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Educational gains in cause-specific mortality: Accounting for cognitive ability and family-level confounders using propensity score weighting

Govert E. Bijwaard [a, *], Mikko Myrskylä [b, e, f], Per Tynelius [c], Finn Rasmussen [d]

[a] Netherlands Interdisciplinary Demographic Institute (NIDI-KNAW/University of Groningen), PO Box 11650, 2502 AR, The Hague, The Netherlands
[b] Max Planck Institute for Demographic Research, Rostock, Germany
[c] Department of Public Health Sciences, Karolinska Institute, Tomtebodavägen 18A; Widerströmska huset, 171 77 Stockholm, Sweden
[d] Department of Health Sciences, Lund University, Box 117, 221 00 Lund, Sweden
[e] Department of Social Policy, London School of Economics and Political Science, London, UK
[f] Department of Social Research, University of Helsinki, Helsinki, Finland

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ABSTRACT

A negative educational gradient has been found for many causes of death. This association may be partly explained by confounding factors that affect both educational attainment and mortality. We correct the cause-specific educational gradient for observed individual background and unobserved family factors using an innovative method based on months lost due to a specific cause of death re-weighted by the probability of attaining a higher educational level. We use data on men with brothers from the Swedish Military Conscription Registry (1951–1983), linked to administrative registers. This dataset of some 700,000 men allows us to distinguish between five education levels and many causes of death. The empirical results reveal that raising the educational level from primary to tertiary would result in an additional 20 months of survival between ages 18 and 63. This improvement in mortality is mainly attributable to fewer deaths from external causes. The highly educated gain more than nine months due to the reduction in deaths from external causes, but gain only two months due to the reduction in cancer mortality and four months due to the reduction in cardiovascular mortality. Ignoring confounding would lead to an underestimation of the gains by educational attainment, especially for the less educated. Our results imply that if the education distribution of 50,000 Swedish men from the 1951 cohort were replaced with that of the corresponding 1983 cohort, 22% of the person-years that were lost to death between ages 18 and 63 would have been saved for this cohort.

1. Introduction

The fact that individuals with lower socioeconomic status have higher mortality rates has been well established in social science research (Hummer and Lariscy, 2011). Of the various socioeconomic measures that are commonly used to investigate this relationship, the educational gradient has been shown to be particularly robust (Cutler et al., 2011). This educational gradient is apparent not only in less-developed countries, but in the US (Masters et al., 2012) and in other western countries with advanced health care systems (Huisman et al., 2005). For example, in the year 2010, life expectancy at age 30 was 53 years for Swedish men with a university degree and only 48 years for Swedish men with less than secondary education. Differences by educational attainment have been reported for most causes of death, and particularly for cardiovascular diseases and some types of cancer (Huisman et al., 2005). Many of these causes of death are theoretically avoidable through prevention or treatment. According to the "fundamental cause theory" proposed by Link and Phelan (1995), the educational gradient is steeper for such causes of death because personal resources and social context can be used to acquire health-related knowledge that prevents these causes or facilitates recovery from these diseases (Link and Phelan, 1995). According to this theory, highly educated individuals find it easier than their less educated counterparts to handle complex treatment regimens; whereas the educational gradient for non-preventable diseases, which are less under human control, is smaller.

While it is commonly assumed that this educational gradient in mortality has a causal interpretation, this assumption has been challenged in the literature. The association may be partly explained by confounding factors that affect both educational

* Corresponding author.
E-mail addresses: bijwaard@nidi.nl (G.E. Bijwaard), Myrskyla@demogr.mpg.de (M. Myrskylä), Per.Tynelius@ki.se (P. Tynelius), finn.evald.rasmussen@gmail.com (F. Rasmussen).

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attainment and mortality (Grossman, 2015). If such common traits exist, the association may be spurious. This would have important policy implications. Yet most of the studies investigating differences by educational attainment in cause-specific mortality account only partially for such factors.

We account for confounding factors using a propensity score method. Propensity score weighting methods for hazard models, such as the mortality hazard, that account for censoring, truncation and dynamic selection issues have recently been introduced (Cole and Hernán, 2004; Austin, 2014). The critical assumption in propensity score weighting is that there is no selection on unobserved factors. However, twin studies have emphasized that even after accounting for an individual's socioeconomic background, the association between education and mortality may be a reflection of other factors shared within a family. In addition to sharing 50% of their genes, siblings typically share an environment during childhood. To account for the impact of these unobserved family characteristics on the educational gradient in mortality, we apply a family fixed effects model that compares only siblings (brothers).

The most common approach used to analyze the impact of education on cause-specific mortality has been to estimate a Cox proportional hazard for each cause of death separately. However, when there are competing risks, and education influences each cause-specific hazard, the interpretation of the proportional hazard results of education on cause-specific mortality is unclear. Even the sign of the effect of education is unclear, because both the total survival and the cause-specific cumulative incidence functions depend not only on the cause-specific hazard, but on the hazards of all of the other causes. Another problem is that the contribution of a given cause to the gain by educational attainment cannot be derived. A direct approach that can be used to account for the importance of a specific cause is to estimate the impact of education on the months lost due to a specific cause. To account for the observed confounding factors, we estimate these month-lost models using inverse probability weighting (IPW) based on the propensity score. Drawing upon this synthetic sample, we estimate linear month-lost models with family fixed effects. The family fixed effects account for the unobserved family confounding factors. Although the family fixed effect approach has been used in previous analyses of cause-specific mortality and education or of other adult characteristics, these analyses have been conducted within the Cox proportional hazard framework (Barclay et al., 2016; Elo et al., 2014).

The Swedish Military Conscription Register for men born in 1951–1983 that are linked to Swedish administrative registers provides us with the opportunity to investigate these questions. These data include information on the men's demographic and socioeconomic characteristics, such as education, parents (both father and mother), socioeconomic status, parents' education, and area of residence. The data also include the results of anthropometric measures, and an intelligence test. We include in our analysis all men with a known conscription date and at least one brother ($N = 700{,}043$). This large sample allows us to distinguish 22 causes of death and five educational levels.

The empirical results show that improving education by one level would lead to three to 10 additional months of life between ages 18 and 63. Most of these gains are attributable to the reduction in mortality due to external causes. Men with primary education would gain the most from the reduction in mortality from suicide (1.3 months) and from other external causes (2.4 months). The reduction in CVDs and cancers with improvements in education is rather small. Ignoring confounding would underestimate the gains by educational level for the men with primary education.

2. Previous research and conceptual framework

2.1. Cause-specific mortality

For most causes of death, large mortality differences by socioeconomic status have been observed in both North America and Europe. These inequalities are persistent and several theories seek to explain them (Mackenbach, 2012); we review only the most prominent ones. According to the “fundamental cause theory” (Link and Phelan, 1995), the educational gradient should be steepest for the causes of death that are more preventable and/or curable. This theory posits that these health differences are caused by variation across socioeconomic groups in access to resources that can be used to avoid these diseases, and to slow down the development of these diseases after they have been contracted, regardless of the current level of exposure to risk factors. The “life course perspective” emphasizes the importance of unfavorable early life circumstances in explaining the pathways to both health and social disadvantages in adulthood. Though widely observed, these negative education-mortality associations may not necessarily reflect the beneficial effects of education on mortality, as other individual factors may influence both education and mortality.

Since the evidence suggests that education has varying associations with different diseases, there is also a range of educational gradients in cause-specific mortality (Galobardes et al., 2004). For example, the educational gradient in mortality from cardiovascular diseases (CVD) appears to be steeper than the educational gradient in mortality due to other causes of death (Kulhánová et al., 2014). A potential explanation for this finding is that having a low level of education tends to be associated with having cardiovascular risk factors, such as being a smoker, having hypertension, and being overweight. For cancers, the educational gradient varies by cancer type (Galobardes et al., 2004; Kulhánová et al., 2014). The relatively high levels of mortality from lung cancer found among the less educated are related to smoking. The relationship between educational level and mortality rates is more complex for other cancers, though it may be attributable to lifestyle factors, such as differences in levels of physical activity. However, a recent study has found little evidence that education affects cancer mortality (Leuven et al., 2016), except mortality from lung and prostate cancer among men.

Several studies have investigated the relationship between education and death from external causes, including suicides and traffic accidents (Borrell et al., 2005; Lorant et al., 2005). Such causes make up a large share of mortality among young adults. Socioeconomic inequalities in suicide rates among men have been observed in many countries. Differences by educational attainment in the incidence of mental illness, which is more prevalent among the less educated, may explain this educational gradient. Meanwhile, the differences by educational level in deaths from traffic accidents can be explained by differences in exposure, such as differences in the use of protective devices and in susceptibility.

2.2. Causal inference

Most existing studies address confounding by using a multivariate regression framework with the putative observed confounders as control variables. We seek to gain a better understanding of the causal impact of education level on cause-specific mortality. In the literature, three distinct approaches have been employed to estimate the causal effects of education on mortality. The first approach exploits changes in compulsory schooling policies as instrumental variables for schooling attainment in order to control for possible confounders. The estimates based on these studies suggest that the causal effect of education