View metadata, citation and similar papers at core.ac.uk

brought to you by CORE

provided by ScholarlyCommons@Penn

University of Pennsylvania
ScholarlyCommons

PSC Working Paper Series

11-9-2006

Black-White Differentials in Cause-Specific Mortality in the United States during the 1980s: The Role of Medical Care and Health Behaviors

Irma T. Elo
University of Pennsylvania, popelo@pop.upenn.edu

Greg L. Drevenstedt
University of Southern California, drevenst@usc.edu

Follow this and additional works at: https://repository.upenn.edu/psc_working_papers

Part of the Demography, Population, and Ecology Commons

Elo, Irma T. and Drevenstedt, Greg L., "Black-White Differentials in Cause-Specific Mortality in the United States during the 1980s: The Role of Medical Care and Health Behaviors" (2006). *PSC Working Paper Series*. 2.
https://repository.upenn.edu/psc_working_papers/2

Elo, Irma T. and Greg L. Drevenstedt. 2006. "Black-White Differentials in Cause-Specific Mortality in the United States during the 1980s: The Role of Medical Care and Health Behaviors." PSC Working Paper Series PSC 06-02.

This paper is posted at ScholarlyCommons. https://repository.upenn.edu/psc_working_papers/2
For more information, please contact repository@pobox.upenn.edu.

Black-White Differentials in Cause-Specific Mortality in the United States during the 1980s: The Role of Medical Care and Health Behaviors

Abstract
In this paper, we examine black-white differences in cause-specific mortality during the 1980s when black-white disparities in mortality widened in the United States. We group causes of death to those amenable to medical intervention, those closely linked to health behaviors or residential location, and all other causes combined. At older ages, we treat cardiovascular disease, stroke, and forms of cancer not amenable to medical or behavioral intervention as distinct causes. We conduct separate analyses by gender and age group. Causes of death amenable to medical intervention and those linked to health behaviors and residential location accounted for over 60% of the absolute black-white difference in male and female mortality at ages 25-44, male mortality at ages 45-74, but somewhat less than 50% of the black-white difference in female mortality at these older ages. The relative black excess risk was most pronounced for causes amenable to medical intervention with and without adjustment for socio-demographic characteristics.

Keywords
Mortality, Death, Causes of death, Blacks, Whites, African Americans, Medical care, Health behavior, Disparities, Whites, Residential location, Disease, Health disparities, Health, Socio-demographic characteristics, Socioeconomic differences, Race, Gender, Age, Ethnicity, Health outcomes, Health surveys, Public health, National Longitudinal Mortality Study, Current Population Surveys, National Death Index, International Classification of Disease

Disciplines
Demography, Population, and Ecology | Social and Behavioral Sciences | Sociology

Comments
Elo, Irma T. and Greg L. Drevenstedt. 2006. "Black-White Differentials in Cause-Specific Mortality in the United States during the 1980s: The Role of Medical Care and Health Behaviors." PSC Working Paper Series PSC 06-02.

This working paper is available at ScholarlyCommons: https://repository.upenn.edu/psc_working_papers/2

November 9, 2006

Black-White Differentials in Cause-Specific Mortality in the United States during the 1980s: The Role of Medical Care and Health Behaviors

Irma T. Elo
Population Studies Center
University of Pennsylvania
3718 Locust Walk
Philadelphia, PA 19104

Greg L. Drevenstedt
Andrus Gerontology Center
University of Southern California
3715 McClintock Avenue
Los Angeles, CA 90089-0191

An earlier version of this paper was presented at the annual meeting of the Population Association of America, Los Angeles, CA, March 23-25, 2000. This research was supported by National Institute of Aging Grant No. 1K01 Ag00717-01A1.

Abstract

In this paper, we examine black-white differences in cause-specific mortality during the 1980s when black-white disparities in mortality widened in the United States. We group causes of death to those amenable to medical intervention, those closely linked to health behaviors or residential location, and all other causes combined. At older ages, we treat cardiovascular disease, stroke, and forms of cancer not amenable to medical or behavioral intervention as distinct causes. We conduct separate analyses by gender and age group. Causes of death amenable to medical intervention and those linked to health behaviors and residential location accounted for over 60% of the absolute black-white difference in male and female mortality at ages 25-44, male mortality at ages 45-74, but somewhat less than 50% of the black-white difference in female mortality at these older ages. The relative black excess risk was most pronounced for causes amenable to medical intervention with and without adjustment for socio-demographic characteristics.

The study of race/ethnic differences in mortality and other health outcomes has a long history in the United States (Krieger & Fee 1996). Mortality estimates by race have been published regularly since the establishment of the death registration area in the early 20th century, and information on race is routinely collected in U.S. health surveys. Comparisons of black-white death rates have consistently shown higher mortality for blacks than for whites, except among the oldest old where differences can be affected by data quality (National Center for Health Statistics 1998; Preston et al. 1996). Even today estimates of life expectancy at birth continue to show a substantial white advantage. The most recent estimates for 2003 show life expectancy at birth to be 78.0 years for whites and 72.7 years for blacks (Arias 2006). The need to improve our understanding of mechanisms that contribute to persistent black-white differences in mortality has long been, and continues to be, a pressing public health concern.

Because behavioral, environmental, and lifestyle factors differentially influence various disease processes, the identification of causes of death for which black-white differentials are large and those for which they are small can help relate mortality variations to potential underlying factors. We extend previous research by examining black-white differentials in cause-specific mortality using a unique classification of causes of death. In addition to selecting leading causes of death, we group together causes that are linked to health behaviors and medical care.

Our focus is on the 1980s, a decade during which black-white disparities in mortality widened in the United States. Between 1984 and 1989, life expectancy at birth declined by 0.8 years for black men and 0.2 years for black women, while it increased by 0.9 years for white men and by 0.5 years for white women (Kochanek, Maurer & Rosenberg 1994). Mortality trends

from several causes of death during this period were adverse for both blacks and whites, but the impact of these trends was more pronounced for blacks. Among the causes that contributed to a decline in life expectancy were HIV/AIDS, diabetes, cancer, pneumonia, accidents (including homicide), and chronic obstructive pulmonary disease (Kochanek, Maurer & Rosenberg 1994). Most of these causes of death are considered amenable to medical, behavioral or public health intervention (Charlton et al. 1983; Holland 1991; Mackenbach et al. 1988; Poikolainen & Eskola 1988; Rutstein et al. 1976).

We begin by describing which cause-of-death groups were largely responsible for the observed black-white difference in all-cause mortality for men and for women at ages 25-74. We then investigate the extent to which demographic and socioeconomic characteristics explained the black-white disparities in cause-specific mortality. We conduct separate analyses for men and women in young adulthood (25-44) and at older ages (45-74) because the relative importance of various causes of death varies by age and gender.

BACKGROUND

In addition to higher overall mortality, blacks have higher death rates from all major causes of death, including heart disease, cancer, infectious diseases, diabetes, and homicide, with suicide being the most notable exception (Howard et al. 2000; Manton, Patrick & Johnson 1987; Rogers 1992; Williams 2001). These major causes account for a large fraction of the racial difference in life expectancy (Keith & Smith 1988; Potter 1991; Rogers 1992). Racial disparities in socioeconomic status (SES) and residential environments together with institutional racism have contributed to these inequalities (Geronimus et al. 1996; Hayward et al. 2000; LeClere, Rogers & Peters 1998; Preston & Taubman 1994; Smith & Kington 1997; Williams 2001). Blacks have lower incomes, less accumulated wealth, and lower levels of schooling than whites

(Danziger & Gottschalk 1995; Oliver & Shapiro 1995) and they are more likely to live in neighborhoods with poor municipal services, limited access to quality health care, high rates of crime and violence, and poor quality housing (Jargowsky 1996; Massey & Denton 1993; Wilson 1987). Socioeconomic characteristics, such as education and family income, have explained a sizable fraction of the racial disparity in all cause-mortality at older ages, but less so at younger ages (e.g., Elo & Preston 1996), where unmeasured factors, including exposure to violence, may be particularly important (Geronimus et al. 1996; Phillips 1997; Williams & Jackson 2005). Cause-specific mortality disparities also vary by socio-demographic characteristics, such as marital status, education, and family income. These factors have explained a larger fraction of the black-white mortality disparity from accidents, violence, and lung cancer than from other leading causes of death, including other forms of cancer and infectious diseases (e.g., Howard et al. 2000; Kallan 1997; Rogers, Hummer & Nam 2000; Richardus & Kunst 2001).

Disparities in health insurance coverage, the quality of that coverage, access to medical technologies, and use of health care services also contribute to black-white health differentials (Garrett & Yemane 2006; Smedley, Stith & Nelson 2003). For example, blacks are less likely than whites to receive appropriate diagnostic tests and/or treatments for cancer, heart disease, kidney failure, and HIV/AIDS (Smedley, Stith & Nelson 2003). Although less is known of the role of individual preferences and the nature of patient-provider relationships, they are also thought to affect treatment decisions and black-white disparities in the utilization of health care services (Ashton et al. 2003; Garrett & Yemane 2006).

In this paper, we use our unique classification of causes of death to estimate the fraction of the black-white difference in overall mortality that can be attributed to causes of death that are amenable to medical intervention. This approach assesses the role of health care in producing

black-white health disparities. In addition, we examine the role of health behaviors by estimating mortality from causes of death that are closely linked to these behaviors together with violent causes of death. In the older age group (45-74), we treat cardiovascular disease, stroke, and forms of cancer not amenable to medical or behavioral intervention as separate causes.

Our identification of causes of death amenable to medical intervention is based on classifications used in previous studies (Charlton et al. 1983; Holland 1991; Mackenbach et al. 1988; Poikolainen & Eskola 1988; Rutstein et al. 1976). The concept of "amenable" or "avoidable" mortality was introduced when Rutstein et al. (1976) published a classification of diseases considered "unnecessary" and "untimely" causes of death. Subsequently, others expanded the concept and used it to measure quality of medical care and its impact on health outcomes (Andreev et al. 2003; Bauer & Charlton 1986; Carr-Hill, Hardman & Russell 1987; Charlton et al. 1983; Charlton & Veléz 1986; Gil & Rathwell 1989; James, Manual & Mao 2006; Korda & Butler 2006; Mackenbach et al. 1988; Malcolm & Salmond 1993; Pampalon 1993; Poikolainen & Eskola 1986, 1988; Westerling 1992). This approach has also been used to examine differences in mortality by gender (Westerling 2003), race (Schwartz et al. 1990; Woolhandler et al. 1985), SES (Mackenbach, Stronks & Kunst 1989; Marshall et al. 1993; Westerling, Gullberg & Rosen 1996; Wood et al. 1999), and nativity (Stirbu et al. 2006; Westerling & Rosen 2002). These causes are comprised of those that are amenable to either preventive measures, such as Pap smears for cervical cancer, or medical intervention, such as radiation and chemotherapy to treat Hodgkin's disease. This broad category includes many specific causes of death from most sections of the International Classification of Diseases (ICD). It includes some but not all infectious and parasitic diseases; neoplasms (cancers); endocrine, nutritional and metabolic diseases and immunity disorders; diseases of the blood and blood-

forming organs, nervous system and sense organs, circulatory system, respiratory system, digestive system, genitourinary system, skin and subcutaneous tissue, musculoskeletal system and connective tissue; complications of pregnancy; congenital anomalies; certain conditions originating in the perinatal period; and symptoms and ill-defined conditions. See Appendix A for a complete list of codes from the Ninth Revision of the ICD used in our classification.

Previous studies have reported higher mortality for blacks than whites from medically amenable causes (Schwartz et al. 1990; Woolhandler et al. 1985). Because racial identity is shown to be associated with access to, utilization of, and quality of medical care received, we also expect to find significant black-white differences in mortality from these causes. We further hypothesize that SES does not fully explain black-white differences in mortality from these causes because of recent evidence of racial differences in the type of care whites and blacks receive even after controlling for income and insurance status (Smedley, Stith & Nelson 2003). Higher black mortality from medically amenable causes would be consistent with these findings, suggesting racial differences in access to medical care and/or in the treatment of conditions amenable to medical interventions.

The behavioral category includes causes of death that are influenced primarily by lifestyle, residential environment, and health behaviors, such as smoking (lung cancer), drinking (cirrhosis of the liver), specific activities (motor vehicle accidents), and exposure to violence (homicide). In addition to causes mentioned above, this category includes all other intentional and unintentional injuries. Because adverse health behaviors are more common among individuals with lower levels of schooling (Lynch 2003; Preston & Taubman 1994; Winkleby et al. 1992), and because blacks are more likely to live in poor neighborhoods and be victims of violence than high-income individuals and whites (Jargowsky 1996; Massey & Denton 1993), we

expect behavioral-cause mortality to be higher for blacks than for whites. We further hypothesize that SES explains a large fraction of the black-white difference in mortality from these causes.

As noted above, we separate out cardiovascular diseases (CVD) and stroke from other causes of death. By far the most important cardiovascular cause of death is ischemic heart disease, a cause of death some analysts have considered partly amenable to medical treatment (Andreev et al. 2003; Poikolainen & Eskola 1988). Mortality from CVD is influenced not only by health behaviors, such as smoking and diet, but also by stress and early life conditions (Barker 1994; Elo & Preston 1992; Adler & Matthews 1994). CVD makes a large contribution to overall mortality at middle and older ages, and has been associated with social class and black-white differences in mortality in other studies (e.g., Feldman et al. 1989; Marmot & Theorell 1988; Rogers, Hummer & Nam 2000). Similarly, death rates from stroke, a cause considered amenable to medical intervention, is higher for blacks than for whites and for individuals of low SES compared to high SES (Howard et al. 2000; Rogers, Hummer & Nam 2000). We thus expect CVD and stroke together to make a sizable contribution to the black-white difference in mortality in middle and older ages and for SES to explain a greater fraction of the black-white disparity in CVD than stroke mortality.

DATA AND METHODS

Data

Our analyses are based on data from the National Longitudinal Mortality Study (NLMS) Release II. The NLMS public use file includes five Current Population Surveys (CPS) conducted between March 1979 and March 1981, and contains 637,162 individual records which have been

linked to the National Death Index (NDI) through 1989. This record linkage has identified 42,919 deaths that occurred between the CPS baseline interviews and the end of the follow-up period (for details of the linkage procedures, see Rogot, Sorlie & Johnson 1986). Follow-up in days is provided for all respondents. Those individuals who were not linked to the NDI, and thus are considered to be alive at the end of 1989, are given a follow-up period of 3,288 days (9 years).[1] We include individuals in the age range 25 to 74 at the baseline interview. Individuals below age 25 at baseline are omitted due to small numbers of deaths and the difficulty in measurement of socioeconomic status. Those aged 75 and above are excluded because a single underlying cause of death often does not fully capture the extent of morbid conditions contributing to death, and the notion of medically amenable causes becomes questionable at the oldest ages. Our final analytic sample includes 310,038 individuals, 23,588 of whom died during the follow-up period.

The NLMS data on demographic, social, and economic characteristics come from the CPS. Linkage to the NDI provides the underlying cause of death reported on the death certificate. Causes of death are coded according to the Ninth Revision of the International Classification of Disease (ICD-9) codes in effect in the United States during the entire follow-up period.

We classify causes into three groups at ages 25-44 and into seven categories for men and eight for women at ages 45-74. The ICD codes for each cause of death group are given in

[1] The five CPS surveys were conducted in March 1979, April, August and December of 1980, and March 1981. We should note that the March 1981 CPS cohort was followed only through the end of 1989, or approximately 8 years and nine months. We cannot determine who belongs to this cohort and must accept the 9-year follow-up period for them as well. In addition, the lack of perfect match to the NDI results in some deaths being missed. Rogot et al. (1992: 2) suggest that "there is some ascertainment loss, of perhaps 5%, occurring in the matching process because of recording errors in the files being matched."

Appendix Table A. At younger ages, our cause groups are: (1) causes amenable to medical intervention (medically amenable); (2) behavioral causes that are not included under medical causes (behavioral); and (3) all other causes of death (all other). Appendix Table B provides a list of the top three causes of death in each cause-of-death group by race and gender at ages 25-44. At older ages, we make further distinctions within these broad categories: (1) stroke is separated from (2) causes amenable to medical intervention; behavioral causes are divided into two groups – (3) smoking-related causes and (4) alcohol-related and external causes; (5) breast cancer is included as a separate category for women, and (6) all other cancers, not included under medical or behavioral causes, are distinguished from all other causes of death; (7) cardiovascular diseases (CVD); and (8) all remaining causes of death. Appendix Tables C and D lists the top three causes of death in each category by race and gender at ages 45-74.

Measurement of Explanatory Variables

To examine the extent to which socio-demographic factors explain black-white differences in cause-specific mortality we include several explanatory variables. Our two measures of SES are the respondents' educational attainment and family income. We do not include occupation because a large percentage of individuals in the age range of interest fall into the category 'occupation not reported, or never worked.'[2] Education refers to respondents' years of school completed and family income is measured in the year preceding the CPS. Education and the natural log of family income are included as linear variables.[3] Because health

[2] In the age range 25 to 74, 14% of the men and 42% of the women fell in the category 'occupation not reported, or never worked.'

[3] To linearize the education variable we placed the value of education at the midpoint of each schooling category as follows: 0-4 (2), 5-7 (6), 8, 9-11 (10), 12, 13-15 (14), 16, and 17+ years (18). Annual family income, adjusted for inflation to 1980 dollars by the Consumer Price Index, is available in the NLMS in the following categories: <$5,000, $5,000-9,999; $10,000-14,999, $15,000-19,999, $20,000-24,999, $25,000-49,999 and $50,000+, unknown. To treat income as a single variable, we first assigned the dollar amount of the midpoint of each income category (e.g., $2500, $7500, etc.) and then include the natural log of income as an explanatory variable. The highest

impairments can influence current income, estimated income effects may be biased by reverse causality. We mitigate this potential bias by excluding individuals who were out of the labor force due to long-term physical or mental illness. Furthermore, because income refers to family rather than personal income, it is also not as closely tied to respondents' health conditions as it would be if personal income were used. We also control for household size because demands on income are related to the number of individuals a given level of income must support.

In addition, we include an indicator of marital status to account for black-white differences in marriage patterns. Social group relations and social ties have been hypothesized to be protective against adverse health outcomes (House, Landis & Umberson 1988; Ross & Mirowsky 2002). The most intimate of such ties are those established within marriage, and previous studies have documented significant protective effects of being married that tend to be stronger for men than for women (Hu & Goldman 1990; Lillard & Waite 1995). Marriage can reduce risky and unhealthy behaviors, contribute to better diets, and provide social support and access to health insurance coverage (Waite 1995; Zuvekas & Taliaferro 2003).

We also distinguish between residence in inner cities, suburban locations within metropolitan areas, and non-metropolitan residence to account for black-white differences in residential patterns. Finally, we control for age and whether the respondent's social security number was included in the CPS record to minimize bias resulting from a failure to match to the NDI.

---

income category in the NLMS is $50,000+, which we coded as $75,000. We also examined a linear specification of household income, but elected to use the natural log of income because this specification explained somewhat more of the variance in all-cause mortality than when a linear term was used (for a similar approach for the coding of education and family income, see Elo & Preston 1996).

Methods

We begin by examining cause-specific contributions to all-cause mortality by race and gender at ages 25-44 and 45-74. To do so, we compute age-standardized death rates by race and sex for the cause-of-death groups discussed previously, and we then estimate the percentage contribution of these causes to the black-white difference in overall mortality.

To assess whether relative black-white differentials in cause-specific mortality can be explained by age, SES, marital status, and place of residence, we estimate Cox proportional hazards models for two age groups: ages 25-44 and 45-74 at the baseline interview. This approach is commonly referred to as competing risk analysis. In each cause-specific mortality model, persons who die from causes of death other than the one under investigation are censored at the date of death (Cox & Oakes 1984; Allison 1984).[4] Models are estimated using maximum-likelihood estimation methods in STATA (StataCorp 2005). We present hazard ratios, or relative risks (RR), calculated from coefficients obtained from proportional hazards models ($RR=e^{\beta}$). Schoenfeld residuals for each covariate were examined for deviations from proportionality, and no systematic deviations were found. Two types of statistical tests were carried out: tests for a significance of individual coefficients, and tests for significant differences between coefficients by cause of death and between estimates for men and women (StataCorp 1999; Allison 1995).

We estimate separate models for men and women and all models control for age and race. Race is often included in mortality studies simply as an individual demographic characteristic, but it is important to keep in mind that an individual's racial identity has a broader meaning due to the history of race relations in the United States. Race captures unmeasured aspects of living

[4] These models are based on the assumption that different event types are independent, or that each event is non-informative for others. To the extent that this assumption is violated, we must interpret results with caution.

conditions, such as potential discrimination in health care, structural factors that limit residential choice, and other unmeasured factors that differentially impact the health of whites and blacks.

Sample characteristics are shown in Table 1. We have excluded cases for which information was missing. Except for income, cases with missing data represented less than 2% of all respondents for any one characteristic. For income, this percentage was about 5% at ages 25-74. We do not believe that exclusion of these cases biases our estimates. Estimated effects for explanatory variables, other than income, were not substantively affected by exclusion of cases for which income was missing.

Table 1 about here

RESULTS

Cause-specific contributions to the absolute difference in black-white mortality are presented in Table 2. Blacks had higher death rates than whites for all cause groups examined, except for smoking-related causes among women at ages 45-74. At the same time, the magnitude and pattern of inequality varied by cause of death, age, and gender.

Black-White Differences in Cause-specific Mortality at Ages 25-44

In young adulthood, causes of death amenable to medical intervention made up a larger fraction of overall black male mortality (21%) than white male mortality (15%) and of overall black female mortality (30%) than white female mortality (22%). Their contribution to the absolute black-white difference in all-cause mortality was 26% for men and 35% for women. Among the top three causes of death in this category were stroke and hypertensive disease for blacks and stroke and diabetes for whites (Table 2 and Appendix Table B).

In contrast, behavioral causes made a larger contribution to all-cause mortality for whites than for blacks in early adulthood, most notably among men. These causes accounted for 51% of

all-cause mortality of white men and 44% of black men. The respective percentages for women were 34% and 31%. Yet these causes made a larger contribution to the absolute difference in black-white male mortality at ages 25-44 (37%) than medically amenable causes, due to the large absolute black-white difference in male mortality from these causes. For women, the contribution of behavioral causes to the black white difference in all-cause mortality (29%) was less than that of medically amenable causes of death. Homicide and cirrhosis of the liver were among the top three causes of death for black men and women, while suicide and motor vehicle accidents emerged as two leading causes in this category for white men and women.

The residual group of causes was responsible for somewhat over a third of the absolute black-white difference in all-cause mortality for men (37%) and for women (36%). The leading causes of death in this category were various forms of heart disease and infectious and parasitic diseases not considered amenable to medical intervention for men and heart disease and breast cancer for women (Table 2 and Appendix Table B).

Table 2 about here

Table 3 presents the results from multivariate analyses that examine the extent to which socio-demographic factors explained the relative excess mortality risk of black men and black women at ages 25-44. The unadjusted hazard ratios ranged from 3.2 from medically amenable causes of death to 1.91 for all other causes for black men; the respective range for black women was from 2.96 to 1.96. These excess risks remained significant in the fully adjusted model, but the extent to which socio-demographic characteristics explained these disparities depended on the cause-of-death group and gender.

Table 3 about here

Educational attainment, family income, marital status, and place of residence explained about 49% of the black excess risk associated with causes amenable to medical intervention for men ((3.20-2.17)/(3.12-1.00) = 0.49), but only 34% for women (2.96 versus 2.29). The unadjusted relative risks from behavioral causes were somewhat less than from causes amenable to medical intervention, and socio-demographic controls explained a larger fraction of this excess risk for men (64%; 1.97 versus 1.35). For women the reduction in the relative risk was similar (36%; 2.26 versus 1.81) to that estimated for causes amenable to medical intervention (Table 3).

Similarly, socio-demographic characteristics explained only a portion of the black excess risk associated with mortality from all other causes of death. The magnitude of this reduction (57%) fell between medically amenable and behavioral causes for men; it was smaller for women (15%).

Black-White Differences in Cause-specific Mortality at Ages 45-74

At older ages (45-74), causes of death amenable to medical intervention (medically amenable causes and stroke) continued to make up a larger fraction of overall black male mortality (22%) than white male mortality (16%) and of black female mortality (30%) than white female mortality (22%). These causes also accounted for a large fraction of the absolute black-white difference in all-cause mortality – 35% for men and 44% for women. In addition to stroke, the most important causes in this category were colon cancer, pneumonia, and diabetes for both blacks and whites and hypertensive disease for blacks (Table 2 and Appendix Tables C and D).

Behavioral causes (smoking-related causes and alcohol and external causes) made similar contributions (26%) to all-cause mortality for white men and for black men, but their contribution to overall mortality among women was somewhat higher for whites (18%) than for blacks (12%). They accounted for 27% of the absolute black-white difference in all cause male

mortality. In contrast, these causes made a minimal contribution (2%) to absolute black-white difference in female mortality.

At older ages, we were able to examine the separate contributions of such leading causes of death as cardiovascular diseases (CVD) and cancers (other cancers) other than those considered medically amenable or smoking-related and breast cancer in the case of women. CVD, with ischemic heart disease being the most important single cause in this category, accounted for the largest fraction of all-cause mortality in all four age-race-gender groups examined. It also made a substantial contribution to the absolute black-white difference in female mortality (32%), while its contribution to the absolute race difference in male mortality was smaller (18%). Other cancers comprised 10%-12% of the absolute black-white difference in mortality among men and women, respectively (Table 2).

Table 4 presents the results from the multivariate analyses for men at ages 45-74. Most notably black men had significantly higher mortality from all cause of death groups examined. This excess risk ranged from nearly two-fold for medically amenable causes (1.88), alcohol-related and external causes (1.89), stroke (1.89), and all other causes combined (1.87) to 1.13 for cardiovascular diseases. Educational attainment, family income, and other socio-demographic characteristics explained this excess risk for CVD and smoking-related causes. For all other cause-of-death groups, black male mortality remained significantly higher in the fully adjusted model. The relative risks were highest for causes amenable to medical intervention (1.43), stroke (1.46), and all other causes of death (1.40). They continued to be notable for alcohol-related and external causes (1.35) and cancers not included in medically amenable or smoking-related causes (1.22).

Table 4 about here

In contrast to men, mortality risks among middle-aged and older black women were not significantly higher than those of white women from smoking-related causes, alcohol and external causes and breast cancer, as shown in Table 5. Black women had significantly higher mortality than white women from all other causes of death, with the relative risks being most pronounced for causes amenable to medical intervention (1.97) and stroke (1.84). The inclusion of socio-demographic characteristics explained the significantly higher mortality of black women from CVD, but the risks stayed significantly higher from causes of death amenable to medical intervention (1.52), including stroke (1.55), and all other cancers (1.27), other than breast cancer and those included in medically amenable or smoking-related causes.

Table 5 about here

Other Explanatory Variables

Several socio-demographic characteristics were also significant predictors of all-cause and cause-specific mortality. For example, educational attainment remained a significant predictor of all-cause mortality in the fully adjusted model. At ages 25-44, the hazard of death from all causes combined declined by 6.1% (100[0.939-1] = -6.1) with each additional year of education for men and by 4.1% for women (Table 3). At older ages, the respective figures were 1.4% for men and 2.2% for women (Tables 4 and 5).

The size and strength of the association between education and mortality, however, varied by cause of death. Education is hypothesized to influence health behaviors, such as smoking, and its association with cause-specific mortality was consistent with this interpretation. The mortality hazard from behavioral causes declined by 8.5% with each additional year of education for men and by 6.2% for women at ages 25-44 (Table 3). At older ages, education was a significant predictor of male mortality from smoking-related causes and male and female

mortality from CVD (Table 4 and 5). That education remained a significant predictor of CVD mortality is consistent with findings that document an association between educational attainment and risk factors for CVD, such as smoking, sedentary lifestyle, obesity, and hypertension (Winkleby et al. 1992; NCHS 1998; Hayward et al. 2000). We also found a significant positive association between education and mortality from breast cancer for women, results that are consistent with previous findings (Heck et al. 1997).

In contrast, education was not a significant predictor of mortality from medically amenable causes, except for women at ages 45-74. However, when family income was excluded education exhibited a significant association with male mortality from medical causes and stroke and with female stroke mortality (results not shown). In these cases, schooling effects appeared to be indirect and operated through their association with family income.

Link and Phelan (1995) hypothesize that social conditions act as fundamental causes of disease and influence multiple disease outcomes simultaneously. Our results for family income were generally consistent with this expectation. Higher levels of family income were associated with lower all-cause mortality in all four age-sex groups examined. Family income was also a significant predictor of male mortality from all causes of death and its association with female mortality was significant except from smoking-related cancers, breast cancer, and other cancers at older ages. For men, the mortality reductions associated with a doubling of family income ranged from 21% (100[0.69-1.00][0.693]) for medically amenable causes to 13% for all other causes at ages 25-44, and from 18% for alcohol-related and external causes, to 8% for other cancers at ages 45-74. For women, these reductions, for causes for which family income was a significant predictor of mortality, ranged from 27% for causes amenable to medical intervention to 14% for behavioral and all other causes in young adulthood and from 19% for all other causes

to 8% for stroke at older ages.

It has been suggested that residential segregation, institutional racism, and discrimination have meant that similar socioeconomic resources bring less health benefits for African Americans than whites (Williams & Collins 1995; Williams 1997, 2001). We tested this hypothesis by introducing an interaction term for black × income and black × education in models when the main effects of race, education, and income were significant (Tables 3-5). Each interaction was entered separately for men and women at ages 25-44 and 45-74. Of all interaction terms tested, only two were statistically significant (results not shown). These results provide inconsistent support for the hypothesis that additional levels of schooling and family income are less protective for blacks than for whites.

Consistent with previous research, we found the protective effects of marital status to be more pronounced for men than for women. Married men had significantly lower all-cause mortality than previously married or never married men and this protective effect of marriage extended to most causes of death in both young adulthood and middle and older ages. For women, marital status was an insignificant predictor of mortality at ages 25-44. However, at older ages married women had lower mortality than previously married and/or never married women from most causes of death. With respect to place of residence we documented higher mortality in inner cities than in non-metropolitan areas for some but not all causes of death and with one exception these results were restricted to older ages (45-74).

CONCLUSIONS

Our results corroborate findings from previous studies that show black-white differences in mortality to be closely linked to racial differences in social and economic circumstances and that the black excess varies by cause of death (LeClere, Rogers & Peters 1997; Mackenbach et al. 1999; Pappas et al. 1993; Rogers, Hummer & Nam 2000). Our coding of cause-specific mortality further highlights the important contributions causes of death amenable to medical intervention and those closely linked to health behaviors and residential location make to black-white disparities in mortality in young adulthood (25-44) and middle and older ages (45-74).

Causes of death amenable to medical intervention and those linked to health behaviors accounted for 63% of the absolute black-white difference in male mortality and 65% of the absolute black-white difference in female mortality at ages 25-44 during the 1980s. Medically amenable causes of death made a larger contribution than behavioral causes to the black-white difference in female mortality. The reverse was true for men, a finding that is related to the large contribution of homicide to all-cause mortality among young black men, a cause of death that is closely tied to residence in poor, segregated, urban areas (Geronimus et al. 1996). Consistent with this interpretation, we explained more of the excess relative risk of black men from behavioral causes than from medically amenable causes of death controlling for socio-demographic characteristics. These characteristics explained a similar fraction of the excess risk from both cause-of-death groups for black women. The relative excess risks for black men and women remained the most pronounced from causes of death amenable to medical intervention at ages 25-44.

We also documented significant black-white disparities in mortality from causes amenable to medical intervention at ages 45-74. These causes, including stroke, were

responsible for about a third of the absolute black-white difference in male mortality and 44% of the absolute black-white difference in female mortality at older ages. Although socio-demographic characteristics explained about 50% of the excess relative risk for men and about 46% for women, the excess risks for blacks remained the most pronounced from these causes of death. These results are consistent with previous studies (Schwartz et al. 1990; Woolhandler et al. 1985), which documented significantly higher black mortality than white mortality from causes amenable to medical intervention.

Behavioral causes made smaller contributions to black-white differences in mortality at older than at younger ages. Smoking-related causes and alcohol-related and external causes accounted for 27% of the absolute black-white difference in male mortality and less than 2% of the black-white difference in female mortality. Socio-demographic characteristics explained higher black male mortality from smoking-related causes and 61% of the excess risk from alcohol-related and external causes. Similarly, socio-demographic characteristics explained the excess mortality risk of black men and black women from cardiovascular diseases, causes of death that some have considered amenable to medical intervention (Andreev et al. 2003; Poikolainen & Eskola 1988) and that are also closely tied to health behaviors (Winkleby et al. 1992).

Thus our results suggest that there is considerable room for progress in reducing black-white disparities in mortality. Mortality from causes of death amenable to medical intervention contributes a sizable fraction of the black-white difference in all-cause mortality at ages 25-74. These causes comprise mortality from such diseases as diabetes, hypertensive disease, certain cancers, and infectious and respiratory diseases. Because these conditions can be treated with proper medical care, untimely deaths of many blacks from these causes are a source of concern.

As noted above, racial differences in education, income, marital status, and place of residence explained a smaller fraction of the black excess mortality from these causes than from behavioral causes, causes linked to residential location, e.g., homicide, or CVD. One possible explanation for these findings is unequal access to high quality medical care for whites and blacks in the United States.

The data for our analyses covered the period of the 1980s when black-white differences in mortality were increasing and black life expectancy experienced an unexpected decline. Since then, most notably in the last few years of the 20th century and the first part of the 21st century black as well as white mortality has continued to decline. At the same time, new medical procedures and improved medications have become available for the treatment of chronic diseases. Recent evidence suggests, however, that racial disparities in access to these technologies have continued to persist (Smedley, Stith & Nelson 2002). Investigations of circumstances that contribute to these disparities should be given high priority in future research.

References

Adler, Nancy and Karen Matthews. 1994. "Health Psychology: Why Do Some People Get Sick and Some Stay Well?" *Annual Review of Psychology* 45:229-259.

Allison, Paul D. 1984. *Event History Analysis*. Beverly Hills, CA: Sage Publications.

Allison, Paul D. 1995. *Survival Analysis Using the SAS System: A Practical Guide*. Cary, NC: SAS Institute Inc.

Andreev, Evgueni, Ellen Nolte, Vladimir M. Shkolnikov, Elena Varavikova, and Martin McKee. 2003. "The Evolving Pattern of Avoidable Mortality in Russia." *International Journal of Epidemiology* 32:437-446.

Arias, Elizabeth. 2006. "United States Life Tables, 2003." *National Vital Statistics Reports* 53(6). Hyattsville, MD: National Center for Health Statistics.

Ashton, Carol M., Paul Haidet, Deborah A. Paterniti, Tracie C. Collins et al. 2003. "Racial and Ethnic Disparities in the Use of Health Services: Bias, Preferences, or Poor Communication?" *J Gen Intern Med* 18:146-152

Barker, David J. P. 1994. *Mothers, Babies and Disease in Later Life*. London: British Medical Journal.

Bauer, Richard L. and John R. H. Charlton. 1986. "Area Variation in Mortality From Diseases Amenable to Medical Intervention: The Contribution to Differences in Morbidity." *International Journal of Epidemiology* 15(3):408-412.

Carr-Hill, Roy A., Geoffrey F. Hardman, and Ian T. Russell. 1987. "Variations in Avoidable Mortality and Variations in Health Care Resources." *Lancet* 1(8536):789-792.

Charlton, J. R. H., R. M. Hartley, R. Silver, and W. W. Holland. 1983. "Geographic Variation in Mortality From Conditions Amenable to Medical Intervention in England and Wales." *Lancet* 1(8326):691-696.

Charlton, John R. H. and Ramon Veléz. 1986. "Some International Comparisons of Mortality Amenable to Medical Intervention." *British Medical Journal* 292:295-301.

Cox, D.R. and D. Oakes. 1984. *Analysis of Survival Data*. London: Chapman and Hall.

Danziger, Sheldon and Peter Gottschalk. 1995. *America Unequal*. Cambridge, MA: Harvard University Press.

Elo, Irma T. and Samuel H. Preston. 1992. "Effects of Early Life Conditions on Adult Mortality: A Review." *Population Index* 58(2):186-212.

Elo, Irma T. and Samuel H. Preston. 1996. "Educational Differentials in Mortality: United States 1979-1985." *Social Science and Medicine* 42(1):47-57.

Feldman, Jacob J., Diane M. Makuc, Joel C. Kleinman, and Joan Cornoni-Huntley. 1989. "National Trends in Educational Differentials in Mortality." *American Journal of Epidemiology* 129(5):919-933.

Garrett, Bowen and Alshadye Yemane. 2006. "Racial and Ethnic Differences in Insurance Coverage and Health Care Access and Use: Synthesis of Findings from the *Assessing the New Federalism* Project." Working Paper 06-01. Washington, DC: The Urban Institute.

Geronimus A.T., J. Bound, T.A. Waidmann, M.M. Hillemeier, and P.B. Burns PB. 1996. "Excess Mortality among Blacks and Whites in the United States." *New England Journal Medicine* 335:1552-8.

Gil, Luis M. B. and Tom Rathwell. 1989. "The Effect of Health Services on Mortality: Amenable and Non-Amenable Causes in Spain." *International Journal of Epidemiology* 18(3):652-

657.
Hayward, Mark D., Eileen M. Crimmins, Toni P. Miles, and Yu Yang. 2000. "The Significance of Socioeconomic Status in Explaining the Racial Gap in Chronic Health Conditions." *American Sociological Review* 65(6):910-930.
Heck, K. E., D. K. Wagener, A. Schatzkin, S. S. Devesa, and N. Breen. 1997. "Socioeconomic Status and Breast Cancer Mortality, 1989 through 1993: An Analysis of Education Data from Death Certificates." *American Journal of Public Health* 87(7):1218-1222.
Holland, W. W., Editor. 1991. *European Community Atlas of 'Avoidable Death.'* Second edition. New York: Oxford University Press.
House, James S., Karl R. Landis, and Debra Umberson. 1988. "Social Relationships and Health." *Science* 241:540-545.
Howard, George, Roger T. Anderson, Gregory Russell, Virginia J. Howard, and Gregory L. Burke. 2000. "Race, Socioeconomic Status, and Cause-specific Mortality." *Annals of Epidemiology* 10:214-223.
Hu, Y. and N. Goldman. 1990. "Mortality Differentials by Marital Status: An International Comparison." *Demography* 27:233-250.
James, Paul D., Douglas G. Manuel, and Yang Mao. 2006. "Avoidable Mortality across Canada from 1975 to 1999." *BMC Public Health* 6:137.
Jargowsky, Paul A. 1996. *Poverty and Place: Ghettos, Barrios, and the American City*. New York: Russell Sage Foundation.
Kallan, Jefferey. 1997. "Effects of Sociodemographic Variables on Adult Mortality in the United States: Comparisons by Sex, Age, and Cause of Death." *Social Biology* 44(1-2):136-147.
Keith, Verna M. and David P. Smith. 1988. "The Current Differential in Black and White Life Expectancy." *Demography* 25(4):625-632.
Kochanek, Kenneth D., Jeffrey D. Maurer, and Harry M. Rosenberg. 1994. "Why Did Black Life Expectancy Decline from 1984 to 1989 in the United States?" *American Journal of Public Health* 84(6):938-944.
Korda, R. J. and J. R. Butler. 2006. "Effect of healthcare on mortality: trends in avoidable mortality
in Australia and comparisons with Western Europe." *Public Health* 120(2):95-105.
Krieger, Nancy and Elizabeth Fee. 1996. "Measuring Social Inequalities in Health in the United States: A Historical Review, 1900-1950." *International Journal of Health Services* 26(3):391-418.
LeClere, Felicia, Richard G. Rogers, and Kimberley Peters. 1997. "Ethnicity and Mortality in the United States: Individual and Community Correlates." *Social Forces* 76(1):169-198.
LeClere, Felicia, Richard G. Rogers, and Kimberley Peters. 1998. "Neighborhood Social Context and Racial Differences in Women's Heart Disease Mortality." *Journal of Health and Social Behavior* 39:91-107.
Lillard, Lee A. and Linda J. Waite.1995. "Til Death Do Us Part: Marital Disruption and Mortality." *American Journal of Sociology* 100(5):1131-1156.
Link, Bruce G. and Jo Phelan. 1995. "Social Conditions as Fundamental Causes of Disease." *Journal of Health and Social Behavior* 36:80-94.
Lynch, S. M. 2003. "Cohort and Life-course Patterns in the Relationship between Education and Health: A Hierarchical Approach." *Demography* 40:309-331.
Mackenbach, Johan P., Anton E. Kunst, Feikje Groenhof, Jens-Kristian Borgan, Giuseppe Costa,

Fabrizio Faggiano, Peter Józan, Mall Leinsalu, Pekka Martikainen, Jitka Rychtarikova, and Tapani Valkonen. 1999. "Socioeconomic Inequalities in Mortality Among Women and Men: An International Study." *American Journal of Public Health* 89(12):1800-1806.

Mackenbach, Johan P., Caspar W. N. Looman, Anton E. Kunst, J. Dik F. Habbema, and Paul J. van der Maas. 1988. "Post-1950 Mortality Trends and Medical Care: Gains in Life Expectancy Due to Declines in Mortality from Conditions Amenable to Medical Intervention in the Netherlands." *Social Science and Medicine* 27(9):889-94.

Mackenbach, Johan P., Karien Stronks, and Anton E. Kunst. 1989. "The Contribution of Medical Care to Inequalities in Health: Differences Between Socio-Economic Groups in Decline of Mortality From Conditions Amenable to Medical Intervention." *Social Science and Medicine* 29(3):369-76.

Malcolm, Murray S. and Clare E. Salmond. 1993. "Trends in Amenable Mortality in New Zealand 1968-1987." *International Journal of Epidemiology* 22(3):468-74.

Manton, K. G., C. H. Patrick, and K. W. Johnson. 1987. "Health Differentials Between Blacks and Whites: Recent Trends in Mortality and Morbidity." *Milbank Quarterly* 65(Suppl. 1):129-199.

Marmot, M. G. and T. Theorell. 1988. "Social Class and Cardiovascular Disease: The Contribution of Work." *International Journal of Health Services* 18(4):659-675.

Marshall, Stephen W., Ichiro Kawachi, Neil Pearce, and Barry Borman. 1993. "Social Class Differences in Mortality from Diseases Amenable to Medical Intervention in New Zealand." *International Journal of Epidemiology* 22(2):255-61.

Massey, Douglas S. and Nancy A. Denton. 1993. *American Apartheid: Segregation and the Making of the Underclass*. Boston: Harvard University Press.

National Center for Health Statistics. 1998. *Socioeconomic Status and Health Chartbook. Health, United States, 1998*. Hyattsville, MD: National Center for Health Statistics.

Oliver, Melvin L. and Thomas M. Shapiro. 1995. *Black Wealth/White Wealth.* New York: Routledge.

Pampalon, Robert. 1993. "Avoidable Mortality in Québec and Its Regions." *Social Science and Medicine* 37(6):823-31.

Pappas, Gregory, Susan Queen, Wilbur Hadden, and Gail Fisher. 1993. "The Increasing Disparity on Mortality Between Socioeconomic Groups in the United States, 1960 and 1986." *New England Journal of Medicine* 329(2):103-109.

Phillips J. 1997. "Variation in African American Homicide Rates: An Assessment of Potential Explanations." *Criminology* 35(4):527-559

Poikolainen, Kari and Juhani Eskola. 1986. "The Effect of Health Services on Mortality: Decline in Death Rates from Amenable and Non-Amenable Causes in Finland, 1969-81." *Lancet* 1(8474):199-202.

Poikolainen, Kari and Juhani Eskola. 1988. "Health Services Resources and Their Relation to Mortality From Causes Amenable to Health Care Intervention: A Cross-National Study." *International Journal of Epidemiology* 17(1):86-89.

Potter, Lloyd B. 1991. "Socioeconomic Determinants of White and Black Males' Life Expectancy Differentials." *Demography* 28(2):303-321.

Preston, Samuel H. and Paul Taubman. 1994. "Socioeconomic Differences in Adult Mortality and Health Status." Pp. 279-318 in Linda G. Martin and Samuel H. Preston, Editors, *The Demography of Aging*. Washington, DC: National Academy Press.

Preston, Samuel H., Irma T. Elo, Ira Rosenwaike, and Mark Hill. 1996. "African-American Mortality at Older Ages: Results of a Matching Study." *Demography* 33(2):193-209.
Richardus, Jan H. and Anton E. Kunst. 2001. "Black-White Differences in Infectious Disease Mortality in the United States." *American Journal of Public Health* 91(8):1251-1253.
Rogers, Richard G. 1992. "Living and Dying in the U.S.A: Sociodemographic Determinants of Death Among Blacks and Whites." *Demography* 29(2):287-303.
Rogers, Richard G., Robert A. Hummer, and Charles B. Nam. 2000. *Living and Dying in the U.S.A: Behavioral, Health, and Social Differentials of Adult Mortality.* New York: Academic Press.
Rogot, Eugene, Paul D. Sorlie, and Norman J. Johnson. 1986. "Probabilistic Methods in Matching Census Samples to the National Death Index." *Journal of Chronic Disease* 39:719-734.
Rogot, Eugene, Paul D. Sorlie, Norman J. Johnson and Catherine Schmitt. 1992. *A Mortality Study of 1.3 Million Persons by Demographic, Social, and Economic Factors: 1979-1985 Follow-up.* Washington, DC: national Institutes of Health. NIH Publication No. 92-3297.
Ross, Catherine E. and John Mirowsky. 2002. "Family Relationships, Social Support and Subjective Life Expectancy." *Journal of Health and Social Behavior* 43:469-489.
Rutstein, David D., William Berenberg, Thomas C. Chalmers, Charles G. I. Child, Alfred P. Fishman, and Edward B. Perrin. 1976. "Measuring the Quality of Medical Care: A Clinical Method." *New England Journal of Medicine* 294:582-88.
Schwartz, Eugene, Vincent Y. Kofie, Marc Rivo, and Reed V. Tuckson. 1990. "Black/White Comparisons of Deaths Preventabel by Medical Intervention: United States and the District of Columbia 1980-1986." *International Journal of Epidemiology* 19(3):591-598.
Smedley, Brian D., Adrienne Y. Stith, and Alan R. Nelson, eds. 2003. *Unequal Treatment: Confronting Racial and Ethnic Disparities in Health Care*. Washington, DC: National Academy Press.
Smith, James and Raynard Kington. 1997. "Race, Socioeconomic Status, and Health in Later Life." Pp. 105-162 in Linda G. Martin and Beth J. Soldo, eds. *Racial and Ethnic Differences in the Health of Older Americans*. Washington, DC: National Academy Press.
StataCorp. 2005. *Stata Statistical Software: Release 9*. College Station, TX: Stata Corporation.
Stirbu, I., A. E. Kunst, V. Bos, and J. P. Mackenbach. 2006. "Differences in avoidable mortality between migrants and the native Dutch in the Netherlands." *BMC Public Health* 6:78.
Waite, Linda. 1995. "Does Marriage Matter?" *Demography* 32(4):483-507.
Westerling, Ragnar. 1992. "Trends in 'Avoidable' Mortality in Sweden, 1974-1985." *Journal of Epidemiology and Community Health* 46:489-493.
Westerling, Ragnar. 2003. "Decreasing Gender Differences in 'Avoidable' Mortality in Sweden." *Scandanavian Journal of Public Health* 31(5):342-349.
Westerling, R. and M. Rosen. 2002. "'Avoidable' Mortality among Immigrants in Sweden." *European Journal of Public Health* 12(4):279-286.
Westerling, R., A. Gullberg, and M. Rosen. 1996. "Socioeconomic Differences in 'Avoidable' Mortality in Sweden 1986-1990." *International Journal of Epidemiology* 25(3):560-567.
Wilson, William Julius. 1987. *The Truly Disadvantaged: The Inner City, the Underclass, and Public Policy*. Chicago: University of Chicago Press.
Williams, David R. 1997. "Race and Health: Basic Questions, Emerging Directions." *Annals of*

Epidemiology 7:322-333.
Williams, David R. 2001. "Racial Variations in Adult Health Status: Patterns, Paradoxes and Prospects." Pp. 371-410 in Neil J. Smelser, William Julius Wilson, and Faith Mitchell, eds. *America Becoming: Racial Trends and Their Consequences*. Volume II. Washington, DC: National Academy Press.
Williams, David R. and Pamela Braboy Jackson. 2005. "Social Sources of Racial Disparities in Health." *Health Affairs* 24(2):325-334.
Williams, David R. and Chiquita Collins. 1995. "U.S. Socioeconomic and Racial Differentials in Health: Patterns and Explanations." *Annual Review of Sociology* 21:349-386.
Winkleby, M.A., D.E. Jatulis, E. Frank, and S.P. Fortman. 1992. "Socioeconomic Status and Health: How Education, Income and Occupation Contribute to Risk Factors for Cardiovascular Disease." *American Journal of Public Health* 82(6):816-820.
Wood, E., A. M. Sallar, M. T. Schechter, and R. S. Hogg. 1999. "Social Inequalities in Male Mortality Amenable to Medical Intervention in British Columbia." *Social Science and Medicine* 48(12):1751-1758.
Woolhandler, Steffie, David U. Himmelstein, Ralph Silber, Michael Bader, Martha Harnly, and Alice A. Jones. 1985. "Medical Care and Mortality: Racial Differences in Preventable Deaths." *International Journal of Health Services* 15(1):1-11.
Zuvekas, S.H. and G. S. Taliaferro. 2003. "Pathways to Access: Health Insurance, the Health Care Delivery System, and Racial/Ethnic Disparities, 1996-1999." *Health Affairs* 22(2):139-153.

TABLE 1. Explanatory Variables and Sample Characteristics by Survival Status, Men and Women Ages 25-74, National Longitudinal Mortality Study, 1979-1989

	Men 25-44		Men 45-74		Women 25-44		Women 45-74	
	Alive	**Dead**	**Alive**	**Dead**	**Alive**	**Dead**	**Alive**	**Dead**
Age (mean)	33.3	35.4	56.5	62.9	33.3	36.5	57.7	63.7
	(5.6)	(5.9)	(7.8)	(7.7)	(5.6)	(5.8)	(8.1)	(7.6)
Race								
White	89.7%	80.9%	91.7%	88.8%	87.7%	77.1%	90.4%	87.5%
African American	10.3	19.1	8.3	11.2	12.3	22.9	9.6	12.5
Years of Education (mean)	13.1	12.0	11.6	10.4	12.7	11.9	11.2	10.3
	(3.0)	(3.1)	(3.7)	(3.7)	(2.7)	(2.6)	(3.2)	(3.4)
Family Income (mean)	$24,221	$20,137	$25,514	$17,505	$23,219	$20,139	$20,516	$14,315
	(15,534)	(14,695)	(18,388)	(15,306)	(15,992)	(16,310)	(17,387)	(14,471)
Household Size (mean)	3.5	3.4	2.9	2.5	3.7	3.7	2.6	2.2
	(1.6)	(1.7)	(1.5)	(1.3)	(1.6)	(1.7)	(1.4)	(1.3)
Marital Status								
Married	74.6%	62.9%	86.0%	78.1%	72.7%	67.5%	68.2%	52.5%
Previously Married	9.5	14.8	9.7	16.0	16.0	20.3	27.3	41.8
Never Married	15.9	22.3	4.3	5.9	11.3	12.2	4.5	5.7
Residence								
Non-SMSA	27.0%	33.2%	33.3%	35.8%	30.6%	29.2%	33.6%	33.9%
SMSA, Not CC	42.1	35.7	41.2	35.5	41.6	38.1	38.7	35.2
Central City	30.9	31.1	25.5	28.7	27.8	32.7	27.7	30.9
SS# on CPS record								
No	12.3%	8.3%	12.4%	8.1%	9.6%	6.9%	10.7%	7.4%
Yes	87.7	91.7	87.6	91.9	90.4	93.1	89.3	92.6
Cause of Death								
Medically amenable		14.8%		11.9%		23.8%		17.2%
Stroke				5.1				6.5
Behavioral		43.9				26.3		
Smoking				17.8				11.7
Alcohol & external				6.2				4.0
Cardiovascular				40.8				35.0
Breast Cancer								5.7
Other Cancers				13.1				14.0
All Other Causes		41.3		5.2		49.9		6.0
Number of cases	75,952	1,552	56,141	12,219	82,917	913	71,440	8,904

Note: Percentages may not add up to 100 due to rounding. Number of cases is unweighted. Percentages are based on weighted number of cases. Standard deviations are given in parentheses.

TABLE 2. Age-Standardized Death Rates per 1,000 Persons by Causes of Death at Ages 25-44 and 45-74 by Race and Gender, 1979-1989

	Ages 25-44					
	Males			Females		
Cause of death	Blacks	Whites	Percent contribution to race difference	Blacks	Whites	Percent contribution to race difference
All causes	3.203	1.611	100.0%	1.639	0.702	100.0%
Medically amenable	0.664	0.247	26.2	0.484	0.153	35.3
Behavioral	1.417	0.829	36.9	0.509	0.237	29.0
All other causes	1.122	0.535	36.9	0.646	0.312	35.7
	Ages 45-74					
	Males			Females		
Cause of death	Blacks	Whites	Percent contribution to race difference	Blacks	Whites	Percent contribution to race difference
All causes	24.858	16.749	100.0%	13.733	8.865	100.0%
Medically amenable	3.622	1.889	21.4	3.021	1.474	31.8
Alcohol & external	2.414	1.184	15.2	0.660	0.426	4.8
Smoking	4.079	3.121	11.8	1.052	1.207	-3.2
Cardiovascular	8.315	6.853	18.0	4.372	2.787	32.6
Stroke	1.835	0.747	13.4	1.107	0.493	12.6
Breast cancer	N/A	N/A	N/A	0.705	0.673	0.7
Other cancers	2.941	2.123	10.1	1.907	1.304	12.4
All other causes	1.652	0.832	10.1	0.909	0.501	8.4

Note: Percentages may not add up to 100 due to rounding.

TABLE 3. Hazard Ratios from Cox Regression Models by Cause of Death for Males and Females Ages 25-44, National Longitudinal Mortality Study, 1979-1989

	Males				Females			
	All Causes	Medically amenable	Behavioral	All Other	All Causes	Medically amenable	Behavioral	All Other
Unadjusted								
Race (White)								
Black	2.11 **	3.20**	1.97**	1.91**	2.26**	2.96**	2.26 **	1.96 **
Fully Adjusted								
Race (White)								
Black	1.48**	2.17**	1.35**	1.39*	1.85**	2.29**	1.81**	1.67**
Fully Adjusted Explanatory Variables								
Age	1.09**	1.10**	1.04**	1.13**	1.10**	1.11**	1.06**	1.13**
Years of Education	0.94**	0.98	0.91**	0.95**	0.96**	0.99	0.93**	0.96**
Log of Income	0.77**	0.69**	0.77**	0.81**	0.72**	0.61**	0.79**	0.79**
Household Size	0.98	0.97	0.97	0.98	0.91**	0.92	0.87**	0.94*
Marital Status (Married)								
Previously Married	1.59**	1.29	1.92**	1.36*	0.85	0.72	1.11	0.80
Never Married	1.91**	2.31**	1.59 **	2.17**	1.11	1.12	1.06	1.13
Residence (Non-SMSA)								
SMSA, Not CC	0.98	0.89	0.88	1.13	1.15	1.29	0.96	1.17
Central City	1.17*	1.21	1.10	1.24*	1.13	1.13	1.06	1.19
Log-likelihood	-17,099	-2,463	-7,594	-6,990	-10,122	-2,342	-2,789	-4,970
LR chi-square (df)	716 (10)	158 (10)	268 (10)	394 (10)	446 (10)	143 (10)	87 (10)	258 (10)
Observations	77,504	77,504	77,504	77,504	83,830	83,830	83,830	83,830
Deaths	1,552	226	687	639	913	213	250	450

Notes: Reference category in parentheses; *p <.05, **p < .01 (two-tailed tests). Unadjusted model controls for age and race. Fully adjusted model also controls for the presence of Social Security number on CPS record.

TABLE 4: Hazard Ratios from Cox Regression Models by Cause of Death for Males Ages 45-74, National Longitudinal Mortality Study, 1979-1989

	All Causes	Medically amenable	Alcohol & External	Smoking	Cardiovascular	Stroke	Other Cancers	All Other
Unadjusted								
Race (White)								
Black	1.38 **	1.88 **	1.89**	1.22**	1.13*	1.89**	1.33**	1.87**
Fully Adjusted								
Race (White)								
Black	1.09*	1.43**	1.35*	0.88	0.91	1.47**	1.22*	1.40**
Fully Adjusted Explanatory Variables								
Age								
Age	1.15**	1.09**	1.01*	1.27**	1.18**	1.11**	1.24**	1.09**
Age Squared	0.99**			0.99**	0.99**		0.99*	
Years of Education	0.99**	0.99	0.99	0.96**	0.99**	0.98	1.00	1.00
Log of Income	0.81**	0.80**	0.74**	0.79**	0.81**	0.78**	0.89**	0.75**
Household Size	1.00	1.02	0.97	0.98	1.00	1.06	1.02	1.02
Marital Status (Married)								
Previously Married	1.30**	1.41**	1.99**	1.33**	1.25**	1.39**	0.98	1.47**
Never Married	1.20**	1.45**	1.35*	0.87	1.26**	1.29	1.04	1.59**
Residence (Non-SMSA)								
SMSA, Not CC	1.04	1.21**	0.83*	1.05	1.02	1.03	1.13*	0.96
Central City	1.12**	1.34**	0.95	1.16**	1.07*	1.01	1.14*	1.13
Log-likelihood	-131,207	-15,471	-8,340	-23,503	-53,127	-6,283	-17,572	-6,666
LR chi-square (df)	7,316 (11)	1,055 (10)	242 (10)	1,266 (11)	3,180 (11)	587 (10)	977 (11)	497 (10)
Observations	68,360	68,360	68,360	68,360	68,360	68,360	68,360	68,360
Deaths	12,219	1,450	766	2,187	4,956	596	1,637	627

Notes: Reference category in parentheses; *p <.05, **p< .01 (two-tailed tests). Unadjusted model controls for age and race. Fully adjusted model also controls for the presence of Social Security number on CPS record.

TABLE 5: Hazard Ratios from Cox Regression Models by Cause of Death for Females Ages 45-74, National Longitudinal Mortality Study, 1979-1989

	All Causes	Medically amenable	Alcohol & External	Smoking	Cardiovascular	Stroke	Breast Cancer	Other Cancers	All Other
Unadjusted									
Race (White)									
Black	1.45 **	1.97**	1.33	0.92	1.42**	1.84**	1.09	1.31**	1.60**
Fully Adjusted									
Race (White)									
Black	1.20**	1.52**	1.04	0.80	1.12	1.55**	0.99	1.27*	1.31
Fully Adjusted Explanatory Variables									
Age									
Age	1.08**	1.08**	1.01	1.51**	1.11**	1.12**	1.23*	1.19**	1.09**
Age Squared				0.99**			0.99*	0.99*	
Years of Education	0.98**	0.96**	0.99	0.98	0.96**	0.98	1.05**	0.99	1.01
Log of Income	0.88**	0.83**	0.77**	0.98	0.83**	0.89*	1.02	1.02	0.73**
Household Size	1.02	1.04	0.86**	0.94*	1.06**	1.09*	1.03	0.97	1.06
Marital Status (Married)									
Previously Married	1.19**	1.14*	1.08	1.41**	1.25**	1.23*	1.34**	1.01	1.02
Never Married	1.17**	1.29*	1.04	0.85	1.10	1.52*	1.29	1.37**	0.93
Residence (Non-SMSA)									
SMSA, Not CC	1.09**	1.17*	1.01	1.12	1.04	1.07	1.11	1.17*	1.07
Central City	1.12**	1.19**	1.35*	1.28**	0.99	0.97	1.47**	1.19*	1.09
Log-likelihood	-97,646	-16,828	-4,072	-11,609	-33,105	-6,356	-5,949	-13,510	-5,834
LR chi-square (df)	4,808 (10)	998 (10)	86 (10)	327 (11)	2,754 (10)	570 (10)	85 (11)	378 (11)	374 (10)
Observations	80,344	80,344	80,344	80,344	80,344	80,344	80,344	80,344	80,344
Deaths	8,904	1,542	366	1,048	3,069	591	533	1,219	536

Notes: Reference category in parentheses; *p <.05, **p< .01 (two-tailed tests). Unadjusted model controls for age and race. Fully adjusted model also controls for the presence of Social Security number on CPS record.

APPENDIX

TABLE A. International Classification of Disease, Ninth Revision (ICD-9) Codes for Cause Groups

Cause Group	ICD-9 Codes
	Ages 25-44
Medically amenable	001-018,020,022-023,026,030,032-038,045,050,055,056,060,070,080,081.0,082.0,084,087, 090-099,102,120-128,137-138,153-154,173,179-182,186,190,193,201,240-246,250,260-269,280-286,320-322,345,390-398,401-405,430-438,460-466,474.1,480-487,493,500-505, 510,513,520-535.2,535.4-553,560,574-575,580-589,590,592,594,598,600,610-611,630-676,680-709,710-716,725-730,734-738,745-747,749-751,760-779,E850-E858,E870-E879, E930-E949
Behavioral	140-149,150,161-162,291,303,305.0,490-492,496,535.3,571,577.0-577.1,E800-E848,E860-E869,E880-E9291,E850-E999
All Other	021,024-025,027,031,039-044,046-049,051-054,057,061-066,071-079, 081.1-081.9,082.1-082.9,083,085-086,088,100-101,103-118,129-136,139,151-152,155-159,160,163-165,170-172,174,175,183-185,187-189,191-192,194-200,202-239,251-259,270-279,287-289,290, 292-302,304,305.1-319,323-344,346-389,410-414,415-429,440-459,470-474.0,474.2-478, 494-495,506-508,511-512,514-519,555-558,562-570,572-573,576,577.2-579,591,593,595-597,599,601-608,614-629,717-724,731-733,739,740-744,748,752-759,780-799
	Ages 45-74
Medically amenable	001-018,020,022-023,026,030,032-038,045,050,055-056,060,070,080,081.0,082.0,084,087, 090-099,102,120-128,137-138,153-154,173,179-182,186,190,193,201,240-246,250,260-269,280-286,320-322,345,390-398,401-405,460-466,474.1,480-487,493,500-505,510,513, 520-535.2,535.4-553,560,574-575,580-589,590,592,594,598, 600,610-611,630-676,680-709,710-716,725-730,734-738,745-747,749-751,760-779,E850-E858,E870-E879,E930-E949
Alcohol & external	291,303,305.0,535.3,571,577.0-577.1,E800-E848,E860-E869,E880-E9291,E850-E999
Smoking	140-149,150,161-162,490-492,496
Cardiovascular	410-414,415-429,440-459
Stroke	430-438
Breast cancer	174
Other cancers	151-152,155-159,160,163-165,170-172,175,183-185,187-189,191-192,194-200,202-239
All other	021,024-025,027,031,039-044,046-049,051-054,057,061-066,071-079,081.1-081.9,082.1-082.9,083,085-086,088,100-101,103-118,129-136,139,251-259,270-279,287-289,290,292-302,304,305.1-319,323-344,346-389,470-474.0,474.2-478,494-495,506-508,511-512,514-519,555-558,562-570,572-573,576,577.2-579,591,593,595-597,599,601-608,614-629,717-724,731-733,739,740-744,748,752-759,780-799

TABLE B. Top 3 Specific Causes in each Cause of Death Category at Ages 25-44 by Race and Gender, 1979-1989

	Males			
	Blacks		Whites	
Cause of death category	Cause of death	Percentage of deaths in category	Cause of death	Percentage of deaths in category
Medically amenable	Stroke	20.00%	Diabetes mellitus	15.91%
	Accidental poisoning by drugs, medicaments & biologicals	16.00%	Stroke	15.34%
	Hypertensive disease	14.00%	Cancer, colon	10.80%
	Pneumonia	14.00%		
Behavioral	Homicide	31.07%	Suicide	22.77%
	Cirrhosis of liver	12.62%	Motor vehicle accidents	22.59%
	Cancer, trachea, bronchus & lung	11.65%	Homicide	7.02%
All other causes	Ischemic heart disease	25.00%	Ischemic heart disease	38.94%
	Other forms of heart disease	20.65%	Other forms of heart disease	13.89%
	Infectious & parasitic diseases	14.13%	Infectious & parasitic diseases	9.32%
	Females			
	Blacks		Whites	
Cause of death category	Cause of death	Percentage of deaths in category	Cause of death	Percentage of deaths in category
Medically amenable	Stroke	32.74%	Stroke	18.36%
	Hypertensive disease	12.73%	Diabetes mellitus	15.19%
	Cancer, cervix uteri	9.09%	Cancer, colon	11.39%
Behavioral	Cirrhosis of liver	24.53%	Motor vehicle accidents	24.38%
	Homicide	24.53%	Cancer, trachea, bronchus & lung	20.81%
	Motor vehicle accidents	11.32%	Suicide	17.26%
All other causes	Other circulatory diseases	27.37%	Cancer, breast	32.79%
	Cancer, breast	19.05%	Ischemic heart disease	16.39%
	Ischemic heart disease	17.85%	Other circulatory diseases	10.66%

TABLE C. Top 3 Specific Causes in each Cause of Death Category at Ages 45-74 for Males by Race, 1979-1989

	Blacks		Whites	
Cause of death category	Cause of death	Percentage of deaths in category	Cause of death	Percentage of deaths in category
Medically amenable	Hypertensive disease	22.28%	Cancer, colon	22.67%
	Pneumonia	13.99%	Pneumonia	16.23%
	Cancer, colon	13.47%	Diabetes mellitus	13.05%
	Diabetes mellitus	13.47%		
Alcohol & external	Cirrhosis of liver	30.10%	Cirrhosis of liver	31.37%
	Homicide	18.44%	Suicide	21.42%
	Mental disorders, alcohol and drug-related	11.65%	Motor vehicle accidents	13.73%
Smoking	Cancer, trachea, bronchus & lung	70.71%	Cancer, trachea, bronchus & lung	63.60%
	Chronic obstructive pulmonary disease	14.15%	Chronic obstructive pulmonary disease	27.86%
	Cancer, esophagus	10.61%	Cancer, esophagus	3.67%
Cardiovascular	Ischemic heart disease	58.14%	Ischemic heart disease	75.36%
	Other forms of heart disease	33.50%	Other forms of heart disease	18.18%
	Diseases of arteries, arterioles & capillaries	3.59%	Diseases of arteries, arterioles & capillaries	4.73%
Other cancers	Cancer, digestive organs & peritoneum	25.01%	Cancer, digestive organs & peritoneum	23.90%
	Cancer, other & unspecified sites	19.39%	Cancer, other & unspecified sites	20.18%
	Cancer, lymphatic & hematopoietic tissue	11.26%	Cancer, lymphatic & hematopoietic tissue	19.23%
All other causes	Symptoms & ill-defined conditions	24.09%	Diseases of the digestive system	19.66%
	Diseases of the digestive system	24.08%	Diseases of the respiratory system	14.70%
	Diseases of the respiratory system	12.03%	Symptoms & ill-defined conditions	14.70%

Note: Stroke is omitted from this table since this category represents a single cause of death that accounts for all deaths.

TABLE D. Top 3 Specific Causes in each Cause of Death Category at Ages 45-74 for Females by Race, 1979-1989

	Blacks		Whites	
Cause of death category	Cause of death	Percentage of deaths in category	Cause of death	Percentage of deaths in category
Medically amenable	Hypertensive disease	20.92%	Cancer, colon	22.64%
	Cancer, colon	14.64%	Diabetes mellitus	12.59%
	Diabetes mellitus	14.64%	Pneumonia	12.05%
Alcohol & external	Cirrhosis of liver	57.14%	Motor vehicle accidents	15.13%
	Motor vehicle accidents	9.52%	Suicide	14.82%
	Accidental falls	9.52%	Other accidents & late effects	12.05%
Smoking	Cancer, trachea, bronchus & lung	68.24%	Cancer, trachea, bronchus & lung	61.37%
	Chronic obstructive pulmonary disease	17.65%	Chronic obstructive pulmonary disease	32.30%
	Cancer, esophagus	9.41%	Cancer, esophagus	3.22%
Cardiovascular	Ischemic heart disease	56.50%	Ischemic heart disease	68.58%
	Other forms of heart disease	35.59%	Other forms of heart disease	23.68%
	Diseases of pulmonary circulation	3.95%	Diseases of arteries, arterioles & capillaries	4.72%
Other cancers	Cancer, digestive organs & peritoneum	27.41%	Cancer, genitourinary organs	26.01%
	Cancer, other & unspecified sites	25.92%	Cancer, digestive organs & peritoneum	23.71%
	Cancer, lymphatic & hematopoietic tissue	19.99%	Cancer, other & unspecified sites	23.42%
All other causes	Diseases of the digestive system	24.65%	Diseases of the digestive system	24.40%
	Diseases of the nervous system & sense organs	15.94%	Diseases of the nervous system & sense organs	18.81%
	Diseases of the respiratory system	13.05%	Diseases of the respiratory system	15.62%

Note: Stroke and breast cancer are omitted from this table since these two categories each represent a single cause of death that accounts for all deaths.