Why is the Educational Gradient in Mortality Steeper for Men than Women in the United States?

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ABSTRACT

It is often documented that the educational gradient of mortality is steeper for men than women in the U.S., yet the explanation remains a matter of debate. We examine gender differences in the gradients within the context of marriage to determine whether they reflect gender differences in health behaviors or a greater importance of men's education on married household mortality. We use the 1986-1996 National Health Interview Survey Linked Mortality Files. Results reveal that the steeper gradient for men overall reflects a steeper gradient among unmarried men, with low educated never married men exhibiting high levels of mortality. These men are more likely to die from causes for which smoking is a risk factor, supporting a behavioral explanation. No gender difference is observed for married adults. Low education and unmarried status exert a synergistic effect on men's mortality. These men may disproportionately lack social supports that encourage positive health behaviors.

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INTRODUCTION

The inverse association between educational attainment and adult mortality in the United States is a social fact. Further, prior studies frequently report that the educational gradient is steeper for men than for women (Feldman, Makuc, Kleinman, & Cornoni-Huntley, 1989; Jemal et al., 2008; Lin, Rogot, Johnson, Sorlie, & Arias, 2003; Molla, Madans, & Wagener, 2004; Nathanson & Lopez, 1987; Preston & Taubman, 1994; Rogot, Sorlie, & Johnson, 1992; Singh & Siahpush, 2001). However, statistical tests of this visually impressive difference are rarely conducted. Among the four studies that statistically tested for gender differences in the education-mortality gradient in the United States, two found no difference using a linear measure of education (McDonough, Williams, House, & Duncan, 1999; Zajacova, 2006), while two reported a marginally steeper gradient for men using a categorical measure of education, with mortality reduction larger for men at the post-secondary level (Christenson & Johnson, 1995; Zajacova & Hummer, under review).

A gender difference in the gradient potentially signals differential returns to education due to a host of factors including biomedical, behavioral, and/or social structural differences in the lives of men and women (Nathanson & Lopez, 1987). Not surprisingly, given the absence of in-depth attention to this issue, substantial ambiguity surrounds which of these factors come into play. In this paper, we begin by formally testing for differences in the educational gradient of mortality between non-Hispanic white men and women 55 years of age and older. We disaggregate the gradients by marital status because socioeconomic position and marital status are fundamental determinants of life chances, and the association each has with mortality may depend on the presence of the other (Nathanson & Lopez, 1987; Smith & Waitzman, 1994). Where differences exist, we compare leading causes of death to evaluate the role of health behaviors that may have contributed to those differences. We also evaluate the possibility that the steeper gradient among men reflects a disproportionate influence of their education on household resources and health (Preston and Taubman, 1994).

Background

At least as early as 1960, the steepness of the educational gradients for men and women appeared visually distinct (Kitagawa & Hauser, 1973). Subsequent studies on temporal changes in the gradient between 1960 and the mid 1980s revealed its malleability. By the mid 1980s, the gradient had become much steeper for men (Crimmins & Saito, 2001; Lauderdale, 2001; Pappas, Queen, Hadden, & Fisher, 1993; Preston & Elo, 1995; Rogot et al., 1992) largely due to disproportionate declines in heart disease mortality among higher educated men (Feldman et al., 1989). Yet, among women it is unclear whether the gradient became steeper (Lauderdale, 2001; Pappas et al., 1993), flatter (Rogot et al., 1992), was unchanged (Feldman et al., 1989) or changed in a cohort-specific fashion (Crimmins & Saito, 2001; Preston & Elo, 1995). The net result of these gender-specific trends during this period was a visually steeper educational gradient among men in comparison to women across adulthood.

Nathanson and Lopez's (1987) seminal article on this issue introduced the idea that these gender differences in the gradient likely have a behavioral explanation which may be revealed if the gradients are assessed within the context of marriage. Drawing on 1971 data from Canada they showed that the socioeconomic gradient for mortality – indexed by income – was steeper for men than for women largely due to high mortality rates among low-income men. Nathanson and Lopez speculated that compared to women with low income or other men, these men may be less likely to have access to health-enhancing social ties such as marriage, and therefore more likely to engage in risky health behaviors. A subsequent study by Smith and Waitzman (1994) found empirical support for this hypothesized synergy between low income and unmarried status among men. Using U.S. data from the NHANES 1 Epidemiologic Follow-Up Study in 1982-1984 their results confirmed that unmarried men with low income exhibited all-cause mortality rates much greater than would be expected on the basis of income and unmarried status alone, yet this pattern was not evident for women. Further, this pattern was more apparent for causes of death that have a behavioral component. Taken together, these two studies suggest that the combination of low income (or low education) and unmarried status may interact in a way that is deleterious to men's health in particular. Thus, relatively high mortality among unmarried men with low education may undergird gender differences in the overall education-mortality gradient in the U.S. today.

The notion that a synergy between marital status and education on mortality risks exists for men but not for women is also indirectly supported by evidence of, and explanations for, gender differences in the health benefits of marriage. It is well-documented that married adults experience lower mortality risks than unmarried adults. Further, several studies have reported that this disparity is greater among men than women (Gardner & Oswald, 2004; Gove, 1973; Litwak & Messeri, 1989). One compelling explanation for the greater disparity among men points to health behaviors. Specifically, because men exhibit higher baseline levels of health-compromising behaviors than women, the social controls and spousal monitoring of health behaviors that often accompany marriage disproportionately benefit men (Umberson, 1987, 1992). Although selection processes also contribute to the mortality advantage of married adults (Murray, 2000), they may be less relevant for explaining why men exhibit larger mortality differentials between marital statuses (Gove, 1973). Because unmarried men do not benefit from the social controls and shared lifestyle within marriage, their mortality risks are more highly dependent upon individual resources such as educational attainment. Thus, the educational gradient of mortality may be steeper for unmarried men than married men, but largely invariant to marital status among women.

As an alternative to the behavioral hypothesis described heretofore, Preston & Taubman (1994) hypothesized that men exhibit a steeper educational gradient for mortality because household well-being is more closely linked to men's education than to women's. Indeed, women's mortality risks may have historically been more closely linked to their husband's social status than their own. For example, Arber (1987) showed that the gradient for chronic illness among married women was flatter when analyzing their own socioeconomic status, yet converged towards the steeper male gradient when they were analyzed using their husband's status. The gendered nature of paid employment and family responsibilities does tend to constrain the lives of married women to be contingent on their husbands (Moen & Chermack, 2005), although this is less true today that it was just a few generations ago.

Moreover, the increasingly central role that education has played in assortative mating in the U.S. (Schwartz & Mare, 2005) has implications for both hypotheses. First, assortative mating clouds the direction of causality for the behavioral hypothesis. As such, it is difficult to distinguish whether married men exhibit better health behaviors than unmarried men due to social controls and the shared lifestyle and resources within marriage, or whether men with positive health behaviors are more likely to marry women with similarly positive health behaviors. Disentangling these two possibilities is not imperative for testing the hypothesis or for its explanatory utility, as long as this caveat is recognized. It does, however, provide additional motivation for evaluating gender differences in the gradient within the context of marriage. Assortative mating also suggests that these differences will be greatest outside of marriage.

Second, the high degree of educational assortative mating exhibited today means it is increasingly unlikely that men's education is the dominant, upwardly driving force behind household well-being as proposed in the household hypothesis. In fact, recent research finds that the education of both spouses contributes to their mortality risks (Kravdal, 2008).

As noted earlier, we build on the work of Nathanson and Lopez (1987) and Smith and Waitzman (1994) by evaluating gender differences in the education-mortality gradient within the context of marriage. We extend their work by using a newer dataset that contains more recent cohorts and a much larger sample, although we diverge from these studies in two ways. First, we focus on adults 55 years of age and older since most deaths in the U.S. occur to this age range. Second, we select education as our measure of socioeconomic status since, compared to income and occupation, it is a more stable measure, it is available for men, women, and retired individuals, and it is more closely associated with health behaviors (Preston & Taubman, 1994; Winkleby, Jatulis, Frank, & Fortmann, 1992). Specifically, we use the combined 1986 through 1996 National Health Interview Survey Linked Mortality Files to examine the educational gradients in mortality between non-Hispanic white men and women 55 years of age and older. We first test whether the gender difference in gradient is statistically different when aggregating across all marital statuses, and then test for differences within each marital status. Where we find significant gender differences, we compare leading causes of death to more systematically assess the behavioral hypothesis. We also evaluate whether men's steeper gradient is due to a stronger influence on household well-being by simulating whether the gradient among married women becomes steeper and converges toward the gradient for married men once we replace wives' education with their husbands' education.

METHODS

Data

Our data come from the public-use National Health Interview Survey Linked Mortality Files (NHIS-LMF). The NHIS is a cross-sectional survey that has been conducted annually since 1957 and is the primary source of health information on the civilian, non-institutionalized population of the United States (NCHS, 2005). Through household interviews, the NHIS collects information on approximately 100,000 individuals each year. The National Death Index (NDI) is a computerized database of all certified deaths in the United States since 1979. The public-use NHIS-LMF links adult respondents in the NHIS to death records in the NDI through a probabilistic matching algorithm (Lochner, Hummer, Bartee, Wheatcroft, & Cox, 2008; NCHS, 2005). Our data contain NHIS years 1986 through 1996 with respondents linked to the NDI for mortality follow-up through December 31, 2002.

Sample

We select non-Hispanic white adults between 55 and 84 years of age at the time of their NHIS survey, which corresponds to 55 to 100 years of age at death if the adult died during the follow-up period. We focus on non-Hispanic whites because family structures (Spain & Bianchi, 1996) and educational gradients (Jemal et al., 2008) vary by race/ethnicity which warrants separate analyses for each group. We restrict our sample to individuals 55 to 84 years at time of survey for three reasons. First, 88% of deaths to non-Hispanic whites occur after age 55 (Kung, Hoyert, Xu, & Murphy, 2005) ensuring that our findings are relevant for most deaths among this population. Second, because we are interested in the mortality of never married adults, establishing a lower limit of 55 years ensures a sufficiently long exposure to any lifestyle and risk factors associated with a never married status. Third, in preliminary analyses, we discovered that the matching of death certificates among women after ages 80-85 years at survey was less successful than it was for men which could bias the results.

Among the 181,780 non-Hispanic white adults between 55 and 84 years of age interviewed between 1986 and 1996, we excluded 0.9% from further analysis because they were missing information on educational attainment or marital status. These selection criteria resulted in a final analytic sample of 180,208 adults with 63,058 of them identified as subsequent deaths in the NDI. Table 1 contains key demographic information for the final analytic sample.

Methods

We estimate Cox proportional hazards models to test whether the educational gradients among men and women are statistically different. These models estimate the relative risk of death during the follow-up period for adults with less than a high school education, a high school education, or some college, using a college degree or higher as the reference group. The relative risk of death for individuals with a college degree or higher is, by definition, 1.0 and the relative risks of death for individuals with less than a college degree are anticipated to be greater than 1.0. The incremental increases in the relative risks between higher and lower education levels indicate the steepness of the educational gradient.

Marital status is assessed at the time of interview and is categorized as married, never married, divorced or separated, or widowed, as well as two aggregated categories which include the unmarried (never married, divorced, separated, or widowed) and the previously married (divorced, separated, or widowed). Model predictors include age, cohort, gender, education, and the interaction between gender and education. *Age* at time of survey is a continuous measure ranging from 55 to 84 years. *Cohort* is a categorical variable identifying three 10-year cohorts. It identifies individuals 55 to 64 years (reference group), 65 to 74 years, or 75 to 84 years at the time of survey. *Gender* is a dichotomous indicator using females as the reference group. We used a categorical specification of education defined above based on our model fit tests and the analysis of Backlund and colleagues (Backlund, Sorlie, & Johnson, 1999) who found a categorical specification exhibited a better model fit than a linear specification for predicting mortality. A categorical specification also allows gender differences to exist along portions of the gradient. We compared model fits using a likelihood-ratio chi-square test and the BIC test (available on request). Both tests preferred the categorical specification when aggregating across all marital statuses, for married adults, and for unmarried adults as a group, but the tests gave conflicting support for detailed unmarried statuses. Because others report similar (Zajacova & Hummer, under review) or better (Zajacova, 2006) model fit using a linear specification, we also show a model using a linear term for comparison.

For each marital status, we estimate three models. Model 1 includes the main effects of age, cohort, gender, and education. Model 2 adds the education by gender interaction. A statistically significant interaction between education and gender indicates a gender difference in the educational gradients within a given marital status. Model 3 re-estimates model 2 using a linear specification of education. All models were estimated with SUDAAN (SUDAAN, 2005) to account for sampling weights and survey design of the NHIS-LMF.

To evaluate the behavioral hypothesis, where we find significant gender differences in the education-mortality gradient, we compare these men and women with respect to the four leading causes of death in the United States (Kung et al., 2005). These four cause-specific death categories include the following underlying causes of death from the ICD-10 113-group recodes: diseases of the heart (55-68), cancers from all sites (20-43; we exclude skin cancer), cerebrovascular diseases (70), and chronic lower respiratory diseases (83-86). Although lung cancer is included within the cancer from all sites category, we also examine it separately since Nathanson and Lopez (1987) speculated that the relatively high prevalence of smoking among low income men may contribute the steeper gradient for men overall.

To evaluate the household hypothesis, we estimate three additional models that replace married adults' own education levels with various measures of household education. The first model replaces women's education with their husband's education, while the second replaces both spouses' education with their maximum education, and the third replaces both spouses' education with their median education. A similar approach has been used with occupational data (Krieger, Chen, & Selby, 1999). We estimate the median from our categorical specification of education (1 = less than high school; 2 = high school; 3 = some college; 4 = college) such that a median of 1 indicates both spouse have less than a high school education, a median of 1.5 indicates one spouse has less than a high school education while the other has a high school education, et cetera. We interpret our results as follows. If the educational gradient for married women is weaker than that for married men when modeling one's own education, yet becomes similar to men's when given their husband's education, then this supports the hypothesis that the health of married households is disproportionately influenced by men's education. Conversely, if those gradients diverge, or if the gradients for men and women become steeper and similar using the median education, then this contradicts the household hypothesis, and instead supports the notion that the education of both spouses contributes to household well-being.

RESULTS

[TABLE 1 ABOUT HERE]

Table 1 presents a summary of key demographic characteristics of our analytic sample. A few gender differences in the distributions of marital status and educational attainment are noteworthy. First, women were less likely to be married and more likely to be widowed. Just 57% of women were married compared to 83% of men, while 31% of women were widowed compared to just 7% of men. Although a similar proportion of men and women reported very low levels of education, almost twice as many men reported a college education. Specifically, 31% of men and women reported having less than a high school degree, whereas 21% of men and 11% of women reported having a college degree. The distribution of educational attainment within marital statuses reveals a sharp contrast between never married women and men in these cohorts. Never married women had the highest education levels compared to other women and to never married men, whereas never married men had relatively low education. In fact, never married women were more likely to have a college degree than any other combination of gender and marital status.

[TABLE 2 ABOUT HERE]

Table 2 reports the relative risks of death estimated from Cox proportional hazards models. Models 1a-c estimate the relative risks of death across all marital statuses. A relative risk of 1.631 for males in model 1a means that the risk of death for men is 100(1.631-1)=63.1% greater than the risk for women, the reference group (Teachman & Hayward, 1993). As expected, the risks are greater for men, for individuals without a college degree, and the risks increase with age. Consistent with previous reports that the educational gradient is visually steeper for men than women (Feldman et al., 1989; Jemal et al., 2008; Lin et al., 2003; Molla et al., 2004; Nathanson & Lopez, 1987; Preston & Taubman, 1994; Rogot et al., 1992; Singh & Siahpush, 2001), the education-by-gender interactions are statistically significant in model 1b and they are all greater than 1.0. The risk of death for men with a high school degree or less is roughly 9% greater than the risk we would expect on the basis of gender and education alone. These findings support previous reports that the educational gradient is significantly steeper for men than for women when aggregating across marital statuses.

Models 2b and 3b in Table 2 show the relative risks of death for married and unmarried adults, respectively. Among married adults, we find little evidence that the educational gradients in mortality are different between men and women. In contrast, we find a significant gender difference in the gradients among unmarried adults. Unmarried men with less than a high school education exhibit significantly higher mortality risks than their female counterparts. Excluding never married adults from model 3b, the model for previously married adults in 4b shows that these men with a high school education exhibit significantly higher mortality risks than their female counterparts. Gradient comparisons within specific unmarried statuses are shown in models 5b, 6b and 7b. The only specific unmarried status that retains a statistically significant education-by-gender interaction is never married adults, with striking gender differences among those with less than a high school education. The relatively small sample sizes among the detailed statuses may preclude finding other differences however. Figure 1 depicts the gradients.

[FIGURE 1 ABOUT HERE]

Taken together, we find that the gradient is steeper for men than for women when aggregating across marital statuses. However, Table 2 and Figure 1 reveal that unmarried men are primarily responsible for the steeper gradient. More specifically, never married men exhibit a steeper gradient along the primary and secondary education segment, while previously married men exhibit a steeper gradient along the post-secondary segment. These results provide initial support for the behavioral hypothesis because significant differences in the gradients are limited to unmarried adults. We now examine whether unmarried men are more likely to die from causes that are more behaviorally linked than their female peers.

Table 3 compares the four leading underlying causes of death between unmarried men and women, and between never married men and women with less than a high school education. These groups were chosen for further analysis because they exhibited significant gender differences in the educational gradient in Table 2. Columns A1 and A2 compare unmarried men and women with a high school education or less ("low education"). At all ages of death, these women were significantly less likely to die from lung cancer than men. After age 74, these women were also less likely to die from chronic lower respiratory diseases (CLRD), of which smoking is a major risk factor. Consistent with data for the U.S. population overall (Kung et al., 2005), these women were more likely to die from cerebrovascular diseases. Columns B1 and B2 replicate the comparison among adults with some college or college ("high education") to test whether gender differences in causes of death in columns A1 and A2 apply across education levels or are unique to lower education levels. Supporting the latter, we found fewer gender differences in causes of death among unmarried men and women with high education, particularly among causes having smoking as a major risk factor. These men and women exhibited no significance differences in the proportion of deaths due to lung cancer or CLRD. However, women were more likely to die from cancers overall whereas men were more likely to die from heart disease. Lastly, columns C1 and C2 compare causes of death between never married men and women with less than a high school education. The only significant difference in causes of death was lung cancer, where men were more likely to die from lung cancer than women. However, it is important to note that the number of deaths among this subgroup is relatively small which may hinder our ability to statistically detect other differences. In sum, these patterns provide strong support for the behavioral hypothesis because the steeper gradient among unmarried men with low education is primarily responsible for the steeper gradient for men overall, with these men more likely to die from causes for which smoking is a risk factor.

[TABLE 3 ABOUT HERE]

Based on model 2b in Table 2, there is little evidence to support the household hypothesis since we did not find significant gender differences in the gradient among married adults. However, we continue with the proposed analysis to see whether, at least directionally, we find marginal support for this hypothesis. Figures 2a-d display the educational gradients for married men and women using their own education levels and three measures of household education estimated with the model form used in 2b from Table 2. Figure 2a shows the gradient using one's own education. Figure 2b displays the gradients when married women's education is replaced by their husband's education. Because the women's gradient did not become steeper and converge toward the male gradient, we find little evidence that men's education is the primary determinant of household health. In fact, the strong departure from the original gradient in Figure 2a suggests that household health is influenced by both spouses' education. This interpretation is further supported by Figures 2c and 2d. Figure 2c displays marginally flatter gradients for both men and women when the maximum household education is modeled for each spouse, signaling that relevant information has been lost in the model. Finally, the sharpest gradient appeared when the median household education was modeled for each spouse, supporting the notion that education is a household resource to which both spouses contribute. The models behind Figures 2a-d are available on request.

[FIGURE 2 ABOUT HERE]

DISCUSSION

Our findings for non-Hispanic white men and women aged 55 years and older in the 1986-2002 period confirm earlier reports that the educational gradient in mortality is visually steeper for men than for women. Furthermore, we find this difference is statistically significant when aggregating across marital statuses. However, our analyses reveal that the steeper gradient for men overall reflects a steeper gradient among unmarried men. Never married men exhibit a steeper gradient along the primary and secondary education segment, while previously married men exhibit a steeper gradient along the post-secondary segment. We did not find significant differences in the gradient between married men and women, which might be expected based on education's central role in assortative mating in the United States. Our results align with other research that found a strong synergistic effect between low income and unmarried status among working age men (Smith & Waitzman, 1994), and with the hypothesis that the health behaviors and health status of men with low socioeconomic status are particularly vulnerable to a lack of health-enhancing social ties such as marriage (Nathanson & Lopez, 1987).

Our tests of two hypotheses to explain the steeper gradient among men provided strongest support for the behavioral hypothesis. Our finding that significant differences in the gradient were limited to unmarried adults, combined with the finding that unmarried men with a high school education or less were more likely than their female peers to die from causes for which smoking is a major risk factor, provides compelling support for the behavioral explanation originally proposed by Nathanson and Lopez (1987). Moreover, the lack of significant differences in these causes of death between unmarried men and women with at least some college indicates a convergence of health behaviors with increasing education.

It is well documented that both informal (e.g., marriage) and formal (e.g., workplace, medical care) social supports reduce mortality risks (Litwak & Messeri, 1989). Unmarried, low educated men do not benefit from marriage as a key informal support and they likely have less access to high quality formal supports due to their low education and compromised occupational opportunities. Although their female counterparts may also have less access to formal supports, women tend to have larger and closer personal networks than men (McPherson, Smith-Lovin, & Brashears, 2006), which may partly compensate for a lack of spousal support. In fact, unmarried women report more attempts by others to regulate their health behaviors than unmarried men, and this gender gap is most pronounced among the never married (Umberson, 1992). We found the most dramatic gender disparity in the gradient among never married adults with less than a high school education.

We found little evidence to support the household hypothesis that posits educational gradients in mortality are steeper for men because household health is disproportionately influenced by men's education levels. In fact, the gradients between married men and women in our sample were remarkably similar, corroborating a previous U.S. study (Zajacova, 2006). Our simulation of the gradients using various measures of household education in lieu of individual education suggests that mortality risks are likely shaped by the combined education of the household in addition to one's own education. This accords with research using occupational status (Krieger et al., 1999), with research that demonstrates that the education of both spouses influences their mortality risks regardless of gender (Kravdal, 2008), and with the notion that resource pooling, broadly defined, among spouses inextricably links their health experience (Lindau, Laumann, Levinson, & Waite, 2003). Although we found little support for this hypothesis in our cohorts who exhibit a high degree of assortative mating, it may hold for others with large, systematic disparities in education or occupation statuses between spouses (Arber, 1987). Further, the patterns we found may not apply to younger cohorts where socioeconomic gradients are generally steeper and marriage benefits for health are generally larger.

In ancillary analyses (available on request) we examined whether greater financial returns to education for unmarried men compared to unmarried women might also contribute to their steeper gradient. We found little support for this alternative explanation. Controlling for income did not materially change the magnitude or significance of the education-by-gender interactions for unmarried adults which concurs with other studies of gender differences in the educational gradient of mortality (Zajacova, 2006) and depression (Ross & Mirowsky, 2006). Yet, an economic explanation should be fully vetted using a dataset that contains appropriate economic measures for this age group, such as wealth, before it is dismissed. The NHIS-LMF does not collect information on wealth, and the detailed income measure it does provide is top coded at $50,000 with roughly one-quarter of the sample not providing this data. Thus, our ancillary analyses relied on a summary income measure that was available for most of our sample that simply indicated whether or not annual family income was above $20,000.

Our study has several strengths including its recent and large nationally representative sample, as well as information on causes of death as indicators of risk factors. A few limitations must be noted however. First, marital status is assessed once at the time of survey. We set the lower age limit at 55 years at the time of survey to minimize the potential for subsequent transitions into (re)marriage and to allow us to detect the effect that at least 55 years of being never married has on mortality. A second limitation is that we cannot rule out selection effects. Both positive selection and protective effects likely contribute to the marriage advantage for mortality (Murray, 2000). The low educated, never married men in our sample may have experienced a lifetime of poor health, making them undesirable spouses and accelerating their mortality risks regardless of compromising health behaviors. Third, we measure only one type of informal social support. Thus, we cannot account for other informal sources such as parents, children, extended family, friends or colleagues. Finally, our sample sizes of deaths for never married persons with less than a high school education are relatively small which may hide important clues about their cause of death structure and previous lifestyle and risk factors.

Taken together, our results present new and important findings about the educational gradients in mortality among men and women of various marital statuses. As an increasing proportion of men approach their retirement years outside of a marital union, the role of education in reducing their mortality risks is perhaps more important than ever. Future research should evaluate these patterns for other race and ethnic groups, as well as working age adults, since the patterns we found may not apply to these populations. Finally, we encourage similar analyses using data from other countries that also exhibit gender differences in the gradients.

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TABLE 1. Demographic Characteristics of Sample

	Women					Men				
Characteristic	All	Never married	Married	Div or sep	Widow	All	Never married	Married	Div or sep	Widow
Average age (years)	67.5	68.7	65.3	64.6	72.2	66.4	66.2	66.1	63.9	72.3
Cohort (%)										
55-64 years	40.1	34.7	50.5	56.1	17.6	45.0	46.6	46.3	58.9	17.1
65-74 years	37.4	37.6	36.9	32.3	39.7	37.4	36.4	37.6	32.1	40.5
75-84 years	22.5	27.6	12.6	11.6	42.7	17.5	17.0	16.1	8.9	42.4
Marital status (%)										
Never married	4.0	---	---	---	---	3.8	---	---	---	---
Married	57.0	---	---	---	---	83.2	---	---	---	---
Divorced or separated	7.9	---	---	---	---	5.9	---	---	---	---
Widowed	31.1	---	---	---	---	7.1	---	---	---	---
Education (%)										
Less than high school	30.8	25.5	26.0	26.9	41.1	31.3	37.4	30.0	33.2	42.5
High school	43.3	36.1	46.9	41.2	38.0	33.8	30.2	34.4	30.3	31.7
Some college	14.7	13.0	15.3	18.0	13.1	14.1	11.9	14.2	15.8	12.1
College	11.2	25.4	11.8	13.8	7.7	20.8	20.6	21.4	20.7	13.6
Number of deaths	31,325	1,448	13,750	2,211	13,916	31,733	1,394	25,077	1,930	3,332
Percent of deaths	31.3	36.8	24.1	28.5	44.5	39.6	45.4	37.5	41.5	59.0
N	100,004	3,939	57,037	7,766	31,262	80,204	3,070	66,833	4,652	5,649

Notes: Data are from the NHIS-LMF using NHIS 1986-1996 with mortality follow-up to 2002. Percents are weighted to reflect sampling design. The category "college" includes college degree or higher.

TABLE 2. Relative Risks of Death During Follow-Up Estimated from Cox Proportional Hazards Models

	All Marital Statuses			Married			Unmarried			Previously Married			Never Married		
	1a	**1b**	**1c**	**2a**	**2b**	**2c**	**3a**	**3b**	**3c**	**4a**	**4b**	**4c**	**5a**	**5b**	**5c**
Age (years)	1.088**	1.088**	1.088**	1.092**	1.092**	1.092**	1.075**	1.075**	1.075**	1.075**	1.075**	1.074**	1.076**	1.076**	1.076**
Cohort (55-64)															
65-74 years	1.026	1.026	1.030†	1.001	1.001	1.003	1.034	1.033	1.040	1.044	1.044	1.050	0.971	0.970	0.978
75-84 years	1.061†	1.061†	1.065*	1.035	1.034	1.034	1.076	1.075	1.085	1.080	1.080	1.089	1.058	1.059	1.070
Male	1.631**	1.511**	1.776**	1.721**	1.658**	1.731**	1.742**	1.617**	1.840**	1.737**	1.622**	1.792**	1.773**	1.623**	2.134**
Education (college)															
Less than HS	1.565**	1.481**		1.605**	1.570**		1.444**	1.399**		1.420**	1.385**		1.543**	1.392**	
HS	1.297**	1.229**		1.328**	1.282**		1.231**	1.194**		1.212**	1.174**		1.294**	1.303**	
Some college	1.210**	1.147**		1.222**	1.171**		1.170**	1.130**		1.149**	1.113**		1.262**	1.208†	
Education[a]			0.963**			0.956**			0.970**			0.969**			0.974**
Gender*Education															
Male*less than HS		1.091**			1.028			1.088†			1.064			1.226†	
Male*HS		1.089**			1.050			1.082			1.098*			0.990	
Male*some college		1.088*			1.061			1.103			1.095			1.107	
Gender*Education[a]			0.992**			0.999			0.994			0.997			0.984†
$-2LL_{i-1}-(-2LL_i)$[b]	32200**	11*	-130**	21482**	2	-84**	9164**	3	-46**	7971**	3	-35**	1169**	7†	-17**
Number of Deaths	63,058	63,058	63,058	38,827	38,827	38,827	24,231	24,231	24,231	21,389	21,389	21,389	2,842	2,842	2,842
N	180,208	180,208	180,208	123,870	123,870	123,870	56,338	56,338	56,338	49,329	49,329	49,329	7,009	7,009	7,009

Notes: Data are from the NHIS-LMF using NHIS 1986-1996 with mortality follow-up to 2002. Models are weighted and adjusted for the sampling design of the NHIS-LMF. The reference category "college" includes college degree or higher.

**$p \leq 0.01$; *$p \leq 0.05$; †$p \leq 0.10$

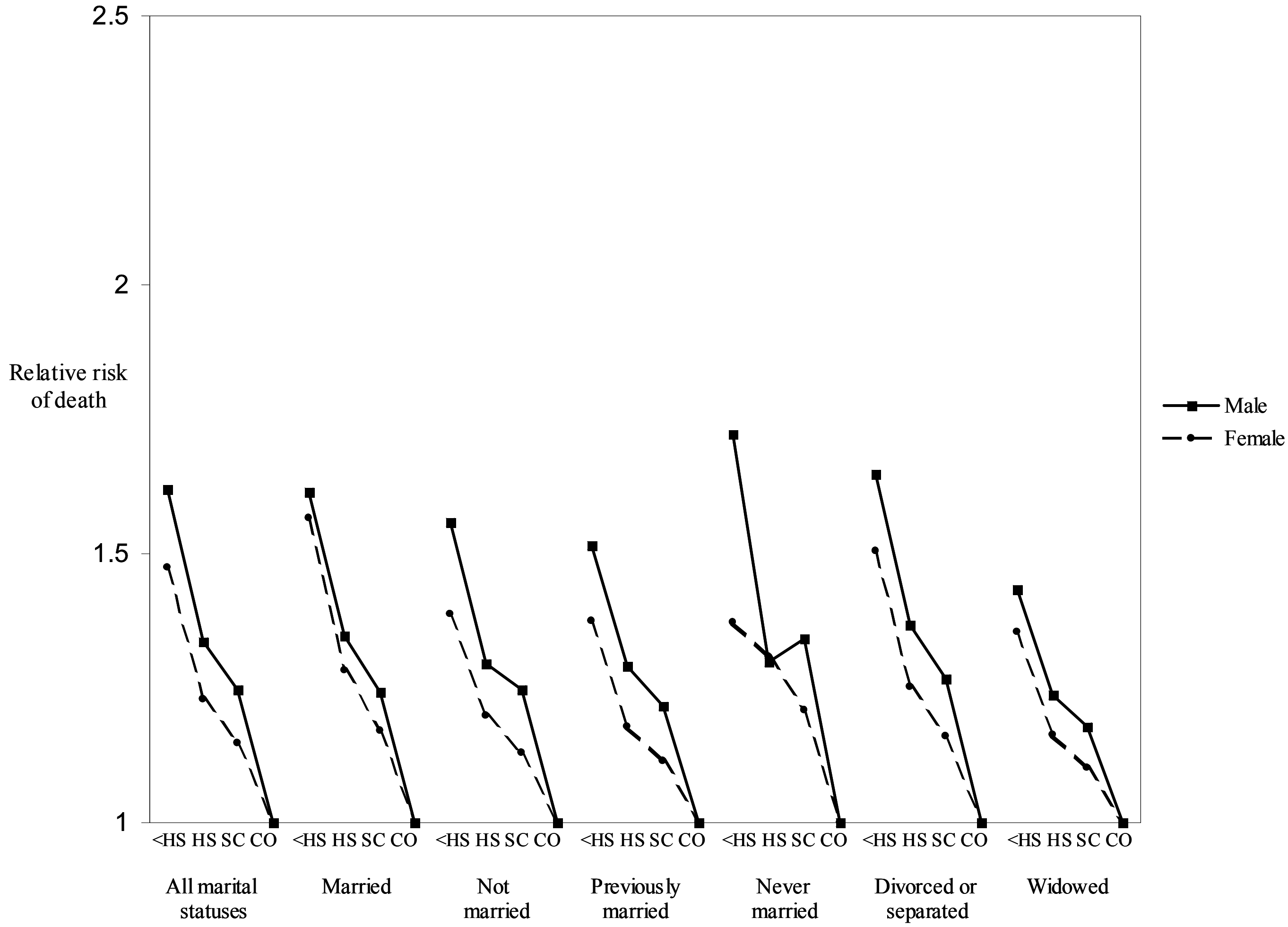
[a] Used as a continuous measure of education in model c only.

[b] Model c is not nested within model b, so the difference in chi-square statistics is negative when model b fits better.

TABLE 2, continued.

	Divorced/Separated			Widowed		
	6a	**6b**	**6c**	**7a**	**7b**	**7c**
Age	1.081**	1.081**	1.079**	1.075**	1.075**	1.075**
Cohort (55-64)						
65-74 years	1.036	1.035	1.046	1.039	1.039	1.044
75-84 years	1.017	1.015	1.036	1.089	1.089	1.094
Male	1.823**	1.708**	1.960**	1.675**	1.600**	1.643**
Education (college)						
Less than HS	1.588**	1.531**		1.373**	1.359**	
HS	1.313**	1.254**		1.180**	1.158**	
Some college	1.219**	1.165†		1.122**	1.101*	
Education[a]			0.959*			0.971**
Gender*Education						
Male*less than HS		1.064			1.031	
Male*HS		1.089			1.079	
Male*some college		1.085			1.076	
Gender*Education[a]			0.993			1.001
$-2LL_{i-1}-(-2LL_i)$	1783**	1	-1	5626**	2	-30**
Number of Deaths	4,141	4,141	4,141	17,248	17,248	17,248
N	12,418	12,418	12,418	36,911	36,911	36,911

FIGURE 1. Educational Gradients by Gender and Marital Status



Notes: Data are from the NHIS-LMF using NHIS 1986-1996 with mortality follow-up to 2002. Relative risks estimated from Cox proportional hazard models controlling for age and cohort. Education categories are less than high school (<HS), high school (HS), some college (SC), or college degree or higher (CO)

TABLE 3. Percent of Death Certificates Listing A Top Four Underlying Cause of Death

	(A1) Reference		(A2) Gender contrast		(B1) Reference		(B2) Gender contrast		(C1) Reference		(C2) Gender contrast	
	Male Unmarried Low education[a]		Female Unmarried Low education[a]		Male Unmarried High education[a]		Female Unmarried High education[a]		Male Never married Less than HS		Female Never married Less than HS	
Age 55-74 at death	%	95% CI	%	95% CI	%	95% CI	%	95% CI	%	95% CI	%	95% CI
Heart disease	33.5	(31.4, 35.6)	30.5	(28.7, 32.4)	31.3	(28.1, 34.4)	25.5†	(22.0, 29.1)	37.8	(32.1, 43.6)	32.4	(22.8, 42.0)
All cancers except skin	30.5	(28.1, 32.8)	33.4	(31.7, 35.1)	30.6	(27.2, 33.9)	41.8*	(38.1, 45.5)	27.0	(21.1, 32.8)	30.8	(24.7, 36.9)
Lung cancer	14.6	(12.9, 16.3)	12.1†	(10.8, 13.4)	13.5	(11.1, 15.9)	15.1	(12.3, 18.0)	14.1	(10.3, 17.9)	7.5†	(4.7, 10.3)
Cerebrovascular diseases	4.5	(3.4, 5.5)	4.8	(3.9, 5.6)	4.1	(2.5, 5.6)	5.1	(3.3, 6.8)	4.6	(2.1, 7.2)	5.1	(0.9, 9.4)
CLRD[b]	8.0	(6.7, 9.2)	9.0	(7.9, 10.2)	5.5	(3.4, 7.6)	5.7	(4.1, 7.3)	5.9	(3.4, 8.5)	5.3	(0.6, 10.1)
N (All deaths, all causes)	1,864		2,946		696		792		275		111	
Age 75-100 at death												
Heart disease	40.2	(38.3, 42.0)	37.8	(36.7, 38.9)	39.5	(36.1, 43.0)	36.4	(34.5, 38.3)	42.6	(37.6, 47.7)	47.0	(41.0, 53.0)
All cancers except skin	19.5	(18.0, 20.9)	16.3 *	(15.5, 17.1)	20.7	(18.1, 23.3)	18.8	(17.1, 20.4)	17.6	(13.0, 22.1)	11.4	(6.8, 16.0)
Lung cancer	6.8	(5.8, 7.8)	3.7*	(3.3, 4.1)	6.3	(4.5, 8.1)	5.0	(4.2, 5.9)	4.1	(1.7, 6.4)	1.0†	(0, 1.9)
Cerebrovascular diseases	6.3	(5.4, 7.2)	9.6*	(9.0, 10.3)	6.0	(4.4, 7.6)	11.0*	(9.7, 12.3)	7.3	(4.7, 9.9)	7.6	(4.6, 10.5)
CLRD	7.3	(6.4, 8.2)	5.6*	(5.1, 6.0)	4.3	(3.0, 5.7)	5.5	(4.7, 6.4)	6.1	(3.5, 8.7)	2.9	(1.3, 4.5)
N (All deaths, all causes)	3,195		11,109		901		2,728		387		360	
N (All deaths, all causes)	**5,059**		**14,055**		**1,597**		**3,520**		**662**		**471**	

Notes: Data are from the NHIS-LMF using NHIS 1986-1996 with mortality follow-up to 2002. Percents adjusted for NHIS-LMF sample design and weights.

[a] Low education includes less than high school and high school. High education includes some college and college degree or higher.

[b] CLRD refers to chronic lower respiratory disease.

*p<0.05; † p<0.10.

FIGURE 2. **Educational Gradients among Married Adults Using Own Education, Husband's Education, Maximum Spouse Education, and Median Spouse Education**