and thus combined these categories to represent "high" social integration. Furthermore, creating two categories of social integration facilitated fitting the joint-effect models described below.

Neighborhood socioeconomic condition

Census tracts served as proxies for neighborhoods. Census tracts are commonly used in the investigation of area-level socioeconomic factors due to their consistent use in government and health research and relevance to public policy decisions for resource allocation [27,36,40,41]. Neighborhood socioeconomic condition was measured via neighborhood poverty, which has been shown to be a reliable measure of socioeconomic inequality in health studies [35]. A two-level classification was created based on the federal definition of poverty areas [40,42]. Low-poverty areas were defined as <20% of residents living below the federal poverty line and high-poverty areas where ≥20% of the residents live below poverty.

Mortality

The outcome of interest was time-to-death due to all-cause mortality or, more specifically, person-months of follow-up from the interview to December 31, 2006. There were 12–18 years of follow-up for the sample depending on the year of NHANES interview with a mean of 167 months (95% confidence interval [CI]: 162–172) for the weighted sample. There were 20,024 participants eligible for the linkage and 5,360 deaths.

Covariates

Age, sex, race/ethnicity, and individual SEP were adjusted for in the multivariable models due to their demonstrated associations with mortality. Race /ethnicity was self-reported and classified as non-Hispanic white, non-Hispanic black, Mexican-American, and other [32]. Individual SEP was based on years of education completed (<8, 9–11, 12, and 13+ years) and the participants' household poverty income ratio (PIR; <1, 1–1.99, 2–2.99, 3–3.99, and >4) [15,25,27,32,43].

Statistical analysis

Descriptive statistics summarize the characteristics of the whole sample and by neighborhood poverty. We used Cox proportional hazards regression to model the relationship between SNI and time-to-death while adjusting for covariates. If no death was recorded, subjects were censored at the end of the follow-up period. The proportional hazards assumption was examined using Kaplan-Meier curves [44]. We assumed that death occurred in this sample at a steady rate equal to that in the general US population and that participation did not alter their mortality risk.

In planning these analyses, we considered how to address both the multilevel nature of the study variables and the complex sample design of NHANES III. We opted to use the sample design variables but assume that the neighborhoods are adequately captured because the primary sampling units were areas which contain several census tracts and are the higher-level grouping [28].

Effect modification was assessed in two ways. First, the Cox regression models were stratified by level of neighborhood poverty to examine differences in the hazard ratios (HRs) which assesses multiplicative interaction between neighborhood poverty and social integration. Next, a four-level dummy variable was inserted