

Educational Differences in All-Cause and Cause-Specific Adult Mortality--Evidence from Bulgaria, Finland and the United States

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Abstract

We analyze educational differentials in all-cause and cause-specific mortality at working ages in Bulgaria, Finland, and the United States during the 1990s. The three countries are characterized by large differences in social and economic structure and historical development as well as differences in health behaviors and access to preventive and curative health care. In particular, we analyze whether cross-country mortality differentials are uniform across the education gradient or whether they are primarily concentrated among individuals with low levels of schooling. We also investigate whether educational differentials in mortality vary by gender or marital status. Finally, we examine whether educational disparities in cause-specific mortality differ among the three countries. International comparisons of educational differences in all-cause and cause-specific mortality shed light on the possible role of health policy and social and economic context on SES inequalities in mortality and the extent to which such inequalities vary by context.

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1. Introduction

A well established pattern in the demographic, sociological, and epidemiological literature is that people with high education, high income, and a higher status occupation experience a lower risk of death. This inverse relationship between socioeconomic status (SES) and health and mortality has been extensively documented for many industrialized countries (Adler et al. 1994; Antonovsky 1967; Drever et al. 1996; Valkonen 1987, 1989; Valkonen and Martelin 1988, Mackenbach et al. 1997, 2000). However, despite an extensive literature on socioeconomic determinants of mortality, discovering the factors that contribute to this SES-health gradient continues to pose a challenge for researchers. The specific mechanisms of how social and economic conditions translate into mortality differentials and how the effect of socioeconomic characteristics depends on the overall social and economic development of a country are not fully understood.

In addition, most existing comparative studies have focused primarily on relative or absolute differences in the level of mortality by sex and socioeconomic group, but they have not investigated differentials by age nor have they included other important demographic determinants of mortality (e.g. marital status). Moreover, few studies have analyzed SES differentials in cause-specific mortality in an international framework.

In this paper we analyze socioeconomic mortality differentials in a comparative perspective. In particular, the aim of the present study is to investigate mortality differentials by SES (i.e., education), marital status and gender for the working age populations in Finland, Bulgaria and the United States. The three countries are different on many salient dimensions relevant to health, morbidity and mortality, and they offer a unique opportunity to assess the effects of national socioeconomic policies and historical contexts on the magnitude and pattern of health inequalities.

We address the following specific research questions in the present paper:

1. What are the major differences and similarities in the SES mortality pattern at adult working ages in Bulgaria, Finland and the United States in the 1990s? In this context, we examine education differences in the level of mortality and how the pattern of mortality by educational attainment varies by age among the three countries. In addition, we compare cross-country differences in the educational mortality gradient, i.e., we examine whether the largest cross-country differences in mortality occur among individuals with the lowest educational attainment or whether these differentials are uniform across the education gradient.
2. An important question in the demographic and sociological literature on mortality is whether SES mortality differentials are smaller among women than among men (Koskinen and Martelin 1994; McDonough et al. 1999). In this context, we investigate at what levels of schooling the sex differences in mortality are the most pronounced and whether these patterns are the same in the three countries. Moreover, we ask the question of whether the sex-specific educational differences in mortality vary by marital status and whether the role of marriage is the same in the three countries. The empirical evidence on

sex differences in SES inequalities in mortality is not straightforward. For example, studies from England and Wales show that the relative mortality differential by educational groups are similar among men and women, while other research suggests that at least in the Finnish context, the relative magnitude of mortality inequalities is considerably smaller among women than among men, but these differences partly diminish once marital status is accounted for (Koskinen and Martelin 1994).

3. Although numerous studies have found persistent differences in all-cause mortality by educational attainment, far fewer studies have attempted to identify which diseases contribute the most to the educational disparities in all-cause mortality. Thus, a third issue we address in this paper has to do with the contribution of various causes of death to educational differences in all cause-mortality in Bulgaria, Finland, and the United States. More specifically, we investigate the association between educational attainment and cause-specific mortality by gender. We hypothesize that any cross-country differences in cause-specific mortality reflect differences in health behaviors and access to health care and that these differences may well be gender-specific.

2. Choice of Countries and Data

Our analyses are set in the context of three countries--Finland, Bulgaria and the United States--that are characterized by substantial differences in historical mortality trends as well as differences in the socioeconomic context and development during the 20th century. In particular, mortality trends in Bulgaria diverged from those in the other two countries in the latter half of the 20th century, as life expectancy decreased for both men and women in the 1990s. Other country-specific differences are also notable. For example, Finland has universal health insurance coverage, which would be expected to diminish socioeconomic differences in health and provide more uniform access to health care. In contrast, in the United States, which has no national health system, approximately 15.4% of the total US population had no health insurance in 1995; 24.3% of those who were 18+ years old without a high school diploma did not have health insurance in 1995. Moreover, the quality and extent of the coverage vary by insurance type (U.S. Census Bureau 2001). Finland also spends a greater percentage of its Gross Domestic Product (GDP) on social programs for men and women at working ages than does the United States (Gottschalk and Smeeding, 1997).

In contrast to the United States and Finland, Bulgaria underwent considerable economic and political change during the 1990s and represents an outlier in terms of many demographic patterns observed in the other two countries during the 1990s. Fertility dropped to unprecedentedly low levels, and the reduction in life expectancy observed after 1989 shattered the silent belief held by many demographers that mortality rates will continue their downward trend in modern societies. Hence, it is of particular interest to investigate whether the educational gradient in mortality in Bulgaria differs from that observed in Finland and the United States and whether these differences are similar for both men and women. These analyses will also enable us to identify those population subgroups in Bulgaria that experienced particularly high mortality during the transition period. For example, published reports on Central and Eastern Europe suggest that relatively large and increasing differences in the level of mortality between socioeconomic groups have emerged during the transition period (Carlson 1989; Carlson and Tsvetarsky 1992; Carlson 2000; Józán and Forster 1999; Mackenbach et al. 1999; Shkolnikov

et al. 1998; Welton et al. 1999). In a comparative study, Lahelma and Valkonen (1990) show, for example, that the mortality differences by education in Europe are largest among Hungarian men and women. These studies indicate that although the achievement of social equality was a main target of the socialist regimes in Central and Eastern Europe, large mortality differentials by social class persisted in these societies. Whether these differences are larger than or comparable to those observed in Western societies in the 1990s is not well known.

We chose education for these analyses for substantive and methodological reasons. Although the health status of a population or individuals can be assessed by using several social and economic indices, education is advantageous for measuring one's relative social position in the society as it can be determined for everybody, whereas occupation or income become problematic, especially in the context of a transition economy such as Bulgaria, or when we are interested in measuring health and mortality differentials among women, some of whom have never worked or do not have independent sources of income. Furthermore, education is largely fixed above age 30 and cannot be affected by health impairments that may emerge during later life. Elo and Preston (1996) describe education as a composite socioeconomic variable that is related to and affects many other social and economic factors such as earnings and income, cognitive abilities, health behavior, etc. In summary, education indexes the socioeconomic position of the individuals early in adulthood as well as the stock of human capital available to them during their life course (see also Feldman et al. 1989; McDonough et al. 1999; Preston and Taubman 1994). We include marital status in these analyses to examine whether gender differences in the effects of education on mortality are modified by marital status.

2.1 The Bulgarian Data

The analyses of Bulgarian mortality are based on an individual-level dataset that is unique for a Central and Eastern European country. In particular, the Bulgarian dataset is obtained from a link between the 1992 population census taken on December 4th and the death certificates for the period December 5, 1992--December 31, 1998. The link between the census and death records has been performed on the basis of a personal identification number that is uniquely assigned to each Bulgarian citizen and that is included on the death and census records. In the year 1993, we were able to link 93.1% and in the following year 93.5% of all death certificates to the census records of the individuals who were known to have died during this period.¹ Information on date and cause of death, coded according to the ninth revision of International Classification of Diseases (ICD-9), come from death records and information on education, age at baseline, and marital status come from the census record. These data offer the first opportunity to study the mortality differentials by various socioeconomic characteristics in Bulgaria. Research on SES inequalities in health and mortality based on individual-level data has a long tradition in the industrialized Western societies, and in particular in the Scandinavian countries, but it represents an innovation for the countries of Central and Eastern Europe.

¹ *The complete dataset covering the period 1993-1998 will be made available to the researchers in the next month.*

2.2 The Finnish Data

For Finland we use the Finnish Longitudinal Census Data File (Statistics Finland, 1995) (permission TK-53-1783-96) for the 1990s, which are similar in their construction to the Bulgarian data. The different Finnish data sources – census, population registration and death records – have been linked by Statistics Finland using a unique personal identification code. Socio-demographic characteristics of respondents come from census records while date and cause of death come from the death records. Non-linkage of death records to census records is less than 0.5%. Causes of death were coded according to the ninth revision of the ICD-9. These data have been used in previous studies to analyze mortality differentials by education (Martikainen & Valkonen, 1998), occupation (Valkonen et al., 2000), family income (Martikainen et al., 2001), and SES differentials in mortality in Finland and the United States (Elo, Martikainen & Smith 2004).

2.3 The U.S. Data

The analyses for the United States are based on a data set that links National Health Interview Survey (NHIS) respondents to the National Death Index (NDI) to determine the respondents' survival status. The NHIS is an annual health survey of the civilian, non-institutionalized population of the United States dating back to 1957 and is considered the main source of annual data on the health status of the US population. The survey's health and demographic core questionnaire also collects information on socio-demographic characteristics of individuals residing in surveyed households, including information on age, race/ethnicity, marital status, and education. Since 1986 NCHS has obtained information for NHIS respondents ages 18 and above that make it possible to link respondents to death records. In this paper, we will use data from NHIS waves from the early 1990s that have been linked to the NDI through 1997 (Massey et al. 1989; NCHS 2000). Information on age, marital status, education, and race come from the NHIS and date of death and underlying cause of death come from the NDI. Causes of death are coded according to the ninth revision of the ICD. The NHIS-MCD data are considered one of the most reliable large nationally representative data sets for the study of SES differentials in mortality in the United States (Rogers, Hummer & Nam 2000). The main difference between these data and the Bulgarian and Finnish data are that the US data are restricted to the civilian, non-institutionalized population and that the baseline is a survey rather than a full census.

3. Methods and Analytic Strategy

One of the challenges in conducting international comparisons of mortality differentials by SES is developing comparable measures (Valkonen, 1993; Martikainen & Valkonen, 1999). We will address this problem through a careful coding of our explanatory variables – education and marital status. All three data sources allow us to code education by completed years of schooling. We will code our categorical education variable to reflect meaningful educational thresholds in the three countries. In addition, we will model years of education as a linear variable. Analyzing linear effects has two advantages over using the categorical variable: the choice of the reference group does not influence results, and the linear coding gives less weight

to education categories with few observations. The disadvantage is that it misses any non-linearities that may be present. Our data sources also permit a similar coding of marital status and we will distinguish between those who are currently married, formerly married, and never married.

We focus our analyses on educational differentials in mortality at working ages, 30-64 years. It has been shown that the observed mortality differentials are large at these ages, deaths are considered premature, and are more likely to be caused by one (leading) cause of death than is the case at older ages. We restrict the present analyses to the civilian, non-institutionalized population due to the sample design of the U.S. data.

In the analyses of cause-specific mortality, we will focus on major causes of death such as ischemic heart disease (410-414), other cardiovascular diseases (390-409, 415-448), lung cancer (162), other cancers (140-161, 163-239), accidents and injuries (E800-E999), and all other causes of death combined (all other ICD-9 codes) to the extent permitted by the US data. We hypothesize that the effects of education and marital status will vary by cause of death.

Several statistical approaches can be used for the analyses of socioeconomic mortality differentials, e.g., logit or probit regression models to estimate the probability of dying in a given interval, non-parametric event-history approaches, or fitting parametric functions to the observed mortality data. In the present analyses, we will estimate a parametric specification of the mortality hazard. In particular, we will begin by estimating the following Gompertz model:²

$$m(x) = a(z)e^{b(z)(x-30)} \quad (1)$$

We assume that the death rate $m(x)$ is an exponential function of age and $z = (z_1 \dots z_n)$ is a vector of covariates such as sex, education and marital status. The parameter $a(z) = \exp(\alpha_0 + \alpha_1 z_1 + \dots + \alpha_n z_n)$ shows the level of mortality at age $x=30$ observed for a given set of socioeconomic characteristics. The parameter $b(z) = \beta_0 + \beta_1 z_1 + \dots + \beta_n z_n$ indicates how the risk of death changes with age for a given socioeconomic group, which is equal to the life table aging rate (LAR) (Horiuchi et al. 1990, 1997).

The Gompertz model is appealing in the present analyses for several reasons. First, it is shown that the Gompertz model describes well the age-specific mortality patterns at adult ages where the logarithm of the risk of death increases linearly with age. Second, we can test for differences in the mortality hazard by SES group. In the case where the parameter $b(z)$ is not statistically significant, the model converts to a proportional hazard model. In contrast to logit regression analyses, which can be used to estimate the probability of dying in a given interval, the Gompertz model makes fuller use of the data on exact date of death. Third, although not unique to this approach, the model also permits the estimation of interaction effects, e.g., whether the effects of education vary by marital status.

² We will examine whether this model fits the data in all three countries and will consider alternative specifications, if warranted.

Finally, using the parameter estimates obtained from the model, we can calculate life table functions by level of education, marital status, and sex in the three countries, and thus we can make straight-forward comparisons for example of death rates and life expectancies between age 30 and 64 by characteristics of interest. Age-specific probabilities of dying can be calculated as follows, which can then aid in the estimation of various life table quantities:

$${}_1q_x = 1 - e^{m(x+.5)} \quad (2)$$

where $m(x)$ can be a function of age, education, marital status, et cetera.

For the analyses of cause-specific mortality, we will use a similar approach to calculate cause-specific death rates by educational attainment, marital status, and gender for the major causes of death specified earlier in this abstract. These analyses will enable us to decompose the educational differences in all-cause mortality by cause of death and assess the contribution of various causes of death to overall mortality. Of specific interest in these analyses is to determine to what extent differences in the cause-of-death composition between men and women are responsible for different educational gradients in all-cause mortality.

Once we have obtained cause-specific death rates, we can obtain the probability of dying at age x from cause i :

$${}_nq_x^i = \frac{{}_nM_x^i}{1 + (n-{}_na_x)({}_nM_x)} \quad (3)$$

from which we can further obtain the share of a given cause of death among all causes.

4. Illustrative Examples: Educational and marital status differentials in life expectancy in Bulgaria, Finland, and the US

Little has been known about differentials in life expectancy by educational attainment and marital status in Bulgaria until the 1990s. Below we present the educational gradient and marital status differentials in life expectancy at age 30 in Bulgaria in 1992-1993, a period that corresponds to the beginning of the mortality follow-up included in the proposed analyses. These estimates are taken from Kohler (2004), which is the first analysis of SES mortality differentials in Bulgaria using data from the 1990s.

Table 1 presents male and female life expectancies at age 30 by educational attainment and marital status for men and women. Life expectancies were calculated based on single year death rates with the open-ended age interval beginning at age 85. We find substantial male-female differences in life expectancy by educational attainment at age 30. The difference in life expectancy of the highly educated compared to those with no education is about 12 years for men and 8 years for women. In addition, female life expectancy is higher at every level of schooling with the biggest male-female difference found among men and women with no education (8.6 years) and the smallest among the highly educated (5.1 years).

Table 1: Male and female life expectancy at age 30 by educational attainment and marital status, Bulgaria 1992-1993

	Life expectancy at age 30	
	Men	Women
<i>Educational attainment</i>		
Some college and higher (13+ yrs.)	44.63	49.71
Some high school or technical school (9-12 yrs.)	42.22	48.96
Less than high school (1-8 yrs.)	39.03	46.83
No formal education	32.75	41.37
<i>Marital Status</i>		
Married	41.70	47.69
Single	36.33	44.00
Divorced	33.68	45.44
Widowed	37.73	46.86

We also find substantial marital status differentials by educational attainment at age 30 in Bulgaria. Among men, the lowest life expectancy is recorded for divorced men (33.7 years) and the highest for married men (41.7 years). Among women, life expectancy at age 30 is lowest for single women (44.0 years) and highest for married women (47.7 years). Thus these results show considerable differences in life expectancy by both educational attainment and marital status for men and women in Bulgaria in the 1990s.

Figure 1 graphs the observed and fitted death rates (obtained from a parametric logistic model fitted with four parameters using data for the entire age range) by educational attainment for men and women in Bulgaria. As seen in Figure 1, educational differentials in mortality are substantial particularly at the working ages, the focus of the proposed analyses, with some narrowing of the differentials at older ages. They are also more substantial for men than for women.

a) Observed & fitted mortality pattern, males

b) Observed & fitted mortality pattern, females

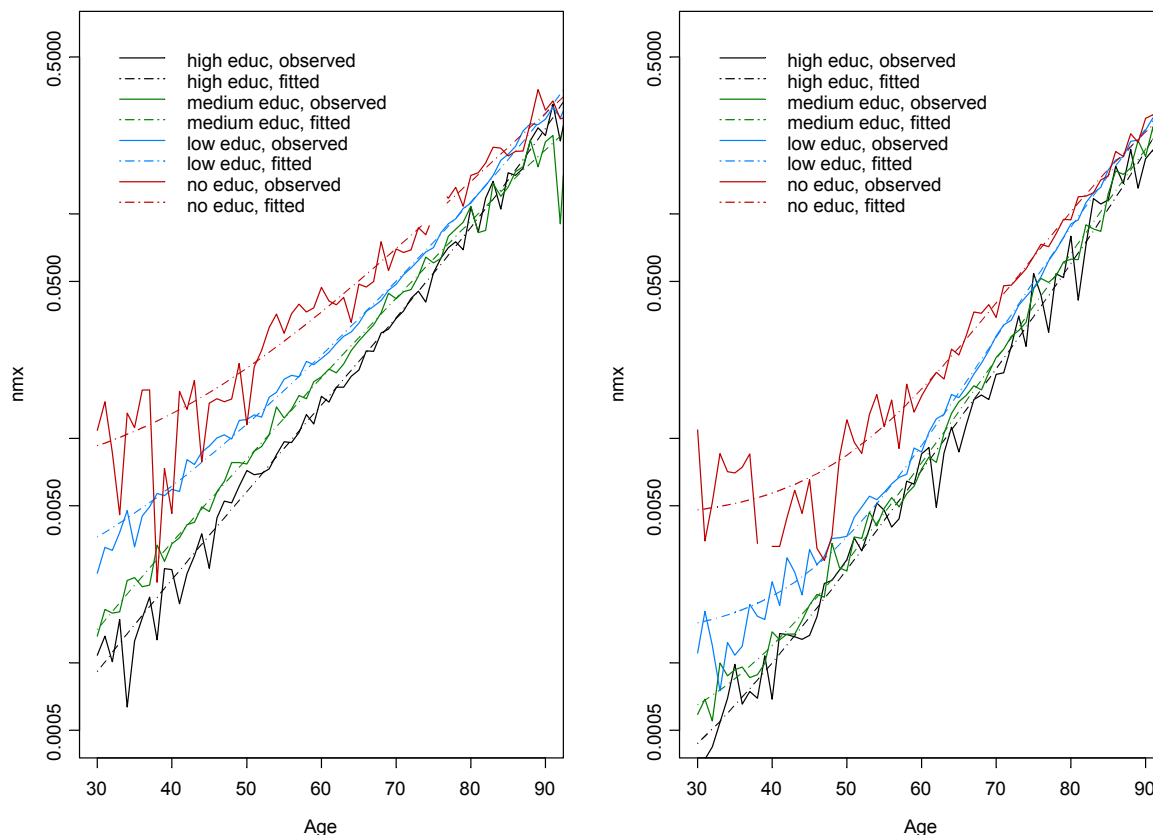


Figure 1: Observed and fitted (based on a four parametric logistic model)

As seen in Table 2, life expectancy at age 30 also varied by educational attainment in Finland in the early 1990s. Men with at least some university education ($e_{30} = 48.0$ years) could expect to live 6.3 years longer than men with only basic schooling ($e_{30} = 41.7$ years) given mortality conditions that prevailed in 1991-1993. This difference for women is smaller but still notable - 3.6 years. As was the case in Bulgaria, female life expectancy at age 30 is higher at every level of schooling than male life expectancy at this age with the biggest male-female difference found among men and women with only basic level of schooling (7.7 years) and the smallest among the most highly educated (5.0 years).

In the United States, educational differentials in mortality are also quite pronounced. Table 3 presents estimates of life expectancy at age 25 for white men and white women derived from the National Longitudinal Mortality Study for 1979-85 by Rogot, Sorlie and Johnson (1992). The differences in life expectancy by educational attainment are broadly similar to those documented in Bulgaria and Finland. However, these comparisons indicate that Bulgaria stands out from the other two countries in having a particularly large life expectancy difference between the lowest and the second lowest educational categories. Also in the United States, at all levels of educational attainment females live longer than males and the biggest difference in life expectancy between men and women is recorded among those with less than high school

education and the smallest among the college educated. However, these data pertain to a period that is about 10 years prior to the estimates for the other two countries and the coding of educational attainment is not strictly comparable among the countries.

Table 2: Male and female life expectancy at age 30 by educational attainment, Finland 1991-1993

	Life expectancy at age 30	
	Men	Women
<i>Educational attainment</i>		
University or higher (13+ yrs.)	48.0	53.0
High school degree (12 yrs.)	45.6	51.9
Lower secondary 10-11 (yrs.)	44.1	51.5
Basic education (up to 9 yrs.)	41.7	49.4

Table 3: Male and female life expectancy at age 25 by educational attainment, United States 1979-1985

	Life expectancy at age 30	
	Men	Women
<i>Educational attainment</i>		
0-4 yrs.	48.2	54.4
5-7 yrs.	47.9	56.1
8 yrs.	47.5	55.7
9-11 yrs.	48.0	56.6
12 yrs.	50.2	57.2
13-15 yrs.	50.9	57.8
16 yrs.	53.3	58.3
17+ yrs.	54.5	59.4

Source: Rogot, Sorlie, and Johnson 1992.

In this paper, we will extend these analyses by focusing on the working age population using a methodology that produces consistent estimates in all three countries.

5. Conclusions

International comparisons of SES differentials in mortality can help to disentangle empirically some of the complex pathways linking social disadvantage to premature mortality. In this paper we analyze educational differentials in mortality in three developed countries characterized by large differences in social and economic structure and development as well as differences in health behaviors such as smoking, drinking, and access to preventive and curative health care. This international comparison of educational differences in all-cause and cause-specific mortality

will shed light on the possible role of health policy and social and economic context on SES inequalities in mortality and the extent to which educational inequalities in mortality vary by context. Comparing countries is often the only feasible way to evaluate how policy affects mortality inequalities. Comparative studies also improve our understanding of the limits and generalisability of explanations of inequalities in health obtained in particular national settings.

Our paper contributes to the comparative literature of SES inequalities in mortality in the 1990s by examining educational differentials in mortality in a multivariate framework and by incorporating detailed data from an Eastern European country where we know relatively little about mortality patterns by educational attainment and marital status. We explore for the first time one of the most comprehensive data sets for an Eastern European country that will shed light on existing educational differentials in mortality during a period of profound social and economic transformation.

Few comparative studies of SES inequalities in all-cause mortality have considered the effect of education simultaneously with marital status. In addition, few studies have examined to what extent sex differences in the education gradient in mortality can be explained by differences in leading causes of death between men and women. In this paper we specifically address these issues.

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