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Black and White Chains of Risk for Hospitalization Over 20 Years*

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Abstract

Drawing from the life course perspective, racial disparities in hospitalization are considered in light of a chain of risk. We ask whether race influences admission to, length of stay in, and mortality following hospitalization. Analyses address these questions with data from a national longitudinal sample of adults to assess racial disparities in the hospitalization experience ($n = 6,833$). Survey data were merged with hospital records abstracted over 20 years of observation. Multivariate analyses revealed that there were no racial differences in admission, but that black adults generally had longer stays. When isolating each stay prospectively, black adults had longer stays during the first, third, and fourth hospitalizations. Post-hospital mortality after the first stay was also higher for black adults than for their white counterparts, even after controlling for morbidity and status resources. The findings suggest that the racial disparities in hospital length of stay and mortality are explained by the cumulative effects of social and health inequalities over the life course.

The racial/ethnic gap in health is substantial and endures despite many public policy efforts to reduce or eliminate it. Although disparities in health status between European and African Americans (hereafter, termed white and black) have declined on a few outcomes during recent decades, the bulk of the evidence reveals that black people remain disadvantaged on dozens of indicators related to health and medical care (National Center for Health Statistics 2006). The gap is clear, but debate ensues on the reasons for it and how much disparities in medical care contribute to the health inequality (Meyers 2007).

Many forms of racial/ethnic inequality endure despite ameliorative efforts, in part because they involve encounters with social institutions that may perpetuate structural inequality or subtle forms of discrimination. Evidence continues to accumulate showing that black people face disadvantages in access to and use of valued resources in a variety of institutional settings, including the workplace and housing. Is hospital care any different? How do black and white people fare in medical settings when they face serious health problems?

The purpose of this research is to address these questions by using a life course perspective to compare the hospital encounters of black and white adults. Several prominent reports summarize the black/white disparity in medical care (Anderson, Bulatao, and Cohen 2004; Smedley, Stith, and Nelson 2003), but some authors contend that racial disparities are overstated or nonexistent (e.g., Klick and Satel 2006). Although we judge the latter view to be

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implausible, part of the incongruity may be due to an overemphasis on comparisons at any one point in time. Scores of studies examine racial/ethnic disparities in medical care, but few use a life course perspective or examine links across episodes of care delivered to black and white people.

A life course perspective is useful for studying black/white inequality to identify the antecedents of disparities and recurring patterns in the encounters with social institutions. In addition, the perspective helps elucidate how social forces and experiences shape human development and aging (Elder and Shanahan 2006; Kuh and Ben-Shlomo 1997). Although many studies summarize information about hospital experiences for an individual into measures such as average length of stay, the aggregation may mask distinct pathways of social groups. To examine disparities in how black and white people fare in the hospital, there may be value in also studying hospital episodes and how early episodes are related to later ones. Our approach, therefore, is to examine black/white disparities in hospitalization by viewing them as “a succession of life transitions or events” (Elder 1998:5).

Episodic encounters with social institutions, such as hospitals, are of interest in their own right, but sociological studies of black/white disparities can use the life course to identify the social pathways of human lives. Social pathways provide the context for biographical trajectories because human lives “are always constrained by the opportunities structured by social institutions and culture” (Elder, Johnson, and Crosnoe 2003:8). From a life course perspective, we anticipate that racial disparities begin early in life and shape institutional encounters, thereby resulting in the accumulation of disadvantage over time (Dannefer 2003). The present research uses a national sample of community-dwelling adults to prospectively examine racial differences in linked records of hospital admission, length of stay, and vital status after hospitalization during a 20-year observation period.

BLACK/WHITE INEQUALITY AND CHAINS OF RISK

Scientists from a variety of fields are giving systematic attention to how early and recent adversities influence health and social behavior. Applications of the life course perspective in epidemiology and social psychology offer considerable help for identifying mechanisms of inequality (Elder 1998). Drawing from Kuh et al. (2003), we use the concept of a *chain of risk* as a sequence of negative events that accumulate to increase the likelihood of health problems; it is not a self-sustaining series of events, but a life course succession of risks and outcomes. A chain of risk is seen as probabilistic rather than deterministic and typically takes one of two basic forms: one where each disadvantage has both direct and indirect effects on the outcome of interest, the other where earlier disadvantages accumulate to trigger the link between a subsequent disadvantage and an adverse outcome. Both are forms of risk clustering, but latency is more likely in the latter case. If there are independent effects of each disadvantage, then the relationships should be discernible at earlier stages of the chain.

The study of racial/ethnic differences in a chain of risk should be helpful not only for identifying mechanisms of life course inequality, but also for isolating how and when disadvantage accumulates. Indeed, a basic principle of the life course perspective focuses on timing: “the developmental antecedents and consequences of life transitions, events, and behavioral patterns vary according to their timing in a person's life” (Elder et al. 2003:12). The timing of the life course may be altered by early disadvantage, perhaps leading to distinct pathways for social groups (Alwin and Wray 2005; Hatch 2005).

Visualizing black/white disparities as the life course accumulation of disadvantage also helps one to identify the mechanisms of health inequality. The predominant mechanism has been referred to as *scarring*, whereby early adversity negatively alters a life trajectory (Preston, Hill, and Drevenstedt 1998). This is similar to what others have described as the weathering

hypothesis: African Americans experience “early health deterioration as a consequence of the cumulative impact of repeated experience with social, economic, or political exclusion” (Geronimus 2001:133). On the other hand, early adversity can lead to acquired immunity or the development of adaptive strategies to minimize early insults (Elder and Liker 1982; Ferraro and Kelley-Moore 2003; Preston et al. 1998). Such compensatory mechanisms may reduce the scarring effect, but this is probably more difficult for chronic than for acute conditions because of the time required for the development of the former. With chronic conditions, there is often a longer period of an undiagnosed condition, and this period is critical for determining the success of efforts to break the chain of risk.

Evaluating evidence for a chain-of-risk model should consider two additional factors that may be related to black/white differences in the experience of hospitalization. First, mortality selection may be related to early disadvantage, especially if the detection of a health problem is delayed. Death is the ultimate outcome when studying a chain of risk, and black/white differences in survival after a hospital episode would reflect the influence of accumulated disadvantage for the two groups.

Second, the pervasive influence of socioeconomic status (SES) is critical to our understanding of a chain of risk, especially because some apparent disparities may actually be due to lower SES (Mutchler and Burr 1991). For health care use, SES is critical for knowledge of services, access (via insurance and income), and patient routing into select networks of physicians and medical facilities (Bach et al. 1999). The consequence of this, as summarized by a National Academy of Sciences report, is that health care “disparities are associated with socioeconomic differences and tend to diminish significantly, and, in a few cases, disappear altogether when socioeconomic factors are controlled” (Smedley et al. 2003:5). In short, low SES represents a cluster of health risks, but racial disparities exist even within levels of SES.¹

BLACK/WHITE DISPARITIES IN HOSPITALIZATION

Most studies of racial differences in hospitalization consider one outcome (such as admissions or length of stay), but applying a life course perspective to the problem suggests the utility of considering multiple outcomes, especially in a prospective approach. We systematically consider three outcomes that represent potential links in a chain of heightened risk for black people: admission, length of stay, and mortality after hospitalization.

A few studies find that admissions are closely related to medical need and that black adults are more likely than white adults to be hospitalized (e.g., Eggers and Greenberg 2000). Most studies of admission rates, however, reveal that black adults are *less* likely than white adults to be admitted to the hospital (Agency for Healthcare Research and Quality 2003; Ferraro et al. 2006; Wolinsky et al. 1994). One issue that has engaged considerable discussion concerns how much of this racial disparity in hospital admissions is due to socioeconomic inequality between black and white people (Henry J. Kaiser Family Foundation 2000; Smedley et al. 2003; Williams and Rucker 2000). It is significant on a policy front because higher medical need with lower admission rates for minority groups may be a sign of privileged access for the majority.

Although admission rates are generally lower for black people than for their white counterparts, what about disparities after admission? If the disparities disappear after admission, then this would be evidence of an intervention minimizing racial inequality—breaking the chain of risk.

¹It could be argued that the persistence of racial disparity in health is due, in part, to fundamental stratification processes that influence health over the life course. As summarized in an American Sociological Association (2005) publication, “income inequality does not explain all the marked health differences among racial and ethnic groups” (p. 6), but reducing socioeconomic disparities would shrink the racial gap in health.

On the other hand, if the disparities persist, this would be evidence that hospitalization cannot undo the accumulated health inequality.

For the post-admission outcomes, the results are even less consistent than those reported for hospital admission. For instance, Wolinsky and Johnson (1991) reported no differences in length of stay for black and white older adults, and Martin and Smith (1996) found shorter stays for black older adults than for white older adults. By contrast, several studies reveal that black adults generally have *longer* lengths of stay than white adults (e.g., Shi 1996). This result is best considered in light of research showing that black people are more likely than white people to experience delays in accessing care (Weissman et al. 1991), and that they generally experience poorer processes of care (Bach et al. 1999; Kahn et al. 1994). Given the consistent finding that black people are less likely to use medical care, especially ambulatory care, excess morbidity likely goes untreated for longer periods of time. Black people presenting for care may be more likely than white people to be in advanced stages of illness. Thus, longer lengths of hospital stay are not a sign of privileged care for black people, but probably an institutional response to deal with excess morbidity due to inadequate or delayed care (Williams and Rucker 2000).

Beyond length of stay is the question of vital status after discharge. Longevity after hospitalization may be viewed as the final link in a chain of risk. Again, the results are inconsistent; some studies reveal higher mortality for black than white people (Konety, Sarrazin, and Rosenthal 2005) while other studies reveal no racial differences in mortality following a hospital episode (Walter et al. 2001; Wen and Christakis 2005) or even lower mortality risk in Veterans Administration hospitals (Jha et al. 2001). Why the inconsistency in studies of post-admission hospitalization experiences?

Our review identifies several characteristics of the literature that may lead to inconsistency in the results for the three outcomes under consideration. Conclusions from previous studies are constrained by one or more of the following limitations: a limited geographic region (e.g., Wen and Chistakis 2005), cohortcentric designs of older or younger subjects only (e.g., Wolinsky et al. 1994), consideration of only one or of only a select group of reasons for the admission (e.g., heart failure, Kahn et al. 1994), failure to adjust for variables widely known to be related to hospitalization (e.g., rural/urban residence, Shi 1996), and pooling all stays into a composite or average measure of use (e.g., Kahn et al. 1994).²

Research Aims and Questions

Regardless of the reasons for the inconsistency in findings, our aim is to help resolve the discrepancies by using prospective data from a national sample of adults over a 20-year period. The present analysis considers a wide age-range of adults, multiple reasons for hospitalization, and an extensive array of predictors known to be related to health service use (Andersen 1995). Moreover, with prospective data over two decades, we isolate specific stays to detect racial differences in use for each stay rather than just aggregating stays into a composite measure. Indeed, if the delay mechanism is operant, the racial disparity in length of stay may be greatest during the first hospital episode. Admissions which are temporally close may be a sign of compromised health status. Thus, for the second and following hospitalizations, the analysis estimates the influence of prior recent hospitalizations on the outcome under consideration. We are unaware of any published study that prospectively examines racial differences in the chain of risk outlined here or even in the length of stay across a sequence of admissions.

²Other possible explanations for the inconsistency in findings include: small sample sizes, which may result in limited statistical power for testing black/white differences and historical change due to social trends toward decreasing LOS in the past two decades.

Three main research questions guide the analysis. First, are black adults less likely than white adults to be admitted to the hospital? Given the inconsistent findings in the literature, no hypothesis is formulated (cf. Agency for Healthcare Research and Quality 2003; Eggers and Greenberg 2000). Second, is there a racial difference in length of stay? Most previous research suggests either longer stays or no racial difference. On the basis of accumulated disadvantage, we hypothesize that black adults will have longer lengths of stay than white adults. Third, is average age at death higher for black adults than for white adults? As the final outcome in a chain of risks, we hypothesize that black people will die at younger ages than their white counterparts, even after adjusting for resources and morbidity.

METHOD

Sample

This study analyzes data from the *National Health and Nutrition Examination Survey I* (NHANES I) and its *Epidemiologic Follow-up Study* (NHEFS) for those participants who were given the “detailed component” of the baseline interview (1971 to 1975). The initial survey was a multi-stage stratified probability sample of noninstitutionalized Americans ages 24 to 75 years. These subjects were followed for three additional interviews: the second wave (W2) was conducted between 1982 and 1984, the third in 1987 (W3), and the fourth in 1992 (W4). Due to the small proportion of other ethnic groups in the sample (e.g., 41 Asian Americans), the analysis considers only persons identified as black or white. Of the 6,833 subjects at the baseline, 5,955 (87.15 percent) respondents were white and 878 (12.85 percent) respondents were black. At least one hospitalization after the baseline survey was observed for 4,299 persons. All analyses presented below adjust for sample weights and clustering with Stata 9 (StataCorp 2005).

Measurement of Hospitalization Variables

At each follow-up interview, respondents were asked whether they had been hospitalized overnight since the previous interview. Respondents reporting a hospitalization were queried about the approximate date and length of the stay, reason for admission, and name of the hospital. With the respondent's consent, researchers then attempted to match reported hospital stays with facility records (from only those hospitals mentioned by the respondent). A stay was considered to match an existing record if the reported date was within one year of the date on the hospital record and if any of the diagnoses referred to the body system reported by the respondent (e.g., subject admitted for myocardial infarction, and subject reported hospitalized for “heart problem”). For respondents who died during the observation period, NHEFS researchers identified 2,604 hospital records reported by proxy interviews or from death certificate references to a hospital. Hospital record searches for stays not reported by a living respondent yielded less than 1 percent of all records. All analyses reported below are based on hospital records; eliminated from the analyses were hospital stays reported by the respondent or a proxy which could not be confirmed or matched with facility records. Thus, the analysis makes use of 77 percent of all self-reported hospital stays for which hospital records are available.³

Study investigators obtained the following information for each recorded hospital stay: date of admission, date of discharge, and discharge destination. Some stays were determined to be out of the scope of the present study: hospitalizations for childbirth, mental health facility stays,

³Most of the discrepancy between respondent reports and hospital records lies with the respondent or proxy reports of frequent hospitalizations (e.g., subject reported 10 stays, but there are records for 9 stays only). There are relatively few cases with 10 or more stays, however (90 percent of the NHEFS sample reported seven or fewer stays). Even among the persons with a large number of hospital stays, the discrepancy is most often one or two stays. Indeed, 90.2 percent of all reports from respondents were accurate within one visit, and 95.5 percent within two visits.

and nursing home stays were eliminated. About 4 percent of all stays included transfer to another hospital, but contiguous stays were treated as one stay if the transfer occurred within three days of the first admission and both stays shared the same basic disease classification (resulting in 3 percent of the apparent transfers recoded into a single stay). Although emergency room visits are excluded, admissions resulting from emergency room visits are included. There were 15,281 confirmed hospitalizations for 4,229 persons over 20 years. We created separate variables for whether each person was hospitalized after the baseline and the count of all stays during the study divided by years alive. We consider stays per year as an additional measure of admission (i.e., volume), but it is standardized over survival to account for mortality selection. The location of the hospital was not identified in the public-use data set.

Length of stay (LOS), measured in days, is derived by subtracting admission date from the discharge date. A hospital stay required an admission; those who stayed in the hospital but did not spend a night received a score of 0.5. The analysis examines LOS separately during the first through the fourth stays. Descriptive statistics for the hospitalization variables are presented in Table 1 (including the number of cases for the episodic stay data). Variables were also created in preliminary analyses to identify the last stay and mean LOS for all stays.

Measurement of Post-hospital Mortality

Mortality data were collected from brief interviews conducted with proxies of deceased respondents. In addition, matches were made for all participants in the baseline survey to the National Death Index, the Social Security Administration Mortality File, and the enrollment file of the Health Care Financing Administration (Cox et al. 1997). To study racial differences in age at death, we created a binary vital-status variable and a duration variable that refers to the number of days from last discharge to death or to the final interview (persons who died in the hospital were assigned a duration score of 0.1). About 29 percent of all respondents died during the study, and about 34 percent of the respondents who were hospitalized at least once died by the conclusion of the study.

Measurement of Covariates

Means and standard deviations of all covariates are also presented in Table 1, for the total sample and by race. Status characteristics include race, gender, and age. Indicators of *black* race and *female* sex are binary measures (scored with 1 equal to the name of the variable, 0 otherwise). Age is coded in years reported at the baseline survey, ranging from 24 to 75.

Status resources include education (eight categories, with 0 equal to less than eight years of schooling and seven representing a post-college education), income (12 categories, 1 equal to less than \$1,000 and 12 greater than \$25,000), Medicaid status (a binary measure coded 1 for recipients of Medicaid), private health insurance (a binary measure coded 1 for those with private insurance), and having a regular physician for primary care (a binary measure coded 1 for those with a primary care physician).

Independent variables also span a broad range of characteristics related to morbidity and health behaviors among black and white adults. Morbidity measures are derived from a checklist based on the following question at baseline: “Has a doctor ever told you that you have ...”: “cancer,” “diabetes,” etc. Each condition was coded and analyzed as a binary variable (1 = present, 0 = otherwise); the full list of conditions is presented in Table 1.⁴

⁴Variables for stroke, arthritis, and hip fracture were considered in preliminary models but dropped from the final analyses because they were nonsignificant.

Morbidity identifies the type of disease, but not the severity of it. Thus, we added a control measure for self-rated health to account for the respondent's overall sense of his or her health status: "Would you say that your health in general is excellent, very good, good, fair, or poor?" (scores range from 1 = poor to 5 = excellent). This variable was included as a time-dependent covariate in the mortality analyses.

Health-related behaviors include a number of lifestyle factors such as heavy drinking, smoking, and obesity. Heavy drinking was defined as consuming at least 14 or more drinks per week, which is equivalent to two or more drinks a day. Smokers (current and past) were identified by self-reported consumption of cigarettes, cigars, and pipe tobacco at the time of the interview and during one's lifetime. Past smokers were defined as those who reported ever smoking cigars, pipes, or at least 100 cigarettes, but not at the time of the survey. Obesity was defined as body mass index (kilograms/meter²) greater than or equal to 30.

In order to account for recent hospitalizations (which may include early readmissions and those due to infection), in analyses of second and subsequent hospitalizations, we included a binary variable identifying whether a hospitalization occurred in the previous six months.

To adjust for trends in hospitalization over the 20-year period, we included a binary variable to identify whether each stay was before or after implementation of the prospective payment system (PPS) on January 1, 1986 (Cutler 1995). The prospective payment system was designed to standardize payment for Medicare services via diagnostic-related groups. Although it was focused on Medicare reimbursement, it was a major step in the more general social trend toward reducing length of stay. Over half of all observed hospitalizations in the NHEFS occurred prior to PPS, including 74 percent of first stays.

Analytic Strategy

The analysis was divided into three main stages. First, we examined racial differences in hospital admissions. We used logistic regression to estimate the likelihood of being hospitalized at least once during the study. We also tested for racial differences in the number of hospitalizations observed over 20 years. We standardized this measure of volume of stays by years observed to be alive, and we estimated parameters with interval regression, a derivation of tobit regression (Hardin 2005).

Second, we estimated racial differences in LOS by isolating each stay sequentially (stay one to stay four). Each measure of LOS is highly skewed; we therefore used negative binomial regression models to account for the overdispersion of the outcome (Long 1997).⁵

Third, with information on the exact date of discharge and date of death, we estimated black/white differences in age at death with Cox proportional-hazards models. Moreover, to account for changing health status during the 20-year observation period, these analyses made use of a time-dependent covariate for self-rated health identified at each interview. The analyses presented below are for all-cause mortality and were conducted for the hazard of dying after the first and second hospital stays. We also explored supplemental analyses with the third and fourth stays, but we found that statistical power was sufficient for testing racial differences in age at death for the first two stays only.

⁵We present analyses for up to four stays because only about 25 percent of the sample had more than four hospital stays during 20 years, which makes detecting racial differences in LOS unlikely for five or more stays (i.e., insufficient statistical power).

RESULTS

Descriptive statistics and bivariate tests of racial differences are presented in Table 1. At the bivariate level, black adults were less likely than white adults to be admitted to the hospital during the 20-year period of the study. Among respondents who were admitted at least once, however, the survival-adjusted stays per year were actually slightly higher for black than for white respondents.

On three of the four measures of length of stay, black adults generally had longer stays than white adults (the exception being the second stay). On average, they stayed three days longer than white adults ($p < .001$). The risk for dying at younger ages was also higher for black than for white respondents. After discharge, black persons lived on average 5.3 years (i.e., 1,929.6 days) compared to 6.5 years for white persons ($p < .001$). Supplementary analyses also showed that black persons were 1.3 times more likely to die after a hospital stay and 1.4 times more likely than white persons to die in the hospital ($p < .001$). As expected, the status resource differences were noticeable between the black and white respondents. Education and income differences were substantial, and black adults were three times more likely than white adults to be receiving Medicaid. Also, black adults were less likely than white adults to have private insurance and a regular physician. Regarding health status, black persons were more likely than their white counterparts to have diabetes, heart trouble, and hypertension. We also examined black/white differences in morbidity among the hospitalized respondents only, finding that black adults had higher morbidity than their white counterparts ($p < .001$). Not surprisingly, black respondents were also more likely than white respondents to rate their health negatively.

Hospital Admission and Length of Stay

Table 2 displays multivariate results of analyses for hospital admission and length of stay. Although bivariate analyses revealed that black adults were less likely than white adults to have at least one admission, there was no racial difference in admissions after adjusting for the covariates. In a semi-reduced model, not shown, we found that the racial difference in hospital admissions was due to the age and sex composition of the black and white samples. We also see from Table 2 that age, private insurance, having a regular physician, living in a rural area, poor health, and obesity were important predictors of hospitalization.

The interval regression analyses for the number of stays per year show no racial difference, but more stays were observed for older people, men, those with limited education, rural residents, and those in poorer health (most types of morbidity, and those who rated their health more negatively). More stays per year were also observed for smokers and for persons who were not heavy drinkers.

The negative binomial regression analyses for LOS reveal that black people had *longer* stays for the first, third, and fourth admissions. Although no significant difference is observed for the second stay, subsequent stays show a consistent pattern of greater LOS for black adults even after adjusting for other characteristics. As one reviews the LOS analyses, only two variables were significant predictors across all four equations: Older people generally had longer stays, and rural residents generally had shorter stays. The effects of status resources varied across stays (education, income, and Medicaid status), as did the effects of morbidity. Lifestyle variables such as heavy drinking, smoking, and obesity increased LOS, but the racial differences persist even after controlling for these variables. As expected, LOS was generally shorter for those hospitalizations that occurred after the prospective payment system was instituted in 1986.

Finally, the analyses reveal the importance of a recent stay: Persons who had a hospital stay during the preceding six months had longer stays during the subsequent admission. The magnitude of the effect for recent stay is substantial, but the racial differences in LOS observed in the bivariate analyses remained significant. Regardless of recent stays, black people generally had longer LOS.

In supplementary analyses (not shown), we also examined cause of stay between the first and second admissions. Over 68 percent of the recent stays were due to the same basic International Classification of Diseases (ICD) code (41 percent) or to an infection during the second admission (27 percent). We observed no racial differences in the rate of infections or cause incongruence.

Post-hospital Mortality

For the final link in the chain of risk, we consider survival after hospitalization. Table 3 displays the results of Cox proportional-hazards models of mortality. These models were estimated separately for those who had one or two stays during the two-decade observation period, which includes 44 percent of all respondents who were hospitalized. To account for changing health conditions during the 20-year observation period, these analyses make use of a time-dependent covariate for self-rated health (reported at each interview). The first equation reveals that post-hospital mortality for black adults was about double the rate for white adults ($HR = 2.071, p < .01$). As expected, older respondents also had higher risk, and both heart trouble and hypertension raised mortality risk. Length of stay was also related to mortality risk: longer stays, reflecting more complex medical problems, were associated with greater mortality risk.

The second equation reveals that average age at death after the second stay did not differ between black and white adults. Older respondents, men, and persons on Medicaid had higher mortality risk, as did persons with diabetes and heart trouble. The lifestyle factors of heavy drinking, smoking, and obesity were all associated with greater mortality. Again, length of stay was positively associated with mortality risk, as was having a recent stay.

Figure 1 graphically displays the cumulative hazard of average age at death for black and white respondents who had one stay during the observation period (derived from the analysis reported in Table 3). The x-axis refers to survival time in days, and the y-axis is the cumulative hazard of mortality. The figure illustrates how the black/white disparity in the cumulative hazard of mortality increased over time. The divergence in the cumulative hazard for black and white adults is evident shortly after discharge and increases over time. Another way to conceptualize the racial disparity is to consider average age at death. Among persons who died after their first hospitalization, the average age for white adults was 69, but the average age for black adults was 65.

DISCUSSION

The aim of the present research was to examine racial inequality in admission to, length of stay in, and survival after hospitalization. Although the unadjusted relative risk of admission was about 12 percent higher for white adults, we found no racial difference in the frequency of admission after adjusting for status characteristics. Some of the antecedents of admission, however, differed by race. In comparison to white adults, black adults who were admitted had more morbidity and poorer health ratings. Also, they were about a year younger than white adults at the time of their first admission.

Unlike many studies that examine hospital patients only and/or aggregate information across stays, the NHEFS permits examining individual admissions and stays for a community-based

sample from the start of the study. Moreover, the current study is not cohortcentric, such as those studying Medicare beneficiaries only.

To our knowledge, this is the first longitudinal study to systematically examine black/ white differences in LOS by isolating each admission over such a long period of observation. The analyses revealed that black adults generally had longer stays than did their white counterparts. This occurred in three out of the four hospital stays analyzed. The longer length of stay may initially seem counterintuitive, but these results are consistent with those of other studies (e.g., Kahn et al. 1994; Shi 1996) and are best seen in light of a chain of risk. Moreover, there is evidence of how major episodes in health care are related to subsequent outcomes: Prior recent hospital stays were associated with greater LOS. Temporally proximal stays reveal medical need that is often addressed by a longer stay.

Isolating each stay separately also revealed that the black/white difference in LOS was greater for the first admission than for the second one. We interpret this pattern as partially reflecting an institutional response to address the earlier inequality—the longer stay helps to offset the accumulated health problems. The institutional response, however, is one that is in many ways insufficient. Thus, by the second stay there are diminishing returns for a hospital stay to undo the accumulated risks. For those who survived to experience four hospital admissions, the black/white gap in LOS widened to roughly the same level as the first admission.

The final link in the analysis of this chain of risk is average age at death by race, and the findings here vividly illustrate the consequences of enduring racial inequality. Findings from event history models of post-hospital mortality reveal that black adults were more likely than white adults to die after hospital admission, and the racial difference increased across the life course. There have been many studies of post-hospital mortality among Medicare beneficiaries (Walter et al. 2001; Wen and Christakis 2005), but the NHEFS permits a more cohort-inclusive view of hospitalization and mortality. Whether in middle age or later life, black adults suffer higher post-hospital mortality. Indeed, as one ponders the timing of death after a hospitalization, one finds that black people died about four years sooner than their white counterparts after their first hospitalization. The difference shrinks somewhat for the second and subsequent hospitalizations, but this must be seen against a backdrop of increasing selectivity. The analyses also show that black adults are more likely than white adults to have long hospital stays, and long stays, in turn, are associated with higher mortality.

The findings of the present research, drawn from longitudinal data, show the utility of an approach to analyzing life course data based on a chain of risk. Aggregating hospitalizations over the years is useful for many analyses, but isolating each hospitalization with these data revealed important variability in the *sequence* of hospitalizations. The analyses imply that the sequence of risk is distinct for black and white adults. It also helps one to see how the timing of life course events is important. Black people generally have poorer health, arrive at the hospital later in the course of their illness, have longer stays, and are at greater risk of mortality.

Although much can be gained from studying any of the outcomes herein, we believe that the analyses help identify the *pathways* by which disparities develop in health and health care. Stated differently, how might the conclusions be different by considering only one outcome? What would longer stays for black adults mean if not in the context of differences in health status and higher post-hospital mortality risk? It may be misleading to consider hospitalization outcomes in isolation. Inequalities develop over the life course, and these analyses illustrate the utility of a chain-of-risk model for assessing racial disparities.

The overwhelming evidence from the present analyses reflects scarring or cumulative inequality and is consistent with what Hart (1971) described as the inverse care law (Fiscella and Shin 2005). Black adults had critical health needs, but they received care that in many

ways was insufficient to ameliorate their health disadvantage relative to white adults (Bach et al. 1999).

Accumulated disadvantage among hospitalized black people is manifested in greater morbidity: Black adults were more likely than white adults to have hypertension, heart trouble, and diabetes. Black adults were also disadvantaged in socioeconomic status, access to a regular physician, and health ratings. Status resources were important predictors of the outcomes, but income, medical insurance, and even having a regular physician were insufficient to eliminate the racial disparity. Socioeconomic status represents a cluster of risk factors, but white adults with limited resources still fared better on multiple outcomes than did black adults.

Although we believe the present study contributes to our understanding of black/white inequality, it is limited in several ways that temper conclusions and suggest fruitful lines of research. First, as noted earlier, NHEFS does not include information on physician visits or waiting time. We adjusted models for whether or not the subject had a regular source of care, but we were unable to see the specific processes leading up to the hospitalization. As such, our hypotheses about delays in accessing care should be considered tentative, at least until others can make use of data that examine these processes in detail. Delays in medical care may occur for a variety of reasons including inability to pay for services, distrust of the medical system, discrimination by practitioners, and both lay and professional referral systems. The aim here was to examine the long-term processes of inequality over two decades, but other studies are needed to discern if the delay mechanism occurs as suggested here.

Second, the NHEFS data do not have official hospital records for all reported stays. More than 75 percent of the reported stays have abstracted records, but the possibility remains that the absence of matching reported and recorded hospital stays may influence the conclusions.

Finally, the NHEFS provides an exceptional opportunity to conduct a long-term analysis of racial inequality in health and hospitalization, but some of the conclusions rest in a historical period. Our aim was primarily hypothesis-testing derived from applying a chain-of-risk model, but the conclusions may be different if current hospitalization patterns are studied. As sociologists, we think it is very unlikely that social change has eliminated racial/ethnic inequality in health and health care. At the same time, it is possible that some of the disparity has been reduced. We controlled for changes induced by the prospective payment system, but the racial differences remained. Nevertheless, to address current public policy, analyses of more recent data are needed.

Despite these limitations, the findings from the present study are helpful for developing a chain-of-risk approach to health and health care. The results favor a model of the chain of risk with independent effects for the accumulation of disadvantage (Kuh et al. 2003). One conception of risk accumulation is the trigger or tipping-point model, where risks accumulate but the disadvantage is not apparent until there is a confluence of a set of risks. Rather, we observed black/white differences in morbidity, having a regular physician, several LOS measures, and average age at death by race; these differences reflect both direct and indirect effects of race on desired outcomes when facing health problems. Trajectories may be altered by exposure to deleterious or salubrious events and processes, and the evidence is clear that these trajectories were distinct for black and white adults. To better understand how inequality accumulates, we will need additional studies to examine other chains of risk such as tracing the occurrence of the same or closely-related health problems across episodes of care.

To advance an interpretation of racial disparities in health based on a chain of risk, one must also make explicit the role of selective survival. Mortality was an outcome in this study and thereby received explicit attention. For any study of a chain of risk, however, mortality selection merits attention because non-random mortality may give the appearance of decreasing

inequality over the life course (Fiscella 2004; Kelley-Moore and Ferraro 2004). For adulthood and later life, mortality is the obvious form of selection. Even if one is studying income differentials or wealth, mortality for selected groups will shape the outcomes. For adolescents and young adults, there may be other forms of selection such as foster care and incarceration. The point is that scholars must attend to sample composition and selection effects when offering conclusions about life course inequalities (Ferraro, Shippee, and Schafer Forthcoming). Failure to consider these influences will likely lead to conclusions that minimize inequalities.

The overall portrait of health and health care for black people that emerges from these analyses is one of enduring and accumulated disadvantage. Higher morbidity, no difference in admission rates, and generally longer stays reveal a racial disparity. Moreover, higher mortality for black adults after their first hospitalization highlights the pernicious effects of the disparity.

Biography

Kenneth F. Ferraro is Professor of Sociology and Director of the Center on Aging and the Life Course at Purdue University. His recent research focuses on cumulative inequality and health, especially between white and African Americans. Recent publications appear in the *American Sociological Review*, *Journal of Health and Social Behavior*, and *Social Forces*. He is currently editor of the *Journal of Gerontology: Social Sciences*.

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FIGURE 1.
Racial Differences in Post-Hospital Mortality for 1,118 Adults who had One Hospital Stay

TABLE 1

Means and Standard Deviations of Variables by Race in National Health and Nutrition Examination Survey I: Epidemiologic Follow-up Study

<i>Dependent Variables</i>	<i>Range</i>	<i>Total</i>	<i>Black</i>	<i>White</i>
Hospitalized	0–1	.619 N = 6833	.560 N = 878	.628 ^{***a} N = 5955
Stays per year	.046–52.142	.304 N = 4207	.396 N = 484	.293 [*] N = 3723
LOS, 1	.5–227	8.409 (11.277) N = 4229	11.467 (16.858) N = 492	8.006 ^{***} (10.256) N = 3737
LOS, 2	.5–580	8.824 (14.771) N = 2976	10.239 (12.387) N = 345	8.639 (15.048) N = 2631
LOS, 3	.5–166	9.031 (10.816) N = 2081	11.756 (14.357) N = 238	8.678 ^{***} (10.222) N = 1843
LOS, 4	.5–147	9.606 (11.757) N = 1444	13.039 (16.771) N = 153	9.200 ^{***} (10.950) N = 1291
Days alive after last hospitalization	.1–7771	2320.960 (2175.08) N = 4225	1929.631 (2084.301) N = 492	2372.537 ^{***} (2181.801) N = 3733
<i>Independent Variables</i>				
Status characteristics and resources				
Black	0–1	.116		
Age	24–75 (.002)	50.989 (13.829)	51.152 (14.149)	50.968 (13.789)
Female	0–1	.536	.546	.535
Education	0–7	3.586 (1.551)	2.886 (1.597)	3.677 ^{***} (1.521)
Income	1–12 (.012)	7.550 (2.762)	5.943 (2.986)	7.762 ^{***} (2.660)
Medicaid	0–1	.035	.093	.027 ^{***}
Private insurance	0–1	.854	.699	.874 ^{***}
Regular physician	0–1	.877	.796	.887 ^{***}
Rural	0–1	.432	.290	.451 ^{***}
Health status				
Cancer	0–1	.028	.016	.030
Diabetes	0–1	.061	.099	.056 ^{***}
Heart trouble	0–1	.086	.128	.080 ^{***}
Hypertension	0–1	.259	.371	.245 ^{***}
Kidney	0–1	.025	.034	.024
Cataracts	0–1	.012	.016	.011
Self-rated health	0–1	3.419	2.929	3.492 ^{***}
Lifestyle				
Heavy drinker	0–1	.119	.096	.123 [*]
Smoker	0–1	.424	.516	.397 ^{***}
Past smoker	0–1	.249	.180	.278 ^{***}

<i>Dependent Variables</i>	<i>Range</i>	<i>Total</i>	<i>Black</i>	<i>White</i>
Obese	0–1	.258	.327	.249***
Hospitalization experiences ^b				
Recent stay (≤ 6 months)	0–1	.302	.329	.298
Post PPS on stay 1	0–1	.514	.473	.520

** $p < .01$

Notes: LOS = length of stay. PPS = Prospective Payment System. All dichotomous variables are scored 0 and 1 (0 = no or otherwise). The standard deviation for a dichotomous variable is omitted because it is a function of the mean.

* $p < .05$

*** $p < .001$ (two-tailed tests)

^a p value from χ^2 tests for categorical variables and t -tests for continuous variables.

^b PPS and recent hospitalization variables are presented for the initial measurement period; variables for each subsequent stay are available upon request.

TABLE 2

Parameter Estimates for Hospitalization, Stays per Year, and Length of Stay (LOS) in National Health and Nutrition Examination Survey
I: Epidemiologic Follow-up Study

Variables	Hospitalized	Stays per Year	LOS, 1	LOS, 2	LOS, 3	LOS, 4
Black	-.113 ^a (.131) ^b	-.051 (.030)	.179 [*] (.079)	-.060 (.082)	.198 ^{**} (.77)	.268 [*] (.114)
Age	.031 ^{***} (.002)	.006 ^{***} (.001)	.014 ^{***} (.001)	.013 ^{***} (.002)	.012 ^{***} (.002)	.012 ^{***} (.005)
Female	-.029 (.053)	-.068 [*] (.030)	-.071 (.051)	.050 (.069)	-.063 (.033)	.027 (.081)
Education	.031 (.017)	-.017 [*] (.009)	-.014 (.019)	-.003 (.012)	-.059 ^{**} (.019)	.010 (.032)
Income	.007 (.012)	-.003 (.004)	-.020 ^{***} (.006)	-.029 (.020)	-.007 (.010)	.001 (.009)
Medicaid	-.097 (.113)	-.040 (.069)	-.115 (.143)	-.130 (.191)	.031 (.187)	-.154 [*] (.074)
Private insurance	.295 ^{***} (.083)	-.082 (.062)	.054 (.065)	-.023 (.120)	-.034 (.080)	-.024 (.099)
Regular physician	.473 ^{***} (.060)	-.001 (.026)	-.162 [*] (.079)	-.363 [*] (.181)	-.291 (.206)	-.031 (.091)
Rural	.382 ^{***} (.096)	.043 ^{**} (.017)	-.132 ^{***} (.034)	-.255 ^{**} (.083)	-.089 [*] (.045)	-.198 [*] (.099)
Cancer	-.230 (.144)	.184 ^{***} (.034)	-.099 (.112)	-.075 (.163)	.172 (.144)	-.089 (.103)
Diabetes	.290 [*] (.121)	.092 (.054)	-.004 (.042)	.046 (.062)	.116 (.074)	.090 (.050)
Heart trouble	.226 [*] (.115)	.194 ^{***} (.060)	-.031 (.115)	-.150 (.080)	.003 (.082)	.083 (.098)
Hypertension	.024 (.053)	.081 [*] (.041)	-.058 (.031)	-.052 (.099)	.008 (.057)	.054 (.099)
Kidney	.055 (.118)	-.013 (.121)	-.022 (.125)	-.345 ^{***} (.078)	-.244 ^{**} (.092)	.035 (.107)
Cataracts	-.347 [*] (.153)	.132 ^{***} (.033)	-.010 (.047)	-.166 [*] (.073)	.034 (.249)	.036 (.333)
Self-rated health	-.135 ^{***} (.028)	-.055 ^{***} (.010)	-.051 ^{***} (.014)	-.063 [*] (.030)	.026 (.023)	.005 (.028)
Heavy drinker	-.019 (.068)	-.014 ^{**} (.013)	.067 (.037)	.185 [*] (.076)	-.093 (.110)	.195 [*] (.086)

Variables	Hospitalized	Stays per Year	LOS, 1	LOS, 2	LOS, 3	LOS, 4
Smoker	.097 (.071)	.085*** (.027)	.144** (.047)	.089 (.071)	.154* (.073)	.078 (.066)
Past smoker	.090 (.085)	-.030 (.017)	-.017 (.047)	.072 (.059)	.005 (.056)	.055 (.089)
Obese	.191** (.065)	-.005 (.029)	.164** (.054)	.101 (.069)	.027 (.062)	.072 (.109)
Post PPS ^c			.024 (.083)	-.170*** (.049)	-.233*** (.034)	-.152* (.063)
Recent stay				.335*** (.082)	.125*** (.032)	.330*** (.077)
χ^2	1243.78	1365.29	1663.76	987.7	754.39	854.25
df	20	20	21	22	22	22
N	6,787	4,180	4,200	2,886	2,021	1,418

Notes: Logistic regression was used to estimate whether individuals were hospitalized during the study. Interval regression was used to estimate models for stays per year. Negative binomial regression was used to estimate models for LOS.

*
 $p < .05$

**
 $p < .01$

 $p < .001$ (two-tailed tests)

^aUnstandardized coefficient.

^bStandard error.

^cProspective Payment System.

TABLE 3

Cox Proportional Hazards Model for Post-Hospital Mortality among Black and White Adults in National Health and Nutrition Examination Survey I: Epidemiologic Follow-up Study

Independent Variables	One Stay	Two Stays
Black	2.071 ^{**a} (1.180–3.636) ^b	1.730 (.725–4.123)
Age	1.087 ^{***} (1.061–1.115)	1.135 ^{***} (1.098–1.172)
Female	.646 (.386–1.111)	.505 [*] (.277–.919)
Education	.920 (.779–1.088)	.979 (.820–1.168)
Income	.994 (.892–1.107)	1.030 (.931–1.139)
Medicaid	1.402 (.549–3.578)	2.637 [*] (1.114–6.243)
Private insurance	.635 (.351–1.149)	.726 (.338–1.561)
Regular physician	1.310 (.638–2.690)	.861 (.437–1.695)
Rural	1.219 (.787–1.889)	1.020 (.641–1.626)
Cancer	.517 (.185–1.441)	.248 (.030–2.060)
Diabetes	1.859 (.859–4.021)	2.620 ^{**} (1.361–5.045)
Heart trouble	3.492 ^{***} (2.071–5.886)	2.042 [*] (1.019–4.093)
Hypertension	1.961 ^{**} (1.217–3.160)	1.266 (.765–2.096)
Kidney	.359 (.076–1.700)	— ^d
Cataracts	.316 (.064–1.564)	.431 (.118–1.571)
Self-rated health ^c	1.014 (.820–1.253)	.996 (.804–1.233)
Heavy drinker	1.570 (.832–2.964)	2.367 ^{**} (1.253–4.470)
Smoker	.971 (.616–1.532)	2.167 ^{***} (1.349–3.482)
Past smoker	1.433 (.846–2.429)	.779 (.413–1.470)
Obese	.763 (.441–1.321)	3.426 ^{***} (2.051–5.721)
Length of stay	1.024 ^{***} (1.015–1.032)	1.020 ^{**} (1.007–1.034)
Recent stay		1.847 ^{**} (1.158–2.946)
χ^2	284.08	260.62
df	21	21
N	1,118	777

*
 $p < .05$

**
 $p < .01$

 $p < .001$ (two-tailed tests)

^aHazard ratio.

^bConfidence interval.

^cTime-dependent covariate.

^dExcluded due to insufficient N of cases.