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Educational inequalities in mortality are larger at low levels of income: A register-based study on premature mortality among 2.3 million Swedes, 2006–2009

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ABSTRACT

Education develops skills that help individuals use available material resources more efficiently. When material resources are scarce, each decision becomes comparatively more important. Education may also protect from health-related income decline, since the highly educated tend to work in occupations with lower physical demands. Educational inequalities in health may, therefore, be more pronounced at lower levels of income. The aim of this study is to assess whether the shape of the income gradient in premature mortality depends on the level of education.

Total population data on education, income and mortality was obtained by linking several Swedish registers. Income was defined as five-year average disposable household income for ages 35–64 and mortality follow-up covered the period 2006–2009. The final population comprised 2.3 million individuals, 6.2 million person-years and 14,362 deaths. Income was modeled using splines in order to allow variation in the functional form of the association across educational categories. Poisson regression with robust standard errors was used.

The curvilinear shape of the association between income and mortality was more pronounced among those with a low education. Both absolute and relative educational inequalities in premature mortality tended to be larger at low levels of income. The greatest income differences in mortality were observed for those with a low education and the smallest for the highly educated.

Education and income interact as predictors of mortality. Education is a more important factor for health when access to material resources is limited.

1. Introduction

The association between socioeconomic position and health is well established. Both education (Sundquist & Johansson, 1997; Mackenbach et al., 2008; Shkolnikov et al., 2012; Mackenbach et al., 2016) and income (Backlund, Sorlie, & Johnson, 1996; Van Doorslaer et al., 1997; Gerdtam & Johannesson, 2004; Mortensen et al., 2016) have been consistently found to predict mortality risk in high-income populations. In social epidemiology, education, occupational class and income have been used interchangeably as an indicator of an underlying construct of socioeconomic position (Geyer, Hemström, Peter, & Vågerö, 2006; Bonaccio et al., 2016). However, empirical evidence suggests that although these dimensions of socioeconomic position are correlated, education, occupational class and income are independent predictors of mortality (Elo & Preston, 1996; Geyer et al., 2006; Torssander & Erikson, 2010; Östergren, 2015). Geyer et al. (2006) interpret this finding as suggesting that different components of socioeconomic position, while correlated, indicate different underlying

phenomena and are related to health through different mechanisms (Geyer et al., 2006).

Although limited attention has been paid to the possibility that education and income may interact as predictors of mortality, some studies do suggest that the shape and size of the income gradient in self-rated health (Mirowsky & Ross, 2003; Schnittker, 2004), physical impairment (Mirowsky & Ross, 2003), and mortality (Bonaccio et al., 2016) are conditional on education. These studies indicate that health differences between educational groups seem to be larger at lower levels of income (and vice versa). Mirowsky and Ross (2003) conclude that "...at any given level of income, health tends to be better at higher levels of education, ...within each level of education, health tends to be worst at the lowest levels of income, but ... the differences in health across levels of income are smaller at higher levels of education." (Mirowsky & Ross, 2003, p. 78–79). Schnittker (2004) attributes a similar finding to differences in consumption patterns, resource allocation and the ability to navigate the medical system, all of which may favor the health of the well-educated within levels of income

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(Schnittker, 2004). In contrast to these findings, a recent Italian study by Bonaccio et al. (2016) found larger differences in mortality by education at higher levels of income "...the inverse association between household income with all-cause death varied across educational level groups and was larger at higher levels of education" (Bonaccio et al., 2016, p. 771). This conclusion is based on an analysis in which a range of health and behavioural factors were adjusted for (Bonaccio et al., 2016). Both Mirowsky and Ross (2003) and Schnittker (2004) suggest that behavioural patterns are the main explanation for why income differences in health are larger among individuals with a low education, which could account for the reverse pattern found by Bonaccio et al. (2016).

The association between income and mortality is curvilinear (Preston, 1975; Gravelle, 1998; Mortensen et al., 2016; Rehnberg & Fritzell, 2016). This indicates that an increase in available material resources has greater benefits for health when resources are scarce than when they are plentiful. Additional resources at the lower end of the income spectrum may help individuals to avoid the most acute material risks, for example being without food and shelter. The health benefits of higher incomes, for example improving the quality of housing and nutrition or purchasing a more comprehensive insurance, are less dramatic. This is the basic outline of the *material explanation* of the curvilinear association between income and mortality (Miething, 2014). As Schnittker (2004) points out, uniformity of resource management is one of the assumptions of the material explanation for the income gradient in mortality (Schnittker, 2004). However, how individuals use their resources may differ systematically across educational groups. Mirowsky and Ross (2005) characterize education as *learned effectiveness*. Education develops cognitive skills such as information-gathering, valuing, synthesizing and decision-making. Developing these skills allows those with a high level of education to be more efficient as agents (Mirowsky & Ross, 2003, 2005). Education may, then, be interpreted as a proxy for decision-making skills, while income may be interpreted as a proxy for available material resources. If the highly educated are better at managing available resources, the amount of available resources should be comparatively less important for mortality in this group than among those with a low education. Having more material resources increases available options. Individuals with more resources have more chances to achieve a given goal, while for individuals with few resources, every decision is important (Molander, 2016). There is therefore an inverse association between the availability of material resources and the importance of decision-making skills. Both material resources and decision-making skills are probably more important for mortality at lower levels of income, which in turn indicates that education may be more important for mortality at lower levels of income.

Education and income may also interact as predictors of mortality if education protects from income decline caused by poor health. While studies have shown that childhood health can have an effect on educational attainment (Case, Fertig, & Paxson, 2005; Bamba, 2011), since education is generally stable across working ages, the impact of adult health on educational attainment is limited. Income, however, fluctuates across the working life. Empirical evidence suggests that the association between income and adult health is reciprocal (Stronks, van de Mheen, Van Den Bos, & Mackenbach, 1997; Benzeval & Judge, 2001; Halleröd & Gustafsson, 2011). This finding is intuitive. Health is needed to be able to work and income is needed to be able to obtain health-promoting resources. Education may protect from income decline resulting from poor health. Falk, Burström, and Nylén (2014) found that individuals with a low education were more likely to be unemployed as a consequence of musculoskeletal disorders, while Elstad and Dahl (2014) found that labor income preceding death started to decline earlier among individuals who had only completed compulsory education than among individuals with university degrees. The highly educated may be better at navigating the medical system (Mirowsky & Ross, 2003; Schnittker, 2004). By seeking medical attention earlier and being better at achieving and complying with treatment, those with a

high level of education may be better at avoiding the severe consequences of ill health for working capacity. Furthermore, individuals with low educational attainment may be more likely to have more mentally and physically strenuous working conditions, while well-educated individuals are likely to have jobs with less strain, greater autonomy and more flexible working conditions (Mirowsky & Ross, 2003). Poor health may therefore be more likely to prevent people with a low level of education from working.

Thus, the income gradient in mortality may be shaped differently across educational groups through several processes. 1) The highly educated may be more efficient at using available resources. Since every decision has a greater impact when resources are scarce, education is expected to have a greater importance for health at lower levels of income. 2) Education may protect from income decline resulting from ill health. The aim of this paper is, therefore, to examine whether the shape of the income gradient in mortality is different across different educational groups.

I hypothesize that educational inequalities in premature mortality are larger among individuals with low income and that the income gradient in mortality is steeper among those with a low educational level.

2. Materials and methods

2.1. Data material

The data were obtained from several linked Swedish national registers. Demographic characteristics were obtained from the total population register. Information about sex, births, and deaths were used to define the study population and to assess mortality. The aim of the paper, to examine whether the shape of the income gradient in mortality is different across different educational groups, requires accurate measurements of education and income. Therefore, the population was restricted to individuals for whom accurate information on these were available.

Education was obtained from the educational register and assessed according to the highest level of completed education in three levels: lower secondary or lower (ISCED 0–2, compulsory schooling in Sweden); upper secondary (ISCED 3–4); and tertiary (ISCED 5–6). Educational level will henceforth be referred to as low, intermediate and high. Information about the education of those born outside Sweden is often missing from the educational register (Statistics Sweden, 2006). Consequently, the population comprises only Swedish-born individuals.

The associations between education, income and mortality change over time (Shkolnikov et al., 2012; Mortensen et al., 2016). Using longitudinal data would introduce variation in the main effects that could obscure the interaction between education and income, if not adjusted for properly. Instead, the measurement period was restricted to a limited period in order to isolate the interaction between education and income as predictors of mortality. Income was collected from the tax register and defined as the average annual disposable household income (after taxes and transfers) over a five-year period. Income fluctuates over time and average income over a number of years provides a more stable estimate of available resources than if only one year is used. Household composition was adjusted for by weighting the income using the Oxford method in which each household member is assigned a weight, 1 for the first adult, 0.7 for the second adult and 0.5 for each child. The household income is then divided by the sum of the weights (OECD, 1982). Income was further adjusted for inflation using the consumer price index (KPI) provided by Statistics Sweden, with 2005 as the index year. Individuals for whom income was missing for at least one year during the period were excluded (1.5% of the population). Because income is collected from the tax register, the very low end of the income spectrum is a very heterogeneous group. It contains, among others, the very poor, tax evaders, entrepreneurs and individuals

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