PAA Abstract
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Socioeconomic Differentials in Mortality in Finland and the United States: The Role of Income and Education

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Specific Aims

In this paper we investigate educational and income inequality in all-cause and cause-specific mortality by age and sex in Finland and the United States in the 1980s, and assess whether associations exhibit similar patterns in the two countries. The results will advance our understanding of mortality differentials by socioeconomic status in two settings with very different social welfare and health care systems.

Background, Significance and Research Objectives

Poverty and material hardship have been hypothesized to be one of the main underlying causes of social inequality in mortality and morbidity (Smith and Kington 1997a; McDonough et al. 1997; Davey Smith 1993). Although numerous studies have examined effects of education on mortality in Europe and the United States, far fewer studies have examined the relationship between income and mortality. Results of the handful of studies that do exist for Finland and the United States (e.g., Backlund, Sorlie, and Johnson 1996; McDonough et al. 1997; Martikainen et al. 2001; Rahkonen et al. 2002; Smith and Kington 1997a, 1997b) nevertheless suggest that the association between income and mortality differs between the two countries at the individual level. Specifically, in the US the relationship between income and mortality exhibits a curvilinear relationship, whereas in Finland the association is more linear (Backlund, Sorlie and Johnson 1996; Martikainen et al. 2001). We hypothesize that these differences are related to differences in social welfare and health care systems, and in levels of inequality and poverty, in the two countries. Further analyses are needed, however, to determine whether differences in the association between income and mortality persist when comparable methodologies and analytic strategies are employed.

Like income, educational attainment is closely linked to adult mortality. Previous analyses have documented steeper educational gradients in all-cause mortality at ages 35-54 for men in Finland than in the United States, while the reverse is true for women (Elo and Preston 1996). Although educational attainment influences earnings, and thus its effects in part are mediated by income, research suggests that the relationship between education and mortality is also tied to health behaviors such as smoking and exercise, which are more closely associated with educational attainment than income (Winkelby et al. 1992).

We extend previous analyses of educational and income inequality in mortality in Finland and the Unites States in several ways. We examine the relationship between both income and education and all-cause and cause-specific mortality. For the cause-specific analyses we classify causes of death into major cause-of-death groups. In addition, we examine the utility of alternative classification schemes that categorize causes of death into medically avoidable causes and causes that are closely linked to health behaviors, an approach used by others before us to examine SES differences in mortality. We hypothesize that, because access to health care is more universally available in Finland than in the United States, the association between education and mortality from behavioral causes is more similar in Finland and the United States than is the association with medically avoidable causes. We further expect that the association between income and mortality from all causes of death differs between the two countries,

reflecting differences in income inequality and poverty.

Data

The data for these analyses come from the National Longitudinal Mortality Study (NLMS) for the United States and from census data linked to death records for Finland. The NLMS public use sample is based on five Current Population Surveys (CPS) conducted in 1979-1981 and contains 637,162 individual records that have been linked to the National Death Index (NDI) through 1989 (for details of linkage procedures, see Rogot, Sorlie and Johnson 1986). Demographic, social, and economic characteristics of respondents, including educational attainment and household income, come from the CPS. Cause of death information is obtained from the linkage of CPS respondents to the NDI and is based on the underlying cause of death reported on the death certificate. Causes of death are coded according to the ninth revision of International Classification of Disease (ICD-9) codes in effect in the United States in 1979-1989. This data source has been used for cause-specific mortality analyses in previous studies (e.g., Howard et al. 2000, Elo and Drevenstedt 2000).

The Finnish data are based on censuses carried out every five years from 1970 to 2000. The individual-level census records have been linked to annual death registration data from 1971 to 2001. In these analyses, we restrict the data to the non-institutionalized population and to the 1980s to make them comparable to the NLMS. Socio-demographic characteristics of respondents, including educational attainment and household income, come from census records or population registration data; causes of death are coded according to the ninth revision of the ICD. These data have been previously used to analyze mortality differentials by education (Martikainen and Valkonen 1998, 1999), occupation (Valkonen et al. 2000), and household income (Martikainen et al. 2001).

We focus our analyses on two age intervals – ages 35-64 and 65-84. We exclude individuals below age 35 at baseline due to small number of deaths. At older ages we limit our comparisons to educational differences in mortality because our available household income measure is unlikely to be a good measure of financial resources for older individuals, especially those who have retired (Smith and Kington 1997a). We estimate unadjusted and adjusted effects of education and income on all-cause and cause-specific mortality for men and women.

Our cause-specific classifications draw from previous research on SES gradients in cause-specific mortality and on medically avoidable mortality and disease processes linked to health behaviors. Medically avoidable causes of death consist of those causes that are avoidable through either preventive measures (e.g., Pap smears for cervical cancer) or medical interventions (e.g., radiation and chemotherapy to treat Hodgkin's disease). Examples include respiratory infections, certain cancers, diabetes, digestive system disorders, congenital anomalies, certain circulatory system disorders, and various infectious diseases. The concept of medically avoidable mortality dates back to 1976 when Rutstein et al. published a classification of diseases considered "unnecessary" and "untimely" causes of death. Others subsequently expanded the concept and used it to measure quality of medical care and its impact on health outcomes (Carr-Hill, Hardman and Russell 1987; Charlton and Veléz 1986; Mackenbach et al.

1988; Poikolainen and Eskola 1988). Life-style related causes of death are causes influenced primarily by residential environment and health behaviors. These include lung cancer (smoking), cirrhosis of the liver (alcohol consumption), motor vehicle accidents, suicide, and homicide.

Methods

To examine educational and income differences in all-cause and cause-specific mortality in the two countries, we estimate Cox proportional hazards regression models by sex for two age groups: ages 35-64 and 65-84 at the baseline interview. Respondents who age out of the interval are censored at age 65 and 85, respectively. This approach is commonly referred to as competing risk analysis. In each cause-specific mortality model, persons who die from causes of death other than the one under investigation are censored at the date of death (Cox & Oakes 1984; Allison 1984). Models are estimated using maximum-likelihood estimation methods in STATA. We will base our comparisons of the effects of income and education in Finland and the United States on hazard ratios, or relative risks (RR), calculated from coefficients obtained from proportional hazards models ($RR=e^{\beta}$). We will examine effects of unobserved heterogeneity on estimated coefficients and, if warranted, will incorporate unobserved heterogeneity in the analyses.

Preliminary Results

Tables 1 and 2 provide preliminary results for the association between education and all-cause mortality for men and women ages 35-64 and 65-84 for Finland and the United States. We find that effects of education on all-cause mortality are similar in the two countries. Although point estimates vary, all but two pairs of confidence intervals overlap. The exception is unadjusted and adjusted estimates for men ages 35-64. Focusing on this age and sex group, we find that in the unadjusted model, each one-year increase in education reduces the mortality hazard by 10 percent (100(. 90-1)=-10. 0) for Finnish men and by 7 percent for American men. When we adjust for labor force status, household size and household income, the effect drops to 5 percent in Finland and 2 percent in the United States, rendering the absolute difference between the two countries unchanged. For all other groups, our results suggest that there are no significant differences in the linear effect of education on all-cause mortality in Finland and the United States.

With respect to the relationship between income and mortality, we find that this association is more linear in Finland than in the United States. We also find that in the United States increases in household income have a greater effect on mortality at the lower end of the income distribution than at the upper end for both men and women (results not shown).

We will extend these analyses by investigating linear and non-linear effects of education and income on both all-cause and cause-specific mortality and will discuss implications of our findings for understanding cross-national differences in mortality by SES.

Table 1. Effect of an additional year of schooling on all-cause mortality, Finland and the United States, 1979-1989, ages 35-64

	Finland		United States	
Group	Hazard Ratio	95% CI	Hazard Ratio	95% CI
Men				
Unadjusted[1]	0.90	0.89 – 0.91	0.93	0.93-0.94
Adjusted[2]	0.95	0.93 – 0.96	0.98	0.97-0.99
Deaths	9,296		4,405	
PY-lived	740,806		552,337	
Women				
Unadjusted[1]	0.92	0.90 – 0.94	0.94	0.93-0.95
Adjusted[2]	0.97	0.94 – 0.99	0.98	0.96-0.99
Deaths	4,509		2,672	
PY-lived	825,957		596,955	

[1] Controls for age and education.
[2] Controls for age, education, labor-force status, household size, and household income.

Table 2. Effect of an additional year of schooling on all-cause mortality, Finland and the United States, 1979-89, ages 65-84

	Finland		United States	
Group	Hazard Ratio	95% CI	Hazard Ratio	95% CI
Men				
Unadjusted[1]	0.95	0.94 – 0.96	0.97	0.96 – 0.97
Adjusted[2]	0.97	0.96 – 0.99	0.98	0.98 – 0.99
Deaths	11,070		8,175	
PY-lived	143,276		140,025	
Women				
Unadjusted[1]	0.95	0.94 – 0.97	0.97	0.97 – 0.98
Adjusted[2]	0.97	0.95 – 0.99	0.98	0.97 – 0.99
Deaths	13,924		6,745	
PY-lived	276,756		206,785	

[1] Controls for age and education.
[2] Controls for age, education, labor-force status, household size and household income.

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