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Educational Differences in Cause-Specific Mortality in the United States[1]

IRMA T. ELO, Ph.D., Assistant Professor and Research Associate[1]
GREG L. DREVENSTEDT, Ph.D., Visiting Scholar[2]

[1] Department of Sociology & Population Studies Center, University of Pennsylvania, Philadelphia, USA
[2] Population Studies Center, University of Pennsylvania, Philadelphia, USA

Introduction

Interest in socioeconomic differentials in mortality, as an indicator of social inequality, dates back nearly as far as measurement of mortality itself (Antonovsky 1967). Continued concern over differential longevity is manifested by the recent proliferation of studies on this topic both in Europe and the United States. That one's position in a society's socioeconomic hierarchy is a powerful predictor of one's health status and subsequent mortality has by now been firmly established (for reviews on this topic, see, for example, Valkonen, 1987; Preston and Taubman, 1994; Hummer, Rogers, and Eberstein, 1998).

Past research has also revealed notable demographic variations in the socioeconomic (SES) gradient in adult mortality. Relative differentials by educational attainment, for example, appear to be greater for men than for women and at prime working ages than at older ages, with relative differentials narrowing, although not disappearing, as age advances (Kitagawa and Hauser 1973; Valkonen 1989; Elo and Preston 1996; Koskinen and Martelin 1994). Current evidence further suggests that SES inequalities have widened in recent years in many developed countries. In the United States these trends have been more adverse for men than for women (Feldman et al. 1989; Pappas et al. 1993; Preston and Elo 1995).

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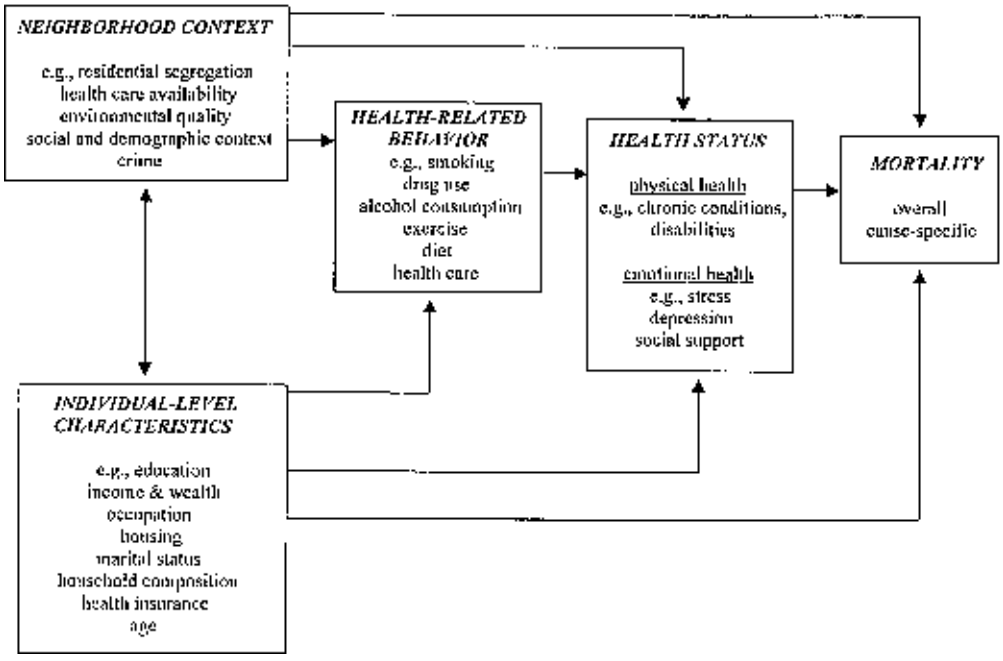
The vast body of literature on socioeconomic differentials in mortality has produced valuable descriptions of such differentials and provided insights into the measurement of socioeconomic status. Much less progress, however, has been made in untangling the causal factors behind the observed inequalities. Because individuals with lower levels of income and educational attainment are more likely to smoke, have high blood pressure, be overweight, and be less likely to exercise than their wealthier and more educated counterparts (Winkleby et al. 1992; Feldman et al. 1989; Pamuk et al. 1998), much of the focus on "accounting" for SES differentials in mortality has been placed on health-related behaviors (see Figure 1). These factors, however, have typically failed to account for the observed differentials (Feldman et al. 1989; Marmot et al. 1984; Rogers, Hummer, and Nam 2000). Other hypothesized pathways linking socioeconomic status to health and mortality include access to health care, psychosocial factors, social relations, and social support (e.g., House et al. 1988; Adler et al. 1994). In addition, neighborhood context is an integral part of sociological and epidemiological theories of health behavior, exposure to stress, access to health care, and environmental quality (Robert 1999). Although left out of the framework in Figure 1, childhood precursors of adult health and mortality have also been hypothesized to influence later life outcomes and be related to SES differentials in adult mortality, including deaths from causes such as heart disease and respiratory infections (Barker 1994; Elo and Preston 1992).

Figure 1. Conceptual model.



Studies of social class differentials in adult mortality by cause of death have been more common in Europe than the United States, where until recent years investigations of socioeconomic differentials in mortality have typically focused on overall mortality, with the exception of the seminal work by Kitagawa and Hauser (1973). This situation stands in contrast to studies of race- and sex-specific mortality differentials that have historically sought to explain current differentials and trends over time through analyses of cause-specific mortality by race and sex. Such analyses have provided valuable insights into potential causal factors accounting for race- and sex-specific variation in overall mortality and trends over time (e.g., Kochanek, Maurer, and Rosenberg 1994; Waldron 1993).

Lack of information on causes of death in studies of socioeconomic differentials in mortality has been unfortunate. As noted by Preston (1976, 1–2) "[i]gnoring causes of death in the study of mortality is somewhat akin to ignoring fecundity, exposure, contraceptive effectiveness, and fetal wastage in the study of fertility. Both sets represent biological variables through which all social and environmental influences must necessarily operate." In the United States, the release of the National Longitudinal Mortality Study (NLMS), a linkage of cohorts drawn from the Current Population Surveys in 1979–81 to the National Death Index (NDI), and the linkage of National Health Interview Survey (NHIS) cohorts to the NDI have provided new opportunities to examine the associations between education, income, occupation, and cause-specific mortality (e.g., Rogers, Hummer, and Nam 2000). In addition, the National Health and Nutrition Examination Survey Epidemiologic Follow-up study provides opportunities to examine SES differentials in cause-specific mortality (e.g., Feldman et al. 1989).

Because of important variations in the etiology of different causes of death, and because causes are influenced differentially by behavioral, environmental, and life-style factors, careful analyses of cause-specific mortality differentials by socioeconomic status may help illuminate some of the causal processes involved (see Figure 1). Identification of causes of death for which SES differentials are particularly large, those for which they are small, and those where differentials are narrowing or widening can help relate mortality variations to potential underlying causal factors. Such analyses can also establish which causes are largely responsible for the observed socioeconomic differentials in mortality.

Based on recent data, an inverse association of mortality by income and educational attainment has been documented for most causes of death in the United States, although the steepness of the gradient has been shown to vary by age, sex, and cause of death (e.g., Pamuk et al. 1995; 1998; Rogers, Hummer, and Nam 2000). Recent analyses of cause-specific mortality differentials have also shed light on possible factors responsible for the widening of educational differentials in mortality and those that may explain different social class gradients in mortality among men

and women. Feldman et al. (1989) have attributed the widening of educational differentials in mortality among white males aged 55–84 to the variation in trends in heart disease mortality between 1960 and 1971–84. In 1960, there were virtually no educational differentials in death rates from heart disease among white men at ages 65–84, but by 1971–84 they had become substantial. Factors the authors consider as contributing to these changes include cohort-specific factors that reflect changing childhood environments; changes in cigarette smoking by educational group; and improvements in medical and surgical treatment of heart disease that may have been more widely used by the better educated men (Feldman et al. 1989; Preston and Elo 1995). The lower social class gradient in all-cause mortality for women has been attributed to the contribution of breast cancer (better educated women have higher death rates from this cause) and to sex-specific differences in death rates from accidents and violence (Kitagawa and Hauser 1973; Koskinen and Martelin 1994). In addition, a gender difference in the cause of death structure has been shown to account for the steeper social class gradient in all-cause mortality among men in Finland (Koskinen and Martelin 1994).

To further our understanding of socioeconomic differentials in mortality, analyses of the cause-specific gradient in death rates should be extended. The relative importance of different causes of death changes from young adulthood to old age, as do relative and absolute SES mortality differentials. Thus, separate investigations of cause-specific contributions to mortality variation by social class in young adulthood, middle, and older ages seem necessary to improve our understanding of the reasons for these mortality variations. Our ability to draw inferences from cause-specific analyses requires that careful thought be given to possible factors that may contribute to cause-specific differences in death rates by age, sex, and social class and their relationship to behavioral, environmental and other individual characteristics. This exercise in turn requires the formulation of hypotheses that guide the classification of causes of death. Analysts often group causes of death into broad categories such as circulatory diseases, cancer, respiratory diseases, and accidents and violence. Within these broad cause-of-death categories, causal mechanisms can vary substantially, such as for lung cancer and cancers of the reproductive system. In these analyses, we use an alternative classification scheme that is tied to potential pathways translating one's position in the social hierarchy to cause-specific mortality differentials.

Data

The data for these analyses come from the National Longitudinal Mortality Study (NLMS) Release II that provide mortality follow-up through 1989 for cohorts drawn from Current Population Surveys administered in 1979–81 (Rogot et al. 1992). The

NLMS public use sample is based on five Current Population Surveys (CPS) conducted between March 1979 and March 1981, and contains 637,162 individual records matched to the National Death Index (NDI) through 1989. This record linkage has identified 42,919 deaths that occurred between the CPS baseline interview and the end of the follow-up period (for details of the linkage procedures, see Rogot, Sorlie and Johnson 1986). For all sample members, follow-up in days is provided in the public use file and all 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). The NLMS data on demographic, social, and economic characteristics come from the CPS, with all individual characteristics pertaining to the time of the CPS interview. Information on cause of death comes from the linkage to the NDI and includes 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), which was in effect in the United States during the entire follow-up period.

We have limited our analyses to white men and women because the sample size does not permit comparable analyses for African Americans. We further restricted the sample to ages 25–64. Ages below 25 are omitted to allow for college completion, whereas ages 65 and above are omitted because the underlying cause of death often does not capture the full extent of morbid conditions contributing to death at older ages. We use educational attainment as a marker of socioeconomic status because it is unaffected by health impairments that may have emerged in adulthood. We examine the contribution of various causes of death to educational differentials in mortality in young adulthood (ages 25–44) and at middle age (ages 45–64) separately by gender because the cause of death structure varies between these age intervals, as do educational and sex differentials in mortality. Education is grouped into four categories: not a high school graduate (less than 12 years of schooling), high school graduate (12 years), some college (13–15 years), and a college graduate (16+ years of schooling).

We classify causes of death in a way that relates specific causes to several hypothesized pathways through which socioeconomic status is associated with mortality, such as behavior, access to medical care, and stress. Causes of death are grouped into three categories for ages 25–44 (medical causes, behavioral causes, and all other causes) and five categories for ages 45–64 (medical causes, behavioral causes, ischemic heart disease, other cancers, and all other causes). In this classification, cause of death refers to the underlying cause of death based on ICD-9 codes. The medical and behavioral categories represent causes of death that are avoidable through either preventive or therapeutic measures. In 1976, Rutstein et al. (1976) published a classification of conditions from which deaths would be considered “unnecessary” and “untimely” given available medical technology. Subsequently, others have expanded the concept of preventable or avoidable

mortality. These classification schemes have been used primarily to measure quality of medical care and its impact on health outcomes (e.g., Carr-Hill, Hardman, and Russell 1987; Charlton and Veléz 1986; Mackenbach et al. 1988; Poikolainen and Eskola 1986; 1988). Studies have also used avoidable causes of death to gain insight into racial (Woolhandler et al. 1985) and socioeconomic differences in mortality (Mackenbach, Stronks, and Kunst 1989; Westerling, Gullberg, and Rosén 1996). See Table A1 in the Appendix for a complete list of ICD-9 codes for deaths by age for each cause group drawn from the NLMS public-use file.

Medically avoidable causes of death may be amenable to either preventive health behavior (e.g., Pap smears for cancer of the cervix uteri) or medical intervention (e.g., radiation treatment and chemotherapy for Hodgkin's disease). In this study, we based our selection of medically avoidable causes on classifications used in previous studies (e.g., Holland 1991; Mackenbach et al. 1988; Poikolainen and Eskola 1988; Rutstein et al. 1976). To the extent that access to timely and quality medical care and use of preventive services vary by educational attainment, we expect to find an educational gradient in mortality from medical causes. This category includes such causes as respiratory infections, selected cancers, diabetes, digestive system disorders, congenital anomalies, certain circulatory system disorders, stroke, and various infectious diseases. Deaths from circulatory diseases (including stroke), cancer, and diabetes make up the majority of all deaths in this category in both age intervals for both men and women.

Behaviorally avoidable deaths are influenced primarily by lifestyle factors, such as smoking (lung cancer), drinking (cirrhosis), specific activities (motor vehicle accidents), and exposure to violence (homicide). Because detrimental health-related behaviors, such as smoking, are more common among individuals with lower levels of schooling, and because individuals with lower educational attainment are more likely to live in poor neighborhoods and be exposed to violence, we expect to find a negative association between behavioral cause mortality and educational attainment. The relative importance of causes of death in this category varies by age. In the younger age group, deaths from motor vehicle accidents, suicide, and homicide account for over 60% of all deaths among both men and women, with lung cancer and cirrhosis being far less important. This pattern reverses at older ages with lung cancer comprising over half of all deaths, followed by cirrhosis, the second most important cause for both men and women.

At ages 25–44, causes of death that are other than medical and behavioral are included in the residual cause of death category due to a small number of deaths from many causes. This category is dominated by cardiovascular diseases not included under medical causes of death among men (around 40% of 'all other' deaths), the most important of which is ischemic heart disease. Cancer deaths are the second most important cause of death group (about one-fifth of 'all other'

deaths), followed by infectious and parasitic diseases (17%), which include HIV-infection. Among women, cancer deaths make up about 60% of deaths in this residual group, followed by cardiovascular diseases (about a fifth of the total). Infectious and parasitic diseases are less important for women than for men.

In the older age group (45–64), we separate ischemic heart disease and other cancers (those not included in the medical or behavioral categories) from the residual cause of death group. Ischemic heart disease makes a large contribution to overall mortality at these ages, particularly among men, and it is associated with social class differences in mortality in many other studies (Marmot et al. 1984; Feldman et al. 1989). It is related to health behaviors, stressful life experiences, and early life conditions (Barker 1994; Preston and Elo 1992; Adler and Matthews 1994). We hypothesize that ischemic heart disease makes a large contribution to educational differences in mortality at ages 45–64.

In the cancer group, we include all cancers other than lung cancer and those not classified as medically avoidable. Among men at ages 45–64, deaths from colon cancer are the most common, followed by pancreatic, stomach, and prostate cancer. Deaths from breast cancer are by far the most common cancer deaths among women, accounting for about a third of all deaths in this category. It is followed by colon and ovarian cancer, although deaths from these cancers are far less prevalent than those from breast cancer. We have no prior expectations about the relationship between other cancers and educational attainment. Cancers for which mortality is hypothesized to be associated with SES fall under medical and behavioral causes, except in the case of breast cancer for women. Unlike other causes, mortality from breast cancer tends to be positively associated with educational attainment.

All other causes of death are included in the residual cause group. At ages 45–64, cardiovascular diseases (other than ischemic heart disease and those included under medical causes) are the most important, followed by diseases of the respiratory and digestive systems. The cause of death composition is similar among both men and women, with heart disease mortality being somewhat more important for men.

Methods

We present both relative and absolute measures of educational inequality in cause-specific mortality based on the Slope Index of Inequality (SII), as well as the percentage contribution of various cause groups to absolute inequality. In brief, the SII provides an estimate of how much change in death rates is associated with increased educational attainment. More specifically, it provides an estimate of the absolute change in death rates associated with moving from the lowest to the highest

level of schooling (Preston, Haines and Pamuk 1981). The SII can be converted into a relative measure by dividing its value by the death rate for all educational groups combined. This measure, referred to as relative inequality, indicates the mean proportionate decline in mortality when educational levels increase. A desirable property of the SII is that it takes into account the educational distribution of the entire population, and does not simply rely on information from the groups with the lowest and highest levels of schooling (for previous applications see Preston and Elo 1995; Pamuk et al. 1995).

To construct the SII for 1979–89, we compute an age-standardized death rate for each sex-education group by weighting age-sex-education specific death rates by a standard age distribution. As a standard we use the age distribution for the total U.S. population in 1985 (U.S. Bureau of the Census 1990). The SII – the relation between the death rates and location on the cumulative education distribution in 1985 – is then obtained by weighted least squares regression, where weights are the proportions in each education category in 1985. The sex-education specific death rates on which these calculations are based are shown in Appendix Tables A2 and A3. We have more confidence in our estimates for men than women because a larger number of male deaths are available to estimate cause-specific death rates, particularly at ages 25–44. In addition, the educational gradient in mortality by cause groups for men exhibits a more consistent linear relationship with educational attainment than is the case for women.

Results

The results of the analyses are presented in Tables 1 and 2. The magnitude and pattern of inequality vary considerably by cause of death, as do cause-specific contributions to overall inequality depending on the magnitude of the death rate and the size of the associated inequality. For both men and women, mortality declines with increasing levels of schooling – as is indicated by the negative sign of the SII – except for other cancers for women at ages 45–64. In general, the long latency period associated with chronic diseases make them more important at older than at younger ages.

At ages 25–44, educational inequalities are more pronounced for white men than for white women whether inequality is measured in absolute or relative terms, and the cause-specific contributions also vary by sex (Table 1). Behavioral causes account for 62% of the absolute inequality in male mortality, but only for about a third in female mortality. Relative inequality is also most pronounced for this cause group (–1.43) for men, but not so for women (–0.64). It is well known that male mortality from many causes of death included in this category, such as motor vehicle

accidents and homicide, is much higher than female mortality from these causes (Waldron 1993). This difference can also be seen in Table 1. The overall age-standardized death rate for males from behavioral causes is 3.4 times higher than the corresponding female rate. Our results further show that not only is male mortality higher than female mortality from these behavioral causes, but that the educational gradient is also steeper for men than for women.

Table 1. Educational inequality in mortality by cause of death for white males and white females ages 25–44, national longitudinal mortality study 1979–1989 (death rates per 1,000 using weighted data)

Cause	Age-Adjusted Death Rate	Slope Index of Inequality (SII)	% Contribution for All-Cause SII	Relative Inequality (SII/Death Rate)
		Males		
All Causes	1.611	–1.84	100.0	–1.14
Medical Causes	0.247	–0.10	5.4	–0.40
Behavioral Causes	0.792	–1.13	61.7	–1.43
All Other Causes	0.572	–0.60	32.9	–1.06
		Females		
All Causes	0.702	–0.42	100.0	–0.60
Medical Causes	0.151	–0.02	5.7	–0.16
Behavioral Causes	0.232	–0.15	35.5	–0.64
All Other Causes	0.319	–0.25	58.8	–0.77

Note: See text for an explanation for the classification of causes of death.

Both the absolute and relative measures of inequality for medical causes are much smaller than for behavioral causes of death at ages 25–44 for both men and women. Although these causes account for 15% of overall mortality for younger white males and 22% of overall mortality for younger white females, their contribution to the absolute educational inequality is only about 5% (Table 1). The all other cause group, which is dominated by deaths from heart disease and cancer not included under medical or behavioral causes of death, makes a far more important contribution to overall inequality than the medically avoidable causes. For women, both absolute (–0.25) and relative (–0.77) measures of inequality are most pronounced for this residual category. It accounts for 45% of overall female mortality and explains close to 60% of the absolute educational inequality. The respective figures for white men are 36% and 33%.

Table 2. Educational inequality in mortality by cause of death for white males and white females ages 45–64, national longitudinal mortality study 1979–1989 (death rates per 1,000 using weighted data)

Cause	Age-Adjusted Death Rate	Slope Index of Inequality (SII)	% Contribution for All-Cause SII	Relative Inequality (SII/Death Rate)
		Males		
All Causes	10.013	–7.43	100.0	–0.74
Medical causes	1.414	–1.30	17.5	–0.92
Behavioral causes	2.301	–2.00	26.9	–0.87
Ischemic Heart Disease	3.049	–2.56	34.4	–0.84
Other Cancers	1.443	–0.45	6.10	–0.31
All Other Causes	1.806	–1.12	15.0	–0.62
		Females		
All Causes	5.371	–3.13	100.0	–0.58
Medical causes	1.014	–0.60	19.1	–0.59
Behavioral causes	0.911	–0.44	13.9	–0.48
Ischemic Heart Disease	0.907	–1.27	40.7	–1.40
Other Cancers	1.627	0.05	–1.60	0.03
All Other Causes	0.912	–0.87	27.9	–0.96

Note: See text for an explanation for the classification of causes of death.

At ages 45–64, we also find that both measures of educational inequality are larger for men than for women, except in the case of ischemic heart disease (Table 2). For men, behavioral causes continue to make a substantial contribution (27%) to educational inequality in mortality in middle age. Among these causes, lung cancer is by far the most important cause of death, reflecting higher rates of smoking prevalence among less educated white men. Between 1974 and 1995, for example, cigarette smoking in the United States declined by about 3% per year among men with at least some college education compared to 1.5% per year among men with 12 or fewer years of schooling (Pamuk et al. 1998). Deaths from ischemic heart disease also make a large contribution to educational inequality in all-cause mortality among white males at ages 45–64, accounting for 34% of the absolute educational inequality. Past trends in smoking prevalence by level of schooling undoubtedly contribute to these differentials as well, although a host of other factors are also likely to play a role (Rogers, Hummer, and Nam 2000).

Behavioral causes and ischemic heart disease explain over half of the absolute inequality among white women as well, but their relative importance differs

substantially from that found for men. For women, the largest contribution to absolute educational inequality is made by ischemic heart disease (40.7%) despite the fact that the age-adjusted death rate from this cause is lower than from the other cause groups examined. It accounts for only 17% of all-cause mortality among women. Similarly, relative inequality for ischemic heart disease is considerably larger (–1.40) than for other cause groups and is almost twice as large than the estimated relative inequality for men (–0.84). These results are consistent with findings of educational differentials in cause-specific mortality in Finland, where women's relative educational differentials in mortality for circulatory diseases also appear to be greater than men's at ages 35 to 64 (Koskinen and Martelin 1994). The reasons why the educational gradient from ischemic heart disease is steeper for women than for men are not obvious and deserve further study.

Behavioral causes make a smaller contribution to educational inequality at older ages for women (13.9%) than for men (26.9%), and relative inequality for women (–0.48) is also smaller than that for men (–0.87). Although deaths from lung cancer make up the vast majority of deaths from behavioral causes for both sexes, the educational gradient is less steep for women. This result may reflect smaller differences in smoking prevalence by educational attainment for women. The difference in smoking prevalence between white women with less than high school education and those who are college graduates was 11% in 1974, compared to a corresponding 24% difference for white men. Although the educational difference in smoking prevalence has increased over time, it was still smaller for women (20%) than for men (26%) in 1985 (Pamuk et al. 1998).

Medical causes (mainly stroke, diabetes, and cancers) make a more substantial contribution to absolute inequality at older than at younger ages for both men (17.5%) and women (19.1%). For men, the relative educational inequality for medical causes (–0.92) is somewhat larger than for other cause groups examined, while among women relative inequality from these causes (–0.59) is smaller than from ischemic heart disease (–1.40) and the all other cause group (–0.96). Relative to other cause groups, cancer mortality (other than lung cancer and cancers classified as medically avoidable) makes much smaller contributions to educational inequality in death rates at ages 45–64. Mortality from these causes (most important of which is breast cancer) among women exhibits a positive relationship with educational attainment. This cause group, which accounts for 30% of the overall white female death rate at ages 45–64, reduces the educational gradient in all-cause mortality for women relative to men. Among men, the SII for other cancers is negative, although its contribution to educational inequality in all-cause mortality is relatively small (6%).

Finally, the residual cause group makes a more substantial contribution to educational inequality in mortality among white women (27.9%) than white men

(15%). The most important causes of death in this category are various cardiovascular diseases. These results may be related to the findings concerning ischemic heart disease mortality, for which women also had a steeper educational gradient than men.

Discussion

In this paper, we examine educational differences in cause-specific mortality among white men and women at ages 25 to 64 in the United States in 1979–89. We present separate analyses for men and women at ages 25–44 and 45–64 because cause-specific contributions to overall mortality vary by age and sex. We use the Slope Index of Inequality as our measure of inequality. It enables us to examine both absolute and relative differences in inequality and the contribution of various causes of death to overall inequality. We group causes of death in the following way: medically avoidable, behavioral, and all other causes of death at ages 25 to 44; and medically avoidable, behavioral, ischemic heart disease, cancers (other than lung cancer and those classified as medically avoidable) and all other causes of death at ages 45–64.

We find that behavioral causes of death, influenced primarily by health-related behaviors and specific activities, factors that are commonly hypothesized to link education to all-cause mortality, play an important role in generating educational differences in overall mortality among white men. These causes make a particularly important contribution in young adulthood, where they account for about 60% of absolute inequality in all-cause mortality. These causes are also important in the older age group for men, where the respective percentage is 36%. Behaviors that may influence these findings include, but are not limited to, commonly measured risk factors, such as smoking and excessive alcohol consumption. At the same time, we find that behavioral causes are far less important in generating educational inequalities in overall mortality among women. They account for 36% of absolute educational inequality in the younger age group and 14% at ages 45–64. Thus, not only is mortality from injuries, lung cancer, and cirrhosis higher for men than for women, but the relative differentials are also larger for men.

Our results further suggest that exposure to stressful circumstances and other disadvantages associated with low educational attainment are important for generating differences in mortality from ischemic heart disease, which makes a sizable contribution to educational inequality in all-cause mortality at ages 45–64. It has been hypothesized that stress, cigarette smoking, lack of exercise, and differential access to or utilization of life-saving medical technologies contribute to SES differences in mortality from heart disease (e.g., Feldman et al. 1989). This suggestion is supported by the findings for medical causes at ages 45–64. Relative

inequality is greater for this cause group than for any of the others examined for men and, while not as large, it is also substantial for women. We should also note that the educational gradient for ischemic heart disease mortality is steeper for women than for men, a finding that deserves further examination.

In this paper, we have not tried to directly examine the pathways through which educational attainment is hypothesized to influence mortality. Rather we have attempted to gain insights into the possible causal processes by using a typology of cause-specific mortality informed by our conceptual framework and previous studies of medically avoidable causes. This classification scheme is just one example of many possible cause-specific classifications that may shed light onto the pathways through which higher levels of schooling translate into longer life spans. Our approach seems to have been more successful in linking educational differentials in mortality to underlying causal processes for men than for women. Among women the residual cause group made consistently larger contributions to educational inequalities in all-cause mortality than was the case for men. Our results thus suggest that further developments in this area must give careful consideration to sex differences in cause-specific mortality by educational attainment and to the pathways that translate one's position in the socioeconomic hierarchy to sex-specific variation in cause-specific and all-cause mortality.

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Appendix

Table A1. ICD-9 codes for deaths among whites by age and cause of death, national longitudinal mortality study 1979–1989

Cause Group	ICD-9 Codes
	Ages 25–44
Behavioral Causes	162, 571, 805, 807, 812–816, 818–822, 826, 828, 830, 832, 841, 850, 851, 853, 868, 869, 882–884, 887, 888, 890, 892, 893, 899, 901, 906, 909–913, 916, 917, 919, 921, 922, 924, 925, 928–930, 938, 950, 952–956, 958, 963, 965, 966, 968, 970, 980, 982, 985, 987, 988
Medical Causes	011, 036, 070, 172, 173, 179, 180, 182, 186, 188–190, 201, 250, 284, 345, 394, 396, 397, 401–403, 415, 416, 430–432, 434, 436, 437, 451, 480–482, 485–487, 491–493, 513, 532, 576, 583, 590, 592, 642, 648, 673, 710, 728, 730, 746, 747,850, 851, 853–855, 857, 858, 878, 879, 930, 938
All Other Causes	038, 040, 042, 043, 046, 078, 112, 117, 136, 141, 142, 150–155, 157, 159, 164, 170, 171, 174, 175, 183, 185, 191, 194, 195, 199, 200, 202–205, 208, 225, 227, 237, 239, 272, 273, 276–279, 288, 289, 295, 303–305, 319, 324, 335, 340, 341, 343, 348, 357, 359, 410–414, 424, 425, 427–429, 441, 443, 447, 456, 459, 496, 507, 511, 512, 514, 516, 518, 530, 537, 557, 562, 569, 572, 573, 577, 578, 585, 586, 599, 614, 620, 753, 758, 768, 780, 786, 799
	Ages 45–64
Behavioral Causes	162, 571, 805, 810, 812–816, 819, 825, 830, 832, 841, 863, 868, 869, 880, 882, 884, 887, 888, 890, 899–901, 906, 910–913, 916, 917, 919, 920, 922, 923, 925, 928, 929, 947, 950, 952–959, 963, 965, 966, 968, 970, 980, 982, 984, 958, 988
Medical Causes	008, 011, 070, 161, 172, 173, 179, 180, 182, 187–190, 193, 201, 242, 244, 250, 261, 263, 281, 284, 320, 345, 394–398, 401–404, 415, 416, 430–434, 436–438, 451, 464, 466, 480–482, 485–486, 487, 490–493, 500, 501, 510, 513, 533, 535, 540, 551–553, 560, 574, 581–583, 590, 592, 682, 707, 710, 714, 716, 729, 730, 745–747, 850, 858, 870, 878, 879, 947
Ischemic Heart Disease	410–414
Other Cancers	141–143, 145–160, 164, 170, 171, 174, 175, 183–185, 187, 189, 191, 192, 194, 195, 199, 200, 202–208, 225, 227, 237–239
All Other Causes	031, 038–040, 042, 049, 070, 079, 112, 116, 117, 135, 136, 138, 145, 251, 255, 272, 273, 275–279, 282, 285–287, 289, 291, 303–305, 310, 322–324, 331–335, 340, 342, 344, 348, 354–356, 358, 359, 420–425, 427–429, 440, 441, 443, 444, 446, 447, 456, 458, 459, 478, 494, 496, 506, 507, 511, 514–516, 518, 519, 530,536, 537,555, 557, 562, 566, 567, 569, 572, 573, 576–579, 584–586, 588, 593, 599, 721, 753, 756, 758, 790, 799

Note: ICD-9 codes 800–988 refer to external cause (E) codes. An ICD-9 code may appear in more than one cause group since four-digit codes are used to distinguish between avoidable and non-avoidable causes.

Table A2. Age-adjusted death rates for white males and white females ages 25–44 by level of education and cause of death, national longitudinal mortality study 1979–1989 (death rates per 1,000 using weighted data)

Education	Medical Causes		Behavioral Causes		All Other Causes		All Causes	
Males								
	Rate	Ratio	Rate	Ratio	Rate	Ratio	Rate	Ratio
< 12 Years	0.34	1.62	1.25	3.68	0.88	2.93	2.47	2.91
12 Years	0.23	1.10	0.96	2.82	0.59	1.97	1.77	2.08
13–15 Years	0.24	1.14	0.68	2.00	0.62	2.07	1.53	1.80
16+ Years	0.21	1.00	0.34	1.00	0.30	1.00	0.85	1.00
All	0.25		0.79		0.57		1.61	
% Contribution to Total Mortality	15.5		49.1		35.4		100.0	
Females								
< 12 Years	0.21	1.40	0.39	2.05	0.40	2.22	1.00	1.92
12 Years	0.13	0.87	0.19	1.00	0.34	1.89	0.67	1.29
13–15 Years	0.14	0.93	0.22	1.16	0.33	1.83	0.69	1.33
16+ Years	0.15	1.00	0.19	1.00	0.18	1.00	0.52	1.00
All	0.15		0.23		0.32		0.70	
% Contribution to Total Mortality	21.4		32.9		45.7		100.0	

Note: See text for an explanation of the classification scheme for causes of death.

Table A3. Age-adjusted death rates for white males and white females ages 45–64 by level of education and cause of death, national longitudinal mortality study 1979–1989 (death rates per 1,000 using weighted data).

Education	Medical Causes		Behavioral Causes		Ischemic Heart Disease		Other Cancers		All Other Causes		All Causes	
Males												
	Rate	Ratio	Rate	Ratio	Rate	Ratio	Rate	Ratio	Rate	Ratio	Rate	Ratio
< 12 Years	1.95	2.17	3.01	2.09	3.85	2.13	1.57	1.34	2.15	1.68	12.53	1.90
12 Years	1.25	1.39	2.31	1.60	3.12	1.72	1.47	1.26	1.86	1.45	10.01	1.51
13–15 Years	1.25	1.39	2.06	1.43	2.82	1.56	1.51	1.29	1.65	1.29	9.29	1.41
16+ Years	0.90	1.00	1.44	1.00	1.81	1.00	1.17	1.00	1.28	1.00	6.61	1.00
All	1.41		2.30		3.05		1.44		1.81		10.01	
% Contribution to Total Mortality	14.1		23.0		30.5		14.4		18.1		100.0	
Females												
< 12 Years	1.31	1.70	1.10	1.90	1.40	4.67	1.68	0.94	1.30	2.13	6.79	1.68
12 Years	0.90	1.17	0.85	1.47	0.80	2.67	1.56	0.87	0.80	1.31	4.91	1.21
13–15 Years	0.98	1.27	1.02	1.76	0.64	2.13	1.63	0.91	0.69	1.13	4.97	1.23
16+ Years	0.77	1.00	0.58	1.00	0.30	1.00	1.79	1.00	0.60	1.00	4.05	1.00
All	1.01		0.91		0.91		1.63		0.91		5.37	
% Contribution to Total Mortality	18.8		16.9		16.9		30.4		16.9		100.0	

Note: See text for an explanation of the classification scheme for causes of death.