

Understanding the Educational Gradient in Mortality

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Abstract

There is a positive association between education and longevity. Individuals with a university degree tend to live longer than high school graduates who, in turn, live longer than those with compulsory education. These differences are neither larger nor smaller in Sweden than in other European countries, despite its ambitious welfare-state policies. Furthermore, educational differences in longevity are growing, especially among women.

In this thesis I look at the structural, individual and behavioral processes which generate and maintain the educational gradient in mortality. This is done by compiling theoretical insights and empirical research from a range of scientific disciplines. In doing so, this thesis aims to contribute to a more comprehensive understanding of the educational gradient in mortality.

Several factors contribute to the association between education and health. Social and biological processes initiated in early life influence both educational achievement and adult health. Education helps individuals become more effective as agents by fostering generic skills such as information-gathering and decision-making. This aspect of education, *learned effectiveness*, promotes control and health regardless of available resources and prevailing conditions. Education thus has a direct influence on health. Education also indirectly influences health by giving access to better occupational positions and higher incomes, as well as by promoting social capital and healthy habits.

The empirical section of the thesis consists of four separate quantitative studies using register data. Three of the studies use Swedish national register data while one uses register data from 18 European populations. The results indicate that widening income inequalities in mortality have contributed to a widening of educational inequalities in mortality, since education is a determinant of income. Both alcohol and smoking contribute to educational inequalities in longevity, but smoking has played an especially pronounced role in the widening of inequalities among women. Smoking represents a significant part of the explanation as to why women with low education have experienced smaller gains in life expectancy than the rest of the population. The results also indicate that the general trend towards more well-educated populations has contributed to the widening educational inequalities in mortality in Europe and that education is a stronger predictor of mortality among low income-earners than among the rest of the population.

Keywords: *social inequalities in health, education, mortality, register data, Sweden, smoking, alcohol.*

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Abstract

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In this thesis I look at the structural, individual and behavioral processes which generate and maintain the educational gradient in mortality. This is done by compiling theoretical insights and empirical research from a range of scientific disciplines. In doing so, this thesis aims to contribute to a more comprehensive understanding of the educational gradient in mortality.

Several factors contribute to the association between education and health. Social and biological processes initiated in early life influence both educational achievement and adult health. Education helps individuals become more effective as agents by fostering generic skills such as information-gathering and decision-making. This aspect of education, *learned effectiveness*, promotes control and health regardless of available resources and prevailing conditions. Education thus has a direct influence on health. Education also indirectly influences health by giving access to better occupational positions and higher incomes, as well as by promoting social capital and healthy habits.

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Sammanfattning

Det finns ett positivt samband mellan utbildning och livslängd. Individer med universitetsexamen lever i genomsnitt längre än individer med gymnasieexamen som i sin tur lever längre än individer med grundskoleutbildning. Skillnaderna i livslängd är inte mindre i Sverige än i övriga Europa, trots en relativt ambitiös välfärdspolitik. Skillnaderna i livslängd mellan utbildningsgrupper ökar dessutom, speciellt bland kvinnor.

Den här avhandlingen sammanfogar teori och empirisk forskning kring sambandet mellan utbildning och hälsa från en rad olika vetenskapliga discipliner och ämnar därmed att bidra till en helhetsbild kring de strukturella, individuella och beteendemässiga processer som tillsammans skapar och upprätthåller utbildningsskillnader i livslängd.

Flera faktorer bidrar till sambandet mellan utbildning och hälsa. Sociala och biologiska processer som har sin grund i barndomen påverkar både individens hälsa i vuxen ålder samt vilken utbildning individen uppnår. En viktig del av sambandet beror på kompetenser som hjälper individer att mer effektivt inhämta information, ta beslut, samt förverkliga dessa. Utbildning, karakteriserat som *inlärdd effektivitet*, hjälper därmed individer att ta kontroll och förbättra sin hälsa oavsett vilka resurser som finns tillgängliga och vilka villkor som råder. Utbildning kan därmed sägas ha en direkt koppling till hälsa. Utbildning är även indirekt kopplat till hälsa genom att ge tillgång till yrkespositioner samt materiella resurser i form av inkomst men även genom att främja socialt kapital samt genom hälsobeteenden.

Avhandlingens empiriska del består av fyra separata kvantitativa studier som baseras på registermaterial. Tre av studierna bygger på svenska nationella register och en studie bygger på registerdata från 18 europeiska populationer. Resultaten indikerar att ökande skillnader i dödlighet mellan inkomstgrupper har bidragit till ökande skillnader även mellan utbildningsgrupper eftersom utbildning är en bestämningsfaktor för inkomst. Både alkohol och rökning bidrar till skillnaderna i livslängd mellan utbildningsgrupper men rökning har spelat en särskilt betydande roll för de ökande skillnaderna bland kvinnor. Rökning är dessutom en viktig förklaringsfaktor för varför lågutbildade kvinnor inte har erfärut samma förbättringar i livslängd som övriga befolkningen. Vidare visar resultaten att höjningen av den genomsnittliga utbildningsnivån i befolkningen har bidragit till ökande skillnader i livslängd mellan utbildningsgrupper i Europa samt att utbildning har en större betydelse för dödlighet bland låginkomsttagare jämfört med övriga befolkningen.

List of studies

- I. Östergren, O. (2015). Growing gaps: The importance of income and family for educational inequalities in mortality among Swedish men and women 1990–2009, *Scandinavian Journal of Public Health*.
- II. Östergren, O., Martikainen, P., & Lundberg, O. (2017). The contribution of alcohol consumption and smoking to educational inequalities in life expectancy among Swedish men and women during 1991–2008, *International Journal of Public Health*.
- III. Östergren, O., Lundberg, O., Artnik, B., Bopp, M., Borrell, C., Kale-
diene, R., Leinsalu, M., Martikainen, P., Regidor, E., Rodríguez-Sanz,
M., de Gelder, R. & Mackenbach, JP. (2017). Educational expansion and
inequalities in mortality—A fixed-effects analysis using longitudinal
data from 18 European populations, *PLOS ONE*.
- IV. Östergren, O. Educational inequalities in mortality are larger at low lev-
els of income, Manuscript.

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Introduction

Individuals in higher socioeconomic positions tend to have better health than individuals in lower socioeconomic positions. This finding may appear both simple and intuitive; those who have more tend to lead safer, more comfortable, and ultimately longer lives than those who have less. However, in order to understand the processes by which social inequality is translated into biological processes, a wide range of factors need to be taken into consideration. Social inequalities in health depend not only on the demographic composition of the population but also on the social structure that determines the conditions in which individuals are born and grow up, go to school and work, form families and eventually die. Social norms and conceptions of gender influence how individuals behave and interact. Health, in turn, influences all these processes. Attempting to understand socioeconomic inequalities in health is accordingly a challenge which obliges us to consider and synthesize theoretical insights and empirical work from a variety of academic disciplines. It requires access to high quality data on demographic characteristics, social position and health, along with the methodological capacity to translate theoretical insight into empirically testable hypotheses. It also demands the statistical know-how to perform and interpret the appropriate tests. It involves going beyond the conventional dichotomies which separate the social from the biological and the structural from the individual. This thesis aims to encourage a more comprehensive understanding of how socioeconomic inequalities in health are generated, maintained and reshaped, drawing on a broad range of literature from multiple disciplines.

However, neither health nor socioeconomic position are concepts that are easily understood. Selye (1973) notes that “Everybody knows what stress is and nobody knows what it is.” (Selye, 1973, p. 692). The same may be concluded about the concept of health. One regularly quoted definition of health is provided by the World Health Organization; “Health is a state of complete, physical, mental, and social well-being and not merely the absence of disease or infirmity” (cited in Callahan, 1973, p. 77). Dew (2007) remarks that health is related to the basic functions of humanity: eating, drinking, and moving (Dew, 2007). Health, from this perspective, seems to encompass all it is to be human. Durkheim (1895/1982) understands health as the continual adaptation

between the organism and the context.¹ Health is thus a continuous process dependent on the specific context. Good and bad health are therefore defined within the context. When one applies Durkheim's perspective on health, the relation between socioeconomic position and health follows intuitively. Social and economic conditions are fundamental aspects of the context, and will not only determine material circumstances and the availability of resources, but will also influence how individuals eat, drink and move. Social and biological processes are then fundamentally intertwined; there is no clear distinction between them.

Length of life is the ultimate outcome of the circumstances and processes that the individual is exposed to and participates in throughout life. Although everybody dies, there is a variation in when this happens; studying mortality means examining how long individuals survive. Shifts in the chances of survival are Durkheim's criteria for successful adaptation to the context (Durkheim, 1895/1982). From this perspective, a longer life is indicative of a successful adaptation to the context, and thereby good health. Length of life is related to how individuals perceive their own health. Self-assessed health, whether an individual perceives him or herself to be in good health, is a consistent indicator of length of life (regardless of medical status) (Idler & Benyamini, 1997; Manderbacka et al., 2003). Mortality is, then, not only a measure of when we live and die, but also of how we live and how we feel.

Socioeconomic position, on the other hand, is a multidimensional concept that is often indicated by either education, occupational class or income in empirical studies. Inequalities in health exist in all these dimensions: university graduates have better health than those who enter the labor market after secondary school; doctors have better health than nurses; the wealthy have better health than the poor. The different dimensions of socioeconomic position are not independent of each other. The highly educated tend to have better jobs and earn more money. However, empirical evidence indicates that the different indicators of socioeconomic position are independently associated with health (Preston & Elo, 1995; Elo & Preston, 1996; Geyer et al., 2006; Torssander & Erikson, 2010). Of two doctors, the one with the higher income will have better health; out of two rich people, the college graduate will have better health than the college drop-out. Socioeconomic position, in relation to health, is not simply a matter of having more or less, or of ranking higher or lower in status. Education, occupational class and income are related to health through different processes. Education is a proxy for cognitive skills which help individuals make healthy decisions; occupational class indicates prestige and which material hazards there may be in an individual's work environment;

¹ Durkheim's concept of health is similar to Selye's concept of stress in that both are described as continual processes of adaptation. Both Selye and Durkheim based their understanding on that of Claude Bernard (Selye, 1950; Dew, 2007;).

income provide the material basis for purchasing goods that are beneficial or harmful to health.

Education is related to health both directly, through the specific content and skills provided and promoted through education, and indirectly, since education is a determinant of the structural position of the individual. The content of education provides the individual with specific information which may promote health, the clearest example being medical professionals. However, perhaps more fundamental to behavior are the generic skills promoted by education, such as information-gathering, valuing, synthesizing, decision-making. Education promotes efficient agency, referred to by Mirowsky and Ross (2003) as *learned effectiveness*. Formal qualifications provided by education are used to gain access to specific occupations, making education a determinant of both occupation and income that plays an important role in determining the social position of individuals and the resources available to them. Education has an enduring influence on an individual's available resources, social context and the behavioral patterns of an individual. It is thereby a central aspect of the association between social position and health. How education is related to health is linked to both structure (which determines socioeconomic position) and agency (how individuals act within positions) and the interplay between these. This is a core issue in sociology.

In Sweden, national register information is kept on demography, socioeconomic conditions (including education) and health. The registers can be linked at the individual level, providing an excellent opportunity to study the relationship between education and mortality. Statistics Sweden regularly publishes reports on life expectancy at age 30 (which is a summary measure of mortality) by education based on register information from national registers of the total population. Figure 1 presents the development in life expectancy by education among men and women in the period 1986 to 2010 compiled from two such reports (Statistics Sweden, 2004, 2011a).



Figure 1. Life expectancy at age 30 by educational attainment among Swedish-born men and women, 1986–2010

Life expectancy at age 30 indicates the number of years an individual can expect to live after the age of 30 assuming that the death risks observed during that year remain stable. The gaps between the lines in Figure 1 constitute the object of study in this thesis. Throughout the period 1986–2010, life expectancy was the longest among the highly educated and shortest among those with a low education. Life expectancy among individuals with an intermediate educational level was in-between. Longer education is associated with longer life across the entire educational distribution. Mortality differences between educational levels can be observed in even smaller educational groups, with seemingly no upper limit to the mortality benefits of additional education (Cutler & Lleras-Muney, 2006; Rogers et al., 2010; Torssander & Erikson, 2010). There is thus, for the entire population, a *gradient* in mortality by educational attainment.

Figure 1 shows, further, that there is a general tendency of increasing life expectancy. Similar long-term trends have been recorded in most European populations (Leon, 2011) as well as globally (Livi-Bacci, 2012; Wang et al., 2013). In 1986, a man with a high educational level could expect to live an additional 44.7 years after 30; by 2010, that had risen to 48 years. Women with low education deviate from the overall pattern. While women with high

and intermediate education experienced an increase in life expectancy of 3.7 and 2.5 years respectively, women with a low level of education experienced a more modest increase of 1.0 years (the corresponding increase among men was 3.3 years). Some empirical results suggest that educational inequalities in mortality have been increasing for several decades (Vagerö, 2011; Shkolnikov et al., 2012), although the observed patterns depend on the way the inequalities are quantified and what age range is under consideration.

Education has been found to be a consistent predictor of mortality across national contexts and over time (Mackenbach et al., 2008; Shkolnikov et al., 2012; Mackenbach, Kulhánová, et al., 2016), although the magnitude and pattern of educational inequalities in mortality change over time and across context. Despite being comparatively comprehensive and egalitarian welfare states, the Nordic countries, including Sweden, are no exceptions (Bambra, 2011; Vagerö, 2011; Mackenbach, 2012; Shkolnikov et al., 2012). The level of and time trends in educational inequalities in mortality are similar in Sweden to most other European populations (Mackenbach et al., 2008; Mackenbach, Kulhánová, et al., 2016). A recent government commission identified education as one of the key components in narrowing social inequalities in health in Sweden (The Swedish Commission for Equity in Health, 2017). In recent decades, the Swedish population has become increasingly well educated, especially women. In 1990, 38% of men and 39% of women were classified as having a low education. In 2010, the proportion of those with a low education was 24% among men and 20% among women. The proportion of highly educated men increased from 18% in 1990 to 30% in 2010. The increase among women was even more substantial; from 18% to 37%.² It has been suggested that this development is empirically linked to changes in educational inequalities in mortality (Mackenbach, 2012).

This thesis takes a broad approach in attempting to advance our understanding, both empirical and theoretical, of the educational gradient in health.

² Numbers are based on own calculations using total population register data.

Aim

The overarching aim of this thesis is to investigate the social processes that generate and shape the educational gradient in mortality. It looks at structural, individual, and behavioral processes and how these are interrelated. This aim is specifically addressed in four empirical studies, all using quantitative methods applied to register data. Studies I and II focus on the widening mortality gaps between educational groups in Sweden during the 1990s and 2000s. Study I focuses on the role of interpersonal relationship, specifically family type, and income, while Study II examines the role of health behaviors, specifically smoking and alcohol use. Study III examines whether the substantive shifts in educational distribution, referred to as educational expansion, have played a role in generating the widening educational inequalities in mortality observed in Europe during recent decades. Study IV addresses the dynamics of education and income as predictors of mortality.

Conceptual framework

Because education is a determinant of social position and a process which trains individuals to be effective agents, it can be understood as a structural component of the individual life course which plays an important role in social processes at different life stages. The relationship between education and health changes throughout life. Health in early life has been demonstrated to influence individual educational attainment (Case et al., 2005; Bambra, 2011) and education may protect against the negative consequences of poor health (Elstad & Dahl, 2014; Falk et al., 2014). At the same time, studies have indicated that additional schooling has a positive causal effect on health (Lager & Torssander, 2012). Education may, then, throughout the life course, be influenced by health, influence health and mediate the relationship between health and less stable dimensions of socioeconomic position, such as occupation and income. The phenomenon of interest in this thesis, the educational gradient in mortality, is generated and shaped by intertwined social and biological processes. These involve intertwined processes of structural conditions and individual agency, which, determine which individuals end up in which educational group, as well as the health of the group members. This chapter describes the conceptual framework of the thesis.

Mortality is a population measure and as such is only measurable at population level using quantitative methods. How mortality is measured and compared between groups is, then, an inherent component in the definition of the educational gradient in mortality. The issue of how to measure and compare mortality involves related technical and conceptual issues. In order to address the different aspects of defining the educational gradient in mortality, the conceptual framework of the thesis first describes some of the technical and conceptual issues. I start by describing the principles of the general concept of mortality as well as how this concept may be measured and interpreted. I then address how we can compare mortality between groups, focusing on the conceptual difference between absolute and relative inequalities in mortality.

I go on to describe how the educational gradient in mortality is generated, by outlining a framework for how education relates to health and mortality. This framework is based on the works of Mirowsky and Ross (2003) and describes the direct relation between education and health as well as the indirect relation through material resources, interpersonal relationships and health behaviors. I then contextualize the framework and combine it with a life-course

perspective in order to understand how educational expansion is related to educational inequalities in mortality. Finally, I discuss the framework in relation to gender.

A matter of life and death

The concept of mortality consists of two components, life and death. The most basic measure of mortality is the death rate, defined as the number of deaths (events) observed in a population divided by the accumulated time lived by the individuals under observation (time at risk). Age is the main predictor of mortality and most measures of mortality adjust for age, either through regression techniques, age standardization or by calculating the life expectancy. Adjusting for age is especially important when comparing the level of mortality between groups. Because of the substantial impact of age on mortality, comparing unadjusted mortality estimates between groups is likely to reflect differences in age structure rather than differences in death rates. Age is not evenly distributed across educational levels. As a consequence of educational expansion, younger individuals (of working age) tend to be more highly educated compared to older individuals. Age adjustment is needed to compare mortality between educational groups, whether by age-standardizing the mortality rate, estimating life expectancy, or by including age and education in a regression model so that variation in mortality by age and by education can be separated.

Life expectancy can be considered a summary measure of mortality and is calculated using life tables (Chiang, 1984; Preston et al., 2000; Hinde, 2014). Life expectancy quantifies the expected number of years of life under the assumption that a cohort of individuals is exposed to the death rates observed in the population during a specific period. Another commonly used summary measure of mortality is the age standardized mortality rate. This describes the number of deaths expected in a population when one applies the observed death rates to a fixed age structure. Both the life expectancy and the age standardized mortality rate are, therefore functions of observed death rates that adjust for age. I refer to both measures in this thesis. While they are expressions of the same underlying data, discussing trends in mortality can be confusing when both measures are used: when life expectancy increases, the age standardized mortality rate decreases. Both of these trends indicate falling death rates.

When calculating life expectancy, deaths occurring at younger ages have a greater impact than deaths occurring at older ages. This is not necessarily the case for the age standardized mortality rate.³ As a result, the measures can

³ The specific influence of age categories are determined by the choice of standard population.

present somewhat different patterns. Alcohol-related mortality, for example, is concentrated in early middle age (Martikainen et al., 2014). In terms of mortality, these are early deaths, with the mode age at death among Swedish men and women in 2006–2010 being 86 and 88 respectively (Statistics Sweden, 2011a). Consequently, alcohol-related deaths have a greater impact on life expectancy than on the age standardized mortality rate. The underlying assumption when calculating life expectancy is that early deaths indicate more life lost than later deaths. It is therefore important to note which measure is being referred to when discussing mortality. Comparing empirical findings from different studies using the different approaches is not necessarily straightforward. As outlined above, the differences are not merely technical but also relate to the deeper assumptions that the methods are based on.

All-cause mortality

This thesis focuses on when death occurs rather than on the cause of death. This is referred to as all-cause mortality. Different causes of death have different etiologies and the relationship between socioeconomic position and different causes of death varies.⁴ For example, the educational differences in cardiovascular disease mortality are generally larger than the differences in cancer mortality (Huisman et al., 2005; Mackenbach et al., 2008), while educational differences in alcohol-related mortality tend to be especially dramatic (Mackenbach, Kulhánová, et al., 2015). Studying specific causes may provide important insights into specific processes and risk factors and how they are distributed across socioeconomic positions. Educational inequalities in all-cause mortality depend on the composition of causes of death and the educational gradient within causes. Population trends in all-cause mortality are often stable, with change taking place gradually over years, both in terms of levels and inequalities. Cause-specific mortality, on the other hand, often displays patterns that are more chaotic. For example, in a US study, Miech et al. (2011) observed mortality trends by education during the period 1989 to 2007. The patterns in cause-specific mortality were heterogeneous, as some causes of death declined and others increased. Whether educational inequalities increased or declined depended on which cause was observed. However, the trends in all-cause mortality indicated a steady increase during the period (Miech et al., 2011). Link and Phelan suggest that “...our tendency to focus on the connection of social conditions to single mechanisms at single points in time neglects the multifaceted and dynamic processes through which social factors may affect health...” (Link & Phelan, 1995, p. 81). Based on the observation that the association between socioeconomic position and health does not depend on specific etiologies, Link and Phelan (1995) suggest that the

⁴ For a review on the associations between education and various chronic conditions see Smith et al. (2015).

socioeconomic position is a *fundamental cause* of disease (Link & Phelan, 1995; Freese & Lutfey, 2011). All-cause mortality reflects a totality of factors across the life-course and may therefore be argued to more accurately reflect the accumulated impact of social (and biological) processes on mortality, rather than selecting a single cause or set of causes.

Highly educated individuals may be more likely than individuals with a lower education to die from certain specific causes, all else being equal. It is possible to identify single health outcomes for which the incidence may be higher among the more highly educated than among those with a lower level of education, the most well-known example being breast cancer among women (Strand et al., 2007). However, as Mirowsky and Ross note, "...other things are not equal." (Mirowsky & Ross, 2005b, p. 213). Education, understood as a learned effectiveness (Mirowsky & Ross, 2003) shapes decisions and conditions that will influence health throughout the individual life-course. One aspect of the decision-making process is weighing up the different risks and benefits of different alternatives. Some decisions and conditions may represent an increased risk for one disease but may protect against another. Manual labor, for example, may be protective against health complications associated with overweight because it requires physical activity. However, it could also be an indicator of a dangerous work environment, lower income or increased stress due to low decision latitude. In the end, all these factors will influence health and mortality, but only some of them will influence the risk of mortality from specific causes.

In one of the studies of this thesis, cause-specific mortality is used to examine the role of alcohol and smoking in educational inequalities in mortality. This is done by comparing the mortality from these risk factors with all-cause mortality, thereby examining the role that these specific risk factors play in generating the educational gradient in mortality, rather than examining educational inequalities in alcohol and smoking-related mortality alone.

The implications of an increasing life expectancy

There are several reasons why mortality may decline over time; these include improving living standards, safer working conditions and medical research resulting in better prevention and treatment of poor health. Life expectancy is steadily increasing in populations globally with remarkable regularity (Oeppen & Vaupel, 2002; Leon, 2011; Wang et al., 2013). In some high-income countries, including Sweden, this development has been ongoing since the mid-18th century (Livi-Bacci, 2012). Figure 2 presents the number of expected years lived after the age of 25 in Sweden during the period 1991–2008. In 1991, the average 25-year old could expect to live another 54 years, while in 2008 that number had risen to just above 57. A similar development has been observed in most high-income countries (Leon, 2011), seemingly without an upper limit (Oeppen & Vaupel, 2002). These stable and continuing

increase in life expectancy is part of the empirical context of any study of changes in mortality (and inequalities in mortality) over time.

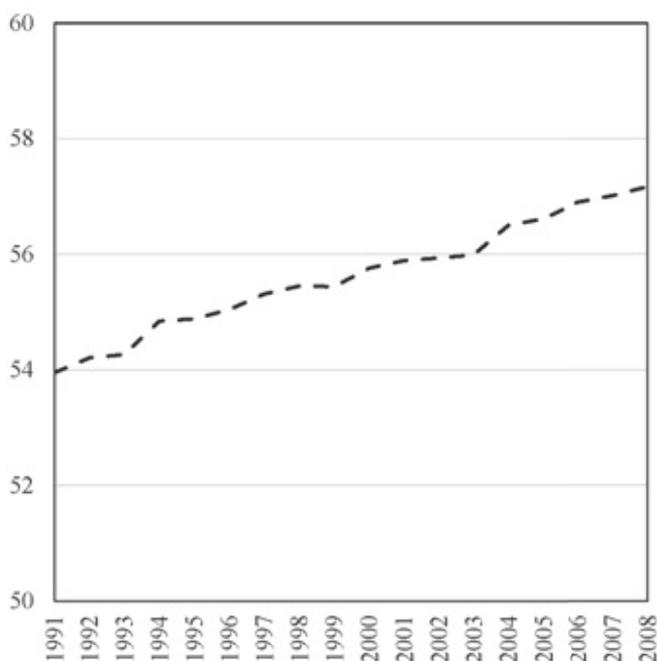


Figure 2. Life expectancy at age 25, 1991–2008, Sweden

While life expectancy is a technical term, as life expectancy increases, the individual expectation of length of life also increases. The individual expectation of length of life has been found to be correlated with observed individual life span (Delavande & Rohwedder, 2011; Elder, 2013). What constitutes a long life, and what may be considered a premature death, changes as life expectancy increases.⁵ Emile Durkheim perceived health as a process in which the organism continually adapts, with varying degrees of success, to the environment (Durkheim, 1895/1982; Fuller, 2004). Durkheim further suggests that to classify health for a given individual, the average biological state (for each organism under a given set of environmental conditions) may be used: “The state known as health ... cannot apply exactly to any individual, since it can only be established for the most common circumstances, from which everyone deviates to some extent.” (Durkheim, 1895/1982) p. 86–87. From this perspective, life expectancy has implications for how a specific biological state should be classified. Changes in life expectancy indicate a change in the expected biological state within a given context, i.e. health. A specific age at death may be considered premature in one context and advanced in another.

⁵ For example, Zhang and Vaupel (2009) suggest a method for classifying deaths as either early or late based on the distribution of deaths across ages in the population.

The next section discusses how changes in life expectancy not only influence the definitions of premature and mature deaths but also how these shifts may influence the measures of differences in mortality between groups, and thus how we interpret time trends in these.

Absolute and relative inequalities in mortality

There are multiple ways of measuring inequalities in mortality. At the most basic level, inequalities in mortality are indicated by the difference in death rates between two or more groups. However, there are different approaches to quantifying the difference. The different methods for quantifying inequalities can be divided into two major categories, namely absolute and relative inequalities. Figures 3–4 illustrate how absolute death rates, absolute and relative inequalities in two educational groups, vary by age. The figures are based on national Swedish register data. Figure 3 shows the observed number of deaths among Swedish men and women with high and low educational level by age per 100 000 person years.⁶ The dramatic variation in death risks by age is immediately noticeable.

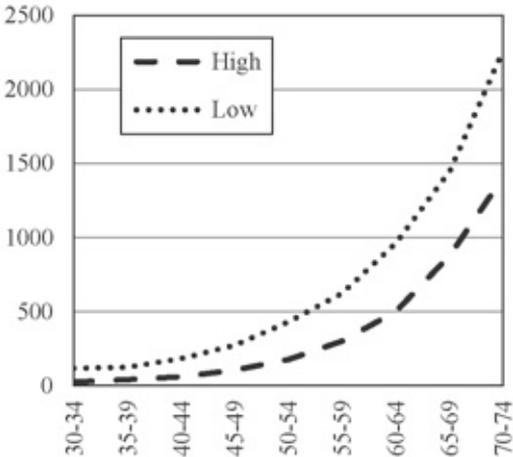


Figure 3. Death rate by education and age per 100 000 person years, Sweden, 2006–2008

⁶ A person year is a measure of time at risk. It indicates the accumulated time of observation across individuals. For example, one person-year can indicate that one person has been observed for one year or that two persons have been observed for half a year each. A death rate of 1000 per 100 000 person years may then be interpreted as to indicating that we observed 100 000 individuals for one year, out of whom 1000 died.

The most basic measure of absolute inequalities in mortality is the rate difference (Figure 4a). It is calculated by subtracting the death rate of the highly educated from that of those with a low level of education ($RD=DR_{low}-DR_{high}$). The rate difference describes how many more deaths occur among those with a low level of education than among the highly educated. A rate difference of 800, for example, means that if we observed 100 000 highly educated and 100 000 individuals with a low level of education for one year, 800 more deaths would occur among individuals with a low educational level. A rate difference of 0 indicates no inequalities.

The rate ratio is the most basic way to quantify relative inequalities in mortality (Figure 4b). It is calculated by dividing the death rate of individuals with a low level of education by the death rate of the highly educated ($RR=DR_{low}/DR_{high}$). The rate ratio describes how many deaths occur among those with a low education per one death among those with a high education. A rate ratio of 2, for example, indicates that for each death observed in the highly educated group, two deaths were observed among those with a low education, assuming that the time at risk was the same. A rate ratio of 1 indicates no inequalities.

At the most fundamental level, absolute and relative inequalities measure the same phenomenon. A condition of the existence of both absolute and relative inequalities is that one of the groups in the comparison dies at a faster rate than the other. If there are no absolute inequalities there can be no relative inequalities (if the $RD=0$ then the $RR=1$).

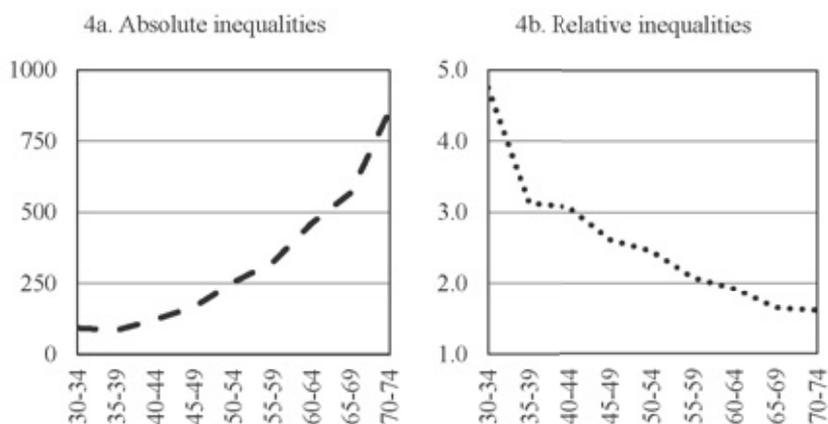


Figure 4. Absolute and relative inequalities between those with high and low education by age. 4a) Rate difference by 100 000 person years. 4b) Rate ratio

Depending on what measure of inequality we are examining, the patterns across age groups are strikingly different. Absolute inequalities are smallest in early ages and become increasingly larger at older ages, while the pattern

for relative inequalities by age is the opposite. This is explained by the underlying mortality risk by age. At lower ages, where the absolute mortality risk is small, comparatively small absolute differences in mortality represent dramatic relative differences. It appears that both absolute and relative inequalities are sensitive to the underlying death risk. There are complexities to the mathematical relationship between absolute rates, absolute, and relative inequalities (Houweling et al., 2007; Mackenbach, Martikainen, et al., 2016). However, in most cases, when the underlying death risk is low, relative inequalities tend to be larger and when the underlying death risk is high, absolute inequalities tend to be larger. This finding has led some scholars to interpret widening educational inequalities in mortality as, at least in part, a consequence of declining death risks (Eikemo et al., 2009; Mackenbach, 2012).⁷

Both the rate difference and the rate ratio provide information about the difference in mortality between educational groups. Different measures may be more or less suitable depending on the research question. Figures 3–4 illustrate that the question of how educational inequalities in mortality vary across age have different answers depending on which measure of inequality is used. When interpreting time trends in inequalities in mortality it is important to understand that the underlying death risk matters for both absolute and relative inequalities, because the underlying death risk in high income populations tends to decline over time (Oeppen & Vaupel, 2002; Leon, 2011). When analyzing time trends, absolute and relative measures of inequality may present seemingly conflicting patterns.

Age patterns in the magnitude of inequalities may also have theoretical implications. Having a high level of education may lead to advantages accumulating over the life course, while having a low education could lead to an accumulation of disadvantages over the life course (Mirowsky & Ross, 2003, 2005a).⁸ This process is referred to as the cumulative disadvantage hypothesis (Dupre, 2007, 2008; Delaruelle et al., 2015). While this hypothesis suggests that educational inequalities in health widen over the life course, the age-as-a-leveler-hypothesis suggest that as individuals grow older, social factors become less important in relation to biological factors, leading to a narrowing of socioeconomic inequalities in health in old age (House et al., 1990; Hoffmann, 2011; Delaruelle et al., 2015). The fact that relative inequalities in mortality tend to be smaller at older ages (Kunst et al., 2004) may appear to support the age-as-a-leveler-hypothesis. However, it is important to note, as Dupre (2007) does, that these hypotheses focus on the age patterns of socioeconomic inequalities *within* life courses and may therefore not directly be used to predict

⁷ There are examples which complicate this pattern. For example, women have lower death risks than men and smaller educational inequalities in mortality (Mackenbach, Kulhánová, et al., 2016), while educational inequalities in cause-specific mortality tend to increase for causes with increasing incidence (Miech et al., 2011).

⁸ See the section on education and health in this thesis.

whether social inequalities in health are larger or smaller at certain ages (Dupre, 2007). Comparing the educational gradient in health at different ages is different from comparing how educational differences in health change when one follows the same individual throughout the life course. The age patterns across different cohorts measured at one point in time will be influenced not only by age but also by cohort and period-specific factors. Furthermore, selective mortality has been found to be a major factor explaining why some studies report narrowing social inequalities in health at older ages (Dupre, 2007; Hoffmann, 2011). Using statistical techniques to account for selective mortality is not feasible when mortality is the health measure of interest.

In a scenario where mortality risks are declining, relative inequalities will tend to increase even if absolute inequalities are stable or even, to some degree, declining. There are several ways to interpret this pattern. One is that those with a low education are experiencing improving levels of mortality at the same rate as those with a high education on an absolute scale. From this perspective, there seem to be no changes in terms of inequalities. Another interpretation is that the highly educated are experiencing improvements in mortality at a faster rate on a relative scale, and for each death among the highly educated, there is an increasing number of deaths among those with a low education. Seen from this perspective, inequalities are increasing.

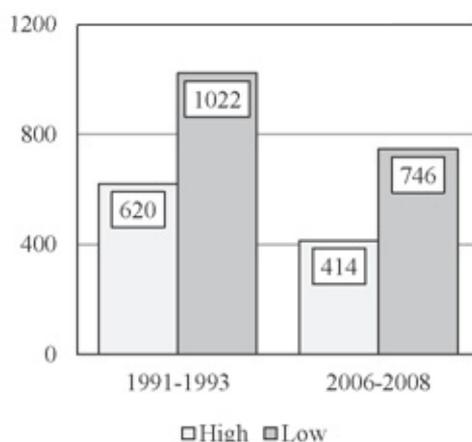


Figure 5. Age-standardized mortality rate per 100 000 person years by education among men, 30–74 years, 1991–1993 and 2006–2008

Figure 5 shows mortality rates among Swedish men by education in the periods 1991–1993 and 2006–2008. The rates are age standardized using the age distribution observed in 1991–1993. Mortality declined during the period among both educational groups. From an absolute perspective, the decline among individuals with a low education was larger (276 compared to 206 among the highly educated). The difference is 70 deaths per 100 000 person

years, which means that the rate difference between the two educational groups declined by 70 deaths. In relative terms, the mortality decline was 33% among the highly educated ($1-414/620=0.33$) and 27% among those with a low education ($1-746/1022=0.27$). Since the highly educated had lower mortality at the start of the period and also experienced a greater relative decline, relative inequalities between the groups increased. The rate ratio increased from 1.65 to 1.80. In 1991–1993, an individual with a low level of education was 65% more likely to die within a year compared than an individual with a high level of education. In 2006–2008, the individual with a low education was 80% more likely to die.

The decline in mortality in all groups could be interpreted as indicating that health is improving in all groups. The fact that this development has been relatively faster among the highly educated is less important than the fact that the health of those with a low education is improving. This perspective does not emphasize the overall tendency of mortality to decline, which implies that absolute mortality will, with few exceptions, decline in most groups. Under the assumption that the most important factor is that health improves over time within groups, examples of a negative development in a context where mortality is declining at population level are rare.⁹

If one instead looks at the relative development, the highly educated experienced a faster decline in mortality than those with a low education, and inequalities widened across the period. This perspective does not consider the de facto improvements in health that persons with a low education experienced, but focuses rather on the relation between the groups. Lundberg et al. (2008) argue that the development in absolute levels of mortality in disadvantaged groups is an important indicator when evaluating policies and making international comparisons (Lundberg et al., 2008). Advantaged individuals tend to do well in terms of health regardless of context and are then less dependent on the specific policy context. Rising relative inequalities are in part caused by the overall decline in mortality. Examples of narrowing relative inequalities over time in a context where mortality is declining at population level are rare.¹⁰ We need both of these contrasting perspectives (focusing on absolute trends in mortality and within-group development and on relative trends and between-group comparisons) in order to form a complete understanding of trends in socioeconomic inequalities in mortality. Our interpretation of both perspectives depends on our understanding of the overall decline in mortality.

⁹ One example is mortality trends among Lithuanian men with a low level of education who experienced increasing mortality rates during the 1990s and 2000s (Mackenbach, Kulhánová, et al., 2016), a period which saw population-level increases in life expectancy among men (Kalėdienė et al., 2009).

¹⁰ Time trends in absolute inequalities in mortality are more heterogeneous, see for example Mackenbach, Kulhánová, et al. (2016).

Returning to Durkheim's definition of health as the expected biological state of the organism in a given context (Durkheim, 1895/1982), we should not see the increase in life expectancy as a mere contextual factor but rather as a continual shift of the expected biological state for an individual (i.e. the definition of good and bad health). This perspective could be seen as favoring a focus on relative inequalities, since mortality decline signifies not only that individuals tend to live longer, but also that the reference point that defines long and short lives changes. When comparing absolute differences across different time points we are comparing states of health for which the definition of good health has changed. Measuring relative inequalities, on the other hand, is sensitive to changes in the level of mortality over time but does not account for changes in the absolute level of mortality within groups. Both perspectives are needed to understand time trends in mortality across socioeconomic groups; while men in both educational categories experienced declining mortality in the period 1991–2008, mortality declined proportionally faster among the highly educated. Mortality among those with a low education was 1.64 times higher in 1991–1993 and 1.80 times higher in 2006–2008.

Education and health

The previous section outlined how the educational gradient in mortality is simultaneously measured and defined through descriptive statistics. The different ways of quantifying mortality differences between groups are based on different substantive assumptions (and have consequences for how we interpret the differences). Regardless of how the educational gradient is defined and measured, the highly educated tend to have lower mortality than those with a low education. There is therefore an association between education and health. The following section presents a theoretical framework for the relationship between education and health.

The framework is specific to the association between *education* and health. In social epidemiology, different indicators of socioeconomic position, mainly education, occupational class and income, are at times used interchangeably (Geyer et al., 2006) and interpreted as indicators of an underlying (and often undefined) concept of social status or socioeconomic position. There are both theoretical and empirical reasons to avoid this practice. Krieger (2008a) has criticized the use of visual metaphors as representations of social stratification, arguing that the use of visual representations of hierarchies, such as ladders or pyramids, has obstructed the development of more complex theories on the determinants of social inequalities in health (Krieger, 2008a). There is more to social stratification than having more or less; classifying individuals on the basis of their status within a single dimension of social stratification may obscure how different forms of social and economic stratification are related to each other and to health. Education, occupational class, and income have been

repeatedly demonstrated to be independently associated with health (Preston & Elo, 1995; Elo & Preston, 1996; Geyer et al., 2006; Torssander & Erikson, 2010) and Geyer et al. (2006) interpret this finding as indicating that the different measures of socioeconomic position are related to health through different mechanisms. Income may be considered an indicator of the availability of the material resources needed to provide the necessities of life; occupational class may capture working conditions, both material and psychosocial. In terms of the relation between health and the different dimensions of socioeconomic position, education plays a key role. Education acts as a determinant of occupational class and income, yet it also develops cognitive skills that individuals can use to successfully manage material resources and avoid health risks.

In the following section I present a theoretical framework for how education may promote health, beginning with the individual level. I discuss how education may promote health directly by fostering effective agency. This is followed by an account of the indirect links between education and health, material resources, interpersonal relationships and health behavior. I then discuss the common determinants of education and adult health. Secondly, I discuss how the educational gradient in mortality is related to educational expansion. I do this by expanding the framework to incorporate contextual changes in terms of educational distribution and the life-course perspective, addressing parental and early life factors and how these relate to the direct and indirect links between education and health. Finally, I discuss the framework in relation to gender. Throughout this account, educational achievement is presented in two groups, high and low. While in reality there are naturally more than just two groups, the aim of this binary division is to improve conceptual and linguistic clarity. The difference between high and low educational levels may be understood as comparing one group with higher education and one group with lower education somewhere along the educational distribution. The framework can then be applied to any classification of educational levels, provided that these can be ordered in a hierarchy.

Education as learned effectiveness

Sociologists John Mirowsky and Catherine Ross have been leading scholars of the relationship between education and health for several decades. In their book 'Education, social status, and health' (Mirowsky & Ross, 2003) they summarize empirical and theoretical insights into the topic. A central concept to their understanding of how education relates to health is education as *learned effectiveness*;

“Education develops general cognitive skills. On the most general level, education teaches people to learn. Education develops the habits and skills of communication: reading, writing, inquiring, discussing, looking things up, and figuring things out.” (Mirowsky & Ross, 2003, p. 26)

Education, then, acts as a structural component in the individual's life, not only as a means to obtain material resources and avoid precarious situations, but also guiding how the individual uses available resources and handles precarious situations, should they arise (Mirowsky & Ross, 2003, 2005b; Cutler & Lleras-Muney, 2006). Educational gradients in cause-specific mortality observed for preventable causes of death are steeper than gradients observed for non-preventable causes (Mackenbach, Kulhánová, et al., 2015; Masters et al., 2015). A cause of death is considered preventable when the risk factors are known and avoidable, or the disease is treatable. However, effective individual agency, enhanced through education, is needed to avoid risk factors and seek treatment when necessary. Learned effectiveness represents a direct link between education and health since it potentially improves health regardless of the context and the level of resources available to the individual. Learned effectiveness accounts for why education is associated with health even though the specific etiology of the association may vary across periods and contexts. Thus, education is compatible with education as a fundamental cause of disease following Link and Phelan's (1995) framework.

Besides developing skills that promote individual agency, education may promote a sense of control. This is the belief that the life course is determined by one's own actions. The opposite is the belief that events and conditions are influenced by external forces (Ross & Mirowsky, 2013). Merton (1938) suggests that when individuals are not provided with the means to achieve culturally desirable goals such as material wealth, one possible reaction is that they adopt the view that success is attributable to luck rather than effort (Merton, 1938). The highly educated have higher levels of perceived control (Pearlin & Schooler, 1978; Schieman, 2001; Ross & Mirowsky, 2013). Those with a low education may feel less in control, not only because they have fewer resources but also because they are more likely to experience a discrepancy between culturally desirable goals and the means to attain these. The feeling of not being in control may have a negative impact on the likelihood of attempting

to improve one's circumstances (Merton, 1938; Ross & Mirowsky, 2013). Education, therefore promotes agency, both through the propensity to act and the efficiency of the acts performed.

Education regulates access to the labor market through formal qualifications and is a determinant of both occupational class and income (Lahelma et al., 2004). Education is, then, both a way to obtain material resources and a key to the effective use of available resources (Mirowsky & Ross, 2003), making education a more central aspect of the association between socioeconomic position and health than, for example, income. Since education promotes both effective agency and resources, these tend to cluster among the highly educated. In other words, resources and effective agency are correlated. This correlation has important health implications for individuals with low material resources, because it means that they also tend to be comparatively less effective as agents. For example, in precarious situations, individuals with a low education are more likely to lack the learned effectiveness needed to minimize the negative consequences. Negative health consequences may then be more severe, and may spill over to affect other aspects of the life course (Mirowsky & Ross, 2005a, 2005b). Negative consequences may then accumulate over the life course, concentrating fewer resources and poor health among those with a low education, a process referred to as *structural amplification* (Mirowsky & Ross, 2005b).

Learned effectiveness, on the other hand, may limit the negative impact of precarious situations. Individuals acting as effective agents can use available resources to compensate for the lack of a specific kind of resource, a process referred to as *resource substitution* (Mirowsky & Ross, 2003, 2005b). Resource substitution requires agency, but individuals also need access to multiple resources in order to use them as substitutes. Furthermore, there are also indications that material poverty as such may impede the decision-making capacity of individuals (Mani et al., 2013; Haushofer & Fehr, 2014). The highly educated are not only more likely to have more resources, but are also better equipped to manage a lack of resources. The concepts of *structural amplification* and *resource substitution* describe a process by which advantages cluster among those with a high education over the life course while disadvantages cluster among those with a low education. This is similar to the cumulative disadvantage hypothesis (Dupre, 2007, 2008).

Among individuals with an abundance of material resources, education may be less important. If two individuals of equal skill and unequal resources are attempting to achieve the same goal, the individual with fewer resources will have fewer attempts before the resources are spent (Molander, 2016). When resources are limited, each decision matters more and inversely, when resources are abundant, each decision matters less. Since education, perceived as learned effectiveness, improves individuals' abilities to manage resources (Mirowsky & Ross, 2003), individuals with a higher level of education are

likely to be more efficient. The highly educated, then, have an advantage independently of the amount of available resources. However, that advantage is likely to be smaller when resources are abundant and each decision thereby less crucial.

Indirect links between education and health

Because education develops skills that help individuals to become more effective agents, education promotes health in any situation (to the extent that health is a desirable goal) and may therefore be considered to have characteristics that are inherently good for health (Mirowsky & Ross, 2003). However, education is also associated with health indirectly. The indirect association between education and health can be divided into three broad categories; material resources, interpersonal relationships and health behaviors (Ross & Wu, 1995; Mirowsky & Ross, 2003, 2005b).

Material resources

Material resources are important for health since they are used to purchase the goods needed to fulfil basic biological needs: food and shelter. Having more material resources also expand the options available to individuals to avoid health risks. Safer and more comfortable housing, higher quality food, safer transportation and health insurance are examples of how material risks can be avoided by spending money. In the literature on the relationship between income and health, this view is referred to as the material explanation (Schnittker, 2004; Berkman et al., 2014; Miething, 2014).¹¹ Material resources are often indicated by income, and although there are several ways to measure income, the relationship between income and health tends to be similar across different measures (Fritzell et al., 2004; Geyer, 2010; Hederos Eriksson et al., 2014). The income gradient in mortality is curvilinear (Preston, 1975; Mortensen et al., 2016), see Figure 6. Higher income is associated with better health across the whole income distribution, but differences are larger at lower levels of income. Having access to better food and shelter is associated with better health, but the difference is not as dramatic as the difference between having access to food and shelter and not having such access.

¹¹ There are other suggested explanations for the associations between income and health, for example the psychosocial and the neo-material. See for example Lynch et al. (2000); Berkman et al. (2014); Miething (2014).



Figure 6. *The shape of the income-mortality association*

Income is an important aspect of the association between education and health from several perspectives. From an empirical perspective, adjusting for income tends to substantively attenuate the association between education and mortality (Elo & Preston, 1996; Östergren, 2015). This finding is intuitive: education may be considered an indicator of social position in early adulthood (Mirowsky & Ross, 2003), while income fluctuates over the life course. Education represents the promise of a career; income measures the realization of that promise. Formal educational qualifications allow the individual to access occupations that generate a higher income; education is then a predictor of income. Education alone cannot be used to capture changes in socioeconomic conditions over the life course. On the other hand, measures of income, especially when measured at one or a small number of points in time, may not represent an enduring socioeconomic position, but rather the position at the specific point of measurement.

Schnittker (2004) correctly identifies that the material explanation of the income gradient in health assumes that all individuals will, on average, apply available resources in a rational and health promoting way (Schnittker, 2004). Based on the understanding of education as learned effectiveness, this assumption could be challenged. It seems more likely that the ways individuals use material resources differ systematically according to their educational level. From this line of reasoning, education and income may be understood as a nexus of factors that together have a strong impact on health. These include available resources (income) and the efficiency with which these resources are used (education). In order to fully benefit from income in terms of health, the material resources need to be used in a health-promoting way. In order to fully benefit from education, material resources are needed. If resources are scarce, each decision is comparatively more important, indicating that education and income may interact in their relation to health, and that education may be more important for health at lower levels of income. Some studies have reported larger educational differences in health at lower levels of income (Mirowsky & Ross, 2003; Schnittker, 2004), but the opposite pattern has also been observed (Bonaccio et al., 2016). Education may, in any

case, not only promote health through access to material resources but may also enhance the health benefits of available resources.

Subjective and objective measures of survival are correlated (Perozek, 2008; Elder, 2013; Sasson, 2016). In other words, guesses about one's own lifespan do give an indication of how long one will live. Delavande and Rohwedder (2011) observed socioeconomic differences in expected survival in eleven high-income countries (Delavande & Rohwedder, 2011). This finding is perhaps not surprising. Self-rated health is a consistent predictor of mortality (Idler & Benyamini, 1997). Those with a low education tend to report worse self-rated health than the highly educated (Eikemo et al., 2008), although there are indications that the correlation between self-rated health and survival is stronger among the highly educated (Dowd & Zajacova, 2007). Sasson (2016) and van Raalte et al. (2011) interpret the larger variation in lifespan among individuals with a low education as indicating that the latter face more uncertainty about how long they will live (van Raalte et al., 2011; Sasson, 2016). There may, then, be other, more uncertain factors influencing the survival of those with a low education, which could also contribute to the weaker association between self-rated health and survival among them. The strategic use of resources may also depend on the expectations held by individuals in terms of future health and length of life; an individual expecting a long and active retirement may choose to use resources differently than an individual expecting a short and restricted retirement. This process could potentially further contribute to differences in available material resources between educational groups.¹²

Interpersonal relationships

Education has consistently been found to be positively associated with social capital (see for example the meta-analysis by Huang et al. (2009)) and to promote health indirectly by granting access to the social and material resources made available through social networks (Ross & Wu, 1995; Lin, 1999; Mirowsky & Ross, 2003; Hout, 2012). Social networks can give different forms of support that may be beneficial to health. For example, social support through interpersonal relationships is an important factor in coping with stressful events. The highly educated are more likely to have the social support needed to minimize the negative impact of stressful events (Mirowsky & Ross, 2003). They are also less likely to experience stressful events, such as, temporary unemployment (Backlund et al., 1996). Social support in the form of material resources, for example having parents who can provide financial support or being able to stay with friends temporarily, may limit the negative impact of stressful and precarious situations. Social capital clusters among the highly

¹² Empirical studies on whether individuals modify their strategies based on survival expectations have given mixed results. See for example Hurd et al. (2004), Post and Hanewald (2013), Spaenjers and Spira (2015), and Van Solinge and Henkens (2010).

educated by means of network homogeneity. In other words, the highly educated are more likely to have social ties to other individuals with a high level of education (McPherson et al., 2001; Hout, 2012; Smith et al., 2014), which may help them in decision-making processes. The highly educated are also more likely to have medical doctors in their personal networks (van Tubergen & Volker, 2015) and thereby have direct access to medical advice without seeking formal medical care. Social relationships are reciprocal, and the highly educated are likely not only to receive more social support but also to provide more social support. It is important to note that while social relationships may provide social support and resources, social relationships may also cost these things, and while some social networks encourage healthy behaviors, others may encourage unhealthy ones (Umberson et al., 2010). Social resources may, then, either promote or damage health depending on the specific conditions.

Although the importance of specific social relationships varies over the life course (Umberson et al., 2010), marriage, or other forms of stable union formation, is often considered the most important relationship in terms of health. Spouses continually interact over long periods of time and may pool resources. The married generally have better health than the unmarried (Kiecolt-Glaser & Newton, 2001; Lewis et al., 2006; Drefahl, 2012). Besides marital status, the quality of marriage is important for health (Robles & Kiecolt-Glaser, 2003) and marital strain has been found to be associated with declining health, especially in older ages (Umberson et al., 2006). Some scholars have suggested that education should be considered a resource shared by couples (Brown et al., 2014), similar to how income is often assessed at a household level. Whether marriage promotes health or vice versa is unclear and the relationship is likely to be reciprocal (Waldron et al., 1996). Married individuals are more likely to consume less alcohol and tobacco, maintain healthier diets, seek medical care, and receive social and psychological support (Wilson, 2002; Mirowsky & Ross, 2003; Lewis et al., 2006). Some of these factors may also be desirable traits in a partner. Part of the explanation of the association between marriage and health is likely to be that healthier individuals with healthy habits are more likely to marry. The relationship between education, family status and health differs between men and women (Wickrama et al., 1995; Kiecolt-Glaser & Newton, 2001). This will be further developed in the section on gender, education and health.

Health behaviors

The term *health behaviors* refers to behavioral patterns that are strongly related to mortality risk (Gabe & Monaghan, 2013), for example smoking, alcohol consumption, diet and exercise. From an empirical point of view, there are clear indications that health behaviors contributes to social inequalities in health (Cavelaars et al., 2000; Hemström, 2002; Bloomfield et al., 2006; Cutler & Lleras-Muney, 2010; Hiscock et al., 2012; Mackenbach, Kulhánová,

et al., 2015). However, how best to interpret the relation between education and health behaviors has been subject to debate. I have divided the discussion of the relationship between education, health behaviors and mortality into two parts. First, I address the relationship between individual agency, social structure and physical addiction. Second, I discuss the impact of health behaviors on mortality by applying this framework to a three phase model of health behaviors (initiation, maintenance and cessation).

Social structure, individual agency and physical addiction

Mirowsky and Ross (2003) focus on information-gathering, decision-making and sense of control. This may underestimate the possibility that individuals in different social positions may adopt different preferences depending on the social environment. Cockerham (2005) criticizes Mirowsky and Ross for overemphasizing purposeful individual agency and decision-making processes in understanding health behavior in relation to education. Instead, Cockerham suggests a model which incorporates both social structure and agency (Cockerham, 2005). From this perspective, it is not only the efficiency of agency that determines health behaviors but also differences in preference that determine what individuals perceive as desirable goals.

The individualistic approach to health behaviors, according to Cockerham (2005), presents health behaviors as a series of decisions, while in reality, health behaviors are habitual patterns (Cockerham, 2005). However, neither Mirowsky and Ross (2003) nor Cockerham (2005) emphasize the role of physical addiction. In this section, I use elements of Giddens' (1984) structuration theory to develop a framework combining individual agency, social structure, and physical addiction in order to understand the relationship between education and health behaviors in relation to mortality.

Giddens (1984) characterizes agency as a continuous *flow of conduct* rather than as a series of discrete decisions. Individuals may consciously change behavioral patterns through motives, which provide an overall strategy that directs the continuous flow of conduct. While motives are overall determinants of agency, they are rarely part of daily conduct; most things are either simply done (practical consciousness) or simply said (discursive consciousness) (Giddens, 1984). When simply saying or doing things, individuals routinely and continuously reproduce social structures, without necessarily being aware that they are doing so. The reproduction of social norms is an unintended consequence of individual action, or as Bourdieu (1990, p. 69) puts it: "It is because agents never know completely what they are doing that what they do has more sense than they know." Giddens (1984) Giddens (1984) Giddens (1984) Giddens (1984) Giddens (1984) further emphasizes the unintended consequences of action, which may change the conditions for further actions, at least in part because individuals continuously monitor their own and others'

actions, continuously drawing from and revising a common understanding of the situation.

In terms of the association between education and health behaviors, the unintended consequences which influence the conditions for further agency are important on at least two levels. First, individual practices influence social norms. As an individual continuously practices a specific health behavior, the expectations on that individual, and others in similar social positions (i.e. educational groups), are modified. On a societal level, the unintended consequences are, then, the reproduction of norms in different social groups. It is important to note that this process both reproduces and modifies norms over time. The social patterns of health behavior change over time. Smoking for example, has in recent decades become a practice increasingly concentrated among those with low education (Giskes et al., 2005) and women (Foulds et al., 2003; Rodu & Cole, 2004).

Second, on an individual level, continuous repetition of specific acts may not only increase the probability of maintaining a specific habit, but may also generate physical addiction, a mechanism often omitted in the literature on health behaviors. Physical addiction represents a further obstacle to behavioral change and may require social support and material resources to break it. Empirical evidence suggests that education is positively correlated with successful smoking cessation (Broms et al., 2004; Layte & Whelan, 2008; Centers for Disease Control & Prevention, 2009; Kotz & West, 2009; Reid et al., 2010) and that individuals with low education have a higher risk of relapsing after quitting (Fernández et al., 2006). Education may, then, be correlated with health behaviors both through social norms and through differences in the rate at which individuals are able to break physical addiction.

The unconscious reproduction and modification of behavioral norms through individual agency exemplifies how structural and individual factors are intertwined and illustrates the difficulty in distinguishing between *upstream* and *downstream* factors. The terms originate from a metaphor in which individuals are caught in a river. Interventions can be designed to target upstream factors (preventing individuals from falling into the river) or downstream factors (getting people out of the river once they have fallen in). Nancy Krieger (2008b, 2011) criticizes the use of the metaphor, suggesting that the upstream/downstream not only temporally separates social and biological processes, but also further “obscures agency and renders it difficult to conceptualize how “downstream” factors can influence “upstream” phenomena.” (Krieger, 2011, p. 226). The unintended consequences of individual health behaviors for addiction and social norms exemplify how individual agency, social processes and biological processes are interrelated.

Health behaviors in relation to mortality

When considering the impact of health behaviors on mortality, lifetime consumption patterns are of interest. Lifetime consumption may be divided into three phases: initiation, maintenance, and cessation (Figure 7). Together, these three phases determine the impact on mortality. Education can be linked to all three phases. This view represents a practical challenge to empirical research, since information obtained from cross-sectional studies often reflects behavior at a specific point in time (although behavior at one point in time is indicative of lifetime behavioral patterns). The impact on of health behaviors on mortality is dependent on whether or not the individual engages in the behavior and, if so, when it is initiated and when it ceases. However, the specific patterns of consumption during the maintenance phase are also important. The processes involved may differ according to the specific behavior in question. Here, I will focus on smoking and alcohol consumption. These behaviors contribute to educational inequalities in mortality and are part of the empirical analysis in the present thesis.

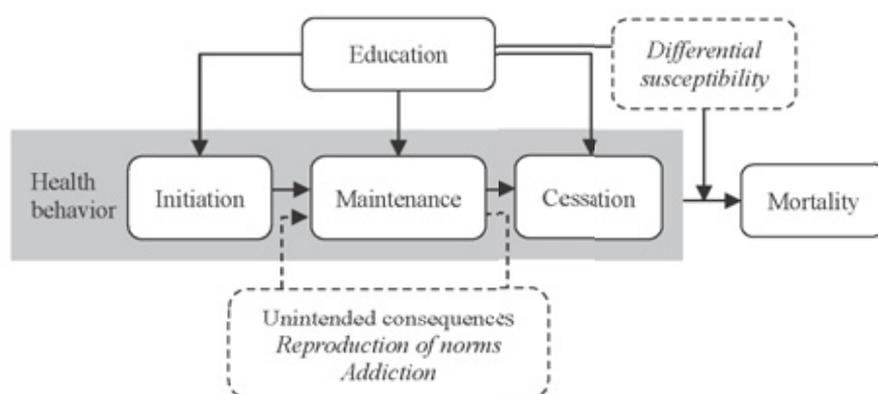


Figure 7. Summary model of the relation between education, health behavior, and mortality

Education may be a predictor of initiation of smoking¹³ and alcohol misuse. Smoking and alcohol have been empirically linked to precarious situations and negative life events, such as poverty and unemployment (Backlund et al., 1996; Van Doorslaer et al., 1997; Berggren & Nystedt, 2006; Bloomfield et al., 2006), which disproportionately affect those with a low education. They

¹³ When considering smoking, it is important to note that initiation typically occurs before education is completed, education and smoking initiation may then be caused by common determinants in childhood and adolescence (Maralani, 2014; Andersson & Maralani, 2015). In this way, smoking may contribute to educational inequalities in mortality both as an intermediate factor, and as part of the processes in which education and adult health is correlated due to common early life determinants.

may also be more likely to use alcohol and smoking as means of coping with precarious situations, or stress and helplessness in general (Seeman et al., 1988; Taylor, 2012; Slopen et al., 2013). Smoking and alcohol use may, then, in part be understood as an example of how the health consequences of precarious situations may be more severe for those with a low education than for those with a high education, who may use other resources to manage precarious situations.

Education has been found to be associated with prevalence of both smoking (Cavelaars et al., 2000; Giskes et al., 2005; Conti et al., 2010; Cutler & Lleras-Muney, 2010) and alcohol use (Laaksonen et al., 2003; Cutler & Lleras-Muney, 2006, 2010), but individuals in different educational groups may also engage in the same type of health behavior in different ways. Previous research has found international variation in the associations between overall alcohol consumption and mortality, indicating that the specific drinking pattern influences mortality, even at similar levels of consumption (Norström & Ramstedt, 2005). In terms of smoking, beyond the absolute number of cigarettes smoked, the specific pattern in which they are consumed (puff interval, puff volume etc.) has an independent effect on health (Hiscock et al., 2012). Practices involving alcohol use, smoking and other health behaviors may help to differentiate and consolidate social groups (Seeman et al., 1988; Skeggs, 1997). Bobak et al. (2000) found an educational gradient in nicotine intake among male smokers, suggesting that addiction may be stronger among those with a low education (Bobak et al., 2000). Education could, then, potentially be correlated with strength of addiction, making it more difficult for those with a low education to quit. Furthermore, individuals with a low level of education are more likely to have worse health in general (Mirowsky & Ross, 2003) and engage in multiple negative health behaviors (Laaksonen et al., 2003). This indicates that, even with similar levels of consumption and specific patterns, the health consequences could be more severe among for those with a low education than for the highly educated. This is sometimes referred to as *differential susceptibility*.

Having a higher level of education may also influence the likelihood of cessation. Empirical findings indicate that education is positively correlated with both attempting to quit smoking and the likelihood that the attempt is successful (Broms et al., 2004; Kotz & West, 2009; Reid et al., 2010). Education as learned effectiveness implies that education improves skills such as information-gathering and decision-making (as well as promoting a sense of control). This contributes to a higher likelihood to attempt to quit. However, Layte and Whelan (2008) found that while the cessation success rate makes an important contribution to the social gradient in smoking, differences in self-efficacy made only a modest contribution to this pattern. Rather, their findings suggest that it is experiences of deprivation that prevent successful cessation (Layte & Whelan, 2008). Education may, then, help individuals quit smoking

by promoting access to social and material resources that prevent exposure to deprivation as well as by providing social support.

Common determinants of education and health

Educational attainment is not randomly distributed in the population. Some of the processes that determine educational attainment also have an influence on adult health. The educational gradient in mortality is, therefore, partly a result of common determinants of education and health.

Educational attainment is influenced by both structural and individual factors (Breen & Goldthorpe, 1997; Goldthorpe & Jackson, 2008; Bukodi et al., 2014). Some of these are also related to adult health, for example parental socioeconomic position (Bowles & Gintis, 2002; Kuh et al., 2002; Galobardes et al., 2004; Hayward & Gorman, 2004; Galobardes et al., 2008), cognitive ability (Kuh et al., 2004) and childhood health (Case et al., 2005; Palloni, 2006). Childhood conditions and individual characteristics are associated with adult health independently of education (Hayward & Gorman, 2004; Montez & Hayward, 2014). Within educational groups, individuals with parents with a higher socioeconomic position (Galobardes et al., 2004), or those with higher cognitive ability (Kuh et al., 2004; Batty et al., 2009) have better health than others with the same education. An educational gradient in mortality has been observed when siblings with different educational levels have been compared (Lundborg et al., 2016; Mortensen & Torssander, 2017), indicating that the educational gradient in mortality persists among individuals with similar genetic and social backgrounds. The focus of this thesis is on the intermediate factors between education and mortality. However, part of the educational gradient in mortality is likely to be generated because individuals with more favorable childhood conditions and individual characteristics that promote health tend to cluster among the highly educated. Conversely, part of the association between childhood factors, individual characteristics and adult health is generated by educational attainment. Favorable childhood conditions, health and cognitive ability promote adult health partly because they help individuals obtain a higher level of education, which in turn promotes access to material resources and social capital as well as promoting positive health behaviors. Formal education may also enhance the benefits of good childhood conditions and individual characteristics. Formal education can be understood as a tool needed in order to convert skills and knowledge into money (Bourdieu, 1986), and risk prevention may be especially effective when cognitive ability is combined with the information and knowledge provided by education (Baker et al., 2011).

Since healthy children of parents with higher socioeconomic positions are more likely to achieve a higher level of education (Bowles & Gintis, 2002; Palloni, 2006; Bukodi et al., 2014), education may be seen as part of a process

by which socioeconomic inequalities in health are transmitted across generations. However, the observation that childhood conditions and education are independently associated with adult health (Galobardes et al., 2004; Hayward & Gorman, 2004) indicates that education is beneficial to all, regardless of childhood conditions. Depending on the strength of the specific associations between childhood conditions, education and adult health, education may either reproduce or attenuate the social inequalities in health originating in childhood. Several studies suggest that the health benefits of education are more pronounced among individuals from disadvantaged social backgrounds (Ross & Mirowsky, 2011; Schafer et al., 2013; Schaan, 2014; Andersson, 2016; Mortensen & Torssander, 2017) (although Bauldry (2014) found the opposite, and several studies emphasize that these patterns are sensitive to period- and cohort-effects (see for example (Bauldry, 2014; Andersson, 2016))). If the health benefits of education were larger among individuals from disadvantaged homes, education would partly compensate for the negative influence of childhood disadvantage on adult health.

The context of educational expansion

The educational distribution is not constant. In Sweden, as in other developed countries, there has been substantive upward shifts in the average level of education in the population (Hannum & Buchmann, 2005; Bar Haim & Shavit, 2013; Meschi & Scervini, 2013). There are both absolute and relative measures of educational inequalities in health, for example the Average Inter-group Difference (AID) (Shkolnikov et al., 2012) and the Relative Index of Inequality (RII) (Pamuk, 1985; Mackenbach & Kunst, 1997), that take the educational distribution into account. These measures reflect both differences in mortality between educational groups and the relative size of the groups. Defined by these measures, shifts in the educational distribution are by definition related to changes in the educational gradient in mortality. However, it remains unclear whether the observed trends in these and similar measures depend on trends in mortality or solely on shifts in average levels of educational attainment. Changes in simpler measures, such as the rate ratio or the rate difference, indicate that the differences in mortality between educational groups have changed.

The educational gradient in mortality is partly generated by the composition of educational groups in terms of early life conditions that are independently associated with education and adult health. The educational gradient in mortality is also in part generated by intermediate factors between education and mortality, such as occupation and income. Educational expansion could lead to changes in the association between education and early life predictors of educational attainment as well as changes in the average returns of educational investment in terms of labor market conditions. To the extent that early life predictors and labor market outcomes of educational attainment are

associated with health independently of education, changes in these associations influence average levels of health in different educational groups. Shifts in the educational distribution could imply changes in the rate ratio through changes in the mortality levels within educational groups. In the following section, I will outline how educational expansion may influence mortality within educational groups through two processes. *Compositional changes* focus on the common determinants of education and adult health, while *displacement* focuses on intermediate factors between education and mortality. While these processes will be described separately, in reality they take place simultaneously.

Compositional changes

The level of health within educational groups is determined in part by their composition in terms of early life structural and individual factors that are associated with both educational attainment and adult health. Educational expansion may influence the distribution of these factors, and thereby average levels of health, within educational groups.

Parental socioeconomic position, cognitive ability and childhood health are examples of early life determinants of educational attainment (Breen & Goldthorpe, 1997; Hayward & Gorman, 2004; Conti et al., 2010; Bukodi et al., 2014; Montez & Hayward, 2014). These factors have also been demonstrated to be associated with mortality within levels of educational attainment (Galobardes et al., 2004; Hayward & Gorman, 2004; Case et al., 2005; Batty et al., 2009; Montez & Hayward, 2014). Absolute educational chances have increased across a range of social backgrounds (Hertz et al., 2007; Breen et al., 2009; Bar Haim & Shavit, 2013; Bukodi et al., 2014; Goldthorpe, 2014) and as the numbers of highly educated grow larger, this group may be recruited from an increasingly wider and more heterogeneous range of social backgrounds. In contrast, those with a low level of education may increasingly consist of the most disadvantaged. Educational expansion leads to *compositional changes* within educational groups in terms of common early life determinants of education and health which may generate a positive association between mortality within educational groups and the average educational level in the population. It is important to note that the common early life determinants of education and health need to be independently associated with adult health. If the health effects of early life determinants influence adult health solely through educational achievements, the composition of determinants would not influence the average health of the group.

Displacement

Part of the association between education and health is generated through intermediate factors, for example occupation and income. Since the associations between education and health on the one hand, and labor market conditions (income, occupational class) and health on the other, are independent (Elo &

Preston, 1996; Geyer et al., 2006; Torssander & Erikson, 2010), mortality within educational groups is in part determined by the distribution of labor market conditions within educational groups. Educational expansion may influence the association between education and labor market conditions, making education relatively less valuable on the labor market as it becomes more available (Wolbers et al., 2001; Härkönen & Bihagen, 2011; Bol & Van de Werfhorst, 2013; Bol, 2015). Solga (2002) suggests that, as the average level of education increases in the population, individuals with a high level of education compete for occupational positions previously held by individuals with intermediate education, who in turn compete with individuals with low education. The latter may increasingly be unemployed or compete by accepting more strenuous and dangerous working conditions or insecure contracts. This process is sometimes referred to as displacement (Solga, 2002, 2008). It is important to note that displacement will not occur if educational expansion is matched by an expanding demand for skilled labor (Psacharopoulos, 1981). Displacement may generate a positive association between mortality within educational groups and the average educational level in the population. The consequences of educational expansion for average levels of health within educational groups generated by *displacement* are then similar to the health consequences of *compositional changes*.

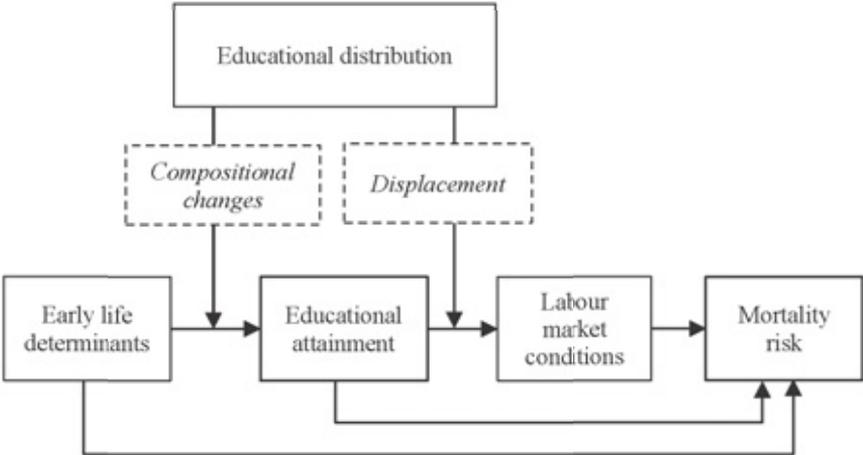


Figure 8. Compositional changes and displacement

As is clear from Figure 8, compositional changes and displacement describe the generic processes which connect changes in group size and between-group inequality. Interpreted as a more general process, *compositional changes* indicate that between-group differences may change if changes in the distribution moderate the association between common determinants of group affiliation and the outcome. *Displacement* indicates that between-group differences

may change if changes in the distribution moderate the association between group affiliation and mediators between group affiliation and the outcome.

Educational expansion and the gradient in mortality

The processes of compositional changes and displacement describe how an association between educational distribution and average levels of mortality within educational groups may be generated. From these accounts alone, it is not clear whether the shifts in average levels of mortality have narrowed or widened the educational inequalities in mortality. A similar issue has been discussed in relation to social mobility and health. It has often been found that the upwardly socially mobile have better health than their group of origin and worse health than their group of destination (Blane et al., 1999; Elstad, 2001; Bartley & Plewis, 2007; Boyle et al., 2009), making it difficult to determine whether social mobility has narrowed or widened health inequalities. Jon-Ivar Elstad (2001) has emphasized the importance of taking the entire mobility process into consideration, claiming that the level of health in specific groups depends on the initial health in the group, the level of health among those leaving the group and the level of health of those joining the group.

This reasoning can be applied to the issue of educational expansion. In order to determine whether educational expansion has widened or narrowed health inequalities, one needs to consider how this process respectively influences the health of those with high and low levels of education. Individuals who come from an advantaged social background and have favourable individual characteristics have the best adult health. They are also likely to achieve high education under all circumstances. Individuals from disadvantaged social backgrounds with unfavourable individual characteristics have the lowest probability of achieving a high level of education in all stages of educational expansion; they also have the worst health. Those who achieve a high level of education during educational expansion, but would not have otherwise, represent an intermediate group. This group is likely to be in-between the two other groups in terms of social background, individual characteristics and health. As the group with low education becomes smaller, it increasingly consists of the individuals who are least likely to achieve higher education and who experience the lowest levels of health. As a consequence of educational expansion, the average level of health in this group is expected to diminish. With the same set of assumptions, the average health of the highly educated is likewise expected to diminish. Both those who achieve a high level of education and those with a low education have comparatively poorer health in settings where education is more widely available.

While both compositional changes and displacement probably generate positive associations between average educational levels and mortality in all groups, there are (at least) three theoretical reasons for why the association may be stronger among those with a low education, thus leading to widening educational inequalities in mortality. 1) *Increasing importance of health-*

based selection among those with a low education: All populations contain a group that have experienced severe health complications from birth or early childhood. This group will probably not achieve a high level of education regardless of educational distribution and will experience high mortality. As the group of those with low education becomes smaller, it will represent an increasing proportion of those with a low education. 2) *Differences in the severity of the consequences of displacement:* Individuals with high and intermediate education may compete with individuals with a lower education, whereas this option is not available to those with only a basic education. The consequences may then be more severe in the latter group in terms of unemployment or the need to accept precarious working conditions. It is also possible that the group of those with low education becomes stigmatized as it becomes smaller (Solga, 2002; Lohmann & Ferger, 2014). 3) *Education as an inherent good for health:* While educational expansion may influence the average returns of educational investment, it will not influence the health benefits of education which derive from the cognitive skills that education promotes (learned effectiveness). The upwardly mobile have worse health than the group they are joining but may have better health than they would have had if they had remained. Although there are indications that the direct link between education and health is decreasing across cohorts (Delaruelle et al., 2015), education in itself is beneficial to health, compensating, to some degree, for increasing heterogeneity in terms of adverse childhood factors and lower average incomes and occupational positions among the highly educated as a result of educational expansion.

Education may, then, improve health at the individual level while educational expansion is associated with higher mortality within educational groups. Even though educational expansion may produce higher mortality in all educational groups, this should not be interpreted as also indicating that education is detrimental to health at population level. Population-level health may improve either by improving the health within sub-groups or by shifting the distribution so that more individuals are in sub-groups with good health while fewer individuals are in sub-groups with poor health. Accordingly, population-level health may improve in situations where health is declining in sub-groups. This phenomenon is well-known in statistics and is referred to as Simpson's paradox (Wagner, 1982; Gorroochurn, 2012). In other words, educational expansion may improve health both at the individual and the population level while having a negative impact on the average health in each educational group.

Gender, education and health

The term *gender* refers to the social categories of men and women, while the term *sex* refers to biology. With regards to the implications for health, it is difficult to draw clear distinctions between the two and it is the interaction

between sex and gender that generates health differences between men and women (Gabe & Monaghan, 2013). For example, the higher mortality among men due to violence (Koskenvuo et al., 1986) may be explained by a combination of biological and social factors: higher levels of testosterone and specific character traits, such as aggression, associated with socially-constructed notions of masculinity. Gender differences in mortality represent a well-known paradox: while women experience higher levels of morbidity and worse self-rated health¹⁴, mortality is higher among men (Verbrugge et al., 1987; Rieker & Bird, 2005).¹⁵

Gender is a fundamental component in the individual life course, influencing the individual's socioeconomic position, social relations and behavioral patterns, as well as mortality. Rather than being a set of stable categories, gender may be characterized as a process in which men and women participate: gender is generated and maintained through continuous agency (West & Zimmerman, 1987). Gender interacts with other forms of social stratification, among them education, in shaping health (Schulz & Mullings, 2006; Bowleg, 2012). The socioeconomic gradient in mortality is generally observed to be wider among men than among women (McDonough et al., 1999; Mustard & Etches, 2003), although this may partly be an artifact due to the less accurate classification of socioeconomic position among women (Gabe & Monaghan, 2013).¹⁶ Ross et al. (2012) reported that, when comparing educational inequalities by gender, educational differences in self-reported health were found to be larger among women, while educational inequalities in mortality were larger among men (Ross et al., 2012). However, in Sweden the gender difference in life expectancy has continually diminished since the 1980s. Moreover, the gender difference in educational inequalities in mortality has narrowed and disappeared in Sweden (Mackenbach, Kulhánová, et al., 2016). The finding that educational inequalities in mortality are of similar magnitude among men and women does not necessarily imply that the processes generating these inequalities are similar among men and women. The gender paradox in health and mortality illustrates the importance of taking into account what aspect of health is being looked at when comparing empirical results on gender differences in health. The patterns may differ depending on what indicator is used.

In the following section I will apply a gender perspective to the theoretical framework for education and health. I will firstly discuss gender and learned

¹⁴ Dahlin and Härkönen (2013) demonstrated that the magnitude of the gender gap in self-rated health varied across European populations and that the size of the gender gap was not related to indicators of gender equality on a societal level (Dahlin & Härkönen, 2013).

¹⁵ A similar paradox has been reported when comparing the native-born to migrants in Denmark; migrants had higher levels of morbidity and lower levels of mortality (Jervelund et al., 2016)

¹⁶ Random misclassification of independent variables biases results towards the null (Delgado-Rodriguez & Llorca, 2004).

effectiveness and then the gendered aspects of education, health behaviors, interpersonal relationships and health. These factors are closely related and will therefore be discussed together. In the final section I will discuss the gender aspects of material resources, educational expansion and health.

Gender and learned effectiveness

Becoming a more efficient agent through learned effectiveness may provide individuals with opportunities to resist oppressive structures. Educated women have been perceived as a threat to male dominance in highly patriarchal societies (Holland, 2012). Sen (1999) attributes the finding that female literacy rates are associated with lower child mortality and lower fertility rates in low- and middle-income countries to the role that education (and other social and economic developments) plays in promoting women's agency. This interpretation is similar to education as learned effectiveness (Mirowsky & Ross, 2005b): education develops the individual capacity for agency and can then provide women with tools to struggle against repressive structures and practices. There are indications that women are more likely than men to experience low perceived control, and that this difference widens with age (Slagsvold & Sørensen, 2008; Ross & Mirowsky, 2013). For example, women tend to earn less than men, which leads to economic dependence. The gender wage gap is wider at higher levels of education (Evertsson et al., 2007; Evertsson et al., 2009), which indicates that women experience disproportionate rewards to efforts in terms of educational investments. Educational expansion, which has been faster among women than men, may contribute to a narrowing of the gender gap in perceived control over time. However, as England (2010) notes, higher levels of individual freedom in combination with internalized gender norms may also lead to the reinforcement of gender structures through gendered individual choices (England, 2010). I will address this further in relation to men's and women's occupational choices.

Gender, health behaviors and interpersonal relationships

The way individuals eat, move, and consume are part of processes that form and maintain social identities. Gendered patterns in behavior have contributed to women's advantage over men in terms of mortality. Smoking, alcohol, exercise and diet are not only behaviors that influence health but also carry cultural content.¹⁷ Male coded behavioral patterns involve risky behavior leading to higher rates of death from alcohol and violence among men than women (Koskenvuo et al., 1986; Ross et al., 2012). However, social norms are fluid and what constitutes masculinity and femininity changes over time, as does the contribution of specific behaviors to mortality. For example, smoking has been found to be one aspect of the processes that form and maintain gender

¹⁷ See for example Klein (1995) for an overview of the cultural history of cigarettes.

identities (Gilbert, 2007; Triandafilidis et al., 2017). As an aspect of the processes that maintain social identities, gender patterns in smoking that are perceived as appropriate for men and women shift over time (Waldron, 1991). The patterns also change across time with respect to gender and education (Giskes et al., 2005); they also vary internationally (Kulik, Menvielle, et al., 2013). In most European countries, educational inequalities in smoking-related causes of death are greater among men, while the opposite is true in Sweden (Kulik, Hoffmann, et al., 2013). In recent decades, survey data has suggested that smoking has shifted from being more common among men to being more common among women in Sweden (Foulds et al., 2003), which is reflected in gender-specific trends in lung cancer incidence (Devesa et al., 2005).

	Men			Women		
	ASMR	RR	95% CI	ASMR	95% CI	RR
All-cause mortality						
1991–93	901	1.72	1.55-1.91	496	1.65	1.59-1.73
2006–08	604	1.84	1.65-2.05	384	1.86	1.75-1.98
Smoking-related mortality						
1991–93	113	2.45	1.85-3.25	55	3.26	2.57-4.12
2006–08	71	3.54	2.94-4.27	75	3.64	2.97-4.47
Alcohol-related mortality						
1991–93	53	4.68	3.48-6.30	10	3.40	2.17-5.34
2006–08	49	3.00	2.42-3.74	13	3.02	2.20-4.14

Mortality rates are age standardized and presented per 100 000 person years. Rate ratios are age adjusted.

Table 1. Age standardized mortality rates (ASMR) and rate ratios (RR) for all-cause, smoking- and alcohol-related mortality 1991–1993 and 2006–2008, comparing men and women with high and low education.

Table 1 shows absolute mortality rates and rate ratios for all-cause mortality, smoking-related mortality¹⁸ and alcohol-related mortality among men and women, comparing 1991–1993 with 2006–2008. The patterns for relative educational inequalities in mortality were similar for men and women, while the patterns for the risk of dying from the specific risk factors were different. While the risk of dying from alcohol decreased among men by 8%, it increased among women by 30% (the absolute risk of dying from alcohol-related causes was substantially higher among men throughout the period). Between 1991 and 2008 the risk of dying from smoking fell among men by 37% while it rose among women by 36%. Relative educational inequalities in both alcohol and smoking-related mortality increased among both men and women. Absolute mortality risks from smoking and alcohol can be found in Study II of this thesis. Time trends and international variations in gender patterns for mortality and social inequalities in mortality suggest that the specific behavioral patterns

¹⁸ Estimates of smoking related mortality are based on the indirect method proposed by Preston et al. (2010).

associated with masculinity and femininity change over time. While patterns in all-cause mortality were similar for men and women, the conflicting patterns in overall incidence and educational inequalities for behavioral causes of death among men and women show that different processes may generate similar population-level patterns. Health behaviors contribute to gender differences in mortality as well as educational inequalities in mortality. However, how large their contribution is, and whether health behaviors widen or narrow gender and educational differences in mortality, depends on the specific time and context.

Marriage and family typically represent the primary social relationships in the individual life-course, especially among those of working age. Married individuals tend to live longer than singles (Drefahl, 2012). Spousal education has been found to be associated with mortality independently of own education (Bosma et al., 1995; Jaffe et al., 2006). Since the highly educated tend to marry each other (Henz & Jonsson, 2003),¹⁹ spousal education also contributes to the educational gradient in mortality. However, there are indications that the way in which marriage promotes health differs between men and women. In a study of Swedish register data, Torssander and Erikson (2009) found that partner's socioeconomic position was associated with mortality independently of the index person's socioeconomic position. The patterns were different for men and women. While men benefitted mainly from having spouses with high educational attainment, women benefitted more from having a spouse with a high income (Torssander & Erikson, 2009). Stronger associations between men's mortality and spousal education have also been reported in other countries (Kravdal, 2008; Skalická & Kunst, 2008; Spoerri et al., 2014). The finding that women benefit from their spouse's income could in part be attributed to education since the highly educated tend to marry each other and education is a predictor of income.

The mechanism by which marriage benefits men and women may be asymmetrical because men and women assume different roles within the family (these roles may also depend on social class, see for example Skeggs (1997)). The different roles of men and women in the family make a biological imprint. For example, stress hormone levels have been observed to decline more slowly among women than among men after work and at weekends (Frankenhaeuser et al., 1989; Lundberg & Frankenhaeuser, 1999), indicating that women's responsibility does not end with paid work. Traditionally, women are expected to take responsibilities for the health of the family by monitoring and modifying the health behavior of their spouses and children (Umberson, 1992). Because of this and the fact that women earn less than men (Boye et al., 2014), marriage may benefit women's health by providing them

¹⁹ This tendency is referred to as educational homogamy. Over time, educational homogamy has declined, this tendency may partly be attributed to shifts in the educational distribution across cohorts (Henz & Jonsson, 2003).

with material resources and men’s health by providing them with psychosocial resources (Brown et al., 2014).

Gender, material resources and educational expansion

Ross and Mirowsky (2010) suggest that women benefit more from education than men do because women, on average, have fewer resources (Mirowsky & Ross, 2003, 2005b; Ross & Mirowsky, 2010). The gender wage gap, the observation that women tend to earn less than men, may then generate a gender difference in the relation between education and health. Table 2 shows median disposable household income by sex and education for men and women aged 40 to 64 in 2001–2005.²⁰

Education	Men	Women
High	204	188
Intermediate	166	160
Low	165	158

1000s of SEK adjusted for inflation.

Table 2. Median disposable household annual income post taxes and transfers 2001–2005 by sex and education

As previously reported (Evertsson et al., 2007; Evertsson et al., 2009), Table 2 indicates that men have higher incomes than women within all educational levels and the difference is larger at higher levels of educational achievement. While both men and women benefit from education, the fact that women have lower returns on education in terms of income could explain why the educational gradient in mortality tends to be wider among men. The gender wage gap has remained roughly similar since the 1980s (Boye et al., 2014), despite the fact that women’s average educational attainment has risen and surpassed that of men.²¹ Similar trends have been observed across high-income coun-

²⁰ The magnitude of the gender wage gap depends on how it is measured and defined. Women tend to work fewer hours than men and hold different occupational positions than men, which is sometimes factored when estimating the gender wage gap. The estimates reported in Table 2 do not take any of these factors into consideration, they are simply meant to provide a description of how much money is available to women and men at different educational levels.

²¹ The fact that women and men have different educational outcomes indicates that equal access to formal education may not represent gender equality in education. Subrahmanian (2005) distinguishes between *parity* (formal equality) and *equality of outcome* (substantive equality): “A move towards *substantive gender equality* ... requires recognising that discrimination arises from differential valuation of what it is men and women contribute, giving rise to differential [unequal] investments in women and men, differential [unequal] rewards paid to men and women, and differential [unequal] resources allocated to men and women” (Subrahmanian, 2005, p. 398).

tries. England (2010) attributes this pattern to a combination of gender egalitarianism, on one hand, and a combination of individualism and gender essentialism on the other. The institutional ideology of gender egalitarianism grants women access to traditionally male spheres, particularly higher education. At the same time, both men and women are encouraged to pursue self-realization, and since gendered norms on what are suitable roles for women and men are internalized, men and women systematically pursue different goals (Charles & Bradley, 2009; England, 2010). High levels of individual freedom may then lead to gendered choices having a greater impact, thereby maintaining a sex-segregated labor market, which facilitates the continuation of the gender wage gap despite a gender egalitarian ideology. As Reskin (1988, p. 62). remarks, differentiation is "...a logical necessity for differential evaluation and differential rewards." This perspective presents a potential challenge to the notion that effective agency always promotes health, because it may in fact lead to increasing gender segregation and may limit the health benefits of education for women.

The educational requirements for occupations traditionally held by women, for example teaching and nursing, have increased (Bradley, 2000), creating an opportunity for women to pursue self-realization through higher education and simultaneously make gendered choices. The Scandinavian countries, and Sweden in particular, combine a relatively high level of gender equality with a highly sex-segregated labor market (Bradley, 2000). It is important to bear in mind that both men's and women's choices need to be gendered in order to maintain sex segregation on the labor market. The increasing requirements of formal credentials for women's occupations may also contribute to the finding that the gender wage gap in Sweden has diminished in unqualified occupations but remained stable in qualified occupations. This leads Boye et al. (2014) to suggest that women's increased education has maintained the gender wage gap, rather than reducing it.

Summary model

Figure 9 presents a summary of the conceptual framework. Education is related to health directly through *learned effectiveness* (1). By promoting efficient agency, education promotes health directly regardless of the specific conditions. Education also promotes health indirectly by granting access to occupations that provide material resources through income (2). The health benefits of material resources depend on how resources are spent, which may differ systematically across educational groups. Education may, through *learned effectiveness* (1), help individuals use available resources more efficiently. It may also limit the negative consequences of poor health on income. Education also promotes skills that help individuals form and maintain social relationships that are beneficial for health by providing social support (3) and by promoting healthier behavior (4). The highly educated are more likely to lead healthier lives. Education protects against negative life events that can lead to unhealthy coping strategies; it also influences how individuals use or misuse substances. Education also gives access to social and material resources that are conducive to successful cessation. Even within similar behavioral patterns, the health consequences may differ for different educational groups due to *differential susceptibility* (5). By positioning the conceptual framework within the life course, the influence of educational expansion can be understood. Through educational expansion, the composition of educational groups in terms of early life determinants of mortality changes. Since there are early life determinants of educational attainment that affect adult health independently from education (6), these *compositional changes* (7) also influence the association between education and health. Educational expansion may also influence the association between education and health through the process of *displacement* (8), by which the relative value on the labor market of a specific level of education shifts due to higher levels of education becoming more common. This, in turn, influences average levels of material resources within educational groups. It is likely that gender modifies all the processes depicted in Figure 9 (not represented graphically here).

The boxes and arrows in Figure 9, along with the systematic account of the different processes that generate the educational gradient in mortality, may give the impression that these processes operate separately from one another. It is, however, more likely that these processes are intertwined, influencing each other across the life course and between individuals through relationships. Education is a determinant of material resources which influence health, but material resources are also determined by the interpersonal relationships that individuals maintain. These relationships also influence health behaviors, and negative health behaviors may limit work capacity and, in turn, influence access to material resources. The processes overlap and influence each other in different ways across the life course.

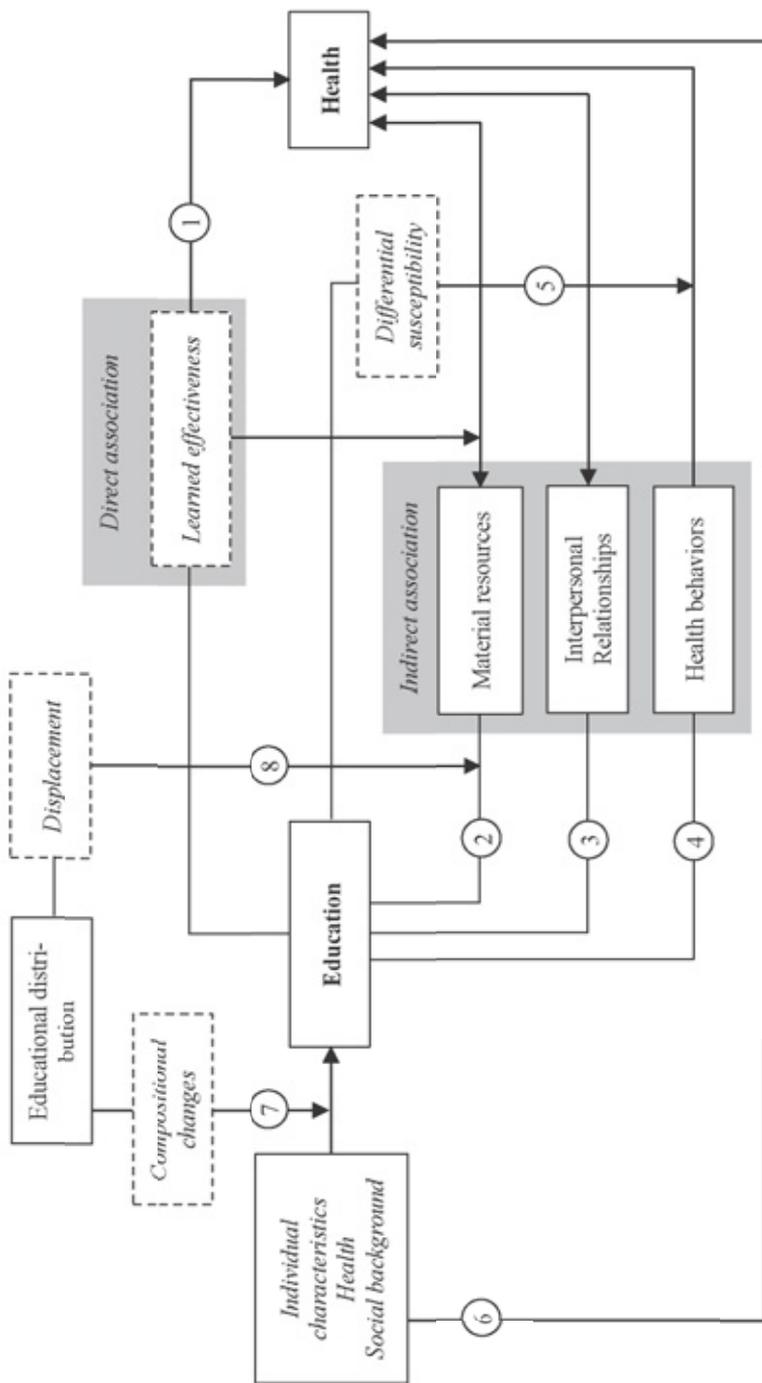


Figure 9. Summary model of the conceptual framework

Methodology and data

In this chapter I outline the methodological principles of this thesis. *Methodology* refers to the underlying principles that inform the way research is carried out. (The specific way in which the analyses is carried out in practice, *methods*, is described in the individual studies.) I then describe the data sources and, finally, the core measures of mortality, education and income.

Analytical strategy

The analytical strategy adopted in this thesis attempts to bridge descriptive statistics, theory and statistical analysis. It has been adopted from Goldthorpe (2000, 2001) and suggests that a sociological phenomenon is first established empirically, after which theoretical accounts and empirical research are used to construct a narrative identifying the *generative process* that causes the phenomenon to arise:

“Social regularities, once relatively securely established by descriptive methods, are then to be regarded as the basic explananda of sociological analysis: sociological problems are ones that can all in one way or another be expressed in terms of social regularities – their formation, continuity, interrelation, change, disruption, and so on. When, therefore, analysis becomes causal, social regularities represent the effects for which causes have to be discovered.” (Goldthorpe, 2000, p. 154)

The process may be observable directly or indirectly through its consequences (Goldthorpe, 2000). This strategy requires a careful consideration of what the phenomenon to be studied *is* and what it *is not*: “The problem is first what to verify and second how to verify it” (Mills 1959/2000, p. 125). In the present thesis, the phenomenon of interest is the educational gradient in mortality. After identifying the educational gradient in mortality as a sociological phenomenon, expressed through descriptive statistics, I describe the generative processes that cause the educational gradient in mortality to appear, be sustained, or change. In this case I draw largely on the theoretical framework of Mirowsky and Ross (2003). Initially suggested by Cox (1992), the purpose of constructing a generative process is to establish a plausible description of how a statistical relationship is generated (Cox, 1992; Blossfeld, 2009). When ap-

plied to the study of social phenomena, this approach emphasizes contextualized, purposeful, individual agency (Goldthorpe, 2001; Blossfeld, 2009) which is compatible with the characterization of education as *learned effectiveness*.²²

There is empirical evidence that health influences education and that education influences health; both mechanisms shape the educational gradient in health. Selecting either education or health as the cause, and the other as the effect (as some methodological frameworks demand, see for example Goldthorpe (2001); Krieger and Smith (2016); Vandenbroucke et al. (2016)), would enforce restrictions on our understanding of the association between education and health and would probably contradict both theoretical considerations and empirical evidence. The generative process-framework allows one to address the social processes which generate the educational gradient in mortality, as opposed to the causal effect of education on mortality or of health on education.

The generative process is constructed in order to understand and explain a phenomenon expressed through descriptive statistics. From the proposed generative processes, testable hypotheses may be extracted and tested, which either reject or corroborate the account of the generative process (Goldthorpe, 2001). The statistical inferences performed should improve our understanding and interpretation of the educational gradient in mortality.

The educational gradient in mortality constitutes the explanandum of this thesis. I describe the proposed generative process in this introductory chapter, and develop it further in the separate empirical studies, where empirical tests of parts of the generative processes described are also presented. The generative process is summarized in Figure 9. Each of the empirical studies in this thesis may be expressed as a subset of the processes outlined in Figure 9. Let us take Study II as an example: it has been suggested the smoking, at least in part, accounts for the educational gradient in mortality (Ross & Wu, 1995; Cutler & Lleras-Muney, 2006, 2010). Empirically testable statements are extractable from this posit: ‘smoking-related mortality is higher among those with low educated than among those with high education’, and ‘educational inequalities in mortality would be smaller if there was no smoking-related mortality’. These are statements about relationship (4) and (5) in Figure 9. Previous empirical studies have suggested that individuals with a low level of education are more likely to smoke (Cavelaars et al., 2000; Giskes et al., 2005) and that there is an educational gradient in smoking-related causes of death (Kulik, Menvielle, et al., 2013). Study II in this thesis found that smoking

²² This generative process-approach assumes some degree of methodological individualism. Although there are several versions of methodological individualism, the basic tenet is that social phenomena should be explained through the purposeful actions and interactions of individuals. For an overview of some of the different versions of methodological individualism, see Udehn (2002).

contributes to educational inequalities in life expectancy, similarly to previous studies in Denmark (Koch et al., 2015) and Finland (Martikainen et al., 2013), thereby corroborating the suggestion that health behaviors, in this case smoking, may in part explain why those with a low education tend to live shorter lives than the highly educated.

There are seemingly infinite ways to measure, quantify, and analyze statistical data. By applying descriptive and analytical methods that are closely related to the descriptive and theoretical understanding of the educational gradient in mortality, I attempt closely connect methods (descriptive and analytical) and theory in this thesis.

Positioning the empirical evidence

The way in which one carries out the empirical analysis of data differs according to the specific research questions and theoretical perspectives addressed. This may have implications for what the results are and how they are interpreted. Differences in analytical approach or data structure may give rise to seemingly contradictory results. Perhaps the most fundamental distinction from this perspective is that between population and individual-level processes.²³ Mills (1959/2000) definition of the concepts of troubles and issues gives an intuitive understanding of the difference, and relationship, between the two; “*Troubles* occur within the character of the individual and within the range of his immediate relation with others...” while “*Issues* have to do with matters that transcend these local environments and the range of inner life” (Mills 1959/2000, p. 8). *Troubles* may, then, be understood as population level *issues* manifested at the individual level. When analyzing and understanding population-level trends, factors that exercise little influence on a large number of individuals are of greater importance than factors that exercise a large influence on a small number of individuals. The focus on the determinants of population parameters is sometimes referred to as the population perspective (Rose, 1992). Qualitative studies, or even observations made in our own everyday life, and results from quantitative studies may then yield seemingly contradictory conclusions, because factors that are of minor importance to the individual may have a large impact on population-level rates and vice versa.

The difference between absolute and relative inequalities has already been discussed. The difference in inequality patterns over different ages presented in that discussion indicates that the specific biological and social processes and contexts that the individual is exposed to and participates in vary greatly across the life course, as does the relationship between socioeconomic position and health. When interpreting any empirical finding about the relation

²³ The relationship between macro and micro-level is one of sociology’s core problems, see for example Giddens (1984); Bourdieu (1990); Coleman (1994); Hedström (2005).

between socioeconomic position and mortality, it is important to take into account the ages which are included in the analysis. Different processes and factors are important in different phases of life; results based on children may not hold for adults, while observations among adults may differ from those among geriatrics. The results I present in this thesis should, accordingly, not be interpreted as reflecting mortality patterns in the population at large, especially since the majority of deaths occur after the age of 74 (the average age at death is over 74 years for both men and women in all educational groups (The Swedish Commission for Equity in Health, 2016)).

The studies in this thesis adopt a period approach, according to which mortality is measured for all individuals within the specified age range during the same period, across one or several calendar years. Official statistics are most commonly presented using this data structure. An alternative approach, often adopted in life-course studies, is the cohort approach. Here, mortality is instead measured for individuals born during a specific period. Both approaches are valid and which approach is most suitable depends on the specific research question. Because of the data structure, different types of factor which influence health are either emphasized or de-emphasized. Historical events, for example a policy change, will influence all individuals at the same time, and will be more visible in a period approach. A period approach may then be used to capture how inequalities change over time. Cohort approaches, on the other hand, favor processes which develop across the individual life-course. The age-as-a-leveler and the cumulative disadvantage hypotheses, which I previously discussed in relation to absolute and relative inequalities, are examples of hypotheses that focus on life-course processes. While general findings, such as whether early life conditions influence adult health, or whether alcohol consumption is influenced by changes in alcohol policy, are detectable in both approaches. However, the reported relative importance of different processes may differ.

Register data

Using register data can be compared to zooming out. It becomes easier to see the big picture, while the details become harder to distinguish. When one moves from qualitative to quantitative data, there is a trade-off between detail and generalizability of findings. The same can be said about using register data, as opposed to survey data and about using international comparative data as opposed to national data. In each of these transitions, analytical detail is traded for generalizability, and from a technical perspective, statistical power. With register data, we as researchers do not have the option to decide what information is gathered. What we are able to observe will, however, have high external validity as it includes nearly all individuals in the studied population.

The focus of this thesis is the educational gradient in mortality, understood as a sociological phenomenon. The fact that this gradient is consistently found whenever it is sought, at least in high-income countries, suggests that there are social processes at work generating this phenomenon that operate across contexts. The actual specifics of the processes may, of course, vary across the contexts and, according to the principle of multiple realizability (Heil, 1999; Hedström, 2005), there may be entirely different processes generating similar population-level patterns.²⁴ The recurring findings of educational gradients in mortality do, however, at very least, open up the possibility that there are common processes across populations which connect education and mortality. In line with Goldthorpe (2001) and Blossfeld (2009), we may see these processes as the causes of the educational gradient in mortality. The studies in this thesis uses register data covering the total population. Hypothesis testing would not be necessary if the aim of the thesis was to document what happened in the specific population during the specified time frame. However, the studied individuals may be regarded as one possible representation of an unlimited number of theoretical populations taking part in the same social processes as the ones being studied. This is the population the findings may be generalized to, and the p-values and confidence intervals refer to their population parameters.

HSIA

The HSIA (Hälsa, Sjukdom, Inkomst, Arbete) database links several registers with national coverage. The use of data for the purpose of this research was approved by the KI regional ethics committee (Ref. 02-481). Studies I, II and IV were based on the HSIA; it was also the basis for the Swedish data used in Study IV. It consists of the Swedish population born in 1985 or earlier and residing in Sweden at the end of 1980 or 1990. The database also includes migrants who arrived 1990–2002. Information about education for the migrant population is often missing or inaccurate (Statistics Sweden, 2006a). Non Swedish-born were consequently excluded from the analyses. The study population was defined as individuals born in Sweden and at least 30 years of age in 1990. The restrictions in the HSIA concerning migrants, residence and years of birth did not affect the results.

²⁴ The principle of multiple realizability concerns the relationship between lower-order properties (for example the properties of individuals) and higher-order properties (the population mean of these individuals) “A property is multiply realizable when it is realized (or realizable) by one or more lower-level property” (Heil, 1999, p. 190). An observed population-level property can be generated through different processes at the individual level. In principle, any population measure has this property.

The total population register

The total population register is kept by Statistics Sweden. It was started in 1968 (although registers on basic demographics have been kept in Sweden since the 18th century), after the census was computerized. Although Statistics Sweden keeps the total population register, the national tax authority has overall responsibility for the civil register, which is the basis for the total population register. The total population register contains basic information on sex, and country of birth and is continually updated by the national tax authority with routine information about demographic events such as births, deaths, changes in civil status, and migration (Statistics Sweden, 2006b). Although not available to the researchers, the total population register contains personal identification codes that are used by government agencies to link other registers to the underlying population at the individual level.

In studies I, II and IV the total population register was used to define the study population. Date of birth and death were used to calculate age and mortality. Information about sex and civil status was also collected from the total population register. Civil status was used as a covariate in Study I and was further used to adjust income for household composition in studies I and IV.

The educational register

Statistics Sweden also keeps the educational register. The earliest version of the educational register started in 1985 and it has been updated annually since (Statistics Sweden, 2006a). Additional information from the 1990 census was added, substantially improving the coverage. Consequently, Statistics Sweden recommend that the period before 1990 not be included in longitudinal comparisons (Statistics Sweden, 2011b). The educational register covers individuals between in the age range 16 to 74 and contains a wide range of information about educational length and content (Statistics Sweden, 2006a). The educational register is based on a variety of sources. The reporting standard changed during the 1990s and 2000s, with a major change taking place between 1999 and 2000 (Statistics Sweden, 2001). The change mainly affected how the specific content of educational programs was classified rather than their level (Statistics Sweden, 2001), which implies that it did not impact the classifications used in this thesis.

In the studies included in this thesis, education was divided into three levels based on the International Standard Classification of Education. The ISCED standard was developed in the 1970s by UNESCO in order to enable international and longitudinal comparisons of education. It received its most important update in 1997 (Schneider, 2013). The information in the educational register was converted into ISCED 97 format, drawing on the work of Halldén (2008), in order to enable comparisons over time.

The tax register

The tax register is kept by Statistics Sweden and combines information on income from various sources for example labor income, capital income, and pensions. Statistics Sweden started compiling income statistics in 1943, but the register did not achieve wide coverage until 1968, when the register was computerized. Because the register covers income and transfers from a range of sources, Statistics Sweden is able to compile information on disposable income at the individual and household level (Statistics Sweden, 2009). Because the information is compiled from administrative register, the tax register does not include income or capital from sources that the authorities do not know about. Examples of this are tax evasion and income from outside of Sweden that is not reported.

Studies I and IV include measures of income. Both studies use disposable income at the household level. Certain types of transfers and benefits are paid to the household or one of the parents in the case of benefits related to children. Other types of transfers and benefits are paid to individuals only if there is no partner in the household. Assessing income at the individual level may, then, give an inaccurate measure of the level of disposable income for the individual. On the other hand, we cannot know whether individuals in a household pool resources or not. Income was analyzed differently in studies I and IV, but in both income level was adjusted using the Oxford method (OECD, 1982) to take variations in household composition into account.

The cause of death register

The cause of death register was initiated in 1960 and is kept by the National Board of Health and Welfare. It covers all deaths of individuals registered in Sweden, including individuals who died abroad. For each death, an investigation is carried out by a trained medical professional, which sometimes involves an autopsy. However, the autopsy rate has been steadily decreasing (The National Board of Health and Welfare, 2010), which may have had an impact on the accuracy of the register. Although there can be uncertainties about the specific cause of singular deaths, especially among elderly people with multimorbidity, validation studies have shown that the cause of death register provides accurate estimates of population rates (Johansson & Westerling, 2000; The National Board of Health and Welfare, 2010). The cause of death is reported with one cause identified as the underlying cause (i.e. the initial condition that eventually resulted in the death) and contributing causes which are assessed to be part of the causal chain (The National Board of Health and Welfare, 2010). In other words, if an individual with cancer is involved in a fatal car accident, cancer will not be recorded as a cause of death (either underlying or contributing). The cause of death register was used in

Study III in order to assess the contribution of smoking and alcohol-related causes to all-cause mortality.

Demetriq

Study III was carried out as part of a European project entitled ‘Developing Methodologies to Reduce Inequalities in the Determinants of Health’ (Demetriq). The database used comprises harmonized longitudinal population-level data on education and mortality from 18 European populations. With the exception of the regions of Turin, Madrid, the Basque Country and the city of Barcelona, the populations covered national territories. The database included data from registers and censuses. For a more detailed account of the Demetriq database see Mackenbach, Menvielle, et al. (2015) and Study III for the specific subsection used in the analysis.

Methods

The analyses in the individual studies included in this thesis apply regression-based methods as well as descriptive statistics. Poisson regression was used in studies I and IV, while a related technique, negative binomial regression, was applied in Study III. Poisson regression is a suitable option when the outcome of interest is measured in number of events, in this case deaths. By fitting an offset, an indicator of the time at risk, the coefficients obtained from Poisson express rates on the log scale and are mathematically closely related to summary measures of mortality such as the age standardized mortality rate and life expectancy (Frome, 1983). The coefficient (β) expresses the average difference in log death rates (DR) per one unit change of a specific variable (X). For example, let us assume that X describes level of education in two levels, X_1 =low and X_2 =high. The coefficient β then describes the average difference in log death rates between high and low education, which can be written as $\beta = \log(\text{DR}_{\text{low}}) - \log(\text{DR}_{\text{high}})$. Another way of writing this equation is $\beta = \log(\text{DR}_{\text{low}}/\text{DR}_{\text{high}})$ or $\exp^{\beta} = \text{DR}_{\text{low}}/\text{DR}_{\text{high}}$. The exponent of the coefficient β is then an estimate of the rate ratio, a basic measure of relative educational inequalities in mortality.²⁵ The coefficients can also be used to express different metrics, for example absolute death risks, which in turn can be used to calculate summary measures of mortality such as the age standardized mortality rate or life expectancy. Thus, the Poisson model, or the related negative binomial model provide the benefits of regression-based techniques, for ex-

²⁵ See the chapter on absolute and relative inequalities for a discussion of different measures of inequality.

ample the possibility to adjust for several covariates simultaneously and perform formal statistical inference, while retaining a close connection to the descriptive measurements which define the educational gradient in mortality.

Measurements

Several types of measure are used in the empirical analyses in the studies in the thesis. Here, I will describe the most central measures. Mortality and education are measured in all four studies and income is measured in studies I and IV. For an account of other measurements, see the separate studies.

Mortality

The educational register covers the age group 16 to 74 (Statistics Sweden, 2006a). A lower age limit of 30 was applied in the empirical analyses in this thesis. The purpose of this was to avoid the misclassification of education for individuals who were enrolled in education at the time of measurement. In addition, an upper age limit of 74 was applied, rather than extrapolating or using imputation to classify educational attainment over the age of 74. In other words, individuals were only observed between the ages of 30 and 74, they were *left censored* at age 30 and *right censored* at age 75 (or death). The age limits have consequences for the two measures of mortality used, namely the age standardized mortality rate (ASMR) and life expectancy. The age standardized mortality rate will reflect the number of deaths observed within the specified age range but will not capture deaths in childhood, early adulthood or in old age, while the consequences for the measurement of life expectancy are somewhat less straightforward.

Life expectancy is calculated using life tables, a technique common in demography (Chiang, 1984; Preston et al., 2000). A life table is structured according to age categories (normally five years) and ends in an open age category, for example 90+. This means that there is no technical maximum for life expectancy (Arriaga, 1984; Hinde, 2014). Life expectancy at age 30, for example, can be interpreted as the expected number of years lived after the age of 30. In this thesis, due to data restrictions, individuals are observed until they turn 75. By using a modified life table, with a closed age category at the top (in this case 70–74), temporary life expectancy can be calculated (Arriaga, 1984; Chiang, 1984). The temporary life expectancy estimates the expected number of years lived within a set age interval, in this case 30 to 74. A theoretical maximum of 45 years is implemented. An observed temporary life expectancy of 45 years would indicate that no deaths were observed between the ages of 30 and 74 during the observation period. The corresponding estimate of age standardized mortality would be 0.

This thesis focuses on central measurements of mortality, namely the average level of mortality or life expectancy in educational groups. However, there is an emerging literature addressing dispersion around averages which has

found that the variation around the averages is greater in groups with low levels of education (van Raalte et al., 2011; van Raalte et al., 2012; Sasson, 2016). Since life span variation will decrease when premature deaths are avoided and increase when late deaths are postponed (Sasson, 2016), it is not necessarily the case that a longer life expectancy is associated with less life span variation. However, countries with longer life expectancy tend to have lower life span variation (Vaupel et al., 2011). This indicates that a longer life expectancy is associated with fewer premature deaths. Furthermore, since all deaths within the age range under consideration in this thesis can be considered somewhat early deaths, a higher life span variation can only be generated by a larger proportion of premature deaths. Table 3 shows life expectancies by education for men and women in Sweden in 2006–2008 along with standard errors obtained from life tables (using the Chiang (1984) method).

Education	Men		Women	
	e(30–74)	S.E.	e(30–74)	S.E.
High	43.15	0.0252	43.67	0.0207
Intermediate	42.06	0.0248	43.11	0.0208
Low	41.23	0.0463	42.26	0.0476

Table 3: Temporary life expectancy (30–74) and standard errors by sex and education, Sweden 2006–2008

Table 3 displays a familiar educational gradient in life expectancy, with the highly educated enjoying on average longer lives. However, there are also educational differences in the variation around these means. While the standard errors are similar among those with high and intermediate education, they are larger among those with a low education. These results indicate that the health status in the lower educated group is more heterogeneous and, on an individual level, individuals with a low education face much more uncertainty about their length of life.

Education

In all the empirical analyses in this thesis, education has been coded into three categories based on the International Standard Classification of Education (ISCED) (United Nations Educational & Cultural Organization, 1976). No education, primary or lower secondary education (ISCED 0–2) were classified as ‘low’ education. Lower secondary education (ISCED 2) represents the end of mandatory schooling in Sweden (Halldén, 2008). Upper secondary education (ISCED 3–4) was classified as ‘intermediate’ education, while ‘high’ education was defined as having completed a tertiary degree (ISCED 5–6).

Although it has been suggested that statistical models perform somewhat differently across social groups and different health outcomes (Montez et al., 2012), models using education in three discrete categories perform well in

terms of model fit (Backlund et al., 1999; Montez et al., 2012). Modeling education as discrete levels of completed education, as opposed to years of education, emphasizes the role of formal educational credentials. A completed degree grants access to occupational positions, which an incomplete degree of equal length will not. However, the substantive content of education may matter. For example, a physician may be better equipped to achieve good health than an engineer even though both will be classified as being highly educated. It is also possible that an individual with an incomplete degree but who has spent more time in education can achieve a higher degree of learned effectiveness. This is not captured by measuring education as the highest achieved level. However, such examples probably represent exceptions rather than the norm. Individuals with a university degree have, on average, longer education than individuals with lower secondary education, and they are more likely to have a higher degree of learned effectiveness and be better equipped to obtain good health.

Income

There are several choices to be made about how to measure income: either on the individual or the household level; income from work or disposable income; before or after taxes and transfers. However, empirical evidence suggests that the choice of income measure does not greatly influence the association between income and health (Geyer, 2010). In studies I and IV, income was defined as disposable household income. This measure was selected on the basis of the theoretical framework, which emphasizes the availability of material resources (Mirowsky & Ross, 2003). Income was adjusted for household composition using the Oxford scale developed by the OECD (1982). This method assigns weights to each household member (1 for the first adult, 0.7 for the second, and 0.5 for each child). The total disposable income is then divided by the sum of the weights in order to calculate estimates of income which are comparable across different household compositions. Married or cohabiting individuals with children are defined as a household in the registers, whereas cohabiters without children are not. The disposable income of cohabiters without children is then defined as individual disposable income. Income measures for individuals classified as living alone is then less precise than for other groups. Whether the income measure is accurate, over- or underestimated then depends on whether or not the individual is actually cohabiting and what the income of the cohabiting partner is – information that is unavailable in the registers over the observed period. In Study I, income was modeled using quintiles while in Study IV income was modeled using splines.

Overview of the studies

While studies I and II concentrate specifically on the context of Sweden during the period 1990–2009, studies III and IV focus on more general processes that generate and shape the educational gradient in mortality.

Study I: Growing gaps: The importance of income and family for educational inequalities in mortality among Swedish men and women 1990–2009

The study focuses on the increase in relative educational inequalities in mortality in Sweden during the 1990s and 2000s. The study sought to answer the question of to what extent the widening of inequalities was attributable to two aspects of the indirect relationship between education and health: family type and income. There were both theoretical and empirical reasons for selecting these particular factors. Income and family type represent two explanatory categories within the theoretical framework, namely material resources and interpersonal relationships respectively. Several studies have reported that income inequalities in health and mortality increased during the period in question. The observations that educational inequalities among women are comparatively large compared with men and that the gains in life expectancy among women with a low education are have been modest motivated the inclusion of family type, because the family represents a gendered arena. In addition to descriptive statistics, Poisson regression models were used to track time trends in educational inequalities in mortality. Income and family type were adjusted for in the final model and time trends before and after adjusting for these factors were compared in order to assess their respective contributions.

As reported elsewhere (Statistics Sweden, 2011a; Shkolnikov et al., 2012), the results indicated that relative educational inequalities in mortality increased among both men and women during the 1990s and 2000s. The increase was faster among women, and at the end of the observation period, there were no gender differences in the magnitude of inequalities. Sweden, then, is an interesting case internationally since inequalities tend to be larger among men (McDonough et al., 1999; Mustard & Etches, 2003; Mackenbach et al., 2014). Differences in mortality by family type were larger for men than for women, although the patterns were similar. Adjusting for family type attenuated educational inequalities in mortality among men but not among women. Spousal education is more important for men’s mortality than women’s (Torssander & Erikson, 2009), and since the highly educated tend to

marry each other, the difference in health benefits for marriage may be more dependent on education among men compared to women. When variation in mortality between income groups was adjusted for, time trends in educational inequalities were attenuated. Since the distribution of income groups across educational groups remained similar throughout the period, the trends were interpreted as being driven by increasing income inequalities in mortality. Since there are more low-income earners among those with low levels of education, educational inequalities increased.

Study II: The contribution of alcohol consumption and smoking to educational inequalities in life expectancy among Swedish men and women during 1991–2008

Shifting the focus from relative inequalities in mortality to absolute inequalities, Study II addresses the importance of another aspect of the indirect relationship between education and mortality, namely health behaviors. The study specifically assesses the contribution of smoking and alcohol to the educational gradient in mortality. Smoking and alcohol-related mortality have previously been found to make important contributions to time trends in social inequalities in mortality in Denmark (Koch et al., 2015) and Finland (Martikainen et al., 2013; Martikainen et al., 2014). The composition of causes of death in educational groups was used to indirectly assess the total damage to mortality levels from the harmful consumption of cigarettes and alcohol. Several factors suggest that individuals with a low level of education may be more susceptible to health damage from harmful consumption. Multiple negative health behaviors, overall levels of morbidity and specific drinking or smoking patterns are all examples of factors that systematically vary by education and influence susceptibility to smoking and alcohol. The results were accordingly a reflection of the group level damage from these risk factors rather than a direct reflection of differences in cigarette and alcohol consumption between educational groups.

The results indicated that smoking and alcohol contributed to educational inequalities in mortality among men and women. Among men, smoking and alcohol contributed equally. Each contributed about 15% to difference in life expectancy between those with a high and those with a low education. These proportions remained largely stable throughout the period. From an international perspective, smoking-related mortality was found to be low among men relative to women, possibly due to the use of smokeless tobacco. Among women, alcohol contributed less to the educational differences, around 8% throughout the 1990s and 2000s. Smoking, on the other hand, made a larger and increasing contribution, increasing from 25% to 32%. Absolute inequalities in life expectancy increased among women, with about 56% of the increase coming from alcohol- and smoking-related mortality. At the end of the 2000s, 40% of educational inequalities in life expectancy were attributable to alcohol- and smoking-related mortality among women and about 30% among

men. Smoking was also identified as an important contributing factor to the modest gains in life expectancy in recent decades among women with a low level of education.

Study III: Educational expansion and inequalities in mortality – A fixed-effects analysis using longitudinal data from 18 European populations

In recent decades, average educational achievement has increased dramatically in Europe and other high-income countries (Bar Haim & Shavit, 2013; Meschi & Scervini, 2013). During the same period, relative educational inequalities in mortality increased (Mackenbach et al., 2014). Scholars have suggested that these two processes are connected (Bambra, 2011; Mackenbach, 2012). Study III empirically investigates this possibility. Two potential processes were identified: 1) compositional changes in the common determinants of educational attainment and adult health, and 2) decreasing average returns on educational investment due to education becoming a more widely available resource on the labor market. Fixed-effects models were applied to longitudinal cross-national data in order to isolate the association between educational distribution and excess mortality by education.

The results support the suggestion that educational expansion has contributed to widening relative inequalities in mortality. Controlling for time trends and international variation in mortality, excess mortality by education proved to be associated with the proportion of those with high and low education. However, higher average educational attainment was positively associated with mortality in all educational groups. In order to assess the association between educational distribution and inequalities in mortality, the regression coefficients were used to predict education-specific life expectancies and rate ratios in three educational distributions which reflect progressively more well-educated populations. With the exception of highly educated men (who had similar life expectancies across the predictions), life expectancies tended to be lower when average levels of educational achievement were higher. However, the differences in life expectancies between the predictions were larger among those with a low education, resulting in a net widening in relative inequalities.

Although the results clearly establish an empirical link between relative inequalities in mortality and educational distributions – a strong indication that educational expansion has contributed to widening inequalities in mortality – there are a few important caveats. The results were calculated net of cross country variation and time trends. As such, educational expansion may appear to have a negative influence on life expectancy. This is not the case, however, as life expectancy generally increased during the study period in all educational groups in most populations. Decontextualizing the results also makes it difficult to quantify how large the contribution to the widening in inequalities is. Finally, the results were in line with both proposed mechanisms. Further research using more detailed data is therefore needed to disentangle their respective contributions.

Study IV: Educational inequalities in mortality are larger at low levels of income

It is well-established that education and income are independently associated with mortality (Elo & Preston, 1996; Geyer et al., 2006; Torssander & Erikson, 2010), but only limited attention has been given to the possibility that education and income may interact as predictors of health (Schnittker, 2004; Bonaccio et al., 2016). This possibility was explored in Study IV. Income may be considered a proxy for material resources that are needed to obtain goods and services that promote and protect health. For material resources to be beneficial to health, they need to be used in a health-promoting way. Education may be considered a proxy for decision-making skills, helping individuals to use available resources more efficiently. The highly educated may be protected from health-related income decline because education improves individuals' ability to navigate the medical system and makes it less likely that they will have physically strenuous occupations which make higher demands on physical functioning.

The research question implies high demands on data. Since education and income are correlated, there are comparatively few individuals with high education and low income and vice versa. Swedish register data with national coverage meets the data demands. Poisson regression models were fitted using splines to model income, allowing for interaction between education and income. The results indicated that educational inequalities in mortality were larger at lower levels of income. By using the coefficients to predict absolute death risks by income and education, it was possible not only to determine that education and income interact as predictors of mortality, but also that the interaction only occurs at low levels of income.

The study gives us new empirical, methodological and theoretical understanding. By establishing the interaction between education and income as predictors of mortality, the study confirms that educational inequalities in mortality are larger at lower levels of income, which has previously been found for other health outcomes (Mirowsky & Ross, 2003; Schnittker, 2004). Since regression splines and interactions are both computationally intensive techniques, alternative modelling approaches were explored. Alternative approaches gave a less good model fit. Furthermore, while the same general conclusions were drawn for the middle part of the income distribution, the results were skewed at very high and very low levels of income. The finding that the interaction is located at the lower levels of income provides additional theoretical understanding of around the processes that generate the interaction. When resources are scarce, each decision matters more. However, the results also showed that educational inequalities in health are observed across the complete income spectrum, indicating that education is an inherent good for health.

Concluding remarks

The aim of this thesis was to investigate the social processes that generate and shape the educational gradient in mortality. The findings gave empirical support to the existence of both behavioral and structural processes. One important conclusion is that there is not one single factor that shapes the educational gradient in mortality. Rather, the association between education and health involves multiple interacting and overlapping processes that revolve around the individual's social position, relationships and behavior. The findings give empirical support to the idea that there is both a direct and an indirect association between education and mortality. Education promotes health indirectly by means of giving access to material resources, interpersonal relationships and health behavior. Educational inequalities in mortality appear across the entire income distribution, and high education appears to some extent compensate for compositional changes and lower returns on educational investment caused by educational expansion. These findings corroborate the notion that education is good for health regardless of the circumstances.

Education promotes access to material resources and improves the individual's ability to use material resources efficiently. Material resources, in the form of income, provide potential health benefits only when applied in a health-promoting way. The combination of education and income has a stronger association with health than the sum of the individual components, each component enhancing or detracting from the health benefits of the other. Education and income as health determinants can perhaps be understood better together than apart: in combination they form a strong determinant of health.

The empirical parts of this thesis have generated several new findings concerning the widening educational inequalities in mortality in Sweden. Both structural and behavioral processes have contributed to this development. The results suggest that the higher concentration of low income-earners among those with a low education combined with increasing mortality risks associated with low income have caused the educational gradient in mortality to widen. The combination of having a low income and a low education is associated with especially high mortality risks. While smoking and alcohol-use contributed to educational differences in mortality among both men and women during the 1990s and 2000s, these behaviors, especially smoking, contributed to growing inequalities only among women. Smoking was also re-

vealed as a major contributing factor for why women with a low level of education have experienced only small gains in life expectancy in recent decades. Relative educational inequalities in mortality have widened among both men and women, but the development was faster among women; at the end of the 2000s, there was no gender difference in the magnitude of inequalities. Educational expansion was faster among women during the period, and since educational expansion contributes to widening relative inequalities, this could have contributed to the narrowing gender difference in inequality. Thus, both behavioral and structural processes have contributed to the widening of educational inequalities in mortality among women.

Educational expansion has contributed to the growth of educational inequalities in mortality. The empirical evidence suggests that educational expansion is detrimental to health at group level in all educational groups, all else being equal. It is important to note that this does not imply that promoting education in a population is detrimental to population health overall or to individual health. Changes in the composition of educational groups and shifts in the labor market returns of education may contribute to this pattern.

When understood through theories and statistics, the link between education and health is somewhat abstract. Considering the role education plays in the individual life course perhaps makes it more concrete. Education plays a key role in our social and economic circumstances, and how we behave. It influences who we form relationships with and how we maintain those relationships. It provides us with the tools to make sense of the surrounding world as well as to take control and change it. Through this multitude of processes, education has an impact not only on how long we live but also, and more importantly, on the content of our lives.

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Reference list

- Andersson, M. A. (2016). Health returns to education by family socioeconomic origins, 1980–2008: Testing the importance of gender, cohort, and age. *SSM-Population Health*, 2, 549-560.
- Andersson, M. A., & Maralani, V. (2015). Early-life characteristics and educational disparities in smoking. *Social Science & Medicine*, 144, 138-147.
- Arriaga, E. E. (1984). Measuring and explaining the change in life expectancies. *Demography*, 21(1), 83-96.
- Backlund, E., Sorlie, P. D., & Johnson, N. J. (1996). The shape of the relationship between income and mortality in the United States: evidence from the National Longitudinal Mortality Study. *Annals of Epidemiology*, 6(1), 12-20.
- Backlund, E., Sorlie, P. D., & Johnson, N. J. (1999). A comparison of the relationships of education and income with mortality: The national longitudinal mortality study. *Social Science & Medicine*, 49(10), 1373-1384.
- Baker, D. P., Leon, J., Smith Greenaway, E. G., Collins, J., & Movit, M. (2011). The education effect on population health: A reassessment. *Population and Development Review*, 37(2), 307-332.
- Bambra, C. (2011). Health inequalities and welfare state regimes: Theoretical insights on a public health ‘puzzle’. *Journal of Epidemiology and Community Health*, 65(9), 740-745.
- Bar Haim, E., & Shavit, Y. (2013). Expansion and inequality of educational opportunity: A comparative study. *Research in Social Stratification and Mobility*, 31, 22-31.
- Bartley, M., & Plewis, I. (2007). Increasing social mobility: An effective policy to reduce health inequalities. *Journal of the Royal Statistical Society: Series A (Statistics in Society)*, 170(2), 469-481.
- Batty, G. D., Wennerstad Modig, K., Smith, G. D., Gunnell, D., Deary, I. J., Tynelius, P., & Rasmussen, F. (2009). IQ in early adulthood and mortality by middle age: Cohort study of 1 million Swedish men. *Epidemiology*, 20(1), 100-109.
- Bauldry, S. (2014). Conditional health-related benefits of higher education: An assessment of compensatory versus accumulative mechanisms. *Social Science & Medicine*, 111, 94-100.
- Berggren, F., & Nystedt, P. (2006). Changes in alcohol consumption: An analysis of self-reported use of alcohol in a Swedish national sample 1988–89 and 1996–97. *Scandinavian Journal of Social Medicine*, 34(3), 304-311.

- Berkman, L. F., Kawachi, I., & Glymour, M. M. (2014). *Social Epidemiology*. New York: Oxford University Press.
- Blane, D., Harding, S., & Rosato, M. (1999). Does social mobility affect the size of the socioeconomic mortality differential?: Evidence from the Office for National Statistics Longitudinal Study. *Journal of the Royal Statistical Society: Series A (Statistics in Society)*, 162(1), 59-70.
- Bloomfield, K., Grittner, U., Kramer, S., & Gmel, G. (2006). Social inequalities in alcohol consumption and alcohol-related problems in the study countries of the EU concerted action 'Gender, Culture and Alcohol Problems: a Multi-national Study'. *Alcohol and Alcoholism*, 41(1), i26.
- Blossfeld, H.-P. (2009). Causation as a generative process. The elaboration of an idea for the social sciences and an application to an analysis of an interdependent dynamic social system. In H. Engelhardt, H.-P. Kohler, & A. Fürnkranz-Prskawetz (Eds.), *Causal Analysis in Population Studies* (pp. 83-109). Dordrecht: Springer.
- Bobak, M., Jarvis, M. J., Skodova, Z., & Marmot, M. (2000). Smoke intake among smokers is higher in lower socioeconomic groups. *Tobacco Control*, 9(3), 310-312.
- Bol, T. (2015). Has education become more positional? Educational expansion and labour market outcomes, 1985–2007. *Acta Sociologica*, 58(2), 105-120.
- Bol, T., & Van de Werfhorst, H. G. (2013). Educational systems and the trade-off between labor market allocation and equality of educational opportunity. *Comparative Education Review*, 57(2), 285-308.
- Bonaccio, M., Di Castelnuovo, A., Costanzo, S., Persichillo, M., Donati, M. B., De Gaetano, G., & Iacoviello, L. (2016). Interaction between education and income on the risk of all-cause mortality: Prospective results from the MOLI-SANI study. *International Journal of Public Health*, 61(7), 765-776.
- Bosma, H., Appels, A., Sturmans, F., Grabauskas, V., & Gostautas, A. (1995). Educational level of spouses and risk of mortality: The WHO Kaunas-Rotterdam Intervention Study (KRIS). *International Journal of Epidemiology*, 24(1), 119-126.
- Bourdieu, P. (1986). The forms of capital. In J. E. Richardson (Ed.), *Handbook of Theory and Research for the Sociology of Education* (pp. 258). Westport: Greenwood Press.
- Bourdieu, P. (1990). *The Logic of Practice*. Cambridge: Polity Press.
- Bowleg, L. (2012). The problem with the phrase *women and minorities*: Intersectionality - An important theoretical framework for public health. *American Journal of Public Health*, 102(7), 1267-1273.
- Bowles, S., & Gintis, H. (2002). The inheritance of inequality. *The Journal of Economic Perspectives*, 16(3), 3-30.
- Boye, K., Halldén, K., & Magnusson, C. (2014). Könslönegapets utveckling. Betydelsen av yrkets kvalifikationsnivå och familjeansvar. In M. Evertsson & C. Magnusson (Eds.), *Ojämlighetens dimensioner*:

- uppväxtvillkor, arbete och hälsa i Sverige* (pp. 185-211). Stockholm: Liber.
- Boyle, P. J., Norman, P., & Popham, F. (2009). Social mobility: Evidence that it can widen health inequalities. *Social Science & Medicine*, 68(10), 1835-1842.
- Bradley, K. (2000). The incorporation of women into higher education: Paradoxical outcomes? *Sociology of Education*, 73(1), 1-18.
- Breen, R., & Goldthorpe, J. H. (1997). Explaining educational differentials towards a formal rational action theory. *Rationality and Society*, 9(3), 275-305.
- Breen, R., Luijkx, R., Müller, W., & Pollak, R. (2009). Long-term trends in educational inequality in Europe: Class inequalities and gender differences. *European Sociological Review*, jcp001.
- Broms, U., Silventoinen, K., Lahelma, E., Koskenvuo, M., & Kaprio, J. (2004). Smoking cessation by socioeconomic status and marital status: The contribution of smoking behavior and family background. *Nicotine & Tobacco Research*, 6(3), 447-455.
- Brown, D. C., Hummer, R. A., & Hayward, M. D. (2014). The importance of spousal education for the self-rated health of married adults in the United States. *Population Research and Policy Review*, 33(1), 127-151.
- Bukodi, E., Erikson, R., & Goldthorpe, J. H. (2014). The effects of social origins and cognitive ability on educational attainment: Evidence from Britain and Sweden. *Acta Sociologica*, 57(4), 293-310.
- Callahan, D. (1973). The WHO definition of 'health'. *Hastings Center Studies*, 1(3), 77-87.
- Case, A., Fertig, A., & Paxson, C. (2005). The lasting impact of childhood health and circumstance. *Journal of Health Economics*, 24(2), 365-389.
- Cavelaars, A., Kunst, A., Geurts, J., Crialesi, R., Grötvedt, L., Helmert, U., Lahelma, E., Lundberg, O., Matheson, J., & Mielck, A. (2000). Educational differences in smoking: International comparison. *BMJ*, 320(7242), 1102.
- Centers for Disease Control & Prevention. (2009). Cigarette smoking among adults and trends in smoking cessation - United States, 2008. *MMWR. Morbidity and mortality weekly report*, 58(44), 1227.
- Charles, M., & Bradley, K. (2009). Indulging our gendered selves? Sex segregation by field of study in 44 countries. *American Journal of Sociology*, 114(4), 924-976.
- Chiang, C. L. (1984). *The Life Table and Its Applications*. Malabar: Robert E. Krieger Publishing Company.
- Cockerham, W. C. (2005). Health lifestyle theory and the convergence of agency and structure. *Journal of Health and Social Behavior*, 46(1), 51-67.
- Coleman, J. S. (1994). *Foundations of Social Theory*. Cambridge: Harvard University Press.

- Conti, G., Heckman, J., & Urzua, S. (2010). The education-health gradient. *The American Economic Review*, 100(2), 234.
- Cox, D. R. (1992). Causality: Some statistical aspects. *Journal of the Royal Statistical Society. Series A (Statistics in Society)*, 291-301.
- Cutler, D. M., & Lleras-Muney, A. (2006). Education and health: Evaluating theories and evidence. *National Bureau of Economic Research Working Paper*, 12352, 1-37.
- Cutler, D. M., & Lleras-Muney, A. (2010). Understanding differences in health behaviors by education. *Journal of Health Economics*, 29(1), 1-28.
- Dahlin, J., & Härkönen, J. (2013). Cross-national differences in the gender gap in subjective health in Europe: Does country-level gender equality matter? *Social Science & Medicine*, 98, 24-28.
- Delaruelle, K., Buffel, V., & Bracke, P. (2015). Educational expansion and the education gradient in health: A hierarchical age-period-cohort analysis. *Social Science & Medicine*, 145, 79-88.
- Delavande, A., & Rohwedder, S. (2011). Differential survival in Europe and the United States: Estimates based on subjective probabilities of survival. *Demography*, 48(4), 1377-1400.
- Delgado-Rodriguez, M., & Llorca, J. (2004). Bias. *Journal of Epidemiology and Community Health*, 58(8), 635-641.
- Dew, K. (2007). Public health and the cult of humanity: A neglected Durkheimian concept. *Sociology of Health & Illness*, 29(1), 100-114.
- Devesa, S. S., Bray, F., Vizcaino, A. P., & Parkin, D. M. (2005). International lung cancer trends by histologic type: Male:Female differences diminishing and adenocarcinoma rates rising. *International Journal of Cancer*, 117(2), 294-299.
- Dowd, J. B., & Zajacova, A. (2007). Does the predictive power of self-rated health for subsequent mortality risk vary by socioeconomic status in the US? *International Journal of Epidemiology*, 36(6), 1214-1221.
- Drefahl, S. (2012). Do the married really live longer? The role of cohabitation and socioeconomic status. *Journal of Marriage and Family*, 74, 462-475.
- Dupre, M. E. (2007). Educational differences in age-related patterns of disease: Reconsidering the cumulative disadvantage and age-as-leveler hypotheses. *Journal of Health and Social Behavior*, 48(1), 1-15.
- Dupre, M. E. (2008). Educational differences in health risks and illness over the life course: A test of cumulative disadvantage theory. *Social Science Research*, 37(4), 1253-1266.
- Durkheim, E. (1895/1982). *The Rules of Sociological Method and Selected Texts on Sociology and its Method*. Houndmills: Palgrave Macmillan.
- Eikemo, T. A., Huisman, M., Bambra, C., & Kunst, A. E. (2008). Health inequalities according to educational level in different welfare regimes: A comparison of 23 European countries. *Sociology of Health & Illness*, 30(4), 565-582.

- Eikemo, T. A., Skalická, V., & Avendano, M. (2009). Variations in relative health inequalities: Are they a mathematical artefact? *International Journal for Equity in Health*, 8(1), 32.
- Elder, T. E. (2013). The predictive validity of subjective mortality expectations: Evidence from the health and retirement study. *Demography*, 50(2), 569-589.
- Elo, I. T., & Preston, S. H. (1996). Educational differentials in mortality: United States, 1979-1985. *Social Science & Medicine*, 42(1), 47-57.
- Elstad, J. I. (2001). Health-related mobility, health inequalities and gradient constraint. Discussion and results from a Norwegian study. *The European Journal of Public Health*, 11(2), 135-140.
- Elstad, J. I., & Dahl, E. (2014). Fordelingsvirkninger av overføringer og trygdekutt blant alvorlig syke menn. *Søkelys på arbeidslivet*(3), 267-277.
- England, P. (2010). The gender revolution: Uneven and stalled. *Gender & Society*, 24(2), 149-166.
- Evertsson, M., England, P., Hermsen, J., & Cotter, D. (2007). How does gender inequality in employment and earnings vary by educational stratum in Sweden and the United States? *International Journal of Sociology*, 37(2), 9-28.
- Evertsson, M., England, P., Mooi-Reci, I., Hermsen, J., De Bruijn, J., & Cotter, D. (2009). Is gender inequality greater at lower or higher educational levels? Common patterns in the Netherlands, Sweden, and the United States. *Social Politics: International Studies in Gender, State & Society*, 16(2), 210-241.
- Falk, J., Burström, B., & Nylén, L. (2014). Social differentials in non-employment following hospital admission for musculoskeletal disorders in Sweden, 2001-2006. *International Journal of Health Services*, 44(1), 155-168.
- Fernández, E., Schiaffino, A., Borrell, C., Benach, J., Ariza, C., Ramon, J. M., Twose, J., Nebot, M., & Kunst, A. (2006). Social class, education, and smoking cessation: Long-term follow-up of patients treated at a smoking cessation unit. *Nicotine & Tobacco Research*, 8(1), 29-36.
- Foulds, J., Ramstrom, L., Burke, M., & Fagerström, K. (2003). Effect of smokeless tobacco (snus) on smoking and public health in Sweden. *Tobacco Control*, 12(4), 349-359.
- Frankenhaeuser, M., Lundberg, U., Fredrikson, M., Melin, B., Tuomisto, M., Myrsten, A. L., Hedman, M., Bergman-Losman, B., & Wallin, L. (1989). Stress on and off the job as related to sex and occupational status in white-collar workers. *Journal of Organizational Behavior*, 10(4), 321-346.
- Freese, J., & Lutfey, K. (2011). Fundamental causality: Challenges of an animating concept for medical sociology. In B. A. Pescolido, J. K. Martin, J. D. McLeod, & A. Rogers (Eds.), *Handbook of the Sociology of Health, Illness, and Healing* (pp. 67-81). New York: Springer.

- Fritzell, J., Neramo, M., & Lundberg, O. (2004). The impact of income: Assessing the relationship between income and health in Sweden. *Scandinavian Journal of Public Health*, 32, 6-16.
- Frome, E. L. (1983). The analysis of rates using Poisson regression models. *Biometrics*, 39(3), 665-674.
- Fuller, S. (2004). Intellectuals: An endangered species in the twenty-first century? *Economy and Society*, 33(4), 463-483.
- Gabe, J., & Monaghan, L. (2013). *Key Concepts in Medical Sociology*. London: Sage.
- Galobardes, B., Lynch, J. W., & Smith, G. D. (2004). Childhood socioeconomic circumstances and cause-specific mortality in adulthood: Systematic review and interpretation. *Epidemiologic Reviews*, 26(1), 7-21.
- Galobardes, B., Lynch, J. W., & Smith, G. D. (2008). Is the association between childhood socioeconomic circumstances and cause-specific mortality established? Update of a systematic review. *Journal of Epidemiology and Community Health*, 62(5), 387-390.
- Geyer, S. (2010). Income, income, or income? The effects of different income measures on health in a national survey. *Journal of Epidemiology and Community Health*, 65, 491-496.
- Geyer, S., Hemström, Ö., Peter, R., & Vågerö, D. (2006). Education, income, and occupational class cannot be used interchangeably in social epidemiology. Empirical evidence against a common practice. *Journal of Epidemiology and Community Health*, 60, 804-810.
- Giddens, A. (1984). *The Constitution of Society: Outline of the Theory of Structuration*. Berkeley and Los Angeles: Univ of California Press.
- Gilbert, E. (2007). Performing femininity: Young women's gendered practice of cigarette smoking. *Journal of Gender Studies*, 16(2), 121-137.
- Giskes, K., Kunst, A. E., Benach, J., Borrell, C., Costa, G., Dahl, E., Dalstra, J. A., Federico, B., Helmert, U., & Judge, K. (2005). Trends in smoking behaviour between 1985 and 2000 in nine European countries by education. *Journal of Epidemiology and Community Health*, 59(5), 395-401.
- Goldthorpe, J. H. (2000). *On Sociology: Numbers, Narratives, and the Integration of Research and Theory*. New York: Oxford University Press.
- Goldthorpe, J. H. (2001). Causation, statistics, and sociology. *European Sociological Review*, 17(1), 1-20.
- Goldthorpe, J. H. (2014). The role of education in intergenerational social mobility: Problems from empirical research in sociology and some theoretical pointers from economics. *Rationality and Society*, 26(3), 265-289.
- Goldthorpe, J. H., & Jackson, M. (2008). Education-based meritocracy: The barriers to its realization. In Annette Lareau & D. Conley (Eds.), *Social class: How does it work* (pp. 93-117). New York: Russell Sage Foundation.

- Gorroochurn, P. (2012). Simpson's Paradox (1951) *Classic Problems of Probability* (pp. 253-259): John Wiley & Sons.
- Halldén, K. (2008). The Swedish educational system and classifying education using the ISCED-97 *The International Standard of Classification of Education (ISCED-97). An Evaluation of Content and Criterion Validity in 15 European Countries* (Vol. 15). Mannheim: MZES.
- Hannum, E., & Buchmann, C. (2005). Global educational expansion and socio-economic development: An assessment of findings from the social sciences. *World Development*, 33(3), 333-354.
- Haushofer, J., & Fehr, E. (2014). On the psychology of poverty. *Science*, 344(6186), 862-867.
- Hayward, M. D., & Gorman, B. K. (2004). The long arm of childhood: The influence of early-life social conditions on men's mortality. *Demography*, 41(1), 87-107.
- Hederos Eriksson, K., Jäntti, M., Lindahl, L., & Torssander, J. (2014). Trends in life expectancy by income and the role of specific causes of death. *Economica*. doi:10.1111/ecca.12224
- Hedström, P. (2005). *Dissecting the Social - On the Principles of Analytical Sociology*. Cambridge: Cambridge University Press.
- Heil, J. (1999). Multiple realizability. *American Philosophical Quarterly*, 36(3), 189-208.
- Hemström, Ö. (2002). Alcohol-related deaths contribute to socioeconomic differentials in mortality in Sweden. *The European Journal of Public Health*, 12(4), 254-262.
- Henz, U., & Jonsson, J. O. (2003). Who marries whom in Sweden? In H.-P. Blossfeld & A. Timm (Eds.), *Who Marries Whom?* (pp. 235-266). Dordrecht: Springer.
- Hertz, T., Jayasundera, T., Piraino, P., Selcuk, S., Smith, N., & Verashchagina, A. (2007). The inheritance of educational inequality: International comparisons and fifty-year trends. *The BE Journal of Economic Analysis & Policy*, 7(2).
- Hinde, A. (2014). *Demographic Methods*. London: Arnold.
- Hiscock, R., Bauld, L., Amos, A., Fidler, J. A., & Munafo, M. (2012). Socioeconomic status and smoking: A review. *Annals of the New York Academy of Sciences*, 1248(1), 107-123.
- Hoffmann, R. (2011). Illness, not age, is the leveler of social mortality differences in old age. *The Journals of Gerontology Series B: Psychological Sciences and Social Sciences*, 66(3), 374-379.
- Holland, J. (2012). *A Brief History of Misogyny: The World's Oldest Prejudice*. London: Hachette UK.
- House, J. S., Kessler, R. C., & Herzog, A. R. (1990). Age, socioeconomic status, and health. *The Milbank Quarterly*, 383-411.
- Hout, M. (2012). Social and economic returns to college education in the United States. *Annual Review of Sociology*, 38, 379-400.
- Houweling, T. A., Kunst, A. E., Huisman, M., & Mackenbach, J. P. (2007). Using relative and absolute measures for monitoring health

- inequalities: Experiences from cross-national analyses on maternal and child health. *International Journal for Equity in Health*, 6(1), 15.
- Huang, J., Van den Brink, H. M., & Groot, W. (2009). A meta-analysis of the effect of education on social capital. *Economics of Education Review*, 28(4), 454-464.
- Huisman, M., Kunst, A. E., Bopp, M., Borgan, J.-K., Borrell, C., Costa, G., Deboosere, P., Gadeyne, S., Glickman, M., & Marinacci, C. (2005). Educational inequalities in cause-specific mortality in middle-aged and older men and women in eight western European populations. *The Lancet*, 365(9458), 493-500.
- Hurd, M. D., Smith, J. P., & Zissimopoulos, J. M. (2004). The effects of subjective survival on retirement and social security claiming. *Journal of Applied Econometrics*, 19(6), 761-775.
- Härkönen, J., & Bihagen, E. (2011). Occupational attainment and career progression in Sweden. *European Societies*, 13(3), 451-479.
- Idler, E. L., & Benyamini, Y. (1997). Self-rated health and mortality: A review of twenty-seven community studies. *Journal of Health and Social Behavior*, 21-37.
- Jaffe, D. H., Eisenbach, Z., Neumark, Y. D., & Manor, O. (2006). Effects of husbands' and wives' education on each other's mortality. *Social Science & Medicine*, 62(8), 2014-2023.
- Jervelund, S. S., Malik, S., Ahlmark, N., Villadsen, S. F., Nielsen, A., & Vitus, K. (2016). Morbidity, self-perceived health and mortality among non-western immigrants and their descendants in Denmark in a life phase perspective. *Journal of Immigrant and Minority Health*, 1-29.
- Johansson, L. A., & Westerling, R. (2000). Comparing Swedish hospital discharge records with death certificates: Implications for mortality statistics. *International Journal of Epidemiology*, 29(3), 495-502.
- Kalėdienė, R., Starkuvienė, S., Petrauskienė, J., & Kaselienė, S. (2009). Inequalities in life expectancy of Lithuanian males and females and contribution of major causes of death. *Medicina (Kaunas, Lithuania)*, 46(11), 774-780.
- Kiecolt-Glaser, J. K., & Newton, T. L. (2001). Marriage and health: His and hers. *Psychological Bulletin*, 127(4), 472.
- Klein, R. (1995). *Cigarettes are sublime*. Durham: Duke University Press.
- Koch, M. B., Diderichsen, F., Grønbaek, M., & Juel, K. (2015). What is the association of smoking and alcohol use with the increase in social inequality in mortality in Denmark? A nationwide register-based study. *BMJ Open*, 5(5), e006588.
- Koskenvuo, M., Kaprio, J., Lönnqvist, J., & Sarna, S. (1986). Social factors and the gender difference in mortality. *Social Science & Medicine*, 23(6), 605-609.
- Kotz, D., & West, R. (2009). Explaining the social gradient in smoking cessation: It's not in the trying, but in the succeeding. *Tobacco Control*, 18(1), 43-46.

- Kravdal, Ø. (2008). A broader perspective on education and mortality: Are we influenced by other people's education? *Social Science & Medicine*, 66(3), 620-636.
- Krieger, N. (2008a). Ladders, pyramids and champagne: The iconography of health inequities. *Journal of Epidemiology and Community Health*, 62(12), 1098-1104.
- Krieger, N. (2008b). Proximal, distal, and the politics of causation: What's level got to do with it? *American Journal of Public Health*, 98(2), 221-230.
- Krieger, N. (2011). *Epidemiology and the People's Health: Theory and Context*. New York: Oxford University Press.
- Krieger, N., & Smith, G. D. (2016). The tale wagged by the DAG: Broadening the scope of causal inference and explanation for epidemiology. *International Journal of Epidemiology*, dyw114.
- Kuh, D., Hardy, R., Langenberg, C., Richards, M., & Wadsworth, M. E. (2002). Mortality in adults aged 26-54 years related to socioeconomic conditions in childhood and adulthood: Post war birth cohort study. *BMJ*, 325(7372), 1076-1080.
- Kuh, D., Richards, M., Hardy, R., Butterworth, S., & Wadsworth, M. E. (2004). Childhood cognitive ability and deaths up until middle age: A post-war birth cohort study. *International Journal of Epidemiology*, 33(2), 408-413.
- Kulik, M. C., Hoffmann, R., Judge, K., Looman, C., Menvielle, G., Kulhánová, I., Toch, M., Östergren, O., Martikainen, P., & Borrell, C. (2013). Smoking and the potential for reduction of inequalities in mortality in Europe. *European Journal of Epidemiology*, 28(12), 959-971.
- Kulik, M. C., Menvielle, G., Eikemo, T. A., Bopp, M., Jasilionis, D., Kulhánová, I., Leinsalu, M., Martikainen, P., Östergren, O., & Mackenbach, J. P. (2013). Educational inequalities in three smoking-related causes of death in 18 European populations. *Nicotine & Tobacco Research*, 16(5), 507-518.
- Kunst, A. E., Bos, V., Andersen, O., Cardano, M., Costa, G., Harding, S., Hemström, Ö., Layte, R., Regidor, E., & Reid, A. (2004). Monitoring of trends in socioeconomic inequalities in mortality: Experiences from a European project. *Demographic Research*, 2(9), 229-254.
- Laaksonen, M., Prättälä, R., & Lahelma, E. (2003). Sociodemographic determinants of multiple unhealthy behaviours. *Scandinavian Journal of Public Health*, 31(1), 37-43.
- Lager, A. C. J., & Torssander, J. (2012). Causal effect of education on mortality in a quasi-experiment on 1.2 million Swedes. *Proceedings of the National Academy of Sciences*, 109(22), 8461-8466.
- Lahelma, E., Martikainen, P., Laaksonen, M., & Aittomäki, A. (2004). Pathways between socioeconomic determinants of health. *Journal of Epidemiology and Community Health*, 58, 327-332.

- Layte, R., & Whelan, C. T. (2008). Explaining social class inequalities in smoking: The role of education, self-efficacy, and deprivation. *European Sociological Review*, 25(4), 399-410.
- Leon, D. A. (2011). Trends in European life expectancy: A salutary view. *International Journal of Epidemiology*, 40(2), 271-277.
- Lewis, M. A., McBride, C. M., Pollak, K. I., Puleo, E., Butterfield, R. M., & Emmons, K. M. (2006). Understanding health behavior change among couples: An interdependence and communal coping approach. *Social Science & Medicine*, 62(6), 1369-1380.
- Lin, N. (1999). Social networks and status attainment. *Annual Review of Sociology*, 25(1), 467-487.
- Link, B. G., & Phelan, J. (1995). Social conditions as fundamental causes of disease. *Journal of Health and Social Behavior*, 80-94.
- Livi-Bacci, M. (2012). *A Concise History of World Population*. Malden: Blackwell.
- Lohmann, H., & Ferger, F. (2014). Educational poverty in a comparative perspective: Theoretical and empirical implications. *SFB 882 Working Paper Series*, 26, 1-25.
- Lundberg, O., Åberg Yngwe, M., Kölegård Stjärne, M., Björk, L., & Fritzell, J. (2008). *The Nordic Experience: Welfare States and Public Health (NEWS)*. Stockholm: Centre for Health Equity Studies (CHESS).
- Lundberg, U., & Frankenhaeuser, M. (1999). Stress and workload of men and women in high-ranking positions. *Journal of Occupational Health Psychology*, 4(2), 142.
- Lundborg, P., Lyttkens, C. H., & Nystedt, P. (2016). The effect of schooling on mortality: New evidence from 50,000 Swedish twins. *Demography*, 53(4), 1135-1168.
- Lynch, J. W., Smith, G. D., Kaplan, G. A., & House, J. S. (2000). Income inequality and mortality: Importance to health of individual income, psychosocial environment, or material conditions. *BMJ*, 320(7243), 1200.
- Mackenbach, J. P. (2012). The persistence of health inequalities in modern welfare states: The explanation of a paradox. *Social Science & Medicine*, 75(4), 761-769.
- Mackenbach, J. P., Kulhánová, I., Artnik, B., Bopp, M., Borrell, C., Clemens, T., Costa, G., Dibben, C., Kalediene, R., Lundberg, O., Martikainen, P., Menvielle, G., Östergren, O., Prochorskas, R., Rodriguez-Sanz, M., Heine Strand, B., Looman, C., & De Gelder, R. (2016). Changes in mortality inequalities over two decades: Register based study of European countries. *BMJ*, 353, 1-8.
- Mackenbach, J. P., Kulhánová, I., Bopp, M., Deboosere, P., Eikemo, T. A., Hoffmann, R., Kulik, M. C., Leinsalu, M., Martikainen, P., Menvielle, G., Regidor, E., Wojtyniak, B., Östergren, O., & Lundberg, O. (2015). Variations in the relation between education and cause-specific mortality in 19 European populations: A test of the “fundamental causes” theory of social inequalities in health. *Social Science & Medicine*, 127, 51-62.

- Mackenbach, J. P., Kulhánová, I., Menvielle, G., Bopp, M., Borrell, C., Costa, G., Deboosere, P., Esnaola, S., Kalediene, R., Kovacs, K., Leinsalu, M., Martikainen, P., Regidor, E., Rodriguez-Sanz, M., Strand, B. H., Hoffmann, R., Eikemo, T., Östergren, O., & Lundberg, O. (2014). Trends in inequalities in premature mortality: A study of 3.2 million deaths in 13 European countries. *Journal of Epidemiology and Community Health*, jech-2014-204319.
- Mackenbach, J. P., & Kunst, A. E. (1997). Measuring the magnitude of socio-economic inequalities in health: An overview of available measures illustrated with two examples from Europe. *Social Science & Medicine*, 44(6), 757-771.
- Mackenbach, J. P., Martikainen, P., Menvielle, G., & de Gelder, R. (2016). The arithmetic of reducing relative and absolute inequalities in health: A theoretical analysis illustrated with European mortality data. *Journal of Epidemiology and Community Health*, jech-2015-207018.
- Mackenbach, J. P., Menvielle, G., Jasilionis, D., & de Gelder, R. (2015). Measuring educational inequalities in mortality statistics. *OECD Statistics Working Papers*, 2015(8), 1-38.
- Mackenbach, J. P., Stribu, I., Roskam, A.-J., Schaap, M. M., Menvielle, G., Leinsalu, M., & Kunst, A. E. (2008). Socioeconomic inequalities in health in 22 European countries. *The New England Journal of Medicine*, 358, 2468-2481.
- Manderbacka, K., Kåreholt, I., Martikainen, P., & Lundberg, O. (2003). The effect of point of reference on the association between self-rated health and mortality. *Social Science & Medicine*, 56(7), 1447-1452.
- Mani, A., Mullainathan, S., Shafir, E., & Zhao, J. (2013). Poverty impedes cognitive function. *Science*, 341(6149), 976-980.
- Maralani, V. (2014). Understanding the links between education and smoking. *Social Science Research*, 48, 20-34.
- Martikainen, P., Ho, J. Y., Preston, S., & Elo, I. T. (2013). The changing contribution of smoking to educational differences in life expectancy: Indirect estimates for Finnish men and women from 1971 to 2010. *Journal of Epidemiology and Community Health*, 67(3), 219-224.
- Martikainen, P., Mäkelä, P., Peltonen, R., & Myrskylä, M. (2014). Income differences in life expectancy: The changing contribution of harmful consumption of alcohol and smoking. *Epidemiology*, 25(2), 182-190.
- Masters, R. K., Link, B. G., & Phelan, J. C. (2015). Trends in education gradients of 'preventable' mortality: A test of fundamental cause theory. *Social Science & Medicine*, 127, 19-28.
- McDonough, P., Williams, D. R., House, J. S., & Duncan, G. J. (1999). Gender and the socioeconomic gradient in mortality. *Journal of Health and Social Behavior*, 40(1), 17-31.
- McPherson, M., Smith-Lovin, L., & Cook, J. M. (2001). Birds of a feather: Homophily in social networks. *Annual Review of Sociology*, 27(1), 415-444.
- Merton, R. K. (1938). Social structure and anomie. *American Sociological Review*, 3(5), 672-682.

- Meschi, E., & Scervini, F. (2013). A new dataset on educational inequality. *Empirical Economics*, 1-22.
- Miech, R., Pampel, F., Kim, J., & Rogers, R. G. (2011). The enduring association between education and mortality: The role of widening and narrowing disparities. *American Sociological Review*, 76(6), 913-934.
- Miething, A. (2014). *Others' Income, One's Own Fate: How Income Inequality, Relative Social Position and Social Comparisons Contribute to Disparities in Health*. Department of Sociology, Stockholm University, Stockholm.
- Mills, C. W. (1959/2000). *The Sociological Imagination*. New York: Oxford University Press.
- Mirowsky, J., & Ross, C. E. (2003). *Education, Social Status, and Health*. New Brunswick: Transaction Publishers.
- Mirowsky, J., & Ross, C. E. (2005a). Education, cumulative advantage, and health. *Ageing International*, 30(1), 27-62.
- Mirowsky, J., & Ross, C. E. (2005b). Education, learned effectiveness and health. *London Review of Education*, 3(3), 205-220.
- Molander, P. (2016). *The Anatomy of Inequality: Its Social and Economic Origins-and Solutions*. London: Melville House.
- Montez, J. K., & Hayward, M. D. (2014). Cumulative childhood adversity, educational attainment, and active life expectancy among US adults. *Demography*, 51(2), 413-435.
- Montez, J. K., Hummer, R. A., & Hayward, M. D. (2012). Educational attainment and adult mortality in the United States: A systematic analysis of functional form. *Demography*, 49(1), 315-336.
- Mortensen, L. H., Rehnberg, J., Dahl, E., Diderichsen, F., Elstad, J. I., Martikainen, P., Rehkopf, D., Tarkiainen, L., & Fritzell, J. (2016). Shape of the association between income and mortality: A cohort study of Denmark, Finland, Norway and Sweden in 1995 and 2003. *BMJ Open*, 6(12), e010974.
- Mortensen, L. H., & Torssander, J. (2017). Family of origin and educational inequalities in mortality: Results from 1.7 million Swedish siblings. *SSM-Population Health*, 3, 192-200.
- Mustard, C. A., & Etches, J. (2003). Gender differences in socioeconomic inequality in mortality. *Journal of Epidemiology and Community Health*, 57(12), 974-980.
- Norström, T., & Ramstedt, M. (2005). Mortality and population drinking: A review of the literature. *Drug and Alcohol Review*, 24(6), 537-547.
- OECD. (1982). *The OECD List of Social Indicators*. Paris: OECD.
- Oeppen, J., & Vaupel, J. W. (2002). Broken limits to life expectancy. *Science*, 296(5570), 1029-1031.
- Palloni, A. (2006). Reproducing inequalities: Luck, wallets, and the enduring effects of childhood health. *Demography*, 43(4), 587-615.
- Pamuk, E. R. (1985). Social class inequality in mortality from 1921 to 1972 in England and Wales. *Population Studies*, 39(1), 17-31.

- Pearlin, L. I., & Schooler, C. (1978). The structure of coping. *Journal of Health and Social Behavior*, 2-21.
- Perozek, M. (2008). Using subjective expectations to forecast longevity: Do survey respondents know something we don't know? *Demography*, 45(1), 95-113.
- Post, T., & Hanewald, K. (2013). Longevity risk, subjective survival expectations, and individual saving behavior. *Journal of Economic Behavior & Organization*, 86, 200-220.
- Preston, S., Heuveline, P., & Guillot, M. (2000). *Demography: Measuring and Modeling Population Processes*. Oxford: Wiley-Blackwell.
- Preston, S. H. (1975). The changing relation between mortality and level of economic development. *Population Studies*, 29(2), 231-248.
- Preston, S. H., & Elo, I. T. (1995). Are educational differentials in adult mortality increasing in the United States? *Journal of Aging and Health*, 7(4), 476-496.
- Preston, S. H., Gleij, D. A., & Wilmoth, J. R. (2010). A new method for estimating smoking-attributable mortality in high-income countries. *International Journal of Epidemiology*, 39(2), 430-438.
- Psacharopoulos, G. (1981). Returns to education: An updated international comparison. *Comparative Education*, 17(3), 321-341.
- Reid, J. L., Hammond, D., Boudreau, C., Fong, G. T., Siahpush, M., & Collaboration, I. (2010). Socioeconomic disparities in quit intentions, quit attempts, and smoking abstinence among smokers in four western countries: Findings from the International Tobacco Control Four Country Survey. *Nicotine & Tobacco Research*, 12(suppl 1), S20-S33.
- Reskin, B. F. (1988). Bringing the men back in: Sex differentiation and the devaluation of women's work. *Gender & Society*, 2(1), 58-81.
- Rieker, P. P., & Bird, C. E. (2005). Rethinking gender differences in health: Why we need to integrate social and biological perspectives. *The Journals of Gerontology Series B: Psychological Sciences and Social Sciences*, 60(Special Issue 2), S40-S47.
- Robles, T. F., & Kiecolt-Glaser, J. K. (2003). The physiology of marriage: Pathways to health. *Physiology & Behavior*, 79(3), 409-416.
- Rodu, B., & Cole, P. (2004). The burden of mortality from smoking: Comparing Sweden with other countries in the European Union. *European Journal of Epidemiology*, 19, 129-131.
- Rogers, R. G., Everett, B. G., Zajacova, A., & Hummer, R. A. (2010). Educational degrees and adult mortality risk in the United States. *Biodemography and Social Biology*, 56(1), 80-99.
- Rose, G. (1992). *The Strategy of Preventive Medicine*. Oxford: Oxford Medical Publications.
- Ross, C. E., Masters, R. K., & Hummer, R. A. (2012). Education and the gender gaps in health and mortality. *Demography*, 49(4), 1157-1183.
- Ross, C. E., & Mirowsky, J. (2010). Gender and the health benefits of education. *The Sociological Quarterly*, 51(1), 1-19.

- Ross, C. E., & Mirowsky, J. (2011). The interaction of personal and parental education on health. *Social Science & Medicine*, 72(4), 591-599.
- Ross, C. E., & Mirowsky, J. (2013). The sense of personal control: Social structural causes and emotional consequences. In C. Aneshensel, J. Phelan, & A. Bierman (Eds.), *Handbook of the Sociology of Mental Health* (pp. 379-402). Dordrecht: Springer.
- Ross, C. E., & Wu, C.-I. (1995). The links between education and health. *American Sociological Review*, 719-745.
- Sasson, I. (2016). Trends in life expectancy and lifespan variation by educational attainment: United States, 1990–2010. *Demography*, 53(2), 269-293.
- Schaan, B. (2014). The interaction of family background and personal education on depressive symptoms in later life. *Social Science & Medicine*, 102, 94-102.
- Schafer, M. H., Wilkinson, L. R., & Ferraro, K. F. (2013). Childhood (mis)fortune, educational attainment, and adult health: Contingent benefits of a college degree? *Social Forces*, 91(3), 1007-1034.
- Schieman, S. (2001). Age, education, and the sense of control: A test of the cumulative advantage hypothesis. *Research on Aging*, 23(2), 153-178.
- Schneider, S. L. (2013). The international standard classification of education 2011. In E. Birkelund (Ed.), *Class and Stratification Analysis (Comparative Social Research, Volume 30)* (pp. 365-379). Bingley: Emerald Group Publishing Limited.
- Schnittker, J. (2004). Education and the changing shape of the income gradient in health. *Journal of Health and Social Behavior*, 45(3), 286-305.
- Schulz, A. J., & Mullings, L. (Eds.). (2006). *Gender, Race, Class, and Health: Intersectional Approaches*. San Francisco: Jossey-Bass.
- Seeman, M., Seeman, A. Z., & Budros, A. (1988). Powerlessness, work, and community: A longitudinal study of alienation and alcohol use. *Journal of Health and Social Behavior*, 185-198.
- Selye, H. (1973). The evolution of the stress concept: The originator of the concept traces its development from the discovery in 1936 of the alarm reaction to modern therapeutic applications of syntoxic and catatoxic hormones. *American Scientist*, 61(6), 692-699.
- Sen, A. (1999). *Development as Freedom*. New York: Oxford University Press.
- Shkolnikov, V. M., Andreev, E. M., Jdanov, D. A., Domantas, J., Kravdal, Ø., Vågerö, D., & Valkonen, T. (2012). Increasing absolute mortality disparities by education in Finland, Norway and Sweden, 1971-2000. *Journal of Epidemiology and Community Health*, 66, 372-378.
- Skalická, V., & Kunst, A. E. (2008). Effects of spouses' socioeconomic characteristics on mortality among men and women in a Norwegian longitudinal study. *Social Science & Medicine*, 66(9), 2035-2047.
- Skeggs, B. (1997). *Formations of Class & Gender: Becoming Respectable*. London: Sage.

- Slagsvold, B., & Sørensen, A. (2008). Age, education, and the gender gap in the sense of control. *The International Journal of Aging and Human Development*, 67(1), 25-42.
- Slopen, N., Kontos, E. Z., Ryff, C. D., Ayanian, J. Z., Albert, M. A., & Williams, D. R. (2013). Psychosocial stress and cigarette smoking persistence, cessation, and relapse over 9–10 years: A prospective study of middle-aged adults in the United States. *Cancer Causes & Control*, 24(10), 1849-1863.
- Smith, J. A., McPherson, M., & Smith-Lovin, L. (2014). Social distance in the United States: Sex, race, religion, age, and education homophily among confidants, 1985 to 2004. *American Sociological Review*, 79(3), 432-456.
- Smith, W. C., Anderson, E., Salinas, D., Horvatek, R., & Baker, D. P. (2015). A meta-analysis of education effects on chronic disease: The causal dynamics of the Population Education Transition Curve. *Social Science & Medicine*, 127, 29-40.
- Solga, H. (2002). 'Stigmatization by negative selection': Explaining less-educated people's decreasing employment opportunities. *European Sociological Review*, 159-178.
- Solga, H. (2008). Employment opportunities for low-skilled persons from a sociological and microeconomic perspective. In K. U. Mayer & H. Solga (Eds.), *Skill formation: Interdisciplinary and cross-national perspectives* (pp. 173-204): Cambridge University Press.
- Spaenjers, C., & Spira, S. M. (2015). Subjective life horizon and portfolio choice. *Journal of Economic Behavior & Organization*, 116, 94-106.
- Spoerri, A., Schmidlin, K., Richter, M., Egger, M., Clough-Gorr, K. M., Puhani, M., Bopp, M., Zwahlen, M., Kuenzli, N., & Paccaud, F. (2014). Individual and spousal education, mortality and life expectancy in Switzerland: A national cohort study. *Journal of Epidemiology and Community Health*, 68(9), 804-810.
- Statistics Sweden. (2001). *Tidsseriebrott i Utbildningsregistret*. Stockholm: Statistics Sweden.
- Statistics Sweden. (2004). *Dödlighet efter utbildning, boende och civilstånd*. Stockholm: Statistics Sweden.
- Statistics Sweden. (2006a). *Evalvering av utbildningsregistret*. Stockholm: Statistics Sweden.
- Statistics Sweden. (2006b). *Registret över totalbefolkningen (RTB)*. Stockholm: Statistics Sweden.
- Statistics Sweden. (2009). *SCB-data för forskning 2009*. Stockholm: Statistics Sweden.
- Statistics Sweden. (2011a). *Livslängden i Sverige 2001–2010*. Stockholm: Statistics Sweden.
- Statistics Sweden. (2011b). *Yearbook of Educational Statistics 2012*. Stockholm: Statistics Sweden.
- Strand, B. H., Kunst, A., Huisman, M., Menvielle, G., Glickman, M., Bopp, M., Borell, C., Borgan, J. K., Costa, G., & Deboosere, P. (2007). The reversed social gradient: Higher breast cancer mortality in the higher

- educated compared to lower educated. A comparison of 11 European populations during the 1990s. *European Journal of Cancer*, 43(7), 1200-1207.
- Subrahmanian, R. (2005). Gender equality in education: Definitions and measurements. *International Journal of Educational Development*, 25(4), 395-407.
- Taylor, S. E. (2012). *Health Psychology* (7 ed.). New York: McGraw-Hill Ryerson, Ltd.
- The National Board of Health and Welfare. (2010). *Dödsorsaksstatistik—historik, produktionsmetoder och tillförlitlighet*. Stockholm: The National Board of Health and Welfare.
- The Swedish Commission for Equity in Health. (2016). *SOU 2016:55 Det handlar om jämlik hälsa. Delbetänkande*. Stockholm: The Swedish Commission for Equity in Health.
- The Swedish Commission for Equity in Health. (2017). *SOU 2017:47 Nästa steg på vägen mot en mer jämlik hälsa. Slutbetänkande*. Stockholm: The Swedish Commission for Equity in Health.
- Torssander, J., & Erikson, R. (2009). Marital partner and mortality: The effects of the social positions of both spouses. *Journal of Epidemiology and Community Health*, 63(12), 992-998.
- Torssander, J., & Erikson, R. (2010). Stratification and mortality - A comparison of education, class, status, and income. *European Sociological Review*, 26(4), 465-474.
- Triandafilidis, Z., Ussher, J. M., Perz, J., & Huppatz, K. (2017). Doing and undoing femininities: An intersectional analysis of young women's smoking. *Feminism & Psychology*, 0959353517693030.
- Udehn, L. (2002). The changing face of methodological individualism. *Annual Review of Sociology*, 28(1), 479-507.
- Umberson, D. (1992). Gender, marital status and the social control of health behavior. *Social Science & Medicine*, 34(8), 907-917.
- Umberson, D., Crosnoe, R., & Reczek, C. (2010). Social relationships and health behavior across the life course. *Annual Review of Sociology*, 36, 139-157.
- Umberson, D., Williams, K., Powers, D. A., Liu, H., & Needham, B. (2006). You make me sick: Marital quality and health over the life course. *Journal of Health and Social Behavior*, 47(1), 1-16.
- United Nations Educational, S., & Cultural Organization, P. D. o. S. o. E. (1976). *International Standard Classification of Education (ISCED)*: ERIC Clearinghouse.
- Vagerö, D. (2011). En folkhälsopolitisk kardinalfråga: Ökade sociala skillnader i dödlighet under fyra decennier. *Socialmedicinsk tidskrift*, 88(4), 292.
- Wagner, C. H. (1982). Simpson's paradox in real life. *The American Statistician*, 36(1), 46-48.
- Waldron, I. (1991). Patterns and causes of gender differences in smoking. *Social Science & Medicine*, 32(9), 989-1005.

- Waldron, I., Hughes, M. E., & Brooks, T. L. (1996). Marriage protection and marriage selection—Prospective evidence for reciprocal effects of marital status and health. *Social Science & Medicine*, *43*(1), 113-123.
- Van Doorslaer, E., Wagstaff, A., Bleichrodt, H., Calonge, S., Gerdtham, U.-G., Gerfin, M., Geurts, J., Gross, L., Häkkinen, U., & Leu, R. E. (1997). Income-related inequalities in health: Some international comparisons. *Journal of Health Economics*, *16*(1), 93-112.
- van Raalte, A. A., Kunst, A. E., Deboosere, P., Leinsalu, M., Lundberg, O., Martikainen, P., Strand, B. H., Artnik, B., Wojtyniak, B., & Mackenbach, J. P. (2011). More variation in lifespan in lower educated groups: Evidence from 10 European countries. *International Journal of Epidemiology*, *40*(6), 1703-1714.
- van Raalte, A. A., Kunst, A. E., Lundberg, O., Leinsalu, M., Martikainen, P., Artnik, B., Deboosere, P., Stirbu, I., Wojtyniak, B., & Mackenbach, J. P. (2012). The contribution of educational inequalities to lifespan variation. *Population Health Metrics*, *10*(1), 3.
- Van Solinge, H., & Henkens, K. (2010). Living longer, working longer? The impact of subjective life expectancy on retirement intentions and behaviour. *European Journal of Public Health*, *20*(1), 47-51.
- van Tubergen, F., & Volker, B. (2015). Inequality in access to social capital in the Netherlands. *Sociology*, *49*(3), 521-538.
- Vandenbroucke, J. P., Broadbent, A., & Pearce, N. (2016). Causality and causal inference in epidemiology: The need for a pluralistic approach. *International Journal of Epidemiology*, dyv341.
- Wang, H., Dwyer-Lindgren, L., Lofgren, K. T., Rajaratnam, J. K., Marcus, J. R., Levin-Rector, A., Levitz, C. E., Lopez, A. D., & Murray, C. J. (2013). Age-specific and sex-specific mortality in 187 countries, 1970–2010: A systematic analysis for the Global Burden of Disease Study 2010. *The Lancet*, *380*(9859), 2071-2094.
- Vaupel, J. W., Zhang, Z., & van Raalte, A. A. (2011). Life expectancy and disparity: An international comparison of life table data. *BMJ Open*, *1*(1), e000128.
- Verbrugge, L. M., Wingard, D. L., & Features Submission, H. C. (1987). Sex differentials in health and mortality. *Women & Health*, *12*(2), 103-145.
- West, C., & Zimmerman, D. H. (1987). Doing gender. *Gender & Society*, *1*(2), 125-151.
- Wickrama, K., Conger, R. D., & Lorenz, F. O. (1995). Work, marriage, lifestyle, and changes in men's physical health. *Journal of Behavioral Medicine*, *18*(2), 97-111.
- Wilson, S. E. (2002). The health capital of families: an investigation of the inter-spousal correlation in health status. *Social Science & Medicine*, *55*(7), 1157-1172.
- Wolbers, M. H., De Graaf, P. M., & Ultee, W. C. (2001). Trends in the occupational returns to educational credentials in the Dutch labor market: changes in structures and in the association? *Acta Sociologica*, *44*(1), 5-19.

- Zhang, Z., & Vaupel, J. W. (2009). The age separating early deaths from late deaths. *Demographic Research*, 20, 721-730.
- Östergren, O. (2015). Growing gaps: The importance of income and family for educational inequalities in mortality among Swedish men and women 1990–2009. *Scandinavian Journal of Public Health*, 1403494815585401.

