Educational Attainment and Adult Mortality

Chapter · January 2011

DOI: 10.1007/978-90-481-9996-9_12

2 authors:

Robert A Hummer
University of North Carolina at Chapel Hill
139 PUBLICATIONS **5,231** CITATIONS
SEE PROFILE

Joseph Lariscy
The University of Memphis
9 PUBLICATIONS **136** CITATIONS
SEE PROFILE

Chapter 12

Educational Attainment and Adult Mortality

Robert A. Hummer and Joseph T. Lariscy

Introduction

Throughout the twentieth century, adult mortality rates in the United States and in all high-income countries exhibited impressive declines. The latter half of the twentieth century was characterized by well-documented differences in adult mortality rates across categories of educational attainment (Elo and Preston 1996; Kitagawa and Hauser 1973; Lauderdale 2001; Rogers et al. 2000), a social fact that now garners much greater concern and research attention than perhaps ever before. Clearly, socioeconomic mortality differentials—including those by educational attainment—stand at the heart of the public health agenda of the United States. This was not always the case. Indeed, education was added to the US Standard Certificate of Death only in 1989; before then, researchers had little readily available data to examine socioeconomic differentials in mortality (Moss and Krieger 1995). Theoretical and empirical understanding of socioeconomic mortality differentials was also hampered by a relative lack of academic interest. Demographic and epidemiologic studies in the 1950s through the 1970s largely downplayed socioeconomic health and mortality differences because of more pressing interest in other topics (Krieger et al. 1993). Because of growing awareness of and concern over social inequalities since that time, as well as substantial improvements in available data and computing power, a new generation of studies in social demography and social epidemiology has focused on the link between socioeconomic and survival inequalities (Hoffmann 2008; Hummer et al. 1998). Moreover, because life itself is such a treasured resource, it stands to reason that wide socioeconomic differences in mortality signal critical inequalities in the way that social structure works to differentiate the life chances of individuals. Thus, the topic of educational differences in adult mortality is not only one of immense scientific and public policy interest, but also one related to issues of opportunity, equity, and fairness within societies.

Beyond the radical improvements in human survival across the twentieth century and the growing recognition of wide educational differences in adult mortality, there were phenomenal changes in education itself that need to be considered to elucidate the link between educational attainment and adult mortality. The distribution, content, and importance of education have changed in fundamental ways over time. Younger individuals tend to have higher levels of education, have been exposed to more sophisticated content than ever before, and have more at stake on their education than individuals in previous cohorts. In terms of distribution, data from the United States illustrate that a higher percentage of individuals graduate from high school and college now than ever before. The percentage of US persons aged 25 and older who were high-school graduates was 41 in 1960, 52 in 1970, 66 in 1980, 78 in 1990, and 84 in 2005–2007 (US Census Bureau 2009). These percentages reflect the steadily increasing levels of education across birth cohorts in the United States. Recent high-school graduates have been exposed to more ideas about health promotion and disease prevention than graduates from decades ago. Students learn about the hazards of smoking, the importance

R.A. Hummer (✉)
Department of Sociology and Population Research Center, University of Texas, Austin, TX 78712, USA
e-mail: rhummer@prc.utexas.edu

R.G. Rogers, E.M. Crimmins (eds.), *International Handbook of Adult Mortality*, International Handbooks of Population 2, DOI 10.1007/978-90-481-9996-9_12, © Springer Science+Business Media B.V. 2011

of diet and exercise, the risk of sexually transmitted diseases, and the prevention of air-, water-, and food-borne diseases (Lynch 2003). Moreover, recent cohorts of people with higher levels of education are taught to deal with such day-to-day complexities as navigating new forms of communication, interacting effectively in the health care setting, and working with people in different cultures and countries. These dramatic educational changes affect not only their ability to navigate an increasingly fluid and global labor market, but also their health and, ultimately, their length of life.

With these immense mortality and educational changes in mind, the overall aim of this chapter is to review current knowledge on adult mortality differences by educational attainment. We focus largely on the United States because that is where our expertise is greatest, and because the enormous size of this literature makes it impossible to provide in-depth international coverage in a single chapter. Moreover, reducing educational differences in mortality is a key goal for *Healthy People 2010* and will likely be one for *Healthy People 2020* when its goals, objectives, and action plans are released sometime in 2010 (U.S. Department of Health and Human Services [DHHS] 2008); thus, it is clear that this is a pressing area of scientific and policy concern in the United States.

This chapter first presents a conceptual framework for understanding educational differences in adult mortality. Second, we document the basic patterns of association between educational attainment and adult mortality using contemporary data from the United States. Third, we give substantial attention to how the education–mortality relationship varies by age, gender, and race/ethnicity, and over time. Although this review and our empirical examples focus primarily on the United States, we then briefly discuss this relationship in an international context. Finally, we discuss policy and future research issues in this area of study.

Conceptual Framework

Measuring Education

Educational attainment, the focus of this chapter, is one of the principal components of socioeconomic status (SES), the others being occupation, income, and wealth (see, for example, Chapter 13 by Krueger and Burgard, 2011, this volume). There are several very important reasons for using educational attainment as the key indicator of SES when studying socioeconomic differentials in adult mortality (Preston and Taubman 1994). First, educational attainment is most often completed relatively early in adult life and usually remains constant throughout adulthood. In contrast, occupational status, income level, and the accumulation of wealth may vary in considerable ways throughout the life course and, at least in part, respond to health fluctuations (Smith 2004). Second, it follows that educational attainment may be more relevant than other measures of SES for individuals who have retired, are currently unemployed, or are out of the labor force. Third, survey and census respondents, as well as informants on death certificates, are more likely to report educational attainment (and with reasonable accuracy) than to report other socioeconomic indicators, particularly income and wealth. Thus, using educational attainment rather than income or wealth tends to prevent exclusion of individuals from study populations because of missing or imprecise data. Fourth, the use of educational attainment rather than income, occupational status, or wealth may make international comparisons more relevant because of the commonalities in educational systems across national contexts (Valkonen 1993). Finally, educational attainment typically precedes occupational status, income, and the accumulation of wealth in both the life course and the causal sense. Thus, we advocate using educational attainment as the most fundamental indicator of SES in studies of adult mortality, though we acknowledge that the choice of indicator must be made with substantial thought and attention to the purpose of the study at hand (Braveman et al. 2005).

Most studies focusing on educational attainment and adult mortality measure educational attainment using a single indicator of years of completed schooling. Such an indicator is used either in a continuous fashion with values ranging from 0 to 17 or so (e.g., Zajacova 2006) or in a set of categories that demarcate important cut-points (e.g., 0–11, 12, 13–15, and 16 or more years) in the distribution of degrees that are usually awarded after a certain number of years of attained education (e.g., Rogers et al. 2000). Backlund et al. (1999) specifically tested whether a continuous or categorical specification of years of education best captured the functional form of the relationship between educational attainment and

working-aged adult mortality risk in the United States. They found that educational attainment was best specified in a trichotomous categorization (less than a high-school diploma, a high-school diploma but no college degree, or a college degree or more) rather than as a continuous predictor of mortality risk. At the same time, another recent paper using US data shows that both a continuous measure of educational attainment and a six-category scheme yield valuable insights that are obscured when only one or the other specification is used (Zajacova and Hummer 2009; also see Elo and Preston 1996). Clearly, researchers should continue to examine the functional form of the education–mortality relationship, most specifically to best determine where in the educational distribution mortality risks are highest and lowest and especially as this relationship changes across time and varies across place.

It is also the case that a single measure of educational attainment based on years of completed schooling misses out on capturing the full extent to which education, in a broader sense, is related to adult mortality risks. One potential line of research is to examine actual degrees awarded, rather than (or, preferably, in addition to) years of schooling. Rogers et al. (2010), for example, show that US adults who have completed some college but without any postsecondary degrees have a 6% lower mortality risk than do high-school diploma holders across a 5-year follow-up period, while persons with an associate of arts degree have an 18% lower mortality risk than do those with a high-school diploma. Measures of the content of educational attainment—quality of education received, courses taken, skills learned, and mastery of the subject matter—are almost never available in population-based data sets that are large enough to analyze mortality risks. Given such a crucial data limitation, we probably know much less about the relationship between education and adult mortality risk than the large array of previous studies might suggest. Much more work that considers a variety of education indicators and subsequent mortality risks is needed.

Beyond individual-level measures of education, some research has examined the influences of a broader set of educational context measures—such as the educational levels of families and neighborhoods—on the mortality risks of individual adults. For example, studies by Jaffe et al. (2005) and Brown et al. (2009) have shown that, among married couples, a spouse's level of education importantly influences individual mortality risk, even after accounting for the individual's own level of education. Similarly, Huie et al. (2002) showed that, net of a range of individual-level factors that include individuals' own educational attainment, a lower level of education within neighborhoods is associated with higher mortality risks. Such work provides evidence that the relationship between educational attainment and adult mortality risk is best conceptualized in a manner that not only takes into account the individual educational characteristics of adults, but their broader educational contexts as well.

Conceptualizing the Association Between Educational Attainment and Adult Mortality

No matter what schemes they use to measure educational attainment, most studies implicitly or explicitly conceptualize that a higher level of educational attainment is associated with lower mortality risk because education helps individuals develop a very useful set of flexible resources that shape health over the life course and, ultimately, how and when individuals die. A higher level of educational attainment helps individuals acquire better and more stable employment, increase earning power, develop effective agency, attain a greater sense of personal control over their lives, and develop beneficial social connections. These resources can help more educated people earn and accumulate more money, work in stable and creative jobs, live a healthier lifestyle, live in a safer environment, and experience less stress and more social support than less-educated people (Mirowsky and Ross 2003). This conceptualization emphasizes that education provides resources well beyond increased income. In a broad sense, education helps individuals to learn by improving reading comprehension, increasing writing skills, enabling learners to better follow important instructions, teaching abstract reasoning skills, creating a future-oriented way of thinking, and facilitating effective and efficient problem solving. Compared to less-educated individuals, highly educated individuals are also more likely to exercise, abstain from tobacco use, maintain a healthy body weight, and incorporate new health knowledge into their lives. In short, "education enables people

to coalesce health-producing behaviors into a coherent lifestyle that improves health" (Mirowsky and Ross 2003: 52). These positive influences of education persist throughout the life course, long after the formal completion of schooling.

The strength and consistency of the inverse relationship between educational attainment and mortality risk over time, across different places, and among individuals in different demographic groups suggests that education is a "fundamental cause" of health and mortality (Link and Phelan 1995; Phelan et al. 2004). That is, the mechanisms by which education works to influence mortality risks—discussed above—are broad and varied, and can and do change over time. As a result, while the mechanisms that link educational attainment to mortality risk may vary across contexts, the flexible resources that are shaped by educational attainment help to make educational differences in adult mortality very resistant to change. In the section on policy implications below, we comment on the immense challenge that this fundamental cause perspective poses to program and policy initiatives that aim to close education–mortality gaps.

The discussion thus far strongly suggests that educational attainment works in a causal fashion to influence adult mortality risk. And indeed, a growing and creative econometric literature demonstrates that a substantial portion of the association between educational attainment and adult health and mortality risk does seem to be due to the causal influences of higher levels of schooling (Chandola et al. 2008; Glied and Lleras-Muney 2008; Lleras-Muney 2005; Smith 2004). Nevertheless, a primary concern of social and epidemiologic scientists who examine the relationship between educational attainment and mortality risk is the possibility of spuriousness. That is, there could be a set of factors—often unobserved by researchers—that influence both educational attainment and adult mortality risk that are the actual causes of this statistical relationship. For example, persons who experience poor health during childhood and adolescence, who have lower levels of intelligence, and/or whose parents were not highly educated may complete fewer years of schooling and die earlier than their counterparts, thus creating a statistical association between educational attainment and mortality risk that is actually caused by those other underlying factors (Batty and Deary 2005; Gottfredson 2004; Hoffmann 2008; Palloni 2006). Recent research that has begun to take into account some of these underlying factors—such as intelligence scores and childhood health and socioeconomic conditions—generally finds that the relationship between educational attainment and mortality risk is modestly weaker than without such controls, but still strong (Hayward and Gorman 2004; Link et al. 2008; but also see Batty et al. 2006). Clearly, this line of research remains important, perhaps most so because answers to critical policy questions will rely on a better understanding of the true causal impacts of educational attainment than most observational studies to date have been able to demonstrate.

Mechanisms Relating Educational Attainment to Adult Mortality Risk

The above section emphasizes that educational attainment is linked to adult mortality risk because it helps individuals acquire and use a set of flexible resources that improve health and lessen age-specific risks of death throughout the life course. Here, we highlight four sets of mechanisms (or mediating factors) through which educational attainment is thought to influence health and mortality risk: socioeconomic attainment, health behaviors, social psychological resources, and access to and utilization of health care (Hoffmann 2008; Mirowsky and Ross 2003; Rogers et al. 2000; Williams 1990). These mechanisms most likely do not operate with equal strength across demographic groups (age, gender, race/ethnicity), across time, or across places.

Socioeconomic Attainment. A substantial portion of the beneficial association between educational attainment and adult mortality risk is due to the increased income that individuals with higher levels of education tend to earn. Income is an immediately available economic resource that can pay for nutritious food, high-quality housing in a safe neighborhood, health insurance premiums, medical bills, and health club memberships, as well as be saved for future needs (Smeeding and Weinberg 2001). Not only does higher education enable individuals to earn more, but it may also improve spending choices. That is, even among individuals who have identical income levels, more educated individuals may be better able to navigate through bureaucracies to obtain the most for their money—for example, by finding the lowest interest

rates and closing costs on a mortgage, making use of appropriate saving and investment strategies, or effectively budgeting their income to meet their needs (Mirowsky and Ross 1998; Schnittker 2004). In turn, higher family income is associated with lower mortality risk among adults of all ages, women and men, and majority and minority populations (Krueger et al. 2003; Pappas et al. 1993; Sorlie et al. 1995).

In addition to income, higher levels of education may also work partly through employment and occupational status to decrease the risk of mortality. Education provides the skills to navigate through tedious or difficult instructions required by some jobs and even job applications. Frequently, workers need to have a certain level of education to qualify for a job or a promotion. More educated individuals may find employment in higher status professions, have more control over their own work and the work of others, be more valuable to a company, be better able to achieve work-related agendas, be viewed with greater esteem by their peers, and gain protection against the risks of job loss even during layoffs. In turn, regular employment, high status occupations, and creatively oriented jobs are associated with better health and lower adult mortality risks (Marmot 2004; Mirowsky and Ross 2007; Rogers et al. 2000; Sorlie et al. 1995).

Health Behavior. A second prominent mechanism that links educational attainment to mortality risk is health behavior. Relative to persons with less education, those with more education are more likely to exercise, refrain from heavy alcohol consumption, quit smoking or avoid smoking altogether, maintain a healthy weight, and eat more nutritious meals. Among all sociodemographic characteristics, education is the only one that correlates positively and consistently with health-enhancing behaviors (Mirowsky and Ross 1998: 419). Most important, educational attainment influences the risk of adult mortality because less-educated individuals are more likely to initiate smoking, less likely to seek out and follow antismoking advice, and less likely to quit (Rogers et al. 2005). Individuals with lower education tend to confront more immediate concerns than quitting smoking, and may smoke as a way to cope with stressful living conditions (Lawlor et al. 2003). And smoking, of course, is a leading cause of preventable mortality, associated with increased risks of mortality from a host of causes, including cardiovascular diseases, various cancers, and respiratory diseases.

In comparing mortality risks across US educational attainment groups over a 7.5-year period, Lantz et al. (1998) found that the odds ratio of mortality for the lowest to the highest education group decreased by 14% with controls for smoking, alcohol use, sedentary lifestyle, and relative body weight (also see Feldman et al. 1989). However, the strength of these behavioral mechanisms, particularly smoking, may be increasing among more recent birth cohorts because cigarette smoking in the United States has become increasingly concentrated among individuals with low levels of schooling (Meara et al. 2008). For example, Denney et al. (2010) show that smoking may account for up to 44% of the education–mortality association among working-aged US men.

Social Psychological Resources. Social psychological resources are another plausible mechanism through which higher levels of education improve health and reduce mortality (Williams 1990). Unfortunately, relatively few studies in this area use data sets that can tap into the wide array of social and psychological resources that are important for mortality risk. Research suggests that education is perhaps most important for increasing effective agency and developing a heightened sense of personal control (Mirowsky and Ross 1998). Increased agency and personal control help individuals to believe that they can effectively alter their surroundings and therefore to seek health-related information and adopt a lifestyle that enhances their health trajectories and length of life.

Additionally, more highly educated individuals may have access to other highly educated individuals—coworkers, religious leaders, friends, and neighbors—who can provide advice in times of need, reinforce healthy lifestyles, and intervene effectively and directly in a crisis. Recent research, for example, finds that marital status affects educational differences in adult mortality: educational differences are particularly wide among unmarried US men and narrower among married individuals (Montez et al. 2009). Persons with more education may also encounter fewer non-health stressors—such as marital and family problems, conflicts with friends and neighbors, legal hassles, and on-the-job troubles—that impair health and increase mortality risks (House et al. 1988; Lantz et al. 2005). Further, education may help individuals ease the impact of stressful life events such as illness and grief.

Access to and Utilization of Health Care. Some research attention has been given to the possibility that access to and utilization of health care is a mechanism linking educational attainment to mortality risk, although the consensus to date suggests that health care most likely plays only a minor mediating role (Hoffmann 2008). This may particularly be the case after accounting for the increased income associated with higher levels of education. In the United States, the implementation of Medicare in 1966 significantly improved access to health care for the elderly and reduced overall old-age mortality (Drevenstedt 2001); however, the program apparently did little to reduce socioeconomic differences in old-age mortality (Preston and Elo 1995; Preston and Taubman 1994). This was consistent with earlier findings regarding the implementation of the British National Health Service in 1946 (Pamuk 1985).

It may be that highly educated individuals are more likely than the less educated to use and successfully navigate the medical system, by seeking care from the most skilled and knowledgeable practitioners, complying with treatment regimens, and learning and retaining crucial medical information during health care visits and hospitalizations. For instance, highly educated persons adhere better to treatments for diabetes and HIV than their less-educated counterparts, resulting in improved self-rated health among HIV patients and a slower decline in self-rated health among diabetics (Goldman and Smith 2002). Relatively few population-based studies have examined such possibilities, however, particularly in relation to mortality.

Educational Attainment and US Adult Mortality: Patterns of Relative Risk

In this section, we use US public use data from the National Health Interview Survey-Linked Mortality File (NHIS-LMF; see Lochner et al. 2008) to produce current estimates of relative educational differentials in mortality. In a subsequent section, we supplement our analyses by focusing on findings from other recent studies using different data sets that examine absolute differences in mortality (in the form of life expectancy estimates) across educational attainment groups.

The NHIS is a multistage probability cross-sectional sample of the US noninstitutionalized adult population that is conducted each year by the National Center for Health Statistics (NCHS). Here we use aggregated data from years 1986 through 2000. The NHIS respondents from 1986 to 2000 are matched by NCHS to 1986–2002 death records in the National Death Index (NDI). A probabilistic algorithm is used to determine whether NHIS respondents match a death record in the NDI during this follow-up period. We chose the NHIS-LMF dataset for this because it is current and nationally representative of the noninstitutionalized US population, contains critical measures of sociodemographic characteristics related to educational attainment and adult mortality risk, has a high response rate, has an excellent record of matching to subsequent death records, and contains underlying cause of death information for respondents who died.

Because most adults complete their education by early adulthood, our analysis includes respondents 25 years old and older. We further restrict our sample to those who report that they are non-Hispanic white, non-Hispanic black, and Hispanic because sample sizes for other racial/ethnic groups are small. Moreover, we exclude a small number of individuals who did not report a value for educational attainment. Thus, our analytic sample contains 831,820 adult respondents aged 25 and over who were interviewed between 1986 and 2000, among whom 104,238 were determined to have died at some point during the follow-up period. We use Cox proportional hazard models to estimate the association between educational attainment and the risk of adult mortality across the follow-up period (Allison 1984). Our tables depict results from the models in the form of hazard ratios, with persons who have 12 years of education (or a completed high-school degree) serving as the reference category of educational attainment in all models. Thus, in each model hazard ratios above one indicate a higher risk of mortality for a particular education category compared to persons with 12 years of education, while hazard ratios below one indicate a lower risk. Analyses were performed in SUDAAN 10.0 to account for the complex NHIS survey design (Research Triangle Institute 2008).

Educational attainment is measured here in six categories (as in Zajacova and Hummer 2009): less than 9, 9–11, 12, 13–15, 16, and 17 or more years. While some studies select different cut-points and credential

thresholds, these categories assure a distribution that allows for detailed documentation of mortality differentials. The categories were selected to roughly represent individuals with a primary school education or less (less than 9 years), some high school (9–11 years), a high-school diploma or its equivalent (12 years), some college (13–15 years), a bachelor's degree (16 years), and graduate school or professional education (17 or more years). Age, sex, and race/ethnicity are included as controls in the most general models (Tables 12.1 and 12.2); subsequently, we stratify our models by age, sex, and race/ethnicity to show educational differences in adult mortality within demographic subgroups (Tables 12.3, 12.4, and 12.5).

We first document educational differences in all-cause mortality among US adults aged 25–84 in Table 12.1. Because the relationship between educational attainment and adult mortality varies across causes of death, we next present results for underlying causes of death in Table 12.2. The underlying causes that we specify include heart disease, stroke, diabetes, lung cancer, all other cancers, respiratory diseases, external causes, and a residual category. We then present the education–mortality association for specific demographic subgroups by age, gender, and race/ethnicity in Tables 12.3, 12.4, and 12.5; this detailed subgroup examination focuses on all-cause mortality rather than on cause-specific mortality because of the relatively small number of deaths within some age-sex-race/ethnic strata of the data set.

Table 12.1 Hazard ratios for the association between educational attainment and US adult mortality, 1986–2002

Educational attainment	
8 or fewer years	1.21***
9–11 years	1.24***
12 years	Ref.
13–15 years	0.93***
16 years	0.75***
17 or more years	0.67***
Age (25–84, continuous)	1.09***
Sex (male=1)	1.60***
Race/ethnicity	
Hispanic	0.94**
Non-Hispanic black	1.26***
Non-Hispanic white	Ref.
Observations	831,820
Deaths	104,238
–2*Log-likelihood	748,730.3

Source: National Center for Health Statistics (2005).
*$p < 0.10$; **$p < 0.05$; ***$p < 0.001$

Educational Attainment and Mortality Risk Among US Adults Aged 25–84

Table 12.1 shows that, in accord with the results of many previous studies, individuals with less education are more likely to die during the follow-up period than individuals with more education, net of age, sex, and race/ethnicity. Because persons with 0–8 years and 9–11 years of schooling have similar mortality risks, many previous studies have tended to group these categories together (e.g., Backlund et al. 1999). Among US adults aged 25–84, individuals with eight or fewer years of education are 21% more likely to die during the follow-up period than are individuals with 12 years of education. Interestingly, persons with 9–11 years of schooling exhibit an even larger difference, of 24%. This suggests that the relationship between educational attainment and adult mortality risk may not be strictly linear, at least for the (nearly) entire age range of adults of both sexes. The results in Table 12.1 also clearly show that adults with more than 12 years of education exhibit increasingly lower risks of death across the follow-up period than do individuals with 12 years of education. And the mortality benefits of education do not top off at 16 years: people with 17 or more years of schooling are 33% less likely to die during the follow-up period than are those with 12 years, in comparison to a 25% lower mortality risk among those with 16 years. There is a substantial difference (not specifically shown in the table) between individuals with 17 or more years of education and those with either 0–8 or 9–11 years; persons in these two lowest educational categories are about 1.8 times as likely to die in the follow-up period as are those in the 17 and over category (for comparable results, see Rogers et al. 2000).

The magnitude of educational differences in mortality varies by specific cause of death (Kitagawa and Hauser 1973; Phelan et al. 2004; Rogers et al. 2000), and eliminating those differences may depend on understanding why. Education generally exhibits a strong, inverse association with circulatory disease mortality, the leading cause of death in the United

Table 12.2 Hazard ratios for the association between educational attainment and US cause-specific adult mortality, 1986–2002

	Heart disease	Stroke	Diabetes	Lung cancer	All other cancers	Respiratory	External	Other causes
Educational attainment								
8 or fewer years	1.32***	1.13**	1.30***	1.23***	1.01	1.25***	1.33***	1.16***
9–11 years	1.28***	1.13**	1.39***	1.40***	1.08**	1.30***	1.30***	1.24***
12 years	Ref.	Ref.	Ref.	Ref.	Ref.	Ref.	Ref.	Ref.
13–15 years	0.91***	0.92*	0.87**	0.87**	0.94**	0.90**	0.92	0.97
16 years	0.76***	0.79***	0.58***	0.61***	0.85***	0.61***	0.63***	0.77***
17 or more years	0.68***	0.76***	0.54***	0.51***	0.76***	0.55***	0.58***	0.68***
Age (25–84, continuous)	1.11***	1.12***	1.08***	1.07***	1.08***	1.11***	1.02***	1.08***
Sex (male=1)	1.79***	1.19***	1.25***	2.21***	1.40***	1.77***	2.36***	1.41***
Race/ethnicity								
Hispanic	0.84***	1.02	1.97***	0.54***	0.96	0.71***	1.16**	1.11**
Non-Hispanic black	1.26***	1.33***	2.02***	1.12**	1.25***	0.77***	1.12*	1.55***
Non-Hispanic white	Ref.	Ref.	Ref.	Ref.	Ref.	Ref.	Ref.	Ref.
Deaths	32,830	6,749	3,221	8,705	20,399	9,490	4,525	18,319
–2*Log-likelihood	281,248.5	73,298.7	40,862.9	99,161.9	207,287.4	100,562.8	59,896.1	184,884.7

Source: National Center for Health Statistics (2005).
*$p < 0.10$; **$p < 0.05$; ***$p < 0.001$.

Table 12.3 Hazard ratios for the association between educational attainment and US adult mortality, stratified by age and sex, 1986–2002

	Female			Male		
	25–44 years	45–64 years	65–84 years	25–44 years	45–64 years	65–84 years
Educational attainment						
8 or fewer years	1.66***	1.43***	1.12***	1.60***	1.48***	1.14***
9–11 years	1.81***	1.40***	1.13***	1.50***	1.33***	1.13***
12 years	Ref.	Ref.	Ref.	Ref.	Ref.	Ref.
13–15 years	0.91*	0.93**	0.94**	0.87**	0.98	0.91***
16 years	0.64***	0.77***	0.84***	0.55***	0.72***	0.80***
17 or more years	0.60***	0.63***	0.82***	0.52***	0.59***	0.76***
Age (25–84, continuous)	1.09***	1.08***	1.09***	1.08***	1.09***	1.09***
Race/ethnicity						
Hispanic	1.43***	0.86***	0.79***	1.31***	0.84***	0.80***
Non-Hispanic black	1.74***	1.39***	1.11***	1.88***	1.32***	1.05**
Non-Hispanic white	Ref.	Ref.	Ref.	Ref.	Ref.	Ref.
Observations	217,467	139,785	88,098	195,621	126,049	64,800
Deaths	4,479	13,255	32,632	6,239	17,254	30,379
–2*Log-likelihood	49,368.8	116,427.8	208,082.7	65,016.5	139,045.1	174,249.3

Source: National Center for Health Statistics (2005).
*$p < 0.10$; **$p < 0.05$; ***$p < 0.001$.

States. Cancer mortality, the second leading cause of death, exhibits a weaker association with education than do other causes of death (Rogers et al. 1996). Low education is linked to higher odds of respiratory disease mortality (Rogers 1992), and perhaps increasingly so as cigarette smoking becomes more concentrated among individuals with low education. Diabetes mortality has also been linked to low education (Zhang et al. 1991). Higher mortality from external causes (homicide, suicide, accidents) is also due in part to low levels of education (Rogers et al. 2000). Similarly, Phelan et al. (2004) find that the education–mortality gradient is strongest for those causes of death that they classify as most preventable. Most recently, deaths from circulatory disease and cancer were shown to have contributed most profoundly to rising relative educational differentials in mortality through the 1980s and 1990s (Meara et al. 2008).

Table 12.4 Hazard ratios for the association between educational attainment and US adult mortality for females, stratified by age and race/ethnicity, 1986–2002

	Hispanic			Non-Hispanic black			Non-Hispanic white		
	25–44 years	45–64 years	65–84 years	25–44 years	45–64 years	65–84 years	25–44 years	45–64 years	65–84 years
Educational attainment									
8 or fewer years	1.51**	1.32**	1.31**	1.62**	1.19**	1.13**	1.85***	1.52***	1.11***
9–11 years	1.45**	1.07	1.30	1.63***	1.21**	1.11	1.99***	1.46***	1.13***
12 years	Ref.	Ref.	Ref.	Ref.	Ref.	Ref.	Ref.	Ref.	Ref.
13–15 years	1.04	0.97	0.89	0.99	0.89	0.99	0.87**	0.93**	0.93**
16 years	0.56*	0.61**	1.28	0.71**	0.67**	0.95	0.64***	0.79***	0.82***
17 or more years	0.59	0.60	1.33	0.27***	0.62**	0.98	0.65***	0.64***	0.80***
Age (25–84, continuous)	1.06***	1.08***	1.09***	1.09***	1.07***	1.07***	1.09***	1.09***	1.10***
Observations	27,927	12,637	4,767	33,832	20,388	10,415	155,708	106,760	72,916
Deaths	686	877	1,187	1,131	2,712	4,172	2,662	9,666	27,273
–2*Log-likelihood	7,932.7	8,908.9	8,466.7	11,066.2	21,902.7	26,231.9	31,352.9	86,549.0	173,155.5

Source: National Center for Health Statistics (2005).
*$p<0.10$; **$p<0.05$; ***$p<0.001$.

Table 12.5 Hazard ratios for the association between educational attainment and US adult mortality for males, stratified by age and race/ethnicity, 1986–2002

	Hispanic			Non-Hispanic black			Non-Hispanic white		
	25–44 years	45–64 years	65–84 years	25–44 years	45–64 years	65–84 years	25–44 years	45–64 years	65–84 years
Educational attainment									
8 or fewer years	1.48***	1.24**	1.03	1.51**	1.32***	1.16**	1.71***	1.57***	1.15***
9–11 years	1.29**	1.25	1.23	1.35**	1.26***	1.06	1.61***	1.33***	1.14***
12 years	Ref.	Ref.	Ref.	Ref.	Ref.	Ref.	Ref.	Ref.	Ref.
13–15 years	0.73**	1.12	1.10	0.89	0.83*	1.00	0.88**	0.99	0.90***
16 years	0.83	0.70**	0.71	0.57***	0.80	0.78	0.54***	0.72***	0.80***
17 or more years	0.61**	0.53**	1.08	0.43***	0.63**	0.79	0.53***	0.59***	0.75***
Age (25–84, continuous)	1.06***	1.07***	1.07***	1.08***	1.07***	1.07***	1.08***	1.09***	1.09***
Observations	25,589	10,822	3,484	23,355	14,786	6,813	146,677	100,441	54,503
Deaths	893	1,087	1,160	1,307	2,849	3,471	4,039	13,318	25,748
–2*Log-likelihood	9,750.5	10,253.3	7,696.3	12,044.3	21,196.8	19,220.3	43,843.5	108,194.2	147,118.2

Source: National Center for Health Statistics (2005).
*$p<0.10$; **$p<0.05$; ***$p<0.001$.

Our analysis by cause of death is depicted in Table 12.2. As is true for overall mortality, there are substantial differences in mortality risk by educational attainment, with the most highly educated persons exhibiting the lowest risk for each underlying cause, net of age, sex, and race/ethnicity. For example, US adults with 17 or more years of education are 49% less likely to die of lung cancer during the follow-up period than are those with 12 years. While the relative mortality risk advantages for the most educated are smallest for the cause categories of stroke and all other cancers, even for these causes people with 17 or more years of education still have a 24% lower risk of mortality than do those with 12 years. People with 8 or fewer years of education do not differ very much from those with 9–11 years in mortality from most causes of death; both of these less-educated groups tend to have cause-specific mortality risks around 13–33% higher than do people with 12 years of education. Again, the educational differences in other cancer-related mortality are the narrowest, while the less educated exhibit especially heightened mortality risk for heart disease, lung cancer, diabetes, respiratory diseases, and external cause mortality. Future work in this area should examine these cause-specific mortality differentials by educational attainment specific to age, sex, and race/ethnicity. Indeed, our next section examines such subgroup differences in overall mortality risk by educational attainment, and illustrates that patterns for the entire population differ to some degree from those for these demographic groups.

Educational Attainment and US Adult Mortality: Differences by Age and Sex

The association between educational attainment and mortality risk does not operate the same way for all population subgroups. For example, analyses invariably show that educational disparities in mortality are narrower at older than at younger adult ages. This finding is consistent with an age-as-leveler hypothesis (Beckett 2000). In contrast, the cumulative advantage hypothesis posits that, unlike the effects of other social and behavioral factors that may fade with increasing age, the benefits of education for health and mortality risk accumulate over the life course, through at least age 75 (Lynch 2003; Ross and Wu 1995). Crimmins (2005), for example, used both mortality and health data to show that mortality selection is the most likely reason for narrower educational differences in mortality observed among the elderly in cross-sectional studies; cumulative advantages operate over the life course but are not easily observed in old-age mortality patterns because of the effects of mortality selection. We do not aim to untangle the age-as-leveler and cumulative advantage hypotheses here; we merely note that there remains considerable debate on this issue.

Furthermore, studies suggest that educational differences in adult mortality vary by sex, although not dramatically. Interestingly, some previous US studies using data from the 1960s and 1970s suggested a stronger education–mortality relationship among women than among men (Feldman et al. 1989; Kitagawa and Hauser 1973). In contrast, more recent studies have found that the relationship between educational attainment and mortality risk may be somewhat stronger for men (Backlund et al. 1999; Pappas et al. 1993). Still others have found no gender differences in the educational gradient of adult mortality risk (Elo and Preston 1996; Zajacova 2006). Most recently, Zajacova and Hummer (2009) specifically examined these relationships and found substantial similarity in the education–mortality association between women and men, but with some exceptions. Most notably, they found a steeper educational gradient at high levels of schooling for white men than for white women, indicating somewhat more substantial benefits at the highest levels of education for men than for women.

Table 12.3 uses the same NHIS-LMF data as above, but this time shows relative differences in overall mortality risk by educational attainment separately both by sex and by three adult age groups. These six separate models each control for individual years of age within the broader age range and for race/ethnicity. Two sets of important patterns, one by age and one by sex, are evident. Relative educational differences in mortality are the widest at ages 25–44, second widest at ages 45–64, and narrowest at ages 65–84 for each sex. While the educational mortality differences at ages 65–84 appear smaller, and *are* smaller in a relative sense, than those seen among younger adults, it is important to remember that overall death rates are far higher in this age range. Thus, for example, the relative differences at ages 65–84 for women—in comparison with women with 12 years of schooling, 12% higher mortality among the least educated and 18% lower mortality

among the most educated—continue to be extremely meaningful because of the concentration of deaths within this age range. Indeed, the work of Huisman et al. (2005), which focused on educational differences in adult mortality among 11 European countries, showed that absolute mortality differentials by education were actually wider among elderly individuals (80–89) than among young adults, even with smaller relative mortality differentials among the elderly. We also show here that, among the youngest age group (25–44), relative differences for both men and women are extremely wide. Both men and women with 9–11 years of schooling, for example, exhibit about three times the mortality risks of their most highly educated gender-specific counterparts (specific comparisons not shown).

Gender differences in the education–mortality relationship are not particularly striking, for the most part, with a couple of exceptions. For adults aged 65–84, there are no real differences. Among the two younger age groups, the relative advantages for men at the highest two levels of education (16 and 17 or more years) appear to be modestly stronger than the relative advantages for women. This is consistent with recent findings discussed above (Zajacova and Hummer 2009).

Educational Attainment and US Adult Mortality: Differences by Race/Ethnicity

With immigration generating increasingly diverse populations in many countries, health and mortality researchers must consider race/ethnicity in their analyses. Most work on education and mortality in the United States does not consider whether educational differences in adult mortality vary for Hispanic subgroups or non-Hispanic blacks in comparison to non-Hispanic whites. There is substantial reason to think, however, that educational differences in mortality may be narrower for racial and ethnic minority groups than for non-Hispanic whites. It is well known that compared to whites, members of racial and ethnic minority groups tend to live in areas that have lower-performing schools, attend less prestigious colleges and universities, and face discrimination in the labor market—all of which would devalue their educational achievements, particularly at the highest levels (Conley 1999; Massey and Denton 1993; Tienda and Mitchell 2005). Accordingly, several recent studies have shown a substantially weaker educational gradient in US adult mortality for Hispanics than for whites (Lin et al. 2003; McKinnon and Hummer 2007; Turra and Goldman 2007).

Tables 12.4 and 12.5 expand upon Table 12.3 by showing estimates of relative educational differences in US adult mortality for Hispanics, non-Hispanic blacks, and non-Hispanic whites, stratified by age group for women (Table 12.4) and men (Table 12.5). For women (Table 12.4), two patterns emerge. First, among the younger age groups, there are relatively higher mortality risks among less-educated non-Hispanic whites than among non-Hispanic blacks or Hispanics. Put another way, the relative penalties for low-educated white women seem to be greater than among low-educated black and Hispanic women. Second, while the highly educated among the oldest age group of non-Hispanic black and Hispanic women do not exhibit lower mortality than do their high-school-educated counterparts, highly educated women in the two younger age categories of *all* race/ethnic groups exhibit substantially lower mortality risks than their high-school-educated counterparts. While the effects of mortality selection surely help to mute educational differences in old-age mortality (Crimmins 2005), it is clear from these data that educational attainment seriously differentiates the mortality prospects of young adult (25–44) and middle-aged (45–64) women for each of these groups in ways that are not seen among the oldest minority group women.

For men, Table 12.5 shows nine mortality risk models that are stratified within age group and race/ethnic group, with 12 years of educational attainment serving as the reference category for each age- and race/ethnic-specific model. The patterns exhibited for men are very similar to those of women: (1) educational attainment differences in mortality are pronounced for each of the three race/ethnic groups among the younger adult age groups, while it is only among non-Hispanic whites that there are wide differences among older (65–84) adults; and (2) heightened mortality risk among less-educated younger adults, compared to each group's reference category of high-school-educated adults, seems to be particularly prominent among non-Hispanic white men. Together, the age-related patterns for both women and men suggest that educational attainment may be becoming more and more important for differentiating mortality risks among younger

cohorts of all racial/ethnic groups in the United States (Lauderdale 2001).

Life Expectancy Differences by Educational Attainment

An important question in this and any subset of the mortality differentials literature involves the extent to which relative mortality differences—as shown and discussed above—translate into variations in life expectancy (a measure of absolute mortality differences) across groups. Preston and Taubman (1994) provide a very useful and important distinction between mortality differentials in a relative and an absolute sense. If, for example, relative mortality differentials between two groups are large (e.g., a risk ratio of two) but both of the mortality rates are very low, then life-expectancy differences between the two groups will be modest. If, on the other hand, the same ratio holds for two groups with high mortality rates, life expectancy differences between the two groups will be much larger. Because life expectancy figures and, hence, life expectancy differentials are calculated using mortality rates rather than ratios, they provide a very useful indicator of the extent to which mortality differences between groups result in meaningful disparities in the estimated length of life for those groups.

Table 12.6 shows data abstracted from three recent studies that have calculated educational differences in US life expectancy at age 25 (e_{25}). Panel A, taken from a study by Molla et al. (2004), uses official US mortality data to generate e_{25} estimates across three educational groups: 0–8, 9–12, and 13 or more years. Official US mortality data, based on numerator mortality counts from death certificates and denominator estimates from census population data, are quite useful because they cover the complete population. An important limitation, however, is that death certificate information is collected from informants and, as a result, data on educational attainment tend to be overstated (Christensen and Johnson 1995; Molla et al. 2004). The 1998 e_{25} estimates from Molla et al. (2004) shown here are grouped in an educational categorization scheme (0–8, 9–12, 13 or more years) that is both unconventional and not particularly useful for understanding the potential impacts that degree attainment has on adult mortality. That being said, the differentials shown in Panel A of Table 12.6 are wide. US women with 13 or more years of education had an e_{25} estimate of 57.8 years, compared to 52.9 among women with 0–8 years of education; this is roughly a 5-year difference. The differential is even larger for men: 54.6 for men with 13+ years compared to 47.0 for men with 0–8 years, or a 7.6-year difference. These data clearly indicate that education differences in US adult mortality rates result in substantial life expectancy differences across educational attainment groups.

Panels B and C of Table 12.6 show e_{25} estimates from Lin et al. (2003) and Meara et al. (2008), respectively. Both research groups use data from the National Longitudinal Mortality Study (NLMS): the Lin et al. estimates come from the 1979–1989 NLMS while the Meara et al. estimates are based on the 1991–1998 NLMS. Like the NHIS-LMF data that we used above, the NLMS consists of survey-based data (multiple years of the US Current Population Survey) linked to follow-up mortality information for those who died from the National Death Index. Thus it shares an important strength with the NHIS-LMF: education data are reported by either the individuals in the survey or a proxy household respondent. One downside of both the NHIS-LMF and the NLMS, however, is that they initially exclude institutionalized individuals, that is, persons who reside in nursing homes, on military bases, or in prison. As a result, life expectancy estimates from both the NHIS-LMF and NLMS should be, and are, slightly higher than those from official data because some high-risk individuals are not included in these survey-based data sets (Hummer et al. 2009).

The estimates from both Panels B and C, though, correspond fairly well with those from the official data in Panel A. Keep in mind as well that the three panels of Table 12.6 categorize educational attainment somewhat differently because of the different ways that education data were collected and/or the specific aims of each of these studies. Both Panels B and C show that life-expectancy differences by education tend to be somewhat larger among men than among women; further, Panel B shows that life expectancy differences between the most and least educated black women and men are wider than those between the most and least educated white women and men. Even though Hispanics are now the largest racial/ethnic minority group in the United States, only Lin et al. (2003) have estimated educational differences in life expectancy

Table 12.6 Three recent estimates of educational differences in US life expectancy at age 25

Panel A	0–8 years	9–12 years	13+ years
All US females	52.9	53.6	57.8
All US males	47.0	47.5	54.6
Source: Molla et al. (2004), using official US mortality data from 1998			
Panel B	<12 years	12 years	13+ years
Non-Hispanic black females	50.2	53.6	56.1
Non-Hispanic white females	55.1	55.1	57.9
Non-Hispanic black males	43.5	46.5	50.2
Non-Hispanic white males	47.2	50.2	52.6
Source: Lin et al. (2003), using data from the National Longitudinal Mortality Study, 1979–1989			
Panel C		< 13 years	13+ years
White females		55.7	58.1
White males		49.6	54.0
Source: Meara et al. (2008) using data from the National Longitudinal Mortality Study 1991–1998			

among Hispanics, and even they did not show life expectancy estimates for Hispanics with 13 or more years of education because of the relatively small number of Hispanic deaths with which they had to work. Future work in this area, then, should focus on both broadening the educational attainment categories that are used and the population subgroups specified; both of these enhancements pose significant challenges because some of the age/sex/race/education cells used to calculate mortality rates become quite sparse among relatively small population subgroups.

Changes in Educational Differences in Mortality over Time

There is a growing literature that examines changes in educational differences in US adult mortality since the classic Kitagawa and Hauser (1973) study (which used data from 1960). In an initial set of studies, most analysts found that educational differences in mortality widened between 1960 and 1985–1990, owing to steeper mortality declines experienced by the more highly educated over that period, particularly among men (Duleep 1989, 1998; Feldman et al. 1989; Lauderdale 2001; Pappas et al. 1993; Preston and Elo 1995). Between 1970 and 1990, for example, the gap in life expectancy for white men at age 30 between those with 0–8 years of education and those with 13 or more years grew from 4.1 to 6.7 years (Crimmins and Saito 2001). With more and more of a premium being placed on educational credentials in the US labor force, there is ample reason to hypothesize that educational differences in mortality have continued to widen between the mid-1980s to late 1980s and the present, as persons with the highest levels reap the greatest rewards while persons with low levels of education are increasingly isolated in low-wage, less-rewarding, and unstable jobs.

Emerging evidence is indeed showing even wider educational differentials in US adult mortality than existed just 20 or so years ago (Jemal et al. 2008; Meara et al. 2008; Montez et al. forthcoming). This is in direct contrast to one of the two current overall US health goals, which aimed to eliminate health disparities across population subgroups by 2010 (US DHHS 2000). Although all three recent studies in this area arrive at the same general conclusion, there are also some differences to note based on the data sets used, specific age groups examined, and measures of educational attainment employed. Both Meara et al. and Montez et al., for example, reported that the widening was more pronounced among women than men, while Jemal et al. reported more pronounced widening among men. Both Jemal et al. and Montez et al. found no particular pattern of widening among blacks (although they did not find any narrowing gaps either), while Meara et al. did report a widening of educational differences among blacks. Finally, Montez et al. showed that the widening between 1990 and 2000 was largely evident among younger cohorts of US adults, among whom the most highly educated have experienced the steepest mortality declines. Despite

their particular differences, all of these most recent studies find that relative educational differences in US adult mortality have probably increased in recent decades, and this unanimity points to the need both to continue to monitor such disparities and to work on program and policy initiatives to help reduce the relatively high risk of mortality among the least educated segments of society.

International Comparisons

International comparisons of mortality differences by educational level can tell us to what extent socioeconomic inequality results in unequal life chances in different contexts. Such international comparisons are difficult, though. Valkonen (1993) outlines a number of data and analytic issues that hamper the comparison of educational differences in adult mortality across national contexts. Studies that link census records or surveys to death certificates through personal identification numbers—such as those we reported above in the main analytic portion of this chapter—provide the strongest evidence of mortality differences by education. But such high-quality data are available in only a few nations. Other nations must estimate death rates from separate data sources; for example, the numerator of a death rate may need to be taken from death records while the denominator will come from census data. Countries without nationally representative data on education and adult mortality often rely on data that are representative of a major metropolitan area. For example, Huisman et al. (2005) use data from Turin, Italy, and Barcelona and Madrid, Spain, to estimate educational differences in adult mortality within those two countries.

Analytic concerns highlighted by Valkonen (1993) include differences in study design across nations, differences in the timing of studies or length of follow-up periods, and coverage of specific subgroups (e.g., by age) for the nations being compared. The skewness of educational distributions may present difficulties in estimating educational differences in mortality. For example, if a large majority of a population obtains a relatively uniform level of schooling, there may not be enough variation in levels of education to estimate educational differences in mortality. Despite these data and analytic concerns, however, more and more studies are making useful comparisons of educational mortality differences across national contexts, as both levels of education and educational inequality increase within countries and data bases that can be used for this purpose proliferate. Nevertheless, most comparisons in this area of study to date have been based on data from Europe and the United States. While most early comparative studies examined only the working-aged population (e.g., 25–64 or 35–64) and often only men, more recent studies have covered broader age ranges and both genders, and have focused on cause-specific as well as overall mortality (Huisman et al. 2004, 2005).

For all countries studied, death rates are higher for less-educated individuals than for more educated ones. This pattern has been established in comparative work examining Scandinavian nations (Denmark, Finland, Norway, and Sweden); western and southern European countries (Austria, Belgium, Bulgaria, the Czech Republic, England and Wales, France, Italy, Hungary, the Netherlands, Spain, and Switzerland); several countries of the former Soviet Union (Estonia, Lithuania, and Russia); and countries in North America (Canada and the United States) (Elo and Preston 1996; Elo et al. 2006; Huisman et al. 2004, 2005; Kalediene and Petrauskiene 2005; Kohler et al. 2008; Kunst and Mackenbach 1994; Mackenbach et al. 1999; Regidor et al. 2003; Roos et al. 2004; Sholnikov et al. 1998). Evidence supporting educational differences in adult mortality certainly exists for additional nations; this list is simply intended to show that educational differences in adult mortality are ubiquitous across the high-income countries that have been examined to date.

Early comparative work in this area found that absolute differences in mortality by education for men appeared to be approximately the same for all countries examined; that is, for every year of education attained, death rates diminished by about 8% (Valkonen 1989). Kunst and Mackenbach (1994) later found that the United States, France, and Italy were characterized by larger educational differences in adult mortality than the Netherlands, Sweden, Denmark, Norway, England and Wales, and Finland; however, the wider disparities in the United States and France were largely explained by greater educational inequality within those countries in comparison to the others. That is, effect sizes of the education–mortality relationship were quite similar in all countries.

Using data from the 1990s, Huisman et al. (2005) more recently showed quite similar patterns in educational inequalities across eight western European populations—Finland, Norway, England and Wales, Belgium, Austria, Switzerland, Italy, and Spain. At the same time, they documented substantial differences in the contribution of specific causes of death to these disparities in different contexts. For example, cardiovascular diseases contribute more strongly to educational differences in mortality in northern European nations than in southern European nations, while cancers and other causes tend to contribute more strongly in the southern European countries. Around the same time, Huisman et al. (2004) examined age patterns of the education–mortality relationship among a somewhat broader set of 11 European nations. They showed that in most of the countries relative educational differences in adult mortality tended to be narrower among older age groups, but persisted all the way through the 80–89 age group. Our findings for US white adults presented above similarly showed persistent educational disparities in adult mortality through at least age 84. Interestingly, Huisman et al. (2004) also showed that absolute differences in mortality rates between the most and least educated groups were largest among the older age group (80–89) of adults in most of these countries, although relative educational differences tended to be widest among the younger age groups (e.g., 50–59).

Finally, another recent set of studies comparing the United States with Finland (Elo et al. 2006) and with Bulgaria and Finland (Kohler et al. 2008) revealed larger educational disparities in mortality for US women than for women in Bulgaria and Finland, but the largest educational differences in mortality were found for Finnish men. In general, most comparative studies using recent data have found somewhat larger educational disparities in adult mortality among men than among women, particularly among working-aged adults (Elo et al. 2006; Koskinen and Martelin 1994; Mackenbach et al. 1999; Mustard and Etches 2003; Zajacova and Hummer 2009). Again, it is important to note that in spite of the particular differences across causes of death by gender and to some degree age in all of these international comparisons, overall educational differences in mortality have been shown to be consistently wide and have shown little if any signs of closure for any of the populations studied.

Policy Implications

If education so powerfully and ubiquitously enhances health-promoting resources, can mortality disparities by educational attainment be reduced or eliminated? This is not an easy question to answer because, if anything, educational disparities in adult mortality risks have widened over the past several decades, even with substantial research and governmental attention devoted to this issue. But it is also the case that the health policy agenda, at least in the United States, is rarely devoted to influencing the basic socioeconomic factors that so powerfully underlie health and mortality patterns of national populations. Such thinking can, however, change. Recent work by Schoeni et al. (2008), for example, emphasizes the potentially powerful influences that social policy can have on population health and urges researchers and policymakers to give more thought to *treating social policy as health policy*. More specifically, Cutler and Lleras-Muney (2008), in a chapter within the Schoeni et al. (2008) volume, estimate that the health benefits of increases in educational attainment may be even greater than the well-documented lifelong financial benefits of educational attainment.

Thus, one possible and very straightforward way to reduce educational differentials in adult mortality would be to shift more and more people out of the lower portions of the educational distribution into more advanced educational categories, as was clearly the case across birth cohorts for most of the twentieth century in the United States (Montez et al. forthcoming). At present, 16% of US adults aged 25 and over do not have a high-school diploma; among the narrower adult age range of 25–34, the figure is not much lower, at 14% (US Census Bureau 2009). Another 30% of US adults have a high-school diploma or its equivalent, but nothing further; moreover, in no adult 10-year age category do college graduates make up even 30% of the US population (U.S. Census Bureau 2009). These figures illustrate that there is very substantial room for improvement within the US educational distribution, even within recent birth cohorts. And such substantial improvements in composition could help lead to progress in health and reductions in mortality over time if the effects of education on health and mortality are at all causal, as seems to be at least partially the case (Chandola et al. 2008; Glied and

Lleras-Muney 2008; Lleras-Muney 2005; Mirowsky and Ross 2003; Smith 2004). While compositional change in educational attainment would, in and of itself, have no impact on relative educational disparities in mortality, it would clearly expose fewer and fewer people to the heightened health and mortality risks that persons with low educational attainment face. Moreover, more highly educated individuals not only live longer lives on average than less-educated individuals, but also live a greater proportion of their lives in good health than do less-educated persons (Crimmins and Saito 2001).

A second policy angle to reduce educational disparities in mortality involves the attempt to influence the hazardous "downstream" mechanisms that are associated with low levels of educational attainment. This is arguably a more difficult and expensive angle than cohort-by-cohort improvements in basic levels of education, and may do little to alter the social structure on which such inequalities in outcomes are based (Link 2008; Link and Phelan 1995). Nevertheless, for the millions and millions of adults who have already completed their educational careers, this may be the only option available. Denney et al. (2010) have recently shown that cigarette smoking may account for more than 40% of the mortality gap between the most and least educated groups of young adults in the United States. Thus, continued efforts to curb cigarette smoking—through policies such as increased taxation on tobacco products, advertising restrictions on tobacco products, and smoking bans in nightclubs, restaurants, and workplaces—will improve health and decrease mortality not only among the population as a whole, but especially so among the less-educated portion of the population. Similarly, policy efforts to make health insurance more accessible to adults who are not covered by employer plans have potential not only to improve the health of the nation as a whole, but to have a particular impact on the least educated segment of society.

Future Research Directions

Educational differences in adult mortality are omnipresent and wide, and may even be increasing in some contexts. Over the next decade or more, it will be important for researchers to continue to monitor trends in the education–mortality relationship, particularly given major governmental initiatives that aim to close socioeconomic disparities in health and mortality. Are education–mortality gaps narrowing or widening? What are the trends when both relative disparities and absolute disparities are considered? Are there widening or narrowing gaps among specific subgroups of the population defined by birth cohort, gender, and race/ethnicity? Are there widening or narrowing gaps for specific causes of death that help indicate pathways by which these educational differences are changing? And if there are changes in the disparities, is one educational attainment group making faster gains than another, or is mortality lessening in one educational group while actually increasing in another? Social demographers and epidemiologists should continue to carefully monitor these large-scale patterns and trends to best inform policymakers. In addition, the changing educational composition of populations needs to be taken into account. For example, in the United States and many other countries, it will no longer be adequate to consider 13 or more years as the highest category of educational attainment when more and more individuals are pursuing college and advanced degrees.

While a huge literature in the United States and Europe has documented education and mortality patterns and trends over the last several decades, and such monitoring should definitely continue, we actually may know less in this area than we seem to, because of the relative scarcity of high-quality educational data in most mortality data sets. On the whole, this leaves us with excellent knowledge of the basic patterns of educational attainment and adult mortality, but with much less specific knowledge regarding just what it is about educational attainment that ends up relating so strongly to how long people live. As new demographic and health surveys are designed, researchers should think carefully about the education questions that are being asked and, if at all possible, probe more deeply into the educational attainment process beyond years of completed schooling. Moreover, innovative data linkages should be explored. For example, individuals in demographic and health surveys may be linked with their high school and postsecondary educational transcripts to allow for a much better sense of what schools they attended, what courses they took while in school, what majors they pursued, what grades they earned, what specific

degrees they acquired, and more. Surveyed individuals can also be linked to the records of other household members in the survey or to neighborhood-based census data to better tap into the educational contexts in which individuals are living. Appending such transcript, household, and neighborhood data to ongoing demographic and health surveys will allow researchers a much greater opportunity to understand the context in which individuals are schooled and allow for a much deeper understanding of educational attainment and adult mortality patterns than has so far been the case.

Important questions regarding whether or not (and to what degree) educational attainment causally influences mortality risks across the life course are also critically important for scientific and policy-related reasons and in need of much additional study. Such investigations should aim to use data sets and measures that better tap into the precursors of educational attainment as well as the subsequent health and mortality patterns. Most studies in this area to date examine educational attainment differences in adult mortality either by looking at age-specific mortality rate differences across educational attainment groups or through regression analyses of educational attainment and mortality risk that control for basic demographic factors like age, sex, and race/ethnicity. These are very informative approaches, but at the same time, cannot speak to the actual causal influences of educational attainment on mortality risk. More comprehensive methodological approaches are needed to take account of the family background, early life, health, and genetic factors that influence the educational trajectories of individuals as well as their length of life. Data requirements for such a true life-course approach to the issue are stringent, but this is probably the most important aspect of future study in this area if we are to truly understand the extent to which educational attainment operates as a causal mechanism to influence the mortality prospects of individuals.

Acknowledgments This chapter was supported by an Eunice Kennedy Shriver National Institute of Child Health and Human Development (NICHD) research grant (1 R01 HD053696) and by an NICHD infrastructure grant (5 R24 HD042849) awarded to the Population Research Center at the University of Texas at Austin. We thank Anna Zajacova and the editors of this handbook, Richard Rogers and Eileen Crimmins, for very helpful comments and edits.

References

Allison, P.D. 1984. *Event History Analysis: Regression for Longitudinal Event Data*. Beverly Hills, CA, Sage.

Backlund, E., P.D. Sorlie, and N.J. Johnson. 1999. "A Comparison of the Relationships of Education and Income with Mortality: The National Longitudinal Mortality Study." *Social Science and Medicine* 49:1373–84.

Batty, G.D. and I.J. Deary. 2005. "Education and Mortality: A Role for Intelligence?" *Journal of Epidemiology and Community Health* 59:809–10.

Batty, G.D., G. Der, S. Macintyre, and I.J. Deary. 2006. "Does IQ Explain Socioeconomic Inequalities in Health? Evidence from a Population Based Cohort Study in the West of Scotland." *British Medical Journal* 332:1–5.

Beckett, M. 2000. "Converging Health Inequalities in Later Life: An Artifact or Mortality Selection?" *Journal of Health and Social Behavior* 41:106–19.

Braveman, P.A., C. Cubbin, S. Egerter, S. Chideya, K.S. Marchi, M. Metzler, and S. Posner. 2005. "Socioeconomic Status in Health Research: One Size Does Not Fit All." *Journal of the American Medical Association* 294:2879–88.

Brown, D.C., M.D. Hayward, and R.A. Hummer. 2009. "Spousal Education and Mortality in the NHIS-LMF." Paper presented at the annual meeting of the Southern Demographic Association, Galveston, TX.

Chandola, T., P. Clarke, J.N. Morris, and D. Blane. 2008. "Pathways Between Education and Health: A Causal Modeling Approach." *Journal of the Royal Statistical Society: Series A (Statistics in Society)* 169(2):337–59.

Christensen, B.A. and N.E. Johnson. 1995. "Educational Inequality in Adult Mortality: An Assessment with Death Certificate Data From Michigan." *Demography* 32(2):215–29.

Conley, D. 1999. *Being Black, Living in the Red: Race, Wealth, and Social Policy in America*. Los Angeles, CA, University of California Press.

Crimmins, E.M. 2005. "Socioeconomic Differentials in Mortality and Health at the Older Ages." *Genus* LXI(1):163–77.

Crimmins, E.M. and Y. Saito. 2001. "Trends in Healthy Life Expectancy in the United States, 1970–1990: Gender, Racial, and Educational Differences." *Social Science & Medicine* 52:1629–41.

Cutler, D.M. and A. Lleras-Muney 2008. "Education and Health: Evaluating Theories and Evidence." In R.F. Schoeni, J.S. House, G.A. Kaplan, and H. Pollack (eds.), *Making Americans Healthier: Social and Economic Policy as Health Policy*, pp. 29–60. New York, NY, Russell Sage Foundation.

Denney, J.T., R.G. Rogers, R.A. Hummer, and F.C. Pampel 2010. "Education Inequality in Mortality: The Age and Gender Specific Mediating Effects of Cigarette Smoking." *Social Science Research* 29:662–673.

Drevenstedt, G.L. 2001. "Mortality Patterns in the United States Since 1960: Essays on Migrant Mortality, the Impact of Medicare, and Demographic Consequences of Cause-specific Mortality Change." *ProQuest,* Paper AAI3003622. Available online at http://repository.upenn.edu/dissertations/AAI3003622

Duleep, H.O. 1989. "Measuring Socioeconomic Mortality Differentials Over Time." *Demography* 26:345–51.

Duleep, H.O. 1998. "Has the U.S. Mortality Differential by Socioeconomic Status Increased Over Time?" *American Journal of Public Health* 88(7):1125.

Elo, I.T., P. Martikainen, and K.P. Smith. 2006. "Socioeconomic Differentials in Mortality in Finland and the United States: The Role of Education and Income." *European Journal of Population* 22:179–203.

Elo, I.T. and S.H. Preston. 1996. "Educational Differentials in Mortality: United States, 1979–85." *Social Science and Medicine* 42:47–57.

Feldman, J.J., D.M. Makuc, J.C. Kleinman, and J. Cornoni-Huntley. 1989. "National Trends in Educational Differentials in Mortality." *American Journal of Epidemiology* 129:919–33.

Glied, S. and A. Lleras-Muney. 2008. "Technological Innovation and Inequality in Health." *Demography* 45(3): 741–61.

Goldman, D.P. and J.P. Smith. 2002. "Can Patient Self-Management Help Explain the SES Health Gradient?" *Proceedings of the National Academy of Sciences of the United States of America* 99(16):10929–34.

Gottfredson, L. 2004. "Intelligence: Is It the Epidemiologists' Elusive 'Fundamental Cause' of Social Class Inequalities in Health?" *Journal of Social and Personality Psychology* 86:174–99.

Hayward, M.D. and B.K. Gorman. 2004. "The Long Arm of Childhood: The Influence of Early-Life Social Conditions on Men's Mortality." *Demography* 41(1):87–108.

Hoffmann, R. 2008. *Socioeconomic Differences in Old Age Mortality*. New York, NY, Springer.

House, J.S., K.R. Landis, and D. Umberson. 1988. "Social Relationships and Health." *Science* 241:540–45.

Huie, S.A.B., R.A. Hummer, and R.G. Rogers. 2002. "Individual and Contextual Risks of Death Among Race and Ethnic Groups in the United States." *Journal of Health and Social Behavior* 43(3):359–81.

Huisman, M., A.E. Kunst, O. Anderson, M. Bopp, J.K. Borgan, C. Borrell, G. Costa, P. Deboosere, G. Desplanques, A. Donkin, S. Gadeyne, C. Minder, E. Regidor, T. Spadea, T. Valkonen, and J.P. Mackenbach. 2004. "Socioeconomic Inequalities in Mortality Among Elderly People in 11 European Populations." *Journal of Epidemiology and Community Health* 58:468–75.

Huisman, M., A.E. Kunst, M. Bopp, J. Borgan, C. Borrell, G. Costa, P. Deboosere, S. Gadeyne, M. Glickman, C. Marinacci, C. Minder, E. Regidor, T. Valkonen, and J.P. Mackenbach. 2005. "Educational Inequalities in Cause-Specific Mortality in Middle-Aged and Older Men and Women in Eight Western European Populations." *Lancet* 365:493–500.

Hummer, R.A., R.G. Rogers, and I.W. Eberstein. 1998. "Sociodemographic Differentials in Adult Mortality: A Review of Analytic Approaches." *Population and Development Review* 24(3):553–78.

Hummer, R.A., R.G. Rogers, R. Masters, and J. Saint Onge 2009. "Mortality Patterns in Late Life." In P. Uhlenberg (ed.), *International Handbook of Population Aging*, pp. 521–42. New York, NY, Springer.

Jaffe, D.H., Z. Eisenbach, Y.D. Neumark, and O. Manor. 2005. "Does One's Own and One's Spouse's Education Affect Overall and Cause-Specific Mortality in the Elderly?" *International Journal of Epidemiology* 34: 1409–16.

Jemal, A., E. Ward, R.N. Anderson, T. Murray, and M.J. Thun 2008. "Widening of Socioeconomic Inequalities in U.S. Death Rates, 1993–2001." *PLoS ONE* 3(5):e2181. doi:10.1371/journal.pone.0002181.

Kalediene, R. and J. Petrauskiene. 2005. "Inequalities in Mortality by Education and Socio-Economic Transition in Lithuania: Equal Opportunities?" *Public Health* 119(9):808–15.

Kitagawa, E.M. and P.M. Hauser. 1973. *Differential Mortality in the United States: A Study in Socioeconomic Epidemiology*. Cambridge, MA, Harvard University Press.

Kohler, I.V., P. Martikainen, K.P. Smith, and I.T. Elo. 2008. "Educational Differences in All-Cause Mortality by Marital Status: Evidence from Bulgaria, Finland, and the United States." *Demographic Research* 19:2011–42.

Koskinen, S. and T. Martelin. 1994. "Why Are Socioeconomic Mortality Differences Smaller Among Women Than Among Men?" *Social Science and Medicine* 38(10):1385–96.

Krieger, N., D. Rowley, A. Herman, B. Avery, and M. Phillips. 1993. "Racism, Sexism, and Social Class: Implications for Studies of Health, Disease, and Well-Being." *American Journal of Preventative Medicine* 9:82–122.

Krueger, P.M., R.G. Rogers, R.A. Hummer, S.A. Bond Huie, and F. LeClere. 2003. "Socioeconomic Status and Age: The Effect of Income Sources and Portfolios on Adult Mortality in the United States." *Sociological Forum* 18(3):465–82.

Krueger, P.M. and S.A. Burgard. 2011. "Work, Occupation, Income, and Mortality." In R.G. Rogers and E.M. Crimmins (eds.), *International Handbook of Adult Mortality*. New York, NY, Springer.

Kunst, A.E. and J.P. Mackenbach. 1994. "The Size of Mortality Differences Associated with Educational Level in Nine Industrialized Countries." *American Journal of Public Health* 84(6):932–37.

Lantz, P.M., J.S. House, J.M. Lepkowski, D.R. Williams, R.P. Mero, and J. Chen. 1998. "Socioeconomic Factors, Health Behaviors, and Mortality." *Journal of the American Medical Association* 279(21):1703–8.

Lantz, P.M., J.S. House, R.P. Mero, and D.R. Williams. 2005. "Stress, Life Events, and Socioeconomic Disparities in Health: Results from the Americans' Changing Lives Study." *Journal of Health and Social Behavior* 46: 274–89.

Lauderdale, D.S. 2001. "Education and Survival: Birth Cohort, Period, and Age Effects." *Demography* 38:551–61.

Lawlor, D.A., S. Frankel, M. Shaw, S. Ebrahim, and G.D. Smith 2003. "Smoking and Ill Health: Does Lay Epidemiology Explain the Failure of Smoking Cessation Programs Among Deprived Populations?" *American Journal of Public Health* 93(2):266–70.

Lin, C.C., E. Rogot, N.J. Johnson, P.D. Sorlie, and E. Arias. 2003. "A Further Study of Life Expectancy by Socioeconomic Factors in the National Longitudinal Mortality Study." *Ethnicity and Disease* 13:240–47.

Link, B.G. 2008. "Epidemiological Sociology and the Social Shaping of Population Health." *Journal of Health and Social Behavior* 49:367–84.

Link, B.G. and J. Phelan 1995. "Social Conditions as Fundamental Causes of Disease." *Journal of Health and Social Behavior* 35(extra issue):80–94.

Link, B.G., J.C. Phelan, R. Miech, and E.L. Westin. 2008. "The Resources that Matter: Fundamental Social Causes of Health Disparities and the Challenge of Intelligence." *Journal of Health and Social Behavior* 49(1):72–91.

Lleras-Muney, A. 2005. "The Relationship Between Education and Adult Mortality in the United States." *Demography* 38(4):551–61.

Lochner, K., R.A. Hummer, S. Bartee, G. Wheatcroft, and C. Cox. 2008. "The Public-Use National Health Interview Survey Linked Mortality Files: Methods of Re-identification Risk Avoidance and Comparative Analysis." *American Journal of Epidemiology* 168:336–44.

Lynch, S.M. 2003. "Cohort and Life-Course Patterns in the Education-Health Relationship." *Demography* 40: 309–31.

Mackenbach, J.P., A.E. Kunst, F. Groenhof, J. Borgan, G. Costa, F. Faggiano, P. Jozan, M. Leinsalu, P. Martikainen, J. Rychtarikova, and T. Valkonen. 1999. "Socioeconomic Inequalities in Mortality Among Women and Men: An International Study." *American Journal of Public Health* 89(12):1800–6.

Marmot, M.G. 2004. *The Status Syndrome: How Social Standing Affects Our Health and Longevity*. New York, NY, Henry Holt and Company.

Massey, D.S. and N.A. Denton 1993. *American Apartheid: Segregation and the Making of the Underclass*. Cambridge, Harvard University Press.

McKinnon, S.A. and R.A. Hummer 2007. "Education and Mortality Risk Among Hispanic Adults in the United States." In J.L. Angel and K.E. Whitfield (eds.), *The Health of Aging Hispanics: The Mexican-Origin Population*. New York, NY, Springer.

Meara, E.R., S. Richards, and D.M. Cutler. 2008. "The Gap Gets Bigger: Changes in Mortality and Life Expectancy, by Education, 1981–2000." *Health Affairs* 27:350–60.

Mirowsky, J. and C.E. Ross. 1998. "Education, Personal Control, Lifestyle and Health: A Human Capital Hypothesis." *Research on Aging* 20(4):415–49.

Mirowsky, J. and C.E. Ross. 2003. *Education, Social Status, and Health*. New York, NY, Aldine de Gruyter.

Mirowsky, J. and C.E. Ross. 2007. "Creative Work and Health." *Journal of Health and Social Behavior* 48:385–403.

Molla, M.T., J.H. Madans, and D.K. Wagener. 2004. "Differentials in Adult Mortality and Activity Limitation by Years of Education in the United States at the End of the 1990s." *Population and Development Review* 30:625–46.

Montez, J.K., M.D. Hayward, D.C. Brown, and R.A. Hummer. 2009. "Why Is the Educational Gradient of Mortality Steeper for Men?" *Journal of Gerontology: Social Sciences* 64B:625–34.

Montez, J.K., R.A. Hummer, M.D. Hayward, H. Woo, and R.G. Rogers. Forthcoming. "Trends in the Educational Gradient of U.S. Adult Mortality from 1986 through 2006 by Race, Gender, and Age Group." Research on Aging.

Moss, N. and N. Krieger. 1995. "Measuring Social Inequalities in Health: Report on the Conference of the National Institutes of Health." *Public Health Reports* 110:302–5.

Mustard, C.A. and J. Etches. 2003. "Gender Differences in Socioeconomic Inequality in Mortality." *Journal of Epidemiology and Community Health* 57(12): 974–80.

National Center for Health Statistics. 2005. "The 1986–2000 National Health Interview Survey Linked Mortality Files: Matching Methodology." Hyattsville, MD, National Center for Health Statistics, Office of Analysis and Epidemiology.

Palloni, A. 2006. "Reproducing Inequalities: Luck, Wallet, and the Enduring Effects of Childhood Health." *Demography* 43:587–615.

Pamuk, E.R. 1985. "Social Class Inequality in Mortality from 1921 to 1972 in England and Wales." *Population Studies* 39:17–31.

Pappas, G., S. Queen, W. Hadden, and G. Fisher. 1993. "The Increasing Disparity in Mortality Between Socioeconomic Groups in the United States, 1960 and 1986." *New England Journal of Medicine* 329:103–9.

Phelan, J.C., B.G. Link, A. Diez-Roux, I. Kawachi, and B. Levin. 2004. "'Fundamental Causes' of Social Inequalities in Mortality: A Test of the Theory." *Journal of Health and Social Behavior* 45:265–85.

Preston, S.H. and I.T. Elo. 1995. "Are Educational Differentials in Adult Mortality Increasing in the United States?" *Journal of Aging and Health* 7:476–96.

Preston, S.H. and P. Taubman. 1994. "Socioeconomic Differences in Adult Mortality and Health Status", Chapter 8. In L.G. Martin and S.H. Preston (eds.), *Demography of Aging*, pp. 279–318. Washington, DC, National Academy Press.

Regidor, E., M.E. Calle, P. Navarro, and V. Domínguez. 2003. "The Size of Educational Differences in Mortality from Specific Causes of Death in Men and Women." *European Journal of Epidemiology* 18:395–400.

Research Triangle Institute. 2008. *SUDAAN Language Manual, Release 10.0*. Research Triangle Park, NC, Research Triangle Institute.

Rogers, R.G. 1992. "Living and Dying in the USA: Sociodemographic Determinants of Death Among Blacks and Whites." *Demography* 29(2):287–303.

Rogers, R.G., B.G. Everett, A. Zajacova, and R.A. Hummer 2010. "Educational Degrees and Adult Mortality Risk in the United States." *Biodemography and Social Biology* 56(1):80–99.

Rogers, R.G., R.A. Hummer, and P. Krueger 2005. "Adult Mortality." In D. Poston and M. Micklin (eds.), *Handbook of Population*, pp. 169–206. New York, NY, Kluwer/Plenum Academic Publishers.

Rogers, R.G., R.A. Hummer, and C.B. Nam. 2000. *Living and Dying in the USA: Behavioral, Health, and Social Differentials of Adult Mortality*. San Diego, CA, Academic Press.

Rogers, R., R. Hummer, C. Nam, and K. Peters. 1996. "Demographic, Socioeconomic, and Behavioral Factors Affecting Ethnic Mortality by Cause." *Social Forces* 74:1419–38.

Roos, L.L., J. Magoon, S. Gupta, D. Chateau, and P.J. Veugelers. 2004. "Socioeconomic Determinants of Mortality

in Two Canadian Provinces: Multilevel Modeling and Neighborhood Context." *Social Science & Medicine* 59(7): 1435–47.

Ross, C.E. and C. Wu. 1995. "The Links Between Education and Health." *American Sociological Review* 60:719–45.

Schnittker, J. 2004. "Education and the Changing Shape of the Income Gradient in Health." *Journal of Health and Social Behavior* 45:286–305.

Schoeni, R.F., J.S. House, G.A. Kaplan, and H. Pollack 2008. *Making Americans Healthier: Social and Economic Policy as Health Policy*. New York, NY, Russell Sage Foundation.

Sholnikov, V.M., D.A. Leon, S. Adamets, E. Andreev, and A. Deev. 1998. "Educational Level and Adult Mortality in Russia: An Analysis of Routine Data 1979 to 1994." *Social Science & Medicine* 47(3):357–69.

Smeeding, T.M. and D.H. Weinberg. 2001. "Toward a Uniform Definition of Household Income." *Review of Income and Wealth* 47:1–24.

Smith, J.P. 2004. "Unraveling the SES-Health Connection." *Population and Development Review* 30:108–32.

Sorlie, P.D., E. Backlund, and J.B. Keler. 1995. "U.S. Mortality by Economic, Demographic, and Social Characteristics: The National Longitudinal Mortality Study." *American Journal of Public Health* 85:949–56.

Tienda, M. and F. Mitchell (eds.). 2005. *Multiple Origins, Uncertain Destinations: Hispanics and the American Future*. Washington, DC, National Academies Press.

Turra, C. and N. Goldman 2007. "Socioeconomic Differences in Mortality Among U.S. Adults: Insights Into the Hispanic Paradox." *Journal of Gerontology: Social Sciences* 62B(3):S184–S92.

U.S. Census Bureau. 2009. "Educational Attainment." 2005–2007 American Community Survey, Table S1501. Available online at http:factfinder.census.gov. Retrieved July 9, 2009.

U.S. Department of Health and Human Services [DHHS]. 2000. *Healthy People 2010: Understanding and Improving Health*. Washington, DC, U.S. Government Printing Office.

U.S. Department of Health and Human Services [DHHS]. 2008. *Healthy People 2020: The Road Ahead*. Washington, DC, U.S. Government Printing Office.

Valkonen, T. 1989. "Adult Mortality and Level of Education: A Comparison of Six Countries." In J. Fox (ed.), *Health Inequalities in European Countries*. Aldershot, England, Gower.

Valkonen, T. 1993. "Problems in the Measurement and International Comparisons of Socio-economic Differences in Mortality." *Social Science & Medicine* 36(4):409–18.

Williams, D.R. 1990. "Socioeconomic Differentials in Health: A Review and Redirection." *Social Psychology Quarterly* 53:81–99.

Zajacova, A. 2006. "Education, Gender, and Mortality: Does Schooling Have the Same Effect on Mortality for Men and Women in the US?" *Social Science & Medicine* 63:2176–90.

Zajacova, A. and R.A. Hummer. 2009. "Gender Differences in Education Effects on All-Cause Mortality for White and Black Adults in the United States." *Social Science and Medicine* 69:529–37.

Zhang, J., K. Markides, and D. Lee. 1991. "Health Status of Diabetic Mexican Americans: Results From the Hispanic HANES." *Ethnicity and Disease* 1:273–79.