Health and Concentrated Disadvantage in Later Life: Evidence from the Health and Retirement Study

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Abstract

Not only are adults who live in racially segregated areas exposed to disadvantage on myriad levels over the lifetime, but, in aging, they also may become even more reliant upon the resources embedded in their neighborhoods. This paper uses multi-level analysis to study residential segregation, concentrated disadvantage, and the health of adults in mid- to late-life. Using data from the 2004 Health and Retirement Survey, I analyze the extent to which health disparities between black and white adults over age 50 are associated with neighborhood-level concentrated disadvantage. Random intercept models show that neighborhood-level factors are associated with both fair or poor health and chronic illness. Concentrated disadvantage is significant and in the expected direction, although the magnitude is small. Findings are consistent with previously identified connections between education and health, suggesting that improving educational outcomes for students in highly disadvantaged areas may yield enduring health benefits.

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BACKGROUND AND INTRODUCTION

Health disparities in the U.S., particularly black-white health disparities, are pervasive, and they persist at older ages. Black Americans have been shown to have faster declines in self-rated health than white Americans (Ferraro & Farmer, 1996; Yao & Robert, 2008). Moreover, for African Americans ages 65 to 79, mortality rates are about thirty to fifty percent higher than those for whites. Cause-specific rates are notably higher for African Americans for three leading causes of death: heart disease, stroke and diabetes (Hummer, Benjamins & Rogers, 2004).

Elderly African Americans also face higher rates of disability and are more likely to report poor health and activity limitations than are whites, Asians, and, except for at the very oldest ages, Hispanics. These disparities are inversely related to a socioeconomic gradient, with mortality and the likelihood of disability inversely associated with income and education levels (Hummer et al., 2004). These differentials vary somewhat for other racial/ethnic groups; whereas mortality rates are considerably higher for African Americans than for non-Hispanic white Americans, mortality rates typically have been shown to be more favorable for Asians, Hispanics, and Native Americans than for non-Hispanic whites (Hummer et al., 2004).

At older ages, some evidence has shown that black-white mortality differentials flatten. A crossover occurs at approximately age 85 with black Americans thereafter exhibiting lower mortality than whites (Hummer et al., 2004). There is some uncertainty, however, as to whether the observed patterns are due to data quality or healthy survivor effects; among groups that are subject to excess mortality, those who survive may be especially robust (Brown & Lynch, 2004). In spite of the apparent crossover at the very oldest ages, however, health disparities for older adults clearly continue for people in their sixties and seventies, and these trends have persisted for several decades (Williams & Jackson, 2005).

Link and Phelan (1995) have argued that health disparities, rather than being functions of health behaviors such as smoking, alcohol consumption, or diet, are better characterized in terms of underlying, fundamental social causes such as socioeconomic position (SEP), race/ethnicity, and gender. Racial residential segregation has been argued to be one such fundamental cause. For a large share of black Americans, residential segregation patterns shape living conditions and socioeconomic position for individuals as well as at the neighborhood and community levels (Fiscella & Williams, 2004; Williams & Collins, 2001).

Racial Residential Segregation and Concentrated Disadvantage

African American segregation arose in the early decades of the 20th century in conjunction with industrialization and with northern migration; discriminatory housing and lending practices led to substandard and spatially isolated housing conditions for black Americans (Massey & Denton, 1993). Spatial assimilation theory holds that families and individuals generally have sought upward mobility by relocating to economically better off areas. However, racial residential segregation curtailed such mobility for black Americans, and many remained in segregated areas (Massey, 2004).

Residential segregation and income inequality, typically at the county and metropolitan area levels, concentrate poverty at the neighborhood level (Massey & Fischer, 2004). During the 1970s, racial residential segregation, in conjunction with economic downturn, created concentrated poverty for African Americans. The weak economic conditions disproportionately affected lower-income households. In areas with little segregation, those hardest hit were fairly widely dispersed. Highly segregated areas, however, included high densities of lower-income households, which were disproportionately burdened by the economic hardship, with those areas suffering more overall (Massey & Eggers, 1990). In the 1980s, rising income inequality, declining incomes, and increasing class isolation interacted with racial residential segregation to further concentrate poverty, with greater levels of segregation associated with stronger and more harmful concentrations of poverty. With about 75 percent of African Americans live in highly segregated areas, these changes were highly deleterious those who lived in sgregated conditions in U.S. cities, particularly for African Americans but also for Latinos and Afro-Caribbeans (Massey & Fischer, 2000). Concentrated poverty was associated with myriad forms of disadvantage, including high rates of single parenthood and public assistance, together with low rates of high school graduation, college matriculation, and employment (Massey, 2004).

Residential segregation, and thus concentrated poverty, persists via individual and household socioeconomic position, which in turn are reinforced through limited educational opportunities in highly segregated neighborhoods. Institutional employment patterns and discrimination are also implicated; due to spatial and skills mismatch, highly segregated areas tend to yield a dearth of employment opportunities. Segregation further operates through neighborhood effects, including lower housing quality, lower levels of investment, and lower levels of service provision (Williams & Collins, 2001).

Residential segregation has diminished in recent decades in smaller metropolitan areas, but many of the nation's older metropolitan areas—in which the preponderance of the U.S. African American population resides—remain highly segregated (Massey, 2004). Low-income black Americans are much more likely to live in poor neighborhoods than poor white Americans (Fiscella & Williams, 2004). In Chicago and other highly segregated cities, blacks of all income levels generally reside in neighborhoods with high poverty, whether or not they themselves are poor (Massey & Denton, 1993). Moreover, poor white Americans live in considerably more affluent neighborhoods than poor black Americans (Williams & Jackson, 2005).

The spatial isolation that defines segregation may make segregated individuals all the more reliant upon the resources, or lack thereof, within their neighborhoods (LaVeist, 2003). In addition, the character and resources therein of neighborhoods may be especially salient for older adults. African American older adults are more likely to reside in heavily segregated areas than younger African American adults (LaVeist, 2003). Older adults in general also are more likely to rely upon the resources available within their own neighborhoods (Diez Roux, 2005).

In considering residential segregation, a further key concept is cumulative disadvantage: difficulties (or, conversely, advantages) accumulate over time, thus creating inequality; further exposure to disadvantage (advantage) may augment or amplify those disadvantages (advantages), with attendant consequences for social position, economic resources, and health pathways (Hatch, 2005). For instance, Kahn and Pearlin (2006) found that the number of periods of financial strain over the life-course was inversely associated with physical and mental health, suggesting that strain may accumulate. Similarly, Davey Smith, Hart, Blane, Gillis and Hawthorne (1997) identified a strong association between cumulative social class and morbidity, all-cause mortality, and, in particular, mortality due to cardiovascular causes.

With regard to residential segregation, cumulative disadvantage is particularly relevant, as the concentrated poverty engendered by segregation positions residents for myriad insults over a lifetime. The history of segregation implies a history of constrained spatial mobility, suggesting that persons in their fifties or older will have spent decades in highly disadvantaged neighborhoods.

There are several mechanisms by which segregation and neighborhood disadvantage impede health: socioeconomic position and the incipient opportunities to which one may have access (LaVeist, 2003); neighborhood investment and services, including access to parks or grocery stores with a range of foods (Pickett & Pearl, 2001), as well as access to such health care resources as quality of health care, quality of physician training and resources (Bach, Pham, Schrage, Tate, & Hargraves, 2004), and low physician Medicaid participation rates (Greene, Blustein, & Weitzman, 2006); and physical environment, such as levels of noise, crime, and transportation access (Balfour & Kaplan, 2002) and perceived social disorder, such as the potential for conflict, crime, or indifference (Ross & Mirowsky, 2001). Low neighborhood socioeconomic status also is associated with neighborhood strain, more neighborhood problems, greater vigilance, lower perceived control (Feldman & Steptoe, 2004), and fewer social supports (Pickett & Pearl, 2001). Such stressors may impair health by increasing allostatic load, a process whereby undue "wear and tear" (McEwen & Seeman, 1999, p. 43) contributes to physiological dysregulation with adverse consequences for cognitive processes, immune system difficulties, ongoing hormone response, and inflammation. Moreover, neighborhood stressors may inhibit walking and other forms of outdoor activity (Ross & Mirowsky, 2001) and influence other health behaviors and norms (Pickett & Pearl, 2001), which independently contribute to poor health.

Previous Findings on Residential Segregation and Health

The majority of research to date on the effects of segregation and health has focused on adults in general and documented associations between segregation and, variously, mortality

(Jackson, Anderson, & Sorlie, 2000; LaVeist, 2003), acute health problems (Lee & Ferraro, 2007), poor birth outcomes for African American mothers (Bell, Zimmerman, Almgren, Mayer, & Huebner, 2006), disability (Lee & Ferraro, 2007), and poor self-rated health (Subramanian, Acevedo-Garcia, & Osypuk, 2005; White & Borrell, 2006), both in national studies and in specific urban areas.

Some findings, however, demonstrated that segregation was also associated with health advantages, including favorable mortality rates in New York City for black, Latino, and white residents (Inagami et al., 2006), better physical health for second- and later-generation Mexican-Americans (Lee & Ferraro, 2007), and some positive birth weight outcomes (Bell et al., 2006), suggesting that "ethnic density" (Inagami et al., 2006, p. 412) may offer protective benefits.

Other research has sought to better understand specific mechanisms of residential segregation, although findings again have been mixed. Greene et al. (2006) used the 2000/2001 Community Tracking Study to show that in counties with higher rates of white/non-white segregation, physicians were significantly less likely to participate in Medicaid; physicians were also less likely to participate in Medicaid in areas where the poor were non-white.

Much of the early research on segregation and both morbidity and mortality has been aggregate in nature, which has led to problems with ecological inference. A stronger approach is multilevel analysis, which explicitly incorporates individual and community effects at the neighborhood-level and/or higher and the associated clustering (Acevedo-Garcia, Lochner, Osypuk, & Subramanian, 2003; Pickett & Pearl, 2001). In an early multilevel study of segregation and black-white health disparities, Subramanian, Acevedo-Garcia, and Osypuk (2005) analyzed CPS data and found that isolation at the level of Metropolitan Statistical Area (MSA) accounted for disparities in self-rated health between blacks and whites. After controlling for individual characteristics, black segregation had a small, significant effect on the probability of poor self-reported health among African Americans but not for whites. Potential sources of the differential effects included disparities in educational, employment, and single parenthood outcomes for blacks versus whites in highly segregated areas. This analysis was somewhat limited by the use of MSA as geographic unit of analysis; neighborhood-level segregation wouldn't necessarily be evident if there was considerable variability within MSAs.

Many studies at the MSA level and other large aggregations in fact have not identified significant associations between health status and residential segregation (Mellor & Milyo, 2004). One implication of research at high geographic aggregations is that neighborhood level studies may be more relevant for understanding the relationship between area characteristics and health (Mellor & Milyo, 2004; Subramanian, Acevedo-Garcia, & Osypuk, 2005).

Few studies of residential segregation and health have specifically considered older adults. In one of the few studies to do so, Robert and Ruel (2006) in a multilevel study of segregation at the county level found limited evidence that living in neighborhoods with higher proportions of African Americans was advantageous for health after controlling for characteristics as the individual and Census tract poverty levels. However, the study may have been limited in that the analyses were based on only moderate sample sizes (n=1,095, n=1,615). As with MSA measures, county-level segregation indices also may obscure differences at the neighborhood level.

Previous Findings on Neighborhood Disadvantage and Health

In addition studies of segregation and health, and second body of relevant work has explored the relationship between concentrated disadvantage more generally and health.

Research has identified various associations between neighborhood socioeconomic status and chronic health conditions (Robert, 1998), overall physical functioning (Feldman & Steptoe, 2004), and self-rated health (Robert, 1998). Again, however, only a limited portion of the research to date has incorporated multilevel analytic methods; less has incorporated measures of racial/ethnic segregation in operationalizing the concepts of neighborhood socioeconomic status or disadvantage; and less yet has specifically considered older adults.

Among the studies that included multilevel modeling, Ross and Mirowsky (2001) found that neighborhood disadvantage was associated with poorer self-rated health, net of individual characteristics; the relationship was mediated to a large degree by social disorder, such as crime and loitering, and to a lesser degree by physical disorder. Do et al. (2007) identified in three-level analyses that neighborhood socioeconomic disadvantage and neighborhood segregation (entered separately) were associated with higher body mass index; however, racial/ethnic disparities persisted between Blacks, Latinos, and whites, net of individual, neighborhood, and county characteristics. Multilevel analysis also has shown that non-residential neighborhood exposure affected health, with the relationship between self-rated health and neighborhood disadvantage ameliorated for persons who worked, worshipped, shopped, etc., in less disadvantaged areas (Inagami, Cohen, & Finch, 2007).

Other multilevel research has shown that neighborhood-level affluence—though not neighborhood-level poverty (Browning, Cagney, & Wen, 2003) or income inequality (Wen, Browning, & Cagney, 2003)—was associated with better self-rated health. Neighborhood affluence and individual characteristics completely accounted for black-white health disparities, although disparities between Latinos and non-Hispanic whites persisted (Browning et al., 2003). Social resources, such as reciprocity and density of networks, was a suspected mechanism. In addition, the neighborhood proportion of college educated persons was significant, suggesting that health behaviors and mastery may also be mechanisms (Wen et al., 2003). However, Weden, Carpiano, & Robert (2008) found using a structural equation model of self-rated health that both neighborhood disadvantage and neighborhood affluence lost significance after including individual-level characteristics, although perceived neighborhood quality (e.g., safety, neighborhood upkeep, etc.) remained predictive of health.

Among the studies that have focused on older adults, single-level analyses have shown neighborhood disadvantage and similar constructs to be associated with disability, kidney disease, and mortality. Lang, Llewellyn, Langa, Wallace, and Melzer (2008) found that neighborhood deprivation in the U.K. was associated with mobility decline for persons age sixty and older, net of individual characteristics. Nordstrom et al. (2007) also found that, for black women in the U.S., neighborhood disadvantage measured at the Census block group level was significantly associated with mobility impairment over time, net of individual characteristics. Similarly, Stein Merkin et al. (2007) found that neighborhood socioeconomic status was associated with kidney disease for adults age 65 and older; however, individual level SEP lost significance, suggesting that area socioeconomic status may be a more apt measure than individual SEP for older adults.

Neighborhood affluence has been shown to offer protective effects for older adults. Waitzman and Smith (1998) found that while neighborhood economic segregation and concentrated poverty were associated with mortality, for people over age 65 concentrated affluence was a protective factor. Multilevel findings by Cagney, Browning and Wen (2005) showed a relationship between neighborhood affluence and better self-rated health; together with individual characteristics, neighborhood affluence mediated the entire black-white health difference. In addition, a multilevel analysis of adults age 55 and older showed that neighborhood economic advantage was associated with lower probability of disability and neighborhood advantage, with stronger effects for men (Freedman, Grafova, Schoeni, & Rogowski, 2008). In that analysis, greater street density and other forms of connectivity also were associated with less disability. However, the relationships were not significant for persons over age 65.

Other multilevel findings specific to older adults further suggest that neighborhood disadvantage has implications and physical disability, cognitive impairment, self-rated health, and chronic disease. Basta, Matthews, Chatfield, and Brayne (2007) showed that neighborhood deprivation predicted cognitive and functional impairment among adults age 65 and older. Robert and Lee (2002) identified that community socioeconomic disadvantage was associated with poorer self-rated health and with a greater number of chronic conditions; moreover, community disadvantage, together with individual characteristics rendered the black-white difference in chronic conditions insignificant. For people age 70 and older, Wight et al. (2008) showed using random intercept models that neighborhood disadvantage predicted self-rated health independent of individual characteristics, although independent effects did not hold for disability or cardiovascular disease.

Most studies that incorporated neighborhood disadvantage or similar concepts have not explicitly included residential segregation in the operationalization of disadvantage. In one of the few to do so, Yao and Robert (2008) used growth curves to model older adults' self-rated health trajectories over time. They found that both individual and neighborhood socioeconomic disadvantage contributed to black-white differences in self-rated health at the start of the study. However, neighborhood disadvantage did not contribute to change over time; moreover, black-white disparities in mortality during the study could not be explained by the combination of neighborhood disadvantage and individual socioeconomic status.

The majority of the existing research has been limited by several factors. Many early studies analyzed neighborhood variables at aggregate levels rather than incorporating true multilevel analytic methods, which would have allowed the simultaneous assessment of individual factors and factors at the neighborhood- or other level. Presumably because of data limitations, many studies of segregation have been at high aggregations rather than exploring neighborhood-level effects. Most neighborhood-level studies of concentrated disadvantage and similar constructs have not incorporated measures of segregation. Finally, little existing research on either concentrated disadvantage or residential segregation has addressed the situations of older adults or adults in mid-to-late life.

To address these shortcomings, this analysis explored the relationship between disadvantage and health among adults in mid- and late-life by utilizing true multilevel methods, and based on a measure of neighborhood-based measure of concentrated disadvantage which was formulated to include both socioeconomic and segregation information.

ANALYTIC STRATEGY AND RESEARCH QUESTIONS

Using data from the Health and Retirement Study, this study analyzed the extent to which disparities in chronic illness and self-rated health between African American and white adults over age fifty are mediated by neighborhood-level concentrated disadvantage. Neighborhoods have been theorized to be an appropriate and needed level at which to assess segregation and its effects, including concentrated disadvantage (Acevedo-Garcia et al., 2003). As contiguous Census areas that contain approximately 5,000 residents and which were originally mapped to reflect some homogeneity, Census tracts have been used as neighborhood proxies in previous studies (e.g., Subramanian, Chen, Rehkopf, Waterman, and Krieger, 2005). Because of the pervasiveness of health disparities and the excess mortality that they are associated with, this sample comprised both older adults and adults in mid-life and thus included persons over age 50. Using a random intercept approach with two levels, this study explicitly estimated neighborhood-level variation in subject-specific models.

DATA SOURCES AND MEASURES

Data are from the 2004 wave of the Health and Retirement Study (HRS), a longitudinal, nationally representative of survey of adults over age 50 (Health and Retirement Study, 2004). The HRS is sponsored by the National Institute of Aging (grant number NIA U01AG009740) and is conducted by the University of Michigan. First implemented in the early 1990s, the original study population consisted of individuals who were born before 1923 and between 1931 and 1941, as well as their spouses. In 1998, birth cohorts 1923-1930 and 1942-1947 and their spouses were added to the study. Surveys have been conducted on a biannual basis with replenishment every six years. Birth cohorts 1948-1953 and spouses were added to the study in 2002. This analysis utilized a geo-coded version of the 2004 core file with state, county, and Census tract identifiers. It was accessed under the auspices of Princeton University's Center for Health and Wellbeing. The HRS sampling strategy is a multi-stage area probability design with oversamples of black respondents, Latino respondents, and respondents in Florida. It is weighted to adjust for oversampling, non-response, and subsamples in areas that were difficult to access.

This analysis was restricted to non-institutionalized individuals over age 50 who were born in the U.S., lived in the U.S. at the time of the 2004 wave, and for whom successful geocode matches were obtained. Because HRS data for married couples can include both spouses, this analysis was restricted to one sampled individual per household. It included Spanish language interviews (less than one percent) and proxy interviews (six percent).

Dependent Variables

The analysis explored the relationship between concentrated disadvantage and two dimensions of health. *Chronic illness* was a dependent variable constructed from self-reported physician diagnoses of the following life-threatening, chronic conditions: hypertension, diabetes, heart condition, stroke, or cancer. These conditions have been used to construct other composite measures of health (Kahn & Fazio, 2005; Kahn & Pearlin, 2006). Using maximum likelihood factor analysis, a composite measure was constructed with all variables loading onto a single factor. The variable “cancer” was dropped because it generated a loading of less than 0.30 (Kline, 1994). As noted in Table 1, factor loadings for the remaining factors ranged from 0.30 to 0.46, which reflected medium correlation. The measure was standardized for a mean of 0 and standard distribution of approximately 1.0. Lower scores reflected better health.

The dependent variable *fair or poor health* was derived from self-rated health as measured by a five-item Likert scale (excellent (1), very good, good, fair or poor (5)). Self-rated health is a markedly robust measure of overall health and has been shown to be highly predictive of health; it has been hypothesized to function as a sensitive summary measure of health and an indicator of sub-clinical morbidity (Idler & Benyamini, 1997). For this study, the scale was dichotomized to a binary variable in which 1 represented “fair or poor health”. Dichotomous ratings of fair/poor versus better health have been shown to represent health distress, the presence of disease, and heightened mortality risk (Finch, Hummer, Reindl, & Vega, 2002).

Individual-Level Independent Variables

Several individual-level socio-demographic variables were incorporated. Race/ethnicity was categorized as non-Hispanic white (reference), non-Hispanic black, Hispanic (of all races), and non-Hispanic "other" for races reported as other than black or white. Age was centered at the approximate grand mean of 68 in order to aid in interpretation; it was modeled with a quadratic term. Educational attainment was modeled as highest degree obtained; specifications with years of schooling yielded similar results. Household income also was centered at the approximate grand mean of $60,000 to facilitate interpretation. The inclusion of more than one socioeconomic variable reduced the potential for confounding of individual-level effects (Pickett & Pearl, 2001). Household assets and net worth were incorporated into preliminary analyses as transformed and untransformed measures; consistent with other research (Kahn & Fazio, 2005), untransformed annual household income was the most robust and thus retained. Marital status was included as the binary variable "married."

Neighborhood-Level Independent Variables

Concentrated disadvantage is a multi-dimensional construct that captures multiple facets of socioeconomic disadvantage and has been widely in other studies (Do et al., 2007; Freedman et al., 2008; Inagami et al., 2007; Robert & Lee, 2002; Ross & Mirowsky, 2001; Wight et al., 2008). In keeping with the work of Sampson, Raudenbush, and Earls (1997) and others (Morenoff, Sampson, & Raudenbush, 2001; Sampson, Sharkey, & Raudenbush, 2008; Weden et al., 2008), concentrated disadvantage was operationalized at the Census tract level and derived from the following characteristics: proportion of tract population below the poverty line, proportion of the population unemployed and over age 15, proportion of households that received public assistance, proportion of female-headed households with children, black population (proportion) in tract, and tract density of children. Variables were obtained from Summary File 3 of the 2000 U.S. Census and accessed through ICPSR (U.S. Dept. of Commerce et al., 2000). Using maximum likelihood factor analysis, the variables loaded onto a single factor. At 0.17, the preliminary factor loading for density of children was below the recommended 0.30 lower bound (Kline, 1994) and the loadings in the literature (e.g., Sampson et al., 1997); density of children therefore was dropped from the factor. As shown in Table 1, final factor loadings ranged from 0.66 to 0.88, which reflected high correlations (Kline, 1994). The variable was normalized to mean 0 and standard deviation of approximately 1.0.

The use of a multi-indicator variable in this context reduced the potential for bias that could have arisen with a single neighborhood level variable, such as percent of female-headed households, as a single indicator could be correlated with other confounding characteristics, e.g., unemployment (Bingenheimer and Raudenbush, 2004).

Statistical Approach

In order to analyze the relationship between concentrated disadvantage and health, random intercept models with individual and neighborhood characteristics were fit with the Stata 10se processes *xtmixed* and *xtmelogit*, which utilized maximum likelihood and adaptive quadrature estimation methods, respectively (StataCorp, 2007).

Analyses were based on approximately eleven thousand respondents nested in 4,469 Census tracts, with a mean of 2.4 respondents per tract and a range of 1 to 61. The large number of tracts was well beyond the number of Level 2 units typically needed to estimate Level 2 variance (Rabe-Hesketh & Skrondal, 2008). Moreover, although the average number of respondents per tract was small, the large number of tracts with two or more respondents enabled sufficiently strong random effects estimation (Rabe-Hesketh & Skrondal, 2008).

Linear, two-level models of chronic illness were structured as follows:

Level 1
Individual: $Y_{ij} = \beta_0 + \beta_1{*}RaceEth_{ij} + \beta_2{*}Income_{ij} + \beta_3{*}IndChar_{ij} + e_{ij}$

Level 2
Neighborhood:

$$\beta_0 = \gamma_{00} + \gamma_{01}{*}Disadv_j + u_{0j}$$
$$\beta_1 = \gamma_{10}$$
$$\beta_2 = \gamma_{20}$$
$$\beta_3 = \gamma_{30}$$

Substituting the Level 2 equation into Level 1 yielded the following model:

$$Y_{ij} = \gamma_{00} + \gamma_{01}{*}Disadv_i + \gamma_{10}{*}RaceEth_{ij} + \gamma_{20}{*}Income_{ij} + \gamma_{30}{*}IndChar_{ij} + u_{0j} + e_{ij}$$

Y_{ij} represented the outcome variable, chronic illness score, for person *i* in neighborhood *j*. β_1, β_2, and β_3 reflected the association between individual level characteristics (race/ethnicity, income, age, age squared, and education) and chronic illness score for person *i* in neighborhood *j*. Neighborhood-specific intercepts for each neighborhood *j* were modeled as the sum of the overall chronic illness score (γ_{00}), the association between chronic illness score and the neighborhood's deviation from mean disadvantage score ($\gamma_{01,}$), and unobserved neighborhood characteristics (u_{0j}). Individual-level error for person *i* in neighborhood *j* was represented as $e_{ij.}$

The binary outcome of fair or poor self-rated health was estimated using two-level, random intercept models with a latent response formulation as follows:

$$Y_{ij} = \begin{cases} 1 & \text{if } Y_{ij}^* > 0 \\ 0 & \text{otherwise} \end{cases}$$

where Y_{ij}^* represented the propensity for fair or poor health for person *i* in neighborhood *j*, conditional upon other model characteristics. Y_{ij}^* was modeled at both the individual (Level 1) and neighborhood (Level 2) levels using the same independent variables and covariates as in the linear random intercept models. After substituting Level 2 equations into Level 1, Y_{ij}^* was depicted as follows:

$$Y_{ij}^* = \gamma_{00} + \gamma_{01}{*}Disadv_i + \gamma_{10}{*}RaceEth_{ij} + \gamma_{20}{*}Income_{ij} + \gamma_{30}{*}IndChar_{ij} + u_{0j} + e_{ij}$$

Much like the linear model, e_{ij} could be considered the unobserved propensity for person *i* in neighborhood *j* for fair or poor health. Similarly, u_{0j} could be considered unobserved characteristics of neighborhood *j* associated with fair or poor health.

Because the goal of this analysis was a better understanding of the relationship between neighborhood characteristics and individual health, rather than producing population estimates, survey weights were not incorporated into regression analyses. Weighted, population average approaches would not have represented real-world complexity and heterogeneity (Subramanian, 2004). Instead, random effects explicitly modeled the heterogeneity of both individuals and neighborhoods. Because of the weighted survey sampling design, however, the hierarchical models were refit as weighted, single-level models in order to assess whether the two approaches diverged; Stata's survey commands *svy: logit* and *svy: regress* with *strata* and *pweight* settings were utilized (analyses not shown).

RESULTS

Table 2 reports weighted descriptive statistics for the entire study sample and for non-Hispanic black and non-Hispanic white sub-groups. The mean chronic illness score was -0.10 (range -1.11 to 3.04), with lower scores reflecting better health. Approximately 28 percent of the sample reported fair or poor health, representing about 25 percent of white respondents but more than forty percent of black respondents. Non-Hispanic white individuals comprised nearly 85 percent of respondents, whereas approximately eleven percent of respondents reported non-

Hispanic black race/ethnicity, with about five percent of respondents reporting Hispanic (any race) or non-Hispanic "other" race/ethnicities. Approximately three-quarters of the sample had completed high school or a higher level of education, with mean income and assets of approximately $59,000 and $270,000, respectively. Slightly more than half of the sample was female, and slightly less than half was married.

The key neighborhood level variable, concentrated disadvantage, reflected a weighted sample mean of -0.13 (range -1.30 to 7.92), with higher scores reflecting more disadvantage.

Several marked differences were apparent between non-Hispanic white and non-Hispanic black respondents. Black individuals were considerably more likely to be in poorer health, with a mean health score of 0.18 for black respondents but -0.14 for whites, with lower scores reflecting better health. More than forty percent of black respondents reported fair or poor health, versus approximately one-fourth of white respondents.

Socioeconomic characteristics reflected similar chasms. High school graduation rates varied dramatically; only about 18 percent of whites, versus forty percent of blacks, had not completed high school. High school, college, and graduate degree completion rates also were higher for whites. Income and asset levels showed similar discrepancies; the weighted mean income was about $34,000 for black respondents, at $63,000, it was nearly twice as large for whites. Even more dramatically, the mean asset level for black respondents of approximately $60,000 was only one-fifth of that of white respondents. Marital status also differed considerably, with more that half of whites versus one-fourth of blacks married.

The level of neighborhood disadvantage also varied considerably between black and white respondents. The mean of -0.34 for non-Hispanic whites reflected far more advantaged surroundings than those of non-Hispanic blacks, with a mean 1.09.

As shown in Figures 1 and 2, greater neighborhood disadvantage was associated with worse health. Concentrated disadvantage quartiles are plotted again chronic illness score in Figure 1; higher quartiles of disadvantage were associated with greater chronic illness (higher scores) at all education levels. Similarly, in Figure 2, increasing disadvantage quartiles were associated with larger proportions of persons with fair or poor health at all education levels, with markedly high proportions with fair or poor health among persons who did not complete high school.

Table 3 presents unweighted regression coefficients for multilevel random intercept models for chronic illness score. Model I, the variance components specification, suggested that the neighborhood level accounted for about six percent of the variation in the model, as based on the intra-class correlation (ICC). A conservative chi-squared test showed that neighborhood-level variance was significant, indicating that heterogeneity within each neighborhood could be represented by a neighborhood-specific intercept.

Race/ethnicity variables entered in model II. The coefficient for non-Hispanic black was highly significant, positive, and sizeable relative to other variables in the model. Hispanic race ethnicity was also significant at five percent. Model III added age and individual socioeconomic variables. Older age was associated with more chronic illness, as expected, with the magnitude declining with age. Based on the R_2^2, model III explained nearly three-fourths of the neighborhood-level variation.

Model IV introduced education and income, which were highly significant and large, revealing particularly strong negative associations between illness and post-secondary education. Coefficients for high school completion and age as considered over several years were reasonably large, significant, and in the expected direction. Race/ethnicity coefficients diminished in this model; the magnitude for non-Hispanic black declined by 20 percent and Hispanic lost significance. The SEP variables explained an additional ten percentage points of neighborhood level variation.

Concentrated disadvantage, introduced in model V, had a small magnitude and accounted for a minute portion of about one percent neighborhood level variation, although it was significant and in the expected direction. The magnitude of non-Hispanic black race/ethnicity diminished by a further 25 percent, however, suggesting that race/ethnicity may operate through concentrated disadvantage.

Based on Aikike's Information Criterion (AIC), a fit statistic in which stronger models are shown by smaller values, model V, with concentrated disadvantage, was the strongest specification. Non-Hispanic black, age and individual SEP variables remained significant. In all specifications, neighborhood variation remained significant throughout at five percent using conservative chi-square tests.

Table 4 presents odds ratios for multilevel logistic models representing propensity for fair or poor health. The variance component specification in model I revealed an intra-class correlation coefficient of 0.218 based on a latent variable formulation, showing that about twenty percent of the variation in propensity for fair or poor health was at the neighborhood level. Again, a conservative chi-squared test showed significant neighborhood-level variation, indicating that a neighborhood-specific intercept could represent the heterogeneity of each neighborhood.

In model II, odds ratios for all race/ethnicity variables were highly significant and large. The ICC declined considerably; thus, individual-level race/ethnicity explained a considerable portion of variation in the null model, with only eight percent remaining unexplained at level two.

In model III, age was significant but the odds ratio was small, with only small changes to the ICC. After controlling for age, the magnitude of the Hispanic coefficient became larger than that for non-Hispanic black.

Individual socioeconomic position was included in model IV. A strong education gradient again was evident. Income was also instructive and somewhat large. Controlling for individual SEP halved the odds ratios for race/ethnicity. With the inclusion of individual SEP, only about 3.5 percent of the propensity for fair or poor health remained unexplained at the neighborhood level.

Model V showed that concentrated disadvantage was highly significant but small. The change to the ICC was negligible, although neighborhood-level variation remained significant. The odds ratios for black and Hispanic race/ethnicity declined between thirty and forty percent, and the odds ratios for socioeconomic position increased slightly. The increase in magnitude for educational attainment suggests that concentrated disadvantage may operate through education; in the previous model (IV), the omission of concentrated disadvantage may have biased downward the education coefficients, thus their smaller magnitudes in model IV.

Neighborhood level variation remained significant across all models of fair or poor health. All race/ethnicity variables also remained significant across all specifications, with Hispanic generally showing larger odds ratios than non-Hispanic black. Cross-level interactions were not feasible for chronic illness or fair or poor health as some neighborhoods did not have sufficient within-group variation.

In further analysis (not shown), education was more meaningfully associated with both chronic illness and fair or poor health than was income. This result was consistent with findings by Pressley (1999) that education was strongly inversely associated with illness, although income was strongly associated with illness progression.

Svy models were estimated for comparability (not shown) and yielded similar results, with most coefficients within ten percent of the multilevel estimates. In the chronic illness models, the few notable differences between the linear random intercept and *svy: regress* models included general non-significance for Hispanic and non-Hispanic other race/ethnicity in the *svy* models, versus 5% and 10% marginal significance in the multilevel models, as well as deflated Hispanic coefficients (0.028 versus 0.034) and inflated non-Hispanic other coefficients (0.058 versus 0.038) in the final specifications. In logistic models for fair or poor health, race/ethnicity and age variables generally were less significant in the *svy: logit* models as compared to the random intercept logit model (non-significant and 1% significance versus 5%, 1% and 0.1% significance levels). The magnitude of nearly all coefficients was within ten percent, with larger *svy: logit* effects for Hispanic than non-Hispanic black respondents and with concentrated disadvantage remaining significant. The differences were attributable to the effect of weighting in the *svy: models*, with particular relevance for Hispanic subgroups.

DISCUSSION

Using data from the Health and Retirement Study, this study analyzed the extent to which disparities in chronic illness and self-rated health between African American and white adults in mid- to late-life are mediated by neighborhood-level concentrated disadvantage. Findings demonstrated that a portion of the variance in health among adults in mid- and late- life was attributable to neighborhood-level factors, net of individual characteristics. Factors at the neighborhood level were associated with about twenty percent of the variation in propensity for fair or poor health and about six percent of the variation in chronic illness. Concentrated disadvantage was significant and in the expected direction for both self-rated health and chronic illness, although the magnitude and associated changes to the intra-class correlation remained small; however, even modest neighborhood variance at the neighborhood level has been argued to suggest important neighborhood level factors (Bingenheimer & Raudenbush, 2004).

At the individual level, education and non-Hispanic black race/ethnicity were strongly associated with both health measures, which is consistent with previous literature. Hispanic race/ethnicity also reflected a sizable association with fair or poor health. Neighborhood-level factors were more salient for self-rated health than for chronic illness. This result is consistent with research that found associations between neighborhood disadvantage and subjective but not objective health (Robert & Lee, 2002; Wight et al., 2008).

This analysis included several important limitations. While the national sampling frame enhanced generalizability, the degree of clustering was thin. Future analyses that focus more intensely on discrete metropolitan areas or regions and include greater sample density may yield stronger results. Smaller geographic aggregations (Hipp, 2007) or geographic aggregations that better represent true neighborhoods also may yield more robust results. In addition, alternate formulations of concentrated disadvantage may improve robustness and interpretability, and may be more appropriate for national samples or studies that focus on older adults. These findings also may be limited by the use of a random effects model on data that were designed to be weighted. However, the direction and significance of the regression coefficients persisted across both subject-specific and population averaged analyses, most coefficient values did not vary by more than ten percent, and other work with the Health and Retirement Study has included multilevel strategies (Freedman et al., 2008; Wight et al., 2008).

In spite of the noted limitations, these findings support associations between neighborhood-level characteristics and health. While more research is needed to identify the specific mechanisms that undergird these relationships, the current findings may offer support for community health initiatives and new agendas for public housing policy. Moreover, in keeping with the call for policy efforts to address upstream causes of health inequality (Acevedo-Garcia, Osypuk, McArdle, & Williams, 2008; Adler & Newman, 2002; Mechanic, 2002), this research may present implications for education policy. Although the focus of this study was adults in mid- to late life, the findings demonstrated that educational attainment accounted for a great of neighborhood variation health over the lifetime, with strong protective effects for high school graduates and college graduates. These results are consistent with a large body of research that supports connections between education and health, including those that operate through income, health behaviors, and sense of mastery (Ross & Wu, 1995; Lauderdale, 2001). Arguably, the dynamic of concentrated disadvantage is such that mobility into more advantaged neighborhoods is curtailed. Older individuals who have experienced considerable concentrated disadvantage may well have spent decades in that or similarly challenged neighborhoods. If that is the case, policies that target areas of concentrated disadvantage in order to improve educational outcomes through increased mentorship, high school graduation rates, and college matriculation, as well as ensure that funding is available for college, are greatly needed. While such policies will not ameliorate health inequality for people who today are in mid and later life, they will create shifts in the opportunity structures that today are available to younger persons and will lay the groundwork for conditions that will enable improved wellbeing over the lifetime of the coming generations.

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Figure 1.
Chronic Illness Score by Disadvantage Quartile
2004 Health and Retirement Study

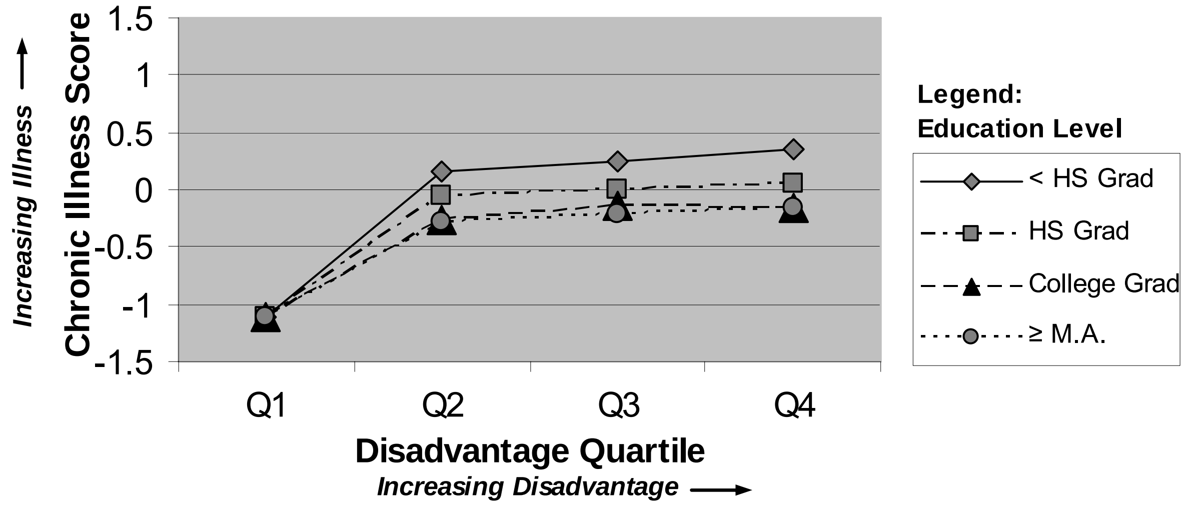

Figure 2.
Proportion with Fair or Poor Health
by Disadvantage Quartile
2004 Health and Retirement Study

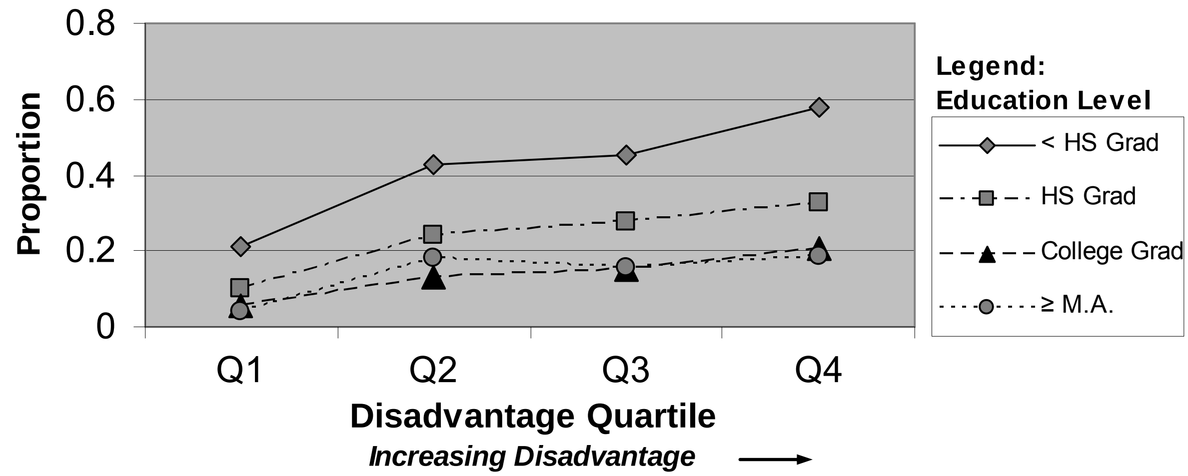

Table 1. Factor Loadings for Physical Illness and Concentrated Disadvantage Indices

	Factor Loading
Physical Illness Score	
Hypertension	0.46
Diabetes	0.38
Heart Condition	0.40
Stroke	0.30
Concentrated Disadvantage	
% Tract population receiving public assistance	0.87
% Tract population below poverty line	0.88
% Tract unemployment	0.83
% Female-headed households with children	0.84
% Tract black population	0.66

Table 2. Descriptive Statistics, 2004 Health and Retirement Study

	Percent or Mean		
	Complete Sample	**Non-Hispanic White Respondents**	**Non-Hispanic Black Respondents**
Outcome Measures			
Mean Chronic Illness Score Range: -1.11 to 3.04; SD 0.03	-0.10	-0.14	0.19
Fair or Poor Health (%)	27.6	24.5	43.0
Individual-level Variables			
Mean Age Range: 51 to 108; SD 0.19	65.9	66.4	63.6
Race/Ethnicity			
Non-Hispanic White	83.6	-	-
Non-Hispanic Black	11.3	-	-
Hispanic (All Races)	3.5	-	-
Non-Hispanic Other Race	1.6	-	-
Educational Attainment			
Did Not Complete HS	22.1	18.2	39.3
High School Graduate	55.7	57.5	48.2
College Graduate	13.0	14.1	7.5
Graduate Degree	9.3	10.1	4.9
Mean Income ($) Range: 0 to 3.6M; SD 1,490	58,549	63,019	33,912
Mean Assets ($) Range: -499K to 76M; SD 18,100	267,537	307,315	60,832
Sex, Female	57.2	56.6	62.4
Married	47.5	50.7	25.3
Proxy Interview	5.9	5.6	7.4
Spanish-language Interview	0.4	0.0	0.0
Neighborhood-level Variables			
Mean Concentrated Disadvantage Range: -1.30 to 7.92; SD 0.03	-0.13	-0.34	1.09

Notes: Data are weighted. For health measures and neighborhood characteristics (chronic illness, self-rated health, and concentrated disadvantage scores), lower values reflect better health and less adversity.

Sample n=11,320; weighted population N=50,003,943

Table 3

Regression Coefficients

Linear Random Intercept Models for Chronic Illness Score

2004 Health and Retirement Study

Variable	I		II		III		IV		V	
Fixed Effects										
Race/Ethnicity *(Non-Hispanic White)*										
Non-Hispanic Black			0.3020	***	0.3584	***	0.2797	***	0.2191	***
			(0.0268)		(0.0252)		(0.0255)		(0.0298)	
Hispanic			0.1186	*	0.1801	***	0.0702		0.0335	
			(0.0477)		(0.0455)		(0.0457)		(0.0466)	
Non-Hispanic, Other Race			0.0511		0.1320	+	0.0693	+	0.0375	
			(0.0795)		(0.0767)		(0.0761)		(0.0765)	
Age					0.0230	***	0.0199	***	0.0199	***
					(0.0009)		(0.0009)		(0.0009)	
Age-squared					-0.0006	***	-0.0006	***	-0.0006	***
					(0.0001)		(0.0001)		(0.0001)	
Education *(Less than High School)*										
High School Graduate							-0.1845	***	-0.1767	***
							(0.0225)		(0.0226)	
College Graduate							-0.2783	***	-0.2641	***
							(0.0339)		(0.0341)	
Graduate Degree							-0.3442	***	-0.3290	***
							(0.0384)		(0.0386)	
Household Income ($000s)							-0.0007	***	-0.0006	***
							(0.0001)		(0.0001)	
Concentrated Disadvantage									0.0445	***
									(0.0113)	
Intercept	-0.0002		-0.0572	***	0.0075		0.1846	***	0.1892	***
	(0.0106)		(0.0117)		(0.0136)		(0.0218)		(0.0218)	
Random Effects										
Residual (L1) Standard Deviation	0.9684		0.9676		0.9537		0.9490		0.9488	
	(0.0076)		(0.0075)		(0.0071)		(0.0069)		(0.0069)	
Neighborhood (L2) Standard Deviation	0.2522	***	0.2269	***	0.1283	**	0.0974	*	0.0926	*
	(0.0190)		(0.0198)		(0.0242)		(0.0283)		(0.0293)	
Proportion Level 2 variance explained (R_2^2)	--		0.191		0.741		0.851		0.865	
Intra-Class Correlation	0.064		0.052		0.018		0.010		0.009	
Log-Likelihood	-15,733		-15,670		-15,339		-15,245		-15,237	
AIC	31,472		31,351		30,693		30,513		30,500	

Notes: Analyses in this table are unweighted. Reference categories are italicized and listed in parentheses. Standard errors are reported below coefficients. Continuous variables are centered at unweighted grand means of age 69 and household income 50 ($50,000). AIC represents Akaike's Information Criterion; smaller values correspond to stronger models. Chronic illness score range: -1.11 to 3.04; concentrated disadvantage range: -1.30 to 7.92. Lower values reflect poorer health and greater neighborhood disadvantage. Significance tests for neighborhood level effects are based on likelihood ratio tests with one-half degree of freedom and are conservative.

n=11,114

+ $p \leq 0.10$; * $p \leq 0.05$; ** $p \leq 0.01$; *** $p \leq 0.001$

Table 4

Odds Ratios for Random Intercept Logistic Regression Models of Fair or Poor Health 2004 Health and Retirement Study

Variable	I		II		III		IV		V	
Fixed Effects										
Race/Ethnicity *(Non-Hispanic White)*										
Non-Hispanic Black			2.2938	***	2.4500	***	1.6382	***	1.3918	***
			(0.1367)		(0.1470)		(0.0984)		(0.0976)	
Hispanic			2.2723	***	2.9680	***	1.7879	***	1.6205	***
			(0.2833)		(0.3101)		(0.1871)		(0.1736)	
Non-Hispanic, Other Race			1.9403	***	2.1080	***	1.5466	*	1.4194	*
			(0.3362)		(0.3667)		(0.2716)		(0.2513)	
Age					1.0242	***	1.0056	**	1.0060	*
					(0.0002)		(0.0023)		(0.0023)	
Age squared					1.0002		1.0004	*	1.0004	*
					(0.0002)		(0.0002)		(0.0002)	
Education *(Less than High School)*										
High School Graduate							0.4888	***	0.4967	***
							(0.0252)		(0.0257)	
College Graduate							0.3057	***	0.3142	***
							(0.0293)		(0.0312)	
Graduate Degree							0.3186	***	0.3282	***
							(0.0364)		(0.0375)	
Household Income ($000s)							0.9905	***	0.9909	***
							(0.0007)		(0.0007)	
Concentrated Disadvantage									1.1291	***
									(0.0303)	
Random Effects										
Neighborhood (L2) Standard Deviation	-0.9580	***	0.5365	***	0.5182	***	0.3443	***	0.3387	***
	(0.0280)		(0.0478)		(0.0486)		(0.0586)		(0.0589)	
Intra-Class Correlation	0.218		0.080		0.075		0.035		0.034	
Log-Likelihood	-6,736		-6,607		-6,537		-6,172		-6,161	
AIC	13,475		13,224		13,089		12,365		12,347	

Notes: Analyses in this table are unweighted.

Reference categories are italicized and listed in parentheses. Standard errors are reported below coefficients.

Continuous variables are centered at unweighted grand means of age 69 and household income 50 ($50,000).

AIC represents Akaike's Information Criterion; smaller values correspond to stronger models.

Chronic illness score range: -0.72 to 2.17; concentrated disadvantage range: -1.23 to 8.18. Lower values reflect poorer health and greater neighborhood disadvantage.

Significance tests for neighborhood level effects are based on likelihood ratio tests with one-half degree of freedom and are conservative.

n=11,151

+ $p \leq 0.10$; * $p \leq 0.05$; ** $p \leq 0.01$; *** $p \leq 0.001$