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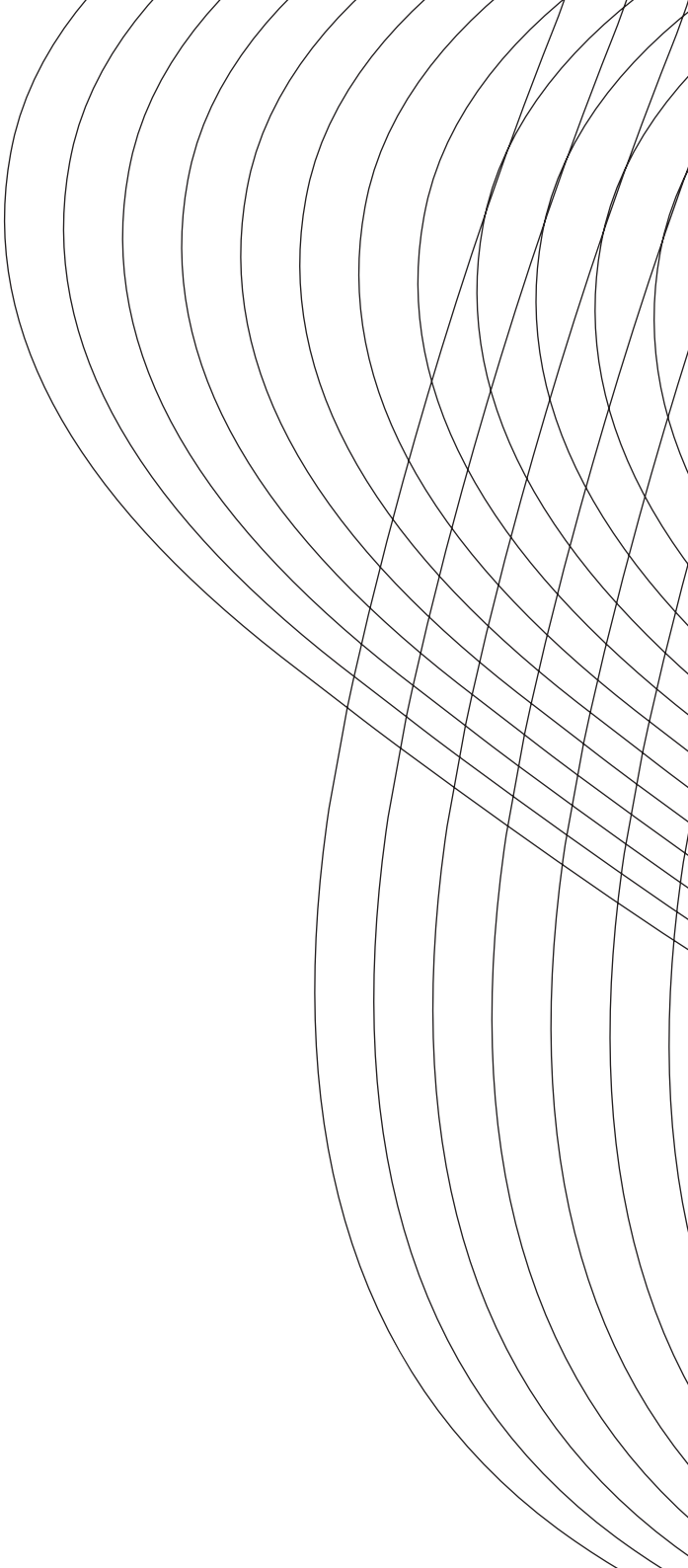
Eddy van Doorslaer, Hans van Kippersluis,
Owen O'Donnell and Tom Van Ourti

Socioeconomic Differences in Health over the Life Cycle: Evidence and Explanations



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PREFACE

Netspar stimulates debate and fundamental research in the field of pensions, aging and retirement. The aging of the population is front-page news, as many baby boomers are now moving into retirement. More generally, people live longer and in better health while at the same time families choose to have fewer children. Although the aging of the population often gets negative attention, with bleak pictures painted of the doubling of the ratio of the number of people aged 65 and older to the number of the working population during the next decades, it must, at the same time, be a boon to society that so many people are living longer and healthier lives. Can the falling number of working young afford to pay the pensions for a growing number of pensioners? Do people have to work a longer working week and postpone retirement? Or should the pensions be cut or the premiums paid by the working population be raised to afford social security for a growing group of pensioners? Should people be encouraged to take more responsibility for their own pension? What is the changing role of employers associations and trade unions in the organization of pensions? Can and are people prepared to undertake investment for their own pension, or are they happy to leave this to the pension funds? Who takes responsibility for the pension funds? How can a transparent and level playing field for pension funds and insurance companies be ensured? How should an acceptable trade-off be struck between social goals such as solidarity between young and old, or rich and poor, and individual freedom? But most important of all: how can the benefits of living longer and healthier be harnessed for a happier and more prosperous society?

The Netspar Panel Papers aim to meet the demand for understanding the ever-expanding academic literature on the consequences of aging populations. They also aim to help give a better scientific underpinning of policy advice. They attempt to provide a survey of the latest and most relevant research, try to explain this in a non-technical manner and outline the implications for policy questions faced by Netspar's partners. Let there be no mistake. In many ways, formulating such a position paper

is a tougher task than writing an academic paper or an op-ed piece. The authors have benefitted from the comments of the Editorial Board on various drafts and also from the discussions during the presentation of their paper at a Netspar Panel Meeting.
I hope the result helps reaching Netspar's aim to stimulate social innovation in addressing the challenges and opportunities raised by aging in an efficient and equitable manner and in an international setting.

Henk Don
Chairman of the Netspar Editorial Board

EXECUTIVE SUMMARY

Relative to the abundance of evidence available on the static correlation between health and socioeconomic status (SES), much less attention has been devoted to whether, and how, the socioeconomic gradient in health changes over the life cycle. A snapshot of socioeconomic differences in health at a given age gives a rather incomplete impression of the extent of health disparities over the life course. It provides, for example, no information on how much more rapidly health declines for some groups than for others. While it is clear that the socially disadvantaged, at any given age, experience a lower level of health, there is no consensus over whether they can also expect their health to deteriorate more rapidly. A sharper deterioration of a lower initial stock of health would be a double blow likely to intensify concerns about socioeconomic inequalities in health.

This paper summarizes the international evidence on socioeconomic differences in health over the life cycle and considers the extent to which this is consistent with economic theory. The paper then presents new evidence from Dutch data on differences, by SES, in the way in which health evolves over the adult life cycle. Finally, the paper outlines some implications for policy and future research of adopting a life-cycle perspective for the analysis of socioeconomic-related health inequalities. A dynamic approach goes beyond merely expanding our knowledge of the extent of socioeconomic-related inequalities in health; it also promises to enrich our understanding of the nature of those inequalities by revealing, for example, whether health differences by education persist into later life.

Cross-sectional data, in the Netherlands and elsewhere, reveal that the socioeconomic gradient in health widens until middle age and narrows thereafter. Cohort effects and selective mortality, as well as heterogeneous health reporting, while appearing to play a role here, do not tell the entire story. Our interpretation of the evidence is that lower socioeconomic groups do indeed suffer a double health penalty in that they begin adult life with a slightly lower level of health, which

subsequently deteriorates at a sharper rate through middle age. Post-retirement, the observed SES-health gradient narrows, but this is due to the fact that it is the most robust of the lower socioeconomic groups that survive into old age in addition to the strengthening of biological (relative to socioeconomic) determinants of health in this age range. Up to late middle age, the rate of deterioration in health appears to be related to education, and not to income. The increasing impact of education on health could be due to the lagged effect of education related to lifestyle choices (such as smoking) on health, and because social advantages (such as knowledge of health services and professionals) accumulate over the life cycle. There may also be an indirect effect operating from education with regard to choice of occupation and subsequent health conditions arising as a result of exposure to health risks and the wear-and-tear on the body caused by strenuous manual work. Despite the fact that there is little evidence from advanced economies that income has a causal impact on health, the rate of decline in health is more strongly correlated with income than it is with education. The explanation appears to be that deterioration in health leads to withdrawal from work and, subsequently, a decline in income. But this reverse effect can still be part of a cumulative disadvantage process, since the less well educated are more likely to enter occupations that are more demanding of physical health. These individuals are more likely to suffer health shocks and to find themselves out of work as a result.

While this study has not attempted to identify any causal impact of socioeconomic indicators on health outcomes using Dutch data, the descriptive analysis in the study reveals patterns that are largely consistent with those observed in US data, and suggests that broadly similar mechanisms are operating. It seems that countries with very different social welfare and health care systems end up displaying not quite identical, but nonetheless remarkably similar, socioeconomic patterns in the life-cycle profile of health. It is hardly surprising that health-related exit from the labor force is an important causal mechanism linking health and socioeconomic status at middle age in the US, a country with relatively limited social protection mechanisms. It is perhaps more surprising that the same holds for a country like the Netherlands, known for its generous social protection, disability insurance and retirement schemes. But this generosity itself may increase the observed correlation between income and health if individuals with

a given health problem are encouraged to withdraw from the labor force and if replacement rates, although generous, are less than 100%. The increase in the income-health gradient is even steeper in the Netherlands than it is in the US, peaking at an age of around 50, and appears to be driven largely by differential employment rates. The steep decline in the reporting of ill-health beyond the age of 55, which is most pronounced at the bottom of the income distribution and absent at the top, suggests that a substantial part of the income-health gradient before this age may be attributable to the reporting of ill-health as a justification for not working. This suggests that the generosity of Dutch disability insurance and the readiness for this to be used as a route out of work into retirement has exerted a considerable bias on the income-health gradient and its life-cycle profile. To a certain extent, this is a problem of the past, given the measures that have been introduced in recent years to tighten up on access to disability benefits.

Overturning these processes of cumulative advantage represents a major challenge to social policy. The potential rewards are, however, immense. Getting closer to a goal of equality of opportunity could raise national wealth by breaking the connection between low education, poor health and early labor-force exit. There could also be substantial savings on expenditures on health care. Of course, breaking the cycle requires identifying the specific causal mechanisms that link education with later-life health outcomes. At present, however, there is very little robust evidence. Much of the education effect appears to operate through health-related lifestyle choices. But we do not know why better educated people choose more healthy lifestyles. Perhaps they have better access to information on the health effects of smoking, drinking, diet, etc. Alternatively, they may be more cognitively able, which would allow them to process health information more effectively. Or, it might not be a causal effect of education at all, but simply a situation in which individuals with lower time discount rates invest more in both education and health. Designing policies that are effective in breaking the link between education and health is contingent on acquiring much better evidence on which of these competing hypotheses is most responsible for the relationship. In addition to interventions in education, the prevention of health-related labor-force exits through policies aimed at improving health conditions at work, particularly for those in low-skilled occupations, are important in extending working lives and maintaining the financial sustainability of pension systems.

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SOCIOECONOMIC DIFFERENCES IN HEALTH OVER THE LIFE CYCLE: EVIDENCE AND EXPLANATIONS

1. Introduction

Health differs by socioeconomic status. The socially and economically advantaged enjoy better health, irrespective of whether it is measured by morbidity, disability or mortality. This strong socioeconomic gradient in health is firmly established in evidence from many countries (Marmot 1999; Smith 1999; Mackenbach *et al*. 2002; CSDH 2008). The huge international literature on socioeconomic inequalities in health reflects the widespread view that they represent an infringement of social justice. The ethical position that health is a fundamental right, and should not be determined by social and economic circumstances, was vociferously defended recently by the World Health Organisation's Commission on the Social Determinants of Health (CSDH 2008).

Relative to the abundance of evidence available on the static correlation between health and socioeconomic status (SES), less attention has been given to whether the socioeconomic gradient in health changes over the life cycle, and, if so, how. This represents a substantial limitation in knowledge of the magnitude and nature of socioeconomic-related health inequality. A snapshot of socioeconomic differences in health at a given age gives a rather incomplete impression of the extent of health disparities over the life course. It provides no information on how much more rapidly health declines for some groups than others. While it is clear that, at any given age, the socially disadvantaged experience a lower level of health, there is no consensus over whether they can also expect their health to deteriorate more rapidly. A sharper deterioration of a lower initial stock of health would be a double blow likely to intensify concerns about socioeconomic inequalities in health.

This paper aims to demonstrate the importance of bringing a life-cycle perspective to the examination of socioeconomic differences in health in order to increase knowledge of their magnitude, nature and, ultimately, source. Opinion is currently divided concerning whether and

how the socioeconomic gradient in health varies over the life cycle. On the one hand, proponents of the *cumulative-advantage hypothesis* maintain that differences in health by SES are established early in life and subsequently widen as the economic and health disadvantages of the less privileged interact and accumulate (House *et al*. 1994; Ross and Wu 1996; Lynch 2003; Willson *et al*. 2007). The competing view — the *age-as-leveler hypothesis* — maintains that deterioration in health is an inevitable part of the process of ageing — irrespective of economic means or social position, with the result that the SES-health gradient narrows at advanced ages (Beckett 2000; Herd 2006). Recognizing that the force of the two arguments may vary at different stages of the life cycle, these views are not necessarily mutually exclusive. A compromise scenario, for which there is growing evidence, is that cumulative advantage operates though middle age, with the SES-health gradient widening until around retirement age, before it narrows in old age (as the biological determinants of health strengthen relative to the socioeconomic).

Establishing the veracity of these competing hypotheses — investigating, in particular, the extent to which there is a process of cumulative advantage in health until old age — is of primary importance with respect to equity and social cohesion. It is equally relevant, however, for economic issues regarding the labor market, pensions, health insurance and health care. If there is cumulative advantage, then interventions that were effective in breaking this process by expanding opportunities to socially disadvantaged groups earlier in life would have large pay-offs in terms of improved health and labor-market prospects over the life cycle. As the ageing of the population creates pressure to extend working lives, it becomes more important to identify whether the constraint placed on this by deteriorating health is stronger for some occupational groups than for others. Social groups that are facing more rapidly declining health have less time to build up pension funds. If the cumulative-advantage hypothesis is correct, then movement toward defined-contribution pensions, and the reduced risk pooling they imply, will result in strong inequalities in lifetime health and earnings spilling over to a greater extent than previously to those in pensions. Another likely outcome, if this hypothesis is true, is that a life-cycle perspective would reveal greater redistribution from the rich to the poor through public pensions and social health insurance than is evident from a static analysis.

It has become common to lament the fact that while there is incontrovertible evidence that health is correlated with socioeconomic status, relatively little is known about the underlying causal mechanisms. In part, this stems from the static nature of much of the analysis. Observation of a correlation between health and SES at any given age does not reveal anything about the direction of causality. Does low economic status in early life lead to the development of health problems? Or, does poor health interfere with the acquisition of education and, subsequently, the chances of securing, or holding onto, a well-paid job? By addressing these questions, a life-cycle perspective can identify the timing of events that is essential to unraveling the causal mechanisms that generate the socioeconomic gradient in health. This paper doesn't aim to present evidence on the causal impact of SES on health, or vice versa, but to serve as a precursor to such analysis, to describe how socioeconomic differences in health evolve over the course of the life cycle. This should help gauge the extent to which data are consistent with various causal mechanisms. For example, the observed narrowing of the post-retirement occupational gradient is consistent with an important effect of working conditions on health. But the narrowing of the income gradient at this age is consistent with causality running from health to income through employment and earnings prior to retirement. This also relates to the well-known *retirement-consumption puzzle* (Banks *et al.*, 1998), since recently Hurd and Rohwedder (2008) identified that health shocks not only induce people to retire early, but are also responsible for the drop in consumption after retirement. A life cycle analysis might shed light on the importance of health deterioration and implied income losses on drops in consumption, offering potential explanations of the puzzle involved in traditional life cycle analysis on savings, consumption, and retirement.

Our interpretation of the evidence is that lower socioeconomic groups do indeed suffer a double health penalty in that they begin adult life with a slightly lower level of health, which subsequently deteriorates at a faster rate through middle age. Post-retirement, the observed SES-health gradient narrows, but this is due to the fact that it is the most robust of the lower socioeconomic groups that survive into old age, in addition to the strengthening of biological (relative to socioeconomic) determinants of health in this age range. Up to late middle age, the rate of deterioration in health appears to be related to education, and not to

income. The increasing impact of education on health could be due to the lagged effect of education related to lifestyle choices (such as smoking) on health, and because social advantages, such as knowledge of health services and professionals, accumulate over the life cycle. There may also be an indirect effect operating from education to choice of occupation and subsequent health, through exposure to health risks and the wear-and-tear on the body caused by strenuous manual work. Despite the fact that there is little evidence from advanced economies that income has a causal impact on health, the rate of decline in health is more strongly correlated with income than it is with education. The explanation appears to be that deterioration in health leads to withdrawal from work and, subsequently, to a decline in income. But this reverse effect can still be part of a cumulative disadvantage process, since the less well educated are more likely to enter occupations that are more demanding of physical health. These individuals are more likely to suffer health shocks and to find themselves out of work as a result.

The paper is organized as follows. Section 2 summarizes and discusses the interpretation of international evidence on the SES health gradient over the life cycle. It is important to emphasize that while we will often refer rather loosely to the 'life cycle', we restrict our attention to the years of adulthood, and thereby do not survey either the ever-expanding literature on socioeconomic differences in the evolution of child health (e.g. Case *et al*. 2002; Currie *et al*. 2003, 2007; Murasko 2008), or that on the impact of early-life conditions on health in adulthood. The latter is the subject of a companion Netspar Panel Paper (Van den Berg and Lindeboom 2007). Section 3 uses economic analysis in an attempt to explain the observed patterns in the life-cycle profile of socioeconomic inequality. Section 4 presents new evidence from Dutch data on the SES-health gradient over the adult life course. We distinguish between health measured by self-reported health, disability and mortality, and consider the lessons that can be drawn about the nature of the SES health gradient from the consistency, or inconsistency, in the life-course patterns of this gradient across these three health outcomes. We also examine whether health differences by income, education and occupation evolve in similar ways over the life cycle, and if not, investigate what this might tell us about the causal mechanisms underlying these relationships. Section 5 summarizes the evidence and considers its consequences both for discussions of inequalities in health and the extent to which they

should provoke social concern, and for policy debates. Given that we do not present any evidence on the causal impact of interventions, our discussion of policy is necessarily at the level of identifying issues that deserve attention rather than making firm recommendations for policy measures.

2. What is known about socioeconomic differences in health over the life cycle?

Our answer to this question, in a nutshell, would be that these differences increase up to late middle age before narrowing in old age. Documenting, explaining and exploring the consequences of this phenomenon are the goals of this paper. The first task is to establish that the evidence does indeed reveal such a relationship. As will become apparent, opinion on the issue is still divided. This is largely because researchers are seeking to identify changes in health across the entire adult lifespan using data that most often provide a mere snapshot of the health of individuals at a given age, and can at best produce a short movie of health events unfolding over a decade or so. Further, the paper compares health trajectories over groups defined by socioeconomic characteristics, some of which (i.e. income) are also changing – possibly in response to the health changes themselves. Inevitably, the relationships that can be estimated from such data are subject to a number of confounding influences, and thus are open to a variety of interpretations with respect to socioeconomic differences in health over the life cycle. After first reviewing the existing international evidence, this section continues by discussing methodological issues that impede interpretation of the evidence. These issues are revisited in section 4, which contains an examination of Dutch data, with the purpose of learning about the nature of socioeconomic inequalities in health and their life-cycle evolution in the Netherlands.

2.1 Summary of evidence

A growing body of evidence, largely obtained from US data, shows increasing socioeconomic differences in health through middle age, and then a narrowing thereafter in old age. Although there is some disagreement about the reason for the divergence in health profiles up to old age, particularly with regard to the extent to which this derives from a process of cumulative advantage, the larger dispute is over the explanation for the observed narrowing of the gradient at older ages. The essential question is whether the data accurately reveal a convergence in health experiences in old age, or whether the observed narrowing is a product of data limitations. Before entering into the subtleties of these methodological issues, we first present the raw patterns observed in some US and European studies.

The evidence is separated according to the nature of the health indicator, distinguishing between (a) self-reported health, (b) disability, (c) mortality and (d) health-adjusted life expectancy.

Self-reported health

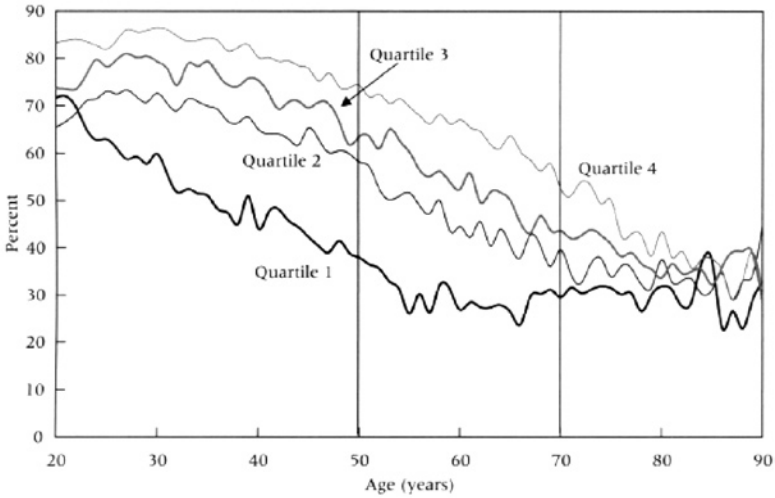
Survey evidence on socioeconomic differences in health is commonly based on a question about how the respondent's health is perceived in general. Responses are usually on a five-point scale running from "excellent" to "poor", for example. Although obviously subject to measurement error, which may bias estimation of socioeconomic inequality if correlated with SES (Bago d'Uva *et al*. 2008), this self-reported health (SRH) variable is known to be a very good predictor of other health outcomes, including mortality (Idler and Benyamini 1997).

Smith (2005a), amongst others, examines how socioeconomic differences in SRH vary with age. Figure 1 shows the percentage in the US reporting excellent or very good health by income quartile, and is typical with regard to the pattern that emerges. First, it shows large differences in health by income at any age, excepting the very youngest and oldest. This is the familiar, strong SES-health gradient. Thereafter, the graph shows the income gradient in health increasing up to age 50–55, before it narrows particularly after age 70, until it eventually seems to disappear by age 80. While there are a large number of potential explanations for this phenomenon (and caution is advised, since the graph is produced from cross-section data, which means that the age pattern may be confounded by differences in health across birth-year cohorts), it is at least consistent with lower-income groups experiencing more rapid deterioration in health up to the age at which retirement begins to be observed.

It is striking that a similar pattern has been observed using other indicators of SES and of health (Smith 2005a; Case and Deaton 2005). Smith finds a similar pattern in the health gradient by education, although the gradient is more persistent and is still marked at very old ages. While Case and Deaton, similar to Smith, find that the income gradient widens with age (at least up to retirement age), they also, after controlling for income and occupation, establish that the education gradient decreases with age. They also establish that the health of males deteriorates more rapidly than that of females — although, interestingly, only at the bottom of the income distribution. Restricting attention to individuals of working age, they also detect a steeper decline in health

with age of those engaged in manual labor, compared with those in non-manual occupations.

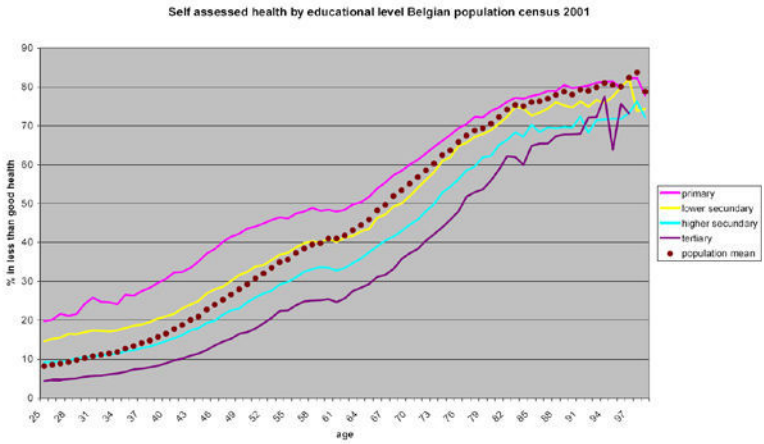
Figure 1: Percent reporting excellent or very good health status by age-specific household income quartiles, US 1991-96



Source: Smith (2005a) calculated from pooled National Health Interview Surveys 1991-96.

While most of the evidence of a widening and then narrowing SES-health gradient is from the US, the phenomenon has also been documented in European countries, which have more generous social protection against earnings losses due to disability and universal social health insurance that is not contingent on old age as it is in the US. A clear example is presented in figure 2, which is derived from Belgian census data (over 6 million observations) and shows the proportion of individuals reporting less than good health by education (Deboosere and Neels 2006). Education differences in health widen until around age 65 before narrowing. A remarkable feature of this graph is the temporary leveling-off in health around the age of 60. This has been observed in other data, and it has been suggested that it reflects a revision in expectations of what constitutes good health after retirement (Deaton 2007). An alternative explanation is that it is due to a cohort effect of those born 60 years earlier during World War II.

Figure 2: Percentage reporting less-than-good health by education level, Belgium, 2001



Source: Deboosere and Neels (2006)

Disability

Socioeconomic differences in disability need not correspond to those in morbidity, or self-reported health. For example, differential access to aids may increase inequality in disability beyond that in basic health conditions. Crimmins (2004) and Freedman *et al*. (2007) both show that trends in self-reported disability can be different from those in morbidity. Unfortunately, as disability is often measured only in the older population, it is more difficult to establish whether its socioeconomic gradient varies with age. One study for Belgium finds that while the absolute gap in rates of disability between low- and high-education groups increases with age for men and decreases for women, the relative difference falls for both sexes, as a result of the strong rise in disability with age (Nusselder *et al*. 2005). A recent UK population-based cohort study (Jagger *et al*. 2007) demonstrates that early-life socioeconomic differentials in transitions into disability continue to contribute to prevalence differences in both sexes at ages beyond 65 years.

Although they find that relative differentials by education narrow as disability rates increase with age (especially in women), absolute differences in disability prevalence are maintained. There is thus no clear evidence that absolute differences in disability (by education) show the convergence in old age that is evident for self-reported health.

Mortality and survival

As for disability, the life-cycle profiles of *absolute* and *relative* socioeconomic inequality in mortality can differ greatly as a result of the strong positive correlation between mortality and age. US evidence suggests that relative inequality in mortality by education decreases with age for both men and women, but absolute inequality increases (Feldman *et al*. 1989; Elo and Preston 1996). Huisman *et al*. (2004) pool mortality-rate differences by education from 11 European populations and find clear evidence of the mortality gap widening with age, for both men and women. Again, relative inequality, as measured by the relative index of inequality, decreases with age.

The age profile of socioeconomic differences in survival, or expected remaining life years, is the mirror image of that in mortality: the absolute gap between high- and low SES falls with age, but relative differences increase because life expectancy falls rather sharply with rising age. This is clearly illustrated in Table 1, using results from a study by Gerdtham and Johanneson (2000) for Swedish males showing both the gap and the ratio of life expectancies between top- and bottom deciles of the income distribution.

Health-adjusted life expectancy

From a social justice perspective, concern about socioeconomic inequality in health should arguably focus on disparities in the number of years an individual can expect to live in good health, or without disability. Quality-adjusted life years (QALYs) are often taken as the gold standard in evaluating the effectiveness of medical interventions on the basis that a longer life in good health is ultimately what people want, and what health care should be aiming to provide. Only a few studies, including that by Gerdtham and Johanneson, have combined measures of health, or quality of life, with survival expectations to examine differences in health-adjusted life expectancy by SES. Gerdtham and Johanneson's

results for quality of life[1] are consistent with the evidence on SRH presented above: the top-to-bottom gap first widens and then narrows, although the narrowing sets in at an older age. However, this makes only a slight impact on the pattern of income-related inequality in healthy life expectancy, which, like unadjusted life expectancy, falls in absolute terms and rises in relative terms with age.

Table 1: Income inequality in life expectancy, quality of life and healthy life expectancy by age, Swedish males

		Age group						
Indicator	Income decile	20-29	30-39	40-49	50-59	60-69	70-79	80-84
Life expectancy (in years)	Top	53.7	43.7	34.4	25.2	17.4	10.36	6.6
	Bottom	49.7	40.1	31.1	22.1	14.6	8.1	4.55
	Gap (top–bottom)	4	3.6	3.3	3.1	2.8	2.26	2.05
	Ratio (top/bottom)	1.08	1.09	1.11	1.14	1.19	1.28	1.45
Quality of life (in 0–1 interv.)	Top	0.946	0.95	0.94	0.927	0.875	0.738	0.612
	Bottom	0.939	0.935	0.91	0.895	0.822	0.689	0.578
	Gap (top–bottom)	0.007	0.015	0.03	0.032	0.053	0.049	0.034
	Ratio (top/bottom)	1.01	1.02	1.03	1.04	1.06	1.07	1.06
Healthy life expectancy (in years)	Top	47.23	37.8	28.9	20.4	12.9	6.3	3.3
	Bottom	43.6	34.4	25.4	17.36	10.3	4.7	2.3
	Gap (top–bottom)	3.63	3.4	3.5	3.04	2.6	1.6	1
	Ratio (top/bottom)	1.08	1.10	1.14	1.18	1.25	1.34	1.43

Source: Derived from Gerdtham & Johannesson (2000). Quality of life is measured on a health utility score from 0 (death) to 1 (perfect health).

Summing up

From this, admittedly selective, review, the following stylized facts concerning variation in the SES gradient in health with age emerge. First, socioeconomic differences in self-reported health tend to increase until late middle age (50-60) (by which point a substantial proportion of the population has withdrawn from the labor force), before they decrease in older age. Second, this is not the same for disability: the absolute gap in rates of disability by SES is maintained with age. Third, absolute gaps in

1 Quality of life is measured by an instrument that places a value, or utility score, on different states of health, with 1 corresponding to perfect health and 0 to death.

mortality by SES rise with age, while relative differences fall – although these differences simply reflect the rising average rate of mortality. Absolute and relative SES inequalities in survival follow the opposite trends with age. While the second and third of these stylized facts have received less attention, the first has piqued the interest of scientists from a variety of disciplines, including epidemiology, demography and sociology, as well as economics. Interpretations of the observed widening and then narrowing of the SES-health gradient with age differ in the extent to which the observed pattern is presumed to reflect substantive changes in the relationship between SES and health over the life course, as opposed to simply being the product of methodological limitations that obscure the true relationship. We now turn attention to these alternative interpretations.

2.2 Interpretation of evidence

Two competing hypotheses have been put forward concerning the strength of the relationship between SES and health over time, as individuals grow old. According to the *cumulative-advantage hypothesis*, the SES-health gradient increases over the life course. This may be due to gestation of some effects of SES on health. For example, the health effects of socioeconomic differences in smoking become apparent only in middle age (Lynch 2003). Alternatively, social advantages in factors that affect health may have accumulated across the life cycle. For example, differences in social capital, networks and information may all increase with age (Lynch 2003). Empirical support of this hypothesis is provided by Ross and Wu (1996), Lynch (2003) and Willson *et al*. (2007), among others. The competing view, the *age-as-leveler hypothesis*, proposes that the (mainly biological) dependence of health on age increases at older ages, and so the contribution of socioeconomic determinants necessarily falls (Herd 2006). A large literature documents the fact that at young ages much of the variation in health is associated with SES (see e.g Case *et al*. 2002). It seems, however, that biology exerts a stronger influence as we age, and there is less room for SES to play a role. Generally, the evidence (including that presented above) is consistent with a cumulative-advantage process operating until middle age, with age indeed acting as a leveler over the years of retirement (Kitagawa and Hauser 1973; Kunst and Mackenbach 1994; House *et al*. 1994; Elo and Preston 1996; Deaton

and Paxson 1998; Beckett 2000; Case and Deaton 2005; Smith 2005; Herd 2006).

Concluding from the available evidence that the impact of SES on health first waxes and then wanes as individuals age may be premature, given a number of methodological issues that could influence the patterns observed in the data. One obvious limitation is that *cohort effects* may confound life-cycle profiles when variation of health by age is examined in cross sections. A second problem is that *selective attrition* through mortality and institutionalization may bias estimation of the socioeconomic gradient. Given that mortality is strongly correlated with SES, at older ages the most robust of the lower socioeconomic groups will have survived. This could explain why socioeconomic differences in health amongst those surviving into old age appear to narrow. Finally, correct interpretation of the evidence obviously requires consideration of the direction of *causality*. Many of the contributions to the literature from epidemiology, demography and sociology presume quite often that the observed correlations are driven mainly by an effect of SES on health, which may vary with age. Recently, economists have argued that an effect of health on SES, which increases in middle age through an increasing impact of health on work, may make a substantial contribution to the SES-health gradient – particularly with regard to its evolution over the life cycle (Case and Deaton 2005; Smith 2005a, 2007). We consider each of these issues in turn.

Cohort effects

The level and nature of health, health care and education have all changed dramatically over the course of the last century. These structural changes could easily have affected the way in which health is related to SES. For example, the expansion of health insurance coverage in Europe has made access to health care less dependent upon income, which would be expected to reduce the socioeconomic gradient in health for younger relative to older cohorts. On the other hand, while the effectiveness of health care has improved, making optimal use of it may have become more contingent on education. Further, education itself may have become more effective in imparting information regarding health. The strength of the relationship between health and education may therefore have increased across cohorts.

There are two standard ways to overcome cohort effects: either explicitly take them into account in the model specification (Deaton and Paxson 1998; Lynch 2003; Willson *et al*. 2007), or simply follow a single cohort as it ages, and so avoid any contamination by cohort effects (Herd 2006). Of course, the latter approach cannot tell us anything about cohort effects, and does not allow for the possibility that the life-cycle relationship itself may vary across cohorts. Applying the first approach to pooled cross-section data from the *US National Health Interview Surveys* (NHIS), Lynch (2003) finds that there are indeed both life-cycle and cohort patterns in the education-health gradient, but that they are offsetting, such that there is no observable age variation in the gradient when cohort effects are not controlled for. The effect of education increases in magnitude in moving from older to younger cohorts, and the life-course effect of education is quadratic, peaking at a later age in more recent cohorts. Lynch interprets this as evidence that the force of selective mortality is weakening over time, and that the age at which the process of cumulative advantage is overtaken by the leveling effect of biological age is increasing. According to this interpretation, the mechanisms driving cumulative advantage are becoming stronger over time, and in the future we should see less narrowing of health inequalities at older ages.

Van Kippersluis *et al*. (2008) examine inequality in self-reported health across the full distribution of income in 11 European countries. Although the pattern varies somewhat across countries and gender, an inverse U-shaped pattern of widening and then narrowing inequality as age increases can be observed for most countries. However, after cohort effects are taken into account, this pattern remains only for males in Britain, France and the Netherlands.

Herd (2006) examines inequalities in functional health by education in a ten-year birth cohort (1931-1941) from the *US Health and Retirement Survey*. Her approach of following a single cohort of around 10,000 older Americans (aged 51 to 61 in 1992) over ten years (1992-2002) substantially reduced, if not eliminated, contamination by cohort effects. Herd attempts to distinguish between two variants of the age-as-leveler hypothesis: (a) higher-SES individuals are able to postpone their health deterioration for longer, but then catch up quickly with the low-SES individuals at older ages; (b) lower-SES individuals, through increased health protection (offered by Medicare and social security), manage to

slow their rate of health deterioration at older ages. She finds that the educational disparity in functional health widens until age 63, after which it diminishes. By age 72, the disparity returned to the level it was at the age of 53. The narrowing above 63 is a consequence of both an accelerated rate of decline among the higher educated and a slowing of the rate of health deterioration among the lower educated.

Selective mortality

Less healthy individuals are more likely to die or become institutionalized at younger ages. This selective mortality will obscure the deterioration in health with age observed in survey data, which is obviously restricted to the more-robust survivors. While this bias will be present for all socioeconomic groups, it will be larger at lower SES, due to the higher rate of mortality. Survivors from lower socioeconomic groups are a more select sample, and their health will be more similar to that of higher groups. Thus, if selective mortality were ignored, then the SES-health gradient of survivors would appear to increase then decrease with age, even if the true model were cumulative advantage (Lynch 2003).

One approach that has been used to deal with selective mortality is to keep the deceased and the dropouts in the sample, and to impute their health scores. For example, Markides, Timbers and Osberg (1984) assign the deceased a self-reported health value lower than the worst score reported by surviving subjects. Beckett (2000) deals with attrition, due not only to mortality, by imputing health scores for non-respondents from survivors with the same background characteristics. Like most corrections for attrition, this relies on the strong assumption that observations are missing at random, conditional on the observable covariates (Little and Rubin 1989; Noymer 2001; Beckett and Elliott 2001). This is particularly implausible in the case of mortality, which presumably follows from a steep decline in health that occurs after the last observation.

A number of recent studies (Lynch 2003; Sacker *et al*. 2005; Herd 2006; Willson *et al*. 2007; Kim and Durden 2007) have addressed the issue by estimating random-coefficient models with imputation of missing data (Little and Rubin 1989, 2002). These models use panel data to estimate individual-specific health trajectories from the within-individual variation, and then average these across individuals. The trajectories can be allowed to vary, on average, with the indicator of SES (education, in these applications) and cohort. While consistency of the approach

still rests on the strong assumption that data are missing at random, it is argued that in the likely case that this does not hold, it will result in an underestimation of the rate of deterioration in health, and an understatement of socioeconomic differences in this rate of health decline (Lynch 2003).
Using a US panel of individuals above the age of 30, Lynch (2003) finds that, after correcting for selective mortality, education slows the decline in health across the life course, and so, in support of the cumulative-advantage hypothesis, health disparities increase as individuals age. Willson *et al*. (2007) use five waves (1984–2001) from the *US Panel Study on Income Dynamics* (PSID) to examine health trajectories, not only by education, but also by income and wealth. Their results are also consistent with a cumulative-advantage pattern, whereby the over-time compounding of early advantages and disadvantages produces trajectories of health that diverge with age. After assessing the bias introduced by selective attrition, their results suggest a process that operates across the life course and is bounded by age, partly as a result of forces of biological ageing and mortality.

Sacker *et al*. (2005) use 11 waves of the *British Household Panel Survey* (BHPS) to estimate ten-year trajectories of self-reported health of adults aged 21–59 in 1991. They find no significant differences in SRH scores at age 21, but noted that social inequalities do become significant and increase as people age. As such, they add to the evidence supporting the cumulative-advantage hypothesis — although, of course, they investigate only a limited age range. While they also find that respondents in poor health are more likely to drop out of the sample, they do not correct for selective sample attrition. In a more recent study, Sacker *et al*. (2007) compare trajectories in SRH in the US and UK using five (biannual) waves from the PSID (1990–2001) and the BHPS (1991–2002) for adults aged 25–55 in 1991/2. Employment status stands out as the most important socioeconomic characteristic differing between the two countries. Given health, more US than UK individuals are employed, but UK individuals with improved health are more likely to return to the labor force.

Direction of causality
Smith (2005b, 2007) used various US panel data sets to probe the SES-health relationship in an effort to unravel the causal mechanisms that may be responsible for it. Very broadly, his argument is that the data

appear to support a strong causal impact (which seems to be mediated through work participation) of health on financial indicators of SES, and a causal impact only of education, among the SES indicators, on health. While still preliminary, this suggests that the life-cycle evolution of the SES-health gradient must be understood not only – or even primarily – as the cumulative effect of socioeconomic forces on health, but as a variation with age in the constraining effect of health on work (and thus on incomes). If confirmed, this would have profound implications for both the concern aroused by differences in health by SES and the appropriate policy response to them.

Much of Smith's argument is derived from the timing of the onset of chronic conditions (assumed to correspond to a health shock) in relation to measures of SES. A substantial impact of a health shock on the probability of future work and the income of older Americans is taken as evidence of a strong causal mechanism running from health to SES (Smith 2007). Using the PSID, Smith repeats the test for an impact of onset of chronic conditions on employment, income and wealth for different age groups. He finds that the group aged 51–61 consistently experiences the strongest effects. This offers quite a different interpretation of the quadratic relationship of the SES-health gradient with age than that of a cumulative-advantage process eventually being overturned by the leveling effect of age.

Smith (2005b) also tested for an effect of early childhood health on SES in adulthood using 30 years of longitudinal data from the PSID. Controlling for many observed background characteristics, including parental health, and even controlling for unobservables using sibling fixed effects, he finds an independent effect of childhood health on all financial outcomes (earnings, income and wealth) that is not mediated through better adult education. This suggests a process of cumulative disadvantage – but one that operates from poor childhood health to persistent health problems in adulthood, reduced earning capacity and lower SES.

In the opposite direction, Smith (2007) consistently finds education to be a strong predictor of the onset of new chronic conditions, having controlled for initial health and a multitude of background factors including employment and smoking behavior, but finds no effect of financial measures of SES (income, wealth and change in wealth) on changes in health. Financial indicators do not predict the onset of health

problems at any age, while the effect of education is largest in the group aged 40–60 years, but is not significant at older ages. The lack of any effect in the older sample may simply be due to the limited sample size. Smith (2007) finds that education does predict the onset of conditions in larger, older samples (HRS and AHEAD[2]), but, again, financial indicators of SES do not predict health problems. These findings are consistent with those from the demographic and sociological literature showing that education slows the rate of decline in health.

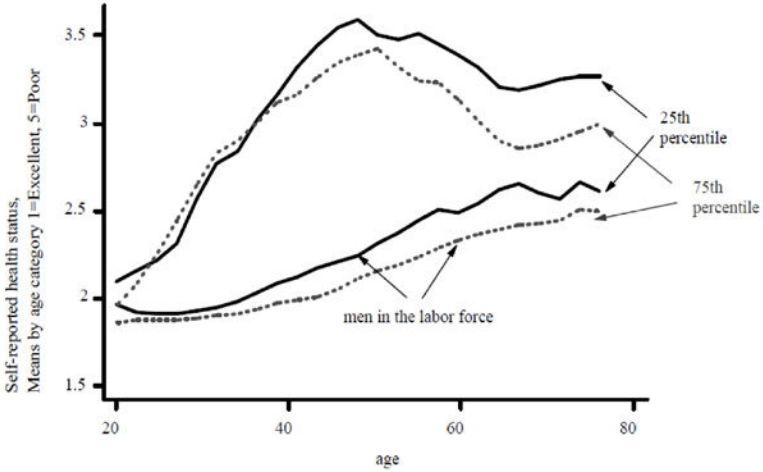
Attempting to determine whether differences in income or education drive the US SES–health gradient, Smith (2005a) plots self-reported health against age by income quartile (as in figure 1, but now within each education level). Particularly at younger ages, there is little difference in health between the higher income quartiles. Only the poorest income quartile stands out: within each education level, the poorest have lower health. Repeating this analysis for employment (rather than health), conditional on education: again, only the poorest income quartile has considerably lower employment rates. This suggests that low income is largely due to lower employment rates. To complete the picture, Smith plots SRH by employment and finds that those not working, at younger ages, report much lower health. Taken together, this series of analyses suggests that the constraining effect of health on work plays a large role in generating the income–health gradient, while there is stronger support for causality from education to health being responsible for health inequality in that dimension of SES.

Case and Deaton (2005) reach the same conclusion regarding the contribution of health-related interruptions to work in explaining the income–health gradient and its variation with age. Pooling data from the 1986–2001 US NHIS, they show that the initial divergence followed by convergence of the age profile in self-reported health is also apparent by labor-force status, even at the same income percentiles. Their graph, reproduced in figure 4, shows that the association of health with income is swamped by the association with employment. They go on to compare rates of change of self-reported health between manual and non-manual occupations, and find that, even when controlling for income and education, the health difference between these two is increasing

2 The Health and Retirement Survey (HRS) tracks adults aged 51–61 at baseline only, and the Asset and Health Dynamics Among the Oldest Old (AHEAD) study tracks the cohort that was over 75 at baseline.

with age. They claim that, because of health selection, the differential is even biased downward. They find evidence of health selection out of the labor force among manual but not among non-manual workers. And even the manual workers that remain in employment experience a more rapid deterioration in health than non-manual workers. This all suggests a strong role for work in adult health trajectories in the US.

Figure 4: Self-reported health by age at the 25th and 75th income percentile of the income distribution by labor-force status, US Men



Source: Case and Deaton (2005) calculated from NHIS 1986-2001.

Summing up

The evidence reviewed in this section belongs to a relatively new and expanding literature from a variety of disciplines. There are contradictory findings, and even more conflicting interpretations. Nonetheless, some consistent results are beginning to emerge. Differences in health by education do seem to result, at least in part, from socioeconomic disadvantages impacting on health. Once we control for cohort effects and (to the greatest extent possible) selective mortality, there is evidence that the health penalty of a low education accumulates with age. In other words, the health of the less educated deteriorates more rapidly.

There is less evidence that financial dimensions of SES exert an independent effect on health trajectories. There is, however, some indirect evidence that the income gradient in health, and its variation with age, derives from an effect of health on work capacity. Since health shocks appear to have their strongest impact on work in middle age, this may explain the peaking of the income–health gradient around retirement age. But some of the apparent effect of health on work, and subsequently income, may be illusory, given that much of the evidence is derived from self-reported measures of health. Use of these measures potentially biases the estimated effect of health on work, since the non-working may report poor health in order to justify their status and remain consistent with claims made for disability insurance (Bound 1991; Kapteyn *et al*. 2007). Smith's analysis, which is based on the onset of health conditions prior to changes in labor-market status, is less vulnerable to this bias, but the graphs showing differences in health by work status and income are more so. The peaking of these differences in middle age may reflect the use of disability insurance as a route into retirement in that age range. The subsequent narrowing of differences beyond conventional retirement ages is consistent with a reduced need to report ill health in order to justify non-work.

3. An economic explanation for socioeconomic differences in health over the life cycle?

While the literature reviewed in the previous section is generally consistent with respect to empirical findings on socioeconomic differences in health over the life cycle, it tends to differ substantially in the interpretation of this evidence. In part, this is because most of the evidence is descriptive, rather than causal, and thus is more open to interpretation. It also reflects the different disciplinary backgrounds of the researchers. Epidemiologists and sociologists, with fundamental interests in health and the consequences of socioeconomic structures, respectively, often focus on the socioeconomic determinants of health, while economists, given their preoccupation with the determination of income and labor markets, tend to emphasize the impact of health on work. Case and Deaton (2005) argue that it is extremely difficult to understand the relationships between health, education, income and labor-force status without some guiding conceptual framework. This section therefore uses the tools of economic analysis to try to understand socioeconomic differences in the way in which health evolves over the life cycle. The discussion is based on Michael Grossman's model of health capital (1972a-b), which Case and Deaton (2005) used to examine whether economic theory can predict the widening socioeconomic disparities in health until retirement ages that have been observed in much of the empirical research. While Case and Deaton conclude with a negative answer, we believe that the model does provide some interesting hypotheses as to why life-cycle health profiles may differ across socioeconomic groups.

3.1 Health capital model

While human capital affects wage rates (Becker 1967; Ben-Porath 1967), health capital is presumed to reduce the time lost to sickness and so raise potential income. Health is thus demanded for its investment benefits, in addition to the direct consumption motive of reducing the discomfort caused by illness. This important insight, together with the observation that medical care is in fact a derived demand for the commodity *good health*, forms the basis of Grossman's (1972a-b) model of the demand for health. The model provides some insight into the causal mechanisms that

may underlie the association between health and socioeconomic status.[3] It is assumed that people care about their consumption and health. An individual is born with an initial health status, or stock of health capital (H_0), which deteriorates over the life cycle at a rate of depreciation, δ_t, but which can be increased by investments in medical care, diet, exercise and interventions to reduce consumption of health-endangering goods, such as tobacco and alcohol (M_t). The change in health between one period and the next is therefore given by

$$H_{t+1} - H_t = M_t - \delta_t H_t. \qquad (1)$$

Individuals also face a budget constraint, in that earnings (which depend on health), augmented with initial assets, must cover expenditure on investments in health plus consumption.

The model defines health as a durable capital good that determines both the quantity and quality of life (Grossman 2000). Death occurs when health capital falls to a sufficiently low level, below some threshold. Length of life is therefore, effectively, a choice variable influenced by varying investments in health to counteract the exogenously given depreciation of health capital.[4] It follows that the model can be used to examine socioeconomic differences in both health and longevity, since at each age individuals have different levels of health capital, and consequently also different timings of death. Selective mortality is then integrated within the analysis of socioeconomic differences in the dynamics of health capital.

Consistent with standard economic logic, the optimal stock of health is at the point of equality between the marginal benefit and marginal cost of investments in health. Marginal benefits take the form of increased healthy time flowing from health capital, which leads to both consumption benefits (people dislike being sick) and investment benefits (they are able to work and earn money). Marginal costs are given by the user cost of health capital, which is determined by the interest rate, the depreciation rate, and the price of health-promoting activities. The latter includes not only the price of medical care, but also the opportunity cost of time spent in healthy activities.

3 Muurinen and Le Grand (1985) is an early example of an attempt to use this model to interpret health inequalities as presented in the *UK Black Report* (Black 1980).

4 The feature of length of life being a choice variable has been criticized frequently, and the reader is referred to e.g. Ehrlich and Chuma (1990) for a detailed treatment.

While marginal benefits of health may differ between individuals, it has been argued that discrepancies in marginal costs create the largest disparities in health (Muurinen and Le Grand 1985). If the depreciation rate increases, then marginal costs increase; in order to maintain equilibrium, marginal benefits must rise also, which can happen only if the level of health capital decreases, given diminishing marginal returns. If some groups face a higher depreciation rate than others do, their optimal health will be lower. Analogously, and quite obviously, those facing a higher price of health investment will settle for a lower level of health.

More interesting than differences in health levels in the present context are predictions about socioeconomic differences in the rate of change in health. To facilitate this, following Grossman (1972a–b), we restrict our attention to the pure investment model in which health has only investment benefits. [5] The way in which health capital evolves over the life cycle depends on the rate of change in the depreciation of health, δ_t. It also depends on the share of depreciation in the user cost of health capital, and the responsiveness of demand to this cost, as represented by the elasticity of the demand curve for health capital, ε_t, as follows,

$$\frac{H_{t+1} - H_t}{H_t} = -\varepsilon_t \frac{\delta_t}{r + \delta_t} \delta_t \quad , \quad (2)$$

where r is the interest rate. Health capital will only fall over the life cycle, and death will eventually occur, if the rate of depreciation increases with age ($\delta_t > 0$).

For further analyses, it is useful to distinguish between absolute versus relative changes in the way in which health evolves with age.[6] Equation (2) can be used directly to consider inequalities in relative changes in health, while both sides must be multiplied by the health stock to examine inequalities in absolute changes. A higher depreciation rate will lead to a more rapid relative decline in health over the life cycle, since

5 Grossman (1972b) also assumes that (i) the price of medical care and (ii) the wage rate are independent of age. This is done for tractability, and also because changes in prices and wages over the life cycle would determine the way in which health capital evolves, and possibly obscure the essential health dynamics. It is recognized, however, that group differences in wage profiles may contribute to observed socioeconomic differences in the life-cycle profile of health.

6 We are grateful to Michael Grossman for drawing our attention to this important distinction.

(holding the interest rate constant) the share of depreciation in the user cost of health will be higher. So, if one presumes that the depreciation of health capital is greater for lower socioeconomic groups (perhaps due to employment in more hazardous manual occupations), then health is predicted to deteriorate relatively more quickly as individuals in these groups age. This does not automatically hold for differences in absolute changes in health, since in this case the higher depreciation rate is multiplied by the health stock, which itself is lower for those with higher depreciation rates. The net effect is ambiguous.

3.2 Using the model to explain the SES-health gradient and its life-cycle evolution

By introducing a model for health capital that is distinct from human capital, Grossman (1972b) did not lose sight of how the two are related. He viewed human capital, produced by education, as an exogenous efficiency factor raising the productivity of medical care, or health inputs, more generally. This may operate through knowledge of the relative effectiveness of medical treatments, and is implemented in the model by making the effective price of medical care depend negatively on education. Muurinen (1982) argues that education is more likely to influence lifestyle decisions – regarding diet, exercise and smoking, for example. She therefore opts to include education as one of many exogenous determinants of health depreciation, with a presumed negative effect on the depreciation rate. Despite the different roles assigned to education, both variants of the model predict that more highly educated individuals have a higher *level* of health capital – but this is predicted to slow the *relative* decline in health over the life cycle only if education impacts on the depreciation rate.

In the original Grossman model, differences in health by economic status are derived from the wage rate, which is presumed to represent the opportunity cost of time spent in all non-work activities. Muurinen challenges this, arguing that the wage rate is a much too crude measure of the price of time. She introduces a concept of 'earned income', which depends positively on health and negatively on time lost due to the utilization of medical care (but not necessarily proportionately to the wage rate). In both models, a higher opportunity cost of time leads to a higher *level* of health, but does not influence the way in which health capital evolves over the life cycle (see equation (2)). If one were to extend

the model by allowing for retirement, and to relax the assumption that the wage does not vary with age (see footnote 4), then one would expect a drop in the *level* of health at the time of retirement as the time price of being ill drops to zero (Case and Deaton 2005). The model would then predict the observed convergence of health after retirement, but mainly due to the fact that higher socioeconomic groups have a larger drop in health, rather than to a slowdown in the rate of health deterioration at lower SES, which the evidence suggests is responsible for the convergence.

Muurinen and Le Grand (1985) distinguish between three types of capital – financial, human and health – and argue that substitution between them can explain the origin of health inequalities. An individual who is better endowed with respect to financial and human capital will thus be less inclined to use up her stock of health capital. Those more constrained in wealth and with lower productivity due to lack of education can meet their consumption needs only by using up their health capital – for example, through arduous and risky manual labor. Basically, the argument is that individuals with fewer outside options are more responsive to the compensating wage differentials of hazardous occupations. Those who are more financially constrained might also be expected to resort more readily to health-damaging consumption of products such as tobacco and alcohol, which are relatively cheap sources of leisure and relaxation. In both cases, health depreciation will be higher among those with meager financial and human capital.

Inspired by this argument, Case and Deaton (2005) attempt to capture it formally in an extended Grossman model. Their main innovation is the introduction of a choice variable that raises earnings at the expense of a faster deterioration of the health stock. This variable, referred to as physical effort, affects both the depreciation rate and earned income. Despite these modifications, they claim their model is only able to explain why individuals who exert greater physical effort have a lower *level* of health; it does not predict any impact on the way in which health evolves over the life cycle. This overlooks the fact that a higher depreciation rate, due to manual labor, will lead to a steeper relative decline in health because of the increased share of depreciation in the user cost of health capital. But the predicted impact on the absolute change in health remains ambiguous, unless one makes assumptions about the impact of physical effort on the rate of change in the depreciation rate.

Kemna (1987) also considers whether the association between health and education is mediated via occupation. His theoretical model allows education to affect health directly and indirectly via occupational choice, and he finds some empirical support for this. He does not consider, however, whether individuals in manual occupations experience more rapidly deteriorating health.

Overall, this economic framework provides clear insight into why both the level of health and its trajectory over the life cycle can differ across socioeconomic groups. Education increases the efficiency of health investment and/or (by choice of lifestyle) lowers the depreciation rate – both of which result in a higher level of health and a slower rate of decline over the life cycle. Arduous and hazardous occupations reduce the level of health and accelerate its relative decline through the depreciation rate. Higher wages raise the level of health, but have no clear predictable impact on its life-cycle trajectory. These predictions are, to an extent, consistent with the empirics. The latter supports a causal impact of education on the rate of decline in health, but finds no strong evidence of an impact of economic indicators of SES. Note, however, that the theory makes no unambiguous predictions about socioeconomic differences in the magnitudes of changes in health over the life cycle. In empirical work, health is seldom measured on a scale that has a non-arbitrary mean, and so comparison of relative changes in health is as much as can be expected. Despite these cautions, if one interprets the *cumulative-advantage hypothesis* as referring to a steeper relative deterioration in health among the less well educated, then not only is it observed empirically, but it is also predicted by conventional economic analysis.

The empirical support for a mechanism running from health to work to income is partially captured by the framework. A decrease in health capital leads to a reduction in the number of healthy days and, consequently, earned income. What is missing from the model in this respect is the option of labor-market withdrawal, or retirement. So, the formal model cannot predict that health problems will increase the probability of retirement, although this would be anticipated if illness increases the disutility of work.[7]

7 An increase in time lost to sickness is predicted to reduce hours of work under standard assumptions (O'Donnell 1995).

4. Evidence from the Netherlands

We now turn attention to the evolution of health over the years of adulthood in the Netherlands, and the extent to which this differs across socioeconomic groups. Our aim is to establish whether the stylized facts that emerge from the international literature (based mainly on US evidence) are also apparent in Dutch data, and considers whether the conceptual framework introduced in the previous section is useful is interpreting these data. The Netherlands differs markedly from the US in relation to social structure, income inequality, health and disability insurance, social protection and health care organization. No doubt as a consequence of these differences, socioeconomic inequality in health is much lower in the Netherlands than it is in the US (Van Doorslaer, Wagstaff et al. 1997). But little or nothing is currently known about whether and how the countries differ in the way in which the socioeconomic gradient in health varies over the life course. If there were no such differences, it would suggest that the patterns observed in section 2 — particularly the peaking of the gradient in late middle age — result from the fundamental relationships between education, occupation, work and health over the life course, and are not responsive to the social, health and economic policy environment.

We first illustrate the evolution of differences in self-reported health and disability by income over the adult life course in the Netherlands, paying particular attention to the age bracket coinciding with early retirement that emerged as a 'turning point' in the US studies, together with other evidence. We also examine how rates of mortality differ by income at various ages, which is informative of the importance of taking account of selective mortality when interpreting the results for self-reported health and disability. Next, we look at differences in the health outcomes by education and occupation, rather than income, given that the US evidence, and the theory, provides stronger support for causal impacts of these dimensions of socioeconomic status on health trajectories. Finally, we examine whether health-related exit from the labor force appears to be a major contributor to the income gradients in self-reported health and disability, and whether it is largely responsible for the peaking of these gradients in late middle age.

The analysis is based on data from the Central Bureau of Statistics (CBS) *Health Interview Surveys* covering 1983-2000 (*Gezondheidsenquête 1983-1996 and Permanent Onderzoek Leef-Situatie 1997-2000*), and from

linked administrative data[8] covering 1998-2005.[9] Compared to previous studies, these data offer some advantages. First, the CBS *Health Interview Surveys* cover an 18-year timeframe, which is long enough to disentangle the effect of ageing – the life cycle – from that of cohort differences in the social, health and economic conditions experienced at a given age. Second, the linked data allow analysis of mortality in relation to actual income from tax files at the level of the Dutch population, which keeps the analysis from suffering from the typical limitations of sample surveys.

4.1 Self-reported health by age and gender

Between 1983 and 2000, the CBS Health Interview Surveys collected information on self-reported health from the question: "How is your health in general?" Responses are on a five-point scale: "very good", "good", "fair", "variable", and "bad". We dichotomize and focus on individuals reporting the bottom two categories, which we refer to as "bad health". We pool the 18 cross-sectional surveys and compute the percentage of unhealthy individuals in two-year age intervals, separately for females and males. We restrict attention to adults between the ages of 18 and 80, the upper cut-off being chosen to maintain sufficient cell sizes.

Before examining socioeconomic differences in the evolution of health over the life cycle, we first present the average picture, stratifying only by gender. The left panel of figure 5 shows the prevalence of bad health by age among Dutch men (based on around 57,000 observations) and women (59,000 observations), and reveals many interesting patterns. First, and not surprisingly, bad health increases with age, particularly in the range of middle age. Second, the prevalence of poor health is lower among males at younger ages, but it rises more rapidly above the age of

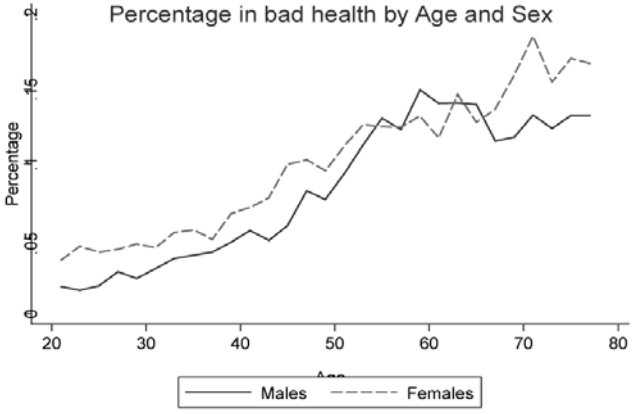
8 Own calculations of Erasmus University Rotterdam (EUR) using data files made available by the Netherlands Central Bureau of Statistics (CBS) on the regional income distribution of persons and households, derived primarily from the Tax Administration and the Municipality Register,(GBA), from the Permanent Survey on Living Conditions (POLS, basis 1998-2004) of the CBS, and from the Cause-of-death statistics 1998-2005.

9 Our study is the first nationally representative and comprehensive analysis of the socioeconomic gradient in health over the adult life course in the Netherlands. Van de Mheen *et al*. (1998) analyzed similar issues for a small geographical area, while Monden (2005) focused only on the role of working conditions in explaining the education-health association.

40, and the rate exceeds that for females between the ages of 55 and 65. Several mechanisms could be responsible for these gender differences in the rate of deterioration of health, which are consistent with those observed by Case and Deaton (2005) for the US. Differences in disease patterns – for example, the greater propensity of cardiovascular disease, which strikes men in middle age – must be largely responsible. The divergence in morbidity rates that re-emerges after 65 might be the result of the higher mortality rate of males, which is selective and leaves the healthiest males in the sample.

The third striking pattern in the data is the leveling-off in rates of bad health after age 55 for both sexes, and the apparent decline for males between 60 and 65. Selective mortality may again be part of the explanation, but employment-related justification bias in the reporting of health could also be responsible. Once retirement age is reached, there is less incentive for non-workers to report poor health – both to relieve the stigma of their non-participation and to qualify for disability benefits. The analysis is based on data covering a period in which disability insurance had strong disincentive effects on employment. Reporting differences, possibly related to the social welfare incentives, explain a large part of the higher rates of reported morbidity in the Netherlands compared with the US (Kapteyn *et al*. 2007).

Figure 5: Self-reported health by age and gender in the Netherlands (1983-2000)



Source: Authors' calculations for CBS Health Interview Surveys, 1983–2000. Sample weights applied.

There might be some worry that the shapes of these life-cycle profiles are dependent on the cut-off chosen to dichotomize self-reported health (SRH). The right-hand panel of figure 5 shows that this concern is largely unwarranted. The age profiles in the percentage reporting very good and good health are generally consistent with those for the rate of bad health. There is one difference: the prevalence of the upper two SRH categories keeps decreasing after 65, while the trend-break between the ages of 55 and 65 is more pronounced for bad health, which is a further indication that selective mortality and/or justification bias resulting from disability insurance incentives may be responsible for this pattern.

4.2 The age profile of self-reported health by income

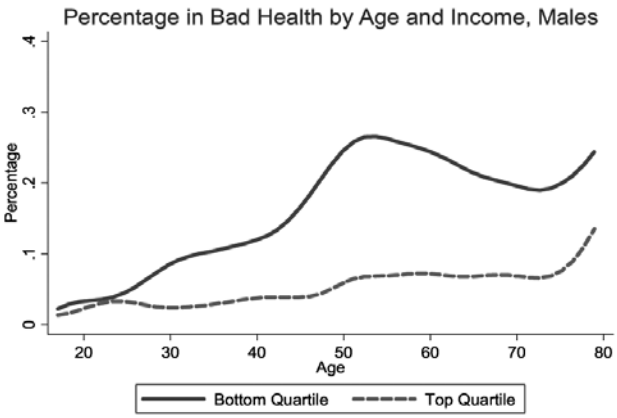
Turning now to our main interest – how the evolution of health over the life cycle differs by socioeconomic status – we begin with income as the indicator of SES. Income is annual net household income, which for the years 1983–96, is recorded in 11 categories with fixed bounds, and for the years 1997–2000 is available in deciles.[10] To allow for variation in living standards within each income category, we rank inversely by household

10 Note that about 20 percent of the individuals in the pooled 1983–2000 data do not report income.

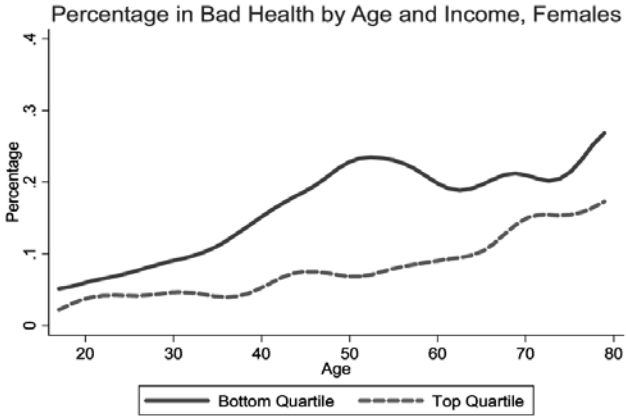
size. The resulting ranks are then used to identify age-gender specific quartiles in the (per capita) income distribution. Moving across ages, we compare the health of those found at the bottom and top of the income distribution. The age profiles are presented in figure 6. Since the number of observations is only about a quarter of those used to compute figure 5 (but still about 13,000 per quartile per gender), we estimate a kernel-weighted local polynomial through the age-specific prevalence rates.[11]

There is a clear income gradient in reported bad health at all but the youngest ages. For example, there is a 10% prevalence of morbidity in the bottom income quartile of females already at age 35, while in the top quartile this prevalence is only reached at 65. The age profile of the gradient displays striking consistency with the evidence reviewed in section 2. For both genders, but particularly for males, income differences in health diverge until 55 or so, at which point almost 30% of males in the bottom quartile report variable or bad health, compared with only 5% in the top quartile, before converging in old age.

Figure 6: Self-reported health by age, split according to income quartile and gender, Netherlands



11 We replicated the profiles in figures 6 and 7 using the Dutch component of the European Community Household Panel (ECHP) dataset. The resulting profiles have a similar shape, but for all ages show a higher prevalence of morbidity for both the lowest and highest quartiles. This is probably due to the different five-point SRH scale used in the ECHP.



Source: Authors' calculations for CBS Health Interview Surveys, 1983–2000. Sample weights applied.

As discussed in section 2, this pattern could reflect a cumulative-advantage process operating until middle age before being overtaken by the leveling effect of age, or it could be due to cohort effects and selective attrition confounding the cumulative-advantage effect at older ages. The theory discussed in section 3 does not predict any direct influence of income on the way in which health evolves with age, but it does allow for an effect of health on income through the interruption of earnings capacity. Indeed, an increasing impact of health on work, and so income, up to (early) retirement age has emerged from the US literature as the most likely explanation for the increasing income gradient in health up to this age. Of course, we cannot yet confirm this hypothesis for the Netherlands.

The increase in the income gradient until the age of 55 is due to a very sharp increase in reported poor health in the bottom quartile, which contrasts with the much more steady increase in the top quartile. This is also consistent with the patterns in the US data that were identified by Smith (2005a). The decline in reported ill-health in the age range of 55–65 that is observable for the whole population in figure 5 is very marked at the bottom of the income distribution, but is absent at the top. Given the negative correlation between income and mortality, and the greater reliance on disability insurance at the bottom of the income distribution, both selective mortality and justification bias could be

responsible for this income difference in the trend of reported morbidity over this age range. Alternatively, it could be an intrinsic health effect from retiring from the labor force that is experienced only at the bottom of the income distribution. Distinguishing between possible explanations of this intriguing pattern poses a challenge for future empirical analyses.

Figure A.1 in the Appendix presents the profiles for each of the four income quartiles. Interestingly, a comparison of these profiles with those for the US in figure 1 reveals more gradual differences between all income groups in the Netherlands, in contrast with the marked difference between the bottom and the remaining three quartiles in the US. In addition, the peak in the prevalence of reported bad health occurs at a younger age in the Netherlands (early fifties) than in the US (late fifties). These differences could possibly arise from the greater accessibility and generosity of disability insurance in the Netherlands over the period covered by the data. The large moral hazard effect of disability insurance in the Netherlands over the last few decades of the twentieth century is well documented (Aarts and de Jong 1992; Lindeboom and Kerkhofs 2008). Extensive use of disability insurance as an exit route from the labor market would be anticipated to reduce the age at which the reporting of ill-health peaks, and the generosity of benefits would spread this effect over a larger part of the income distribution. This is supposition, of course, but it seems plausible that in the Netherlands the impact of health on work, strengthened by welfare incentives, plays an even stronger part in explaining the observed income gradient in health and its life-course pattern than is the case in the US.

As discussed in section 2, one can infer life-cycle behavior from variation by age only if cohort effects are taken into account.[12] To examine whether the life-cycle profile is indeed obscured by cohort effects, we define cohorts by five-year birth intervals. Individuals born between 1915 and 1920 belong to the oldest cohort, and those born between 1975 and 1979 form the youngest.[13] We compute the

12 Although conceptually important, period effects have been found to be empirically unimportant in analyzing life-cycle profiles of health (van Kippersluis *et al.* 2008). Therefore, we have restricted the analysis in this paper to cohort and life-cycle effects only.

13 We disregard individuals born before 1915 because of the small cell sizes and drop individuals born after 1979 because these can be at most 20 on average in the last wave, leaving too few overlap to detect a proper cohort effect.

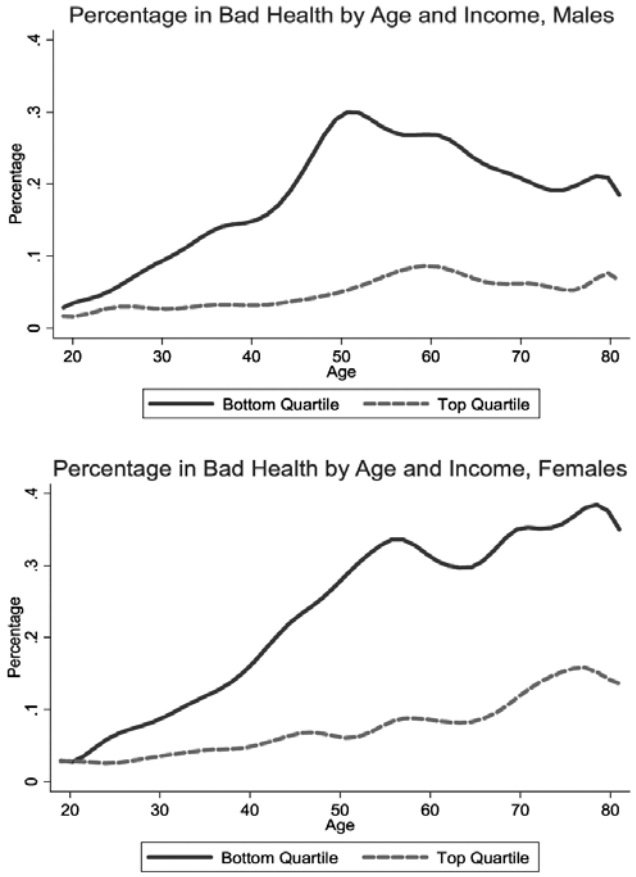
gender-specific prevalence of bad health for each cohort in each of the cross-sections between 1983 and 2000, and do this separately for the bottom- and upper income quartiles. Comparison of the prevalence of bad health of consecutive cohorts at the same age and in the same income quartile makes it possible to identify the cohort effect for each income quartile.[14] The life-cycle profile for each income quartile is identified by the within-cohort variation in reported health with age. These profiles are presented in figure 7. Caution is to be advised in interpreting these results, since some of the cohort effects have been estimated from relatively few observations.[15]

Comparing figures 6 and 7, it would appear that (particularly for males) any cohort effects are small and that life-cycle profiles can be approximated fairly well by raw age variation. This is consistent with previous findings for a number of northern European countries (van Kippersluis *et al*. 2008). However, the number of females in the bottom quartile that reported bad health is lower for the earlier (birth-year) cohorts. As a result, reported ill-health rises more steeply with age, and does not decline at older ages, once cohort effects are taken into account. While the direction of this cohort effect is unexpected, we find a similar effect for mortality reported in the next section, and we postpone discussion of possible explanations until then.

14 In practice, this is done as follows. First, we regress the prevalence of morbidity for each cohort in each year between 1983 and 2000 (and separately for both genders and the top/bottom income quartile) on a set of age- and cohort dummies (i.e. a dummy for each separate cohort, and alternating two- and three-year age dummies; see van Kippersluis *et al*. (2008) for additional motivation for using alternating age dummies). Next, we present the life-cycle profiles – separately for each income quartile – by plotting the estimated coefficients for the age dummies. Since the cohort dummies enter linearly in the regression specification, we assume that the cohort effects cause only parallel shifts in the life-cycle profiles, which means that it doesn't matter (at least up to a constant) for which cohort we present the life-cycle profile. In this application, we have opted to show the life-cycle profiles that apply to the youngest cohort.

15 For example, in the data for 2000, we have only 13 observations with which to calculate the prevalence of morbidity for individuals born between 1915 and 1920 in the bottom income quartile for males.

Figure 7: Self-reported health over the life cycle, split according to income and gender (cohort corrected), the Netherlands



Source: Authors' calculations for CBS Health Interview Surveys, 1983–2000. Sample weights applied.

4.3 Is the picture different for disability or mortality?

We now turn attention to differences by income in the life-cycle profiles of disability and mortality. Trends in disability need not correspond to those in reported health, since the two measures are sensitive to different dimensions of health – with potentially distinct life-cycle profiles (Crimmins 2004; Freedman *et al*. 2007). Socioeconomic differences in the worst health state (death) are arguably of greatest concern, and examination of these differences might provide insight into the importance of selective mortality in explaining the life-cycle profiles of the other outcomes.

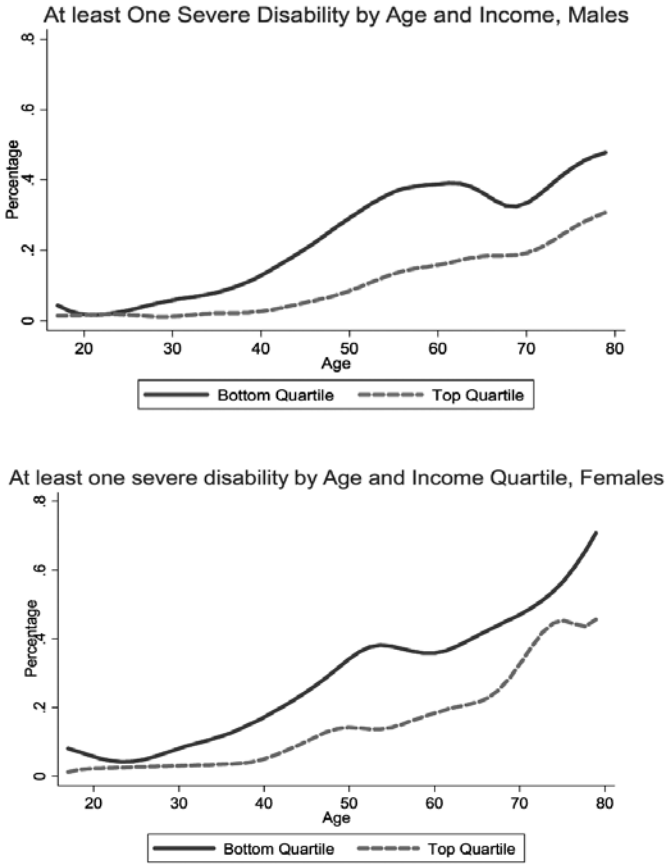
Information on disability is available from the CBS Health Interview Surveys between 1989 and 2000. Disability is measured using the OECD Long-Term Disability Questions on eight selected domains (McWhinnie 1982; Gudex and Lafortune 2000).[16] We create a binary indicator of whether the individual reports at least one severe disability, defined as only being able to carry out an activity with great effort or not at all, in any domain.[17]

Comparing figure 8 with figure 6, it is apparent that the increase in disability with age is more pronounced than that in reported ill health. While the income gradient and its life-cycle pattern are both quite similar for the two measures of health, they are not identical. For males, the peak in the income gradient for disability is at about 60, which is ten years later than that for reported poor health. For both males and females in the bottom income quartile, there is again a distinct fall in the prevalence rate in late fifties (female) and mid-sixties (male) – but it is not as strong as that for reported health, and the rise in disability at older ages is much more pronounced than that in SRH. These differences may be somewhat predictable, given the nature of the measures. While both are self-reported, the general health indicator is more subjective than that of disability, which refers to the ability to undertake defined

16 The activities that are asked include (1) Hear normal conversation with three or four other persons, (2) Hear normal conversation with another, (3) Read ordinary newsprint, (4) See the face of someone from four meters, (5) Bite and chew on hard foods, (6) Carry an object of five kilos for ten meters, (7) Bend down (when standing) and pick up shoe, (8) Walk for 400 meters without resting.

17 We replicated the profiles in figure 4 based on the sum score of the OECD Long-Term Disability Questions (i.e. we dichotomize the response categories "yes" and "no", and sum for each individual across the eight domains). The resulting life-cycle profiles give similar insights.

Figure 8: Prevalence of disability by age, split according to income and gender, the Netherlands



Source: Authors' calculations for CBS Health Interview Surveys, 1989–2000. Sample weights applied.

activities, many of which (hearing, seeing) are anticipated to become more difficult in old age. Older individuals might report their health as good, despite the onset of restricted activities, simply because they expect this to be part of the ageing process. For these reasons, differences in the trends in SRH and disability after the age of 60 are probably of little

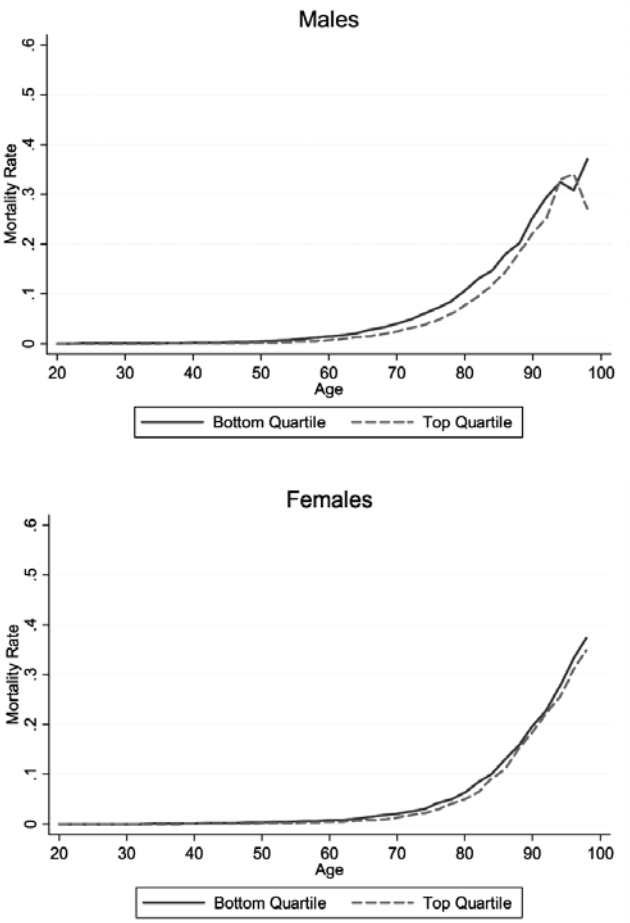
consequence. What is more interesting is that both indicators show that the reported health of low-income individuals deteriorates much more rapidly up to the age of 50-60 than is true of higher-income individuals. It is this divergence, and the relationships between health, work, retirement and income that are responsible for it, that deserves the most attention.

We computed income quartile-specific mortality rates from linked Dutch administrative data covering 1998-2005. From the Municipality Register we observe each death, its timing, and the gender and date of birth of the deceased person. The Municipality Register is linked to income tax files of the previous year, allowing us to compute the age-specific mortality for the bottom- and top income quartiles. This dataset is then linked to the Cause-of-Death Register to identify additional deaths that are not reported in the Municipality Register. We observe income information between 1998-2000 and 2002-2004 for a random sample of around one-third of the Dutch population, corresponding to about 5 million individuals per year (which is linked to mortality information for 1999-2001 and 2003-2005). With such an abundance of data there is no problem of small cell sizes to compute both "raw" and cohort-corrected age profiles of the mortality rate. The age-specific income quartiles are calculated for each year using annual household income calculated after taxes and social benefits and adjusted for household size and age structure.[18] The mortality rates by age, with no cohort correction, follow the familiar Gompertz (1825) exponential form (figure 9).

Mortality is higher in the bottom income quartile at all ages, although this is only visible from age 60 and is more pronounced for males. A mortality rate of 10 percent is reached at age 80 for the bottom quartile of males, while it takes five more years for the top quartile to reach this. The differences suggest that selective mortality could have an important impact on the analysis of socioeconomic differences in reported health and disability. We see that the mortality difference kicks-in from the

18 The CBS provides adjusted (equivalent) income computed using a weight of 1 for the head of household, 0.38 for each additional household member over 18, and weights between 0.19 and 0.30 for household members under 18, depending on age and birth order. Besides the application of this equivalence scale, the income measure differs from the one available from the CBS Health Interview Survey in that it is the income recorded on the individual's tax return and is obviously continuous.

Figure 9: Mortality rate by age, split according to income and gender, the Netherlands



Source: Authors' calculations from linked Dutch administrative data, 1999–2001 & 2003–05.

age 60 onwards, which coincides with the age at which the dip in the prevalence of reported ill health and disability occurs for the bottom income quartile. The differences by income appear to be small in figure 9,

but figure A.6 in the Appendix presents the Mortality Ratio (i.e. the ratio of the bottom quartile mortality rate and the top quartile mortality rate), which shows that the bottom quartile has a higher mortality rate at all ages, up to twice as high in middle age (40–60). Overall, the ratio follows an inverse-U shape with age.

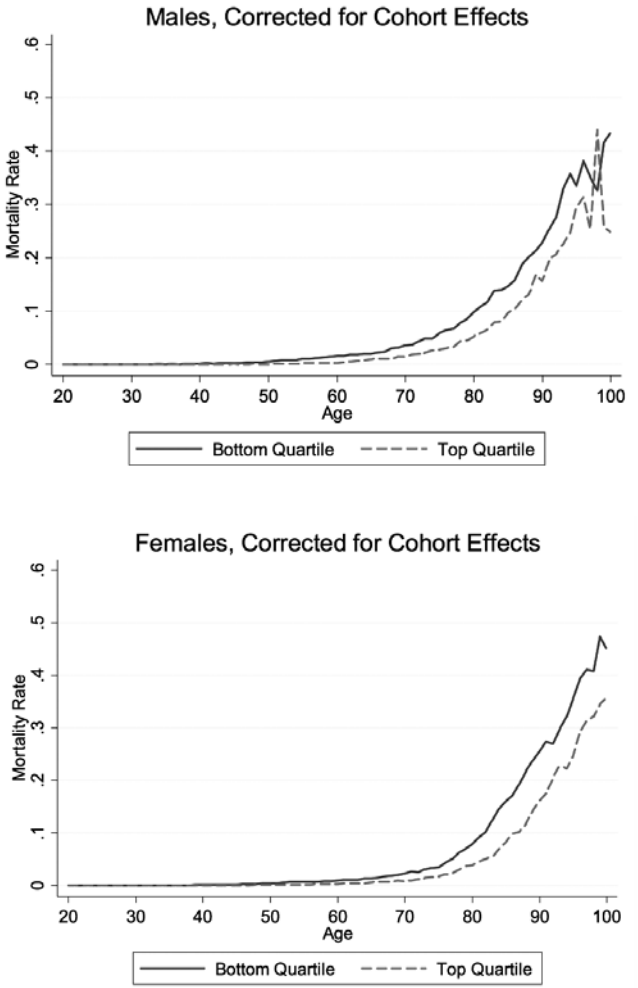
While the absolute differences in mortality by income observable in figure 9 might appear small, one has to bear in mind that differences in mortality rates at any given age do not reflect the much larger cumulative difference in mortality that has occurred up to that age. That is, selective mortality also impinges on the socioeconomic differences in age-specific mortality rates. In order to fully correct for this selection effect, one would need to follow a cohort of individuals from birth until death. While our data do not allow for this, they do make it possible to correct for cohort effects using the methods described above.[19] The resulting life-cycle profiles are presented in figure 10, and the corresponding cohort effects are shown in figure 11.

The mortality profiles in figure 10 have similar shapes to those in figure 9, but accounting for cohort effects clearly widens the gap between the income groups. This accentuation is caused mainly by a negative cohort effect for the cohorts born earlier that belong to the bottom income quartile, and an opposite effect (at least for males) for the earlier cohorts belonging to the upper income quartile. We return to these cohort effects in the next paragraph, but would first like to stress that the mortality differences between the income quartiles in figure 10 are large. For example, the absolute mortality difference between females aged 85 is 6.5 percentage points. We thus confirm our conclusion based on figure 9 that income differences in mortality rates are large, and that cumulative differences are even more pronounced. A consequence is that selective mortality is a potentially important contributor to the observed life-cycle patterns in reported health and disability – but our data, unfortunately, do not allow this to be tested explicitly.

Figure 11 shows the negative cohort effect in the bottom income quartile: cohorts born earlier have a lower mortality rate. In contrast, at the top end of the income distribution, mortality is lower for later-born cohorts of males, and there is no cohort effect for females. The

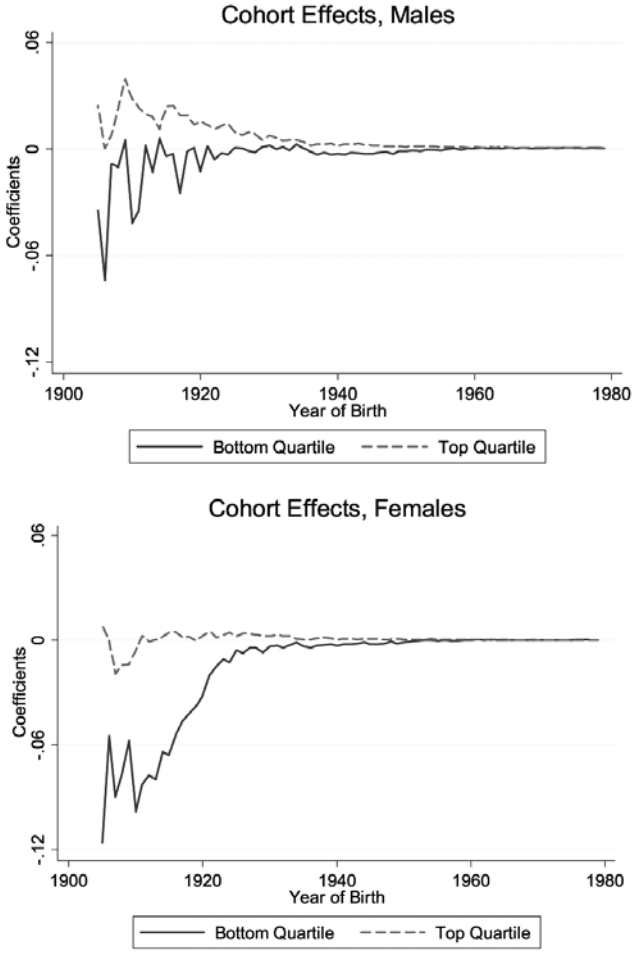
19 An important difference from the methods used in the previous sub-section is that the high number of observations allows us to define one-year cohorts and age dummies, giving the maximum overlap between cohorts.

Figure 10: Mortality rate over the life cycle, split according to income and gender with correction for cohort effects, the Netherlands



Source: Authors' calculations from linked Dutch administrative data, 1999–2001 & 2003–05

Figure 11: Mortality differences by birth year, split according to income and gender, the Netherlands



Source: Authors' calculations from linked Dutch administrative data, 1999-2001 & 2003-05. The vertical axis shows the difference between each cohort's mortality rate and that of the last-born cohort.

first finding seems strange, since it suggests that mortality rates have increased over time for poorer individuals. But it seems likely that this is just the effect of selective mortality: we have a non-random, and presumably particularly healthy, sample of all the individuals who were born at the beginning of the twentieth century and survive to be poor at the end of the century – from which point we can observe mortality. It thus appears that the cohort effect can pick up much of the selective mortality that has built up prior to the time we observe our individuals. If we had observed several cohorts of individuals from their birth until their current age, then the cohort effects for the bottom income quartiles would not be biased and would likely show a decreasing pattern. Allowing for cohort effects can be useful in partially controlling for selective mortality, but the effects must be interpreted with this in mind.

4.4 Is the picture different by education or occupation?

This subsection examines whether the socioeconomic gradient in health follows the same life-cycle profile, irrespective of the indicator of SES used. We compare gradients by education and occupation with those presented above by income. The causal pathways linking health to education and to occupation will differ from those responsible for the relationship between health and income. While our descriptive analysis cannot determine causality, comparison of the relationships over the life cycle can nonetheless be revealing about their nature and may be helpful in suggesting the possible underlying mechanisms.

Educational attainment hardly varies over adulthood and so, for the vast majority, it will not be affected by adult health. Clearly, this does not hold for income. For this reason, education can be considered as a predetermined contributor to the production of adult health. It is a relevant health determinant in both the consumption and investment models of the demand for health, and some claim it to be "the most important correlate of good health" (Grossman 2003). In contrast, income is contingent on labor-market behavior, and as we argued above, its correlation with health may derive from an effect of health on income through employment. The evidence of Smith (2007), consistent with a causal effect of education on health but not of income on health, provides an additional reason to compare health profiles relative to these two indicators of SES.

The CBS Health Interview Surveys record the highest education degree ever obtained.[20] We use this information to construct a low- and high education group. The low education group includes individuals that finished only primary school (21 percent of the total pooled sample), and the high education group refers to university and college graduates (17 percent of the total pooled sample).

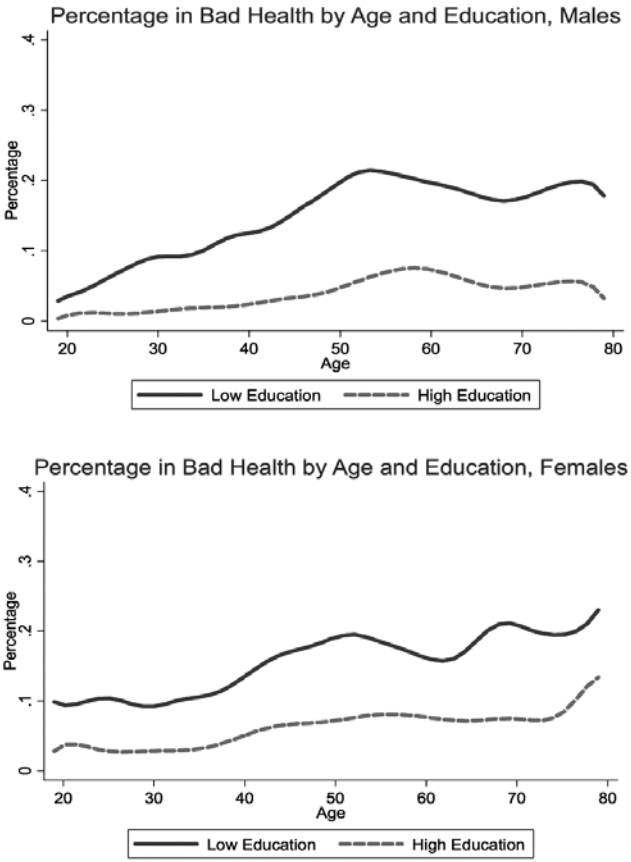
Figure 12 reports the resulting profiles of the prevalence of reported bad health for the low- and high education categories. For males, a widening of the education gradient up to late middle age is immediately apparent. In comparison with the picture for the income gradient in figure 6, the magnitude of the education gradient is larger in early adulthood (which is probably due to the fact that, in this age range, education provides a better indicator than income does of the characteristics of the individual's social background that affect health), and smaller in late middle age.[21] Hence, the widening of the education gradient over the years of normal working age is less pronounced than that for the income gradient. Further, while there is some narrowing of the education gradient beyond the age of 60, this is much less evident than is the case for the income gradient. These differences are consistent with the evidence from the US (Smith 2005b). A plausible explanation is the fact that, unlike income, education is not responsive to health changes. The income gradient may strengthen with age, as health shocks increasingly lead to labor-market withdrawal and a drop in income. But there is no such mechanism to drive the dynamics of the education-health relationship.

For females, the picture is quite different. Already at young ages there is a very strong education gradient in reported health, which remains stable throughout the years of younger adulthood before increasing moderately in middle age. The lack of a pronounced widening of the gradient contrasts both with the pattern observed for males, and with that of the income gradient for females. The latter difference again can

20 For students, we use the education level that is currently attended. Less than one percent of the respondents (both non-students and students) do not report education. Note that this percentage is 20 percent for the income measure. Repeating the analysis with a sample excluding the individuals not reporting income revealed similar education-specific profiles; we thus conclude that income item non-response can be treated as random, at least for the purposes of our empirical exercise.

21 The profiles of the education and income gradients in disability differ in similar ways to those in reported ill health (compare figure A.5 in the appendix with figure 8).

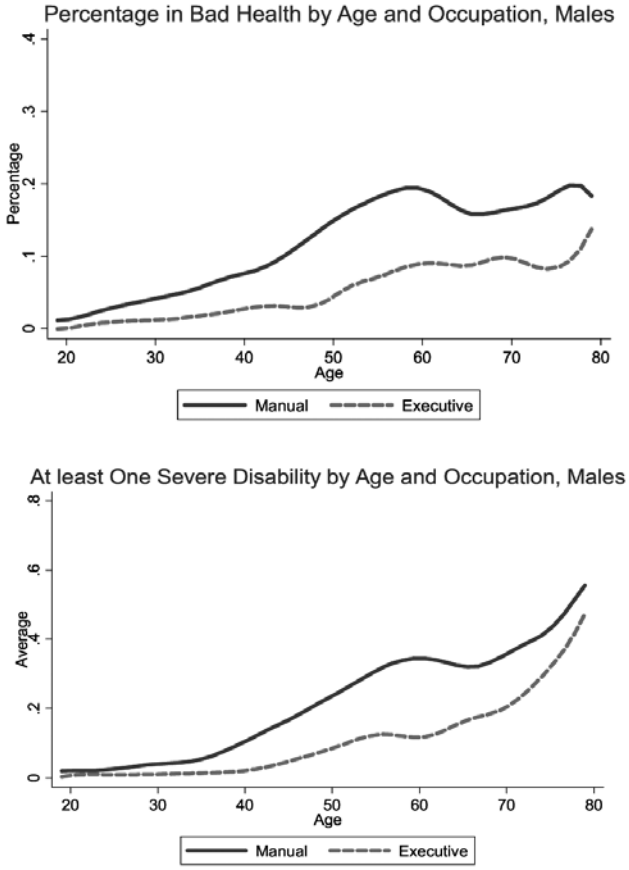
Figure 12: Self-reported health by age, split according to education and gender, the Netherlands



Source: Authors' calculations for CBS Health Interview Surveys, 1983-2000. Sample weights applied.

probably be attributed to the differential responsiveness of education and income to health. The difference with the pattern for males may be due to differential disease patterns, with low-education females being less prone to the onset of cardiovascular disease than low-education males are, and education-determined occupational choice being less relevant to the health of women than of men.

Figure 13: Self-reported health (left panel) and disability (right panel) by age, split according to occupation, the Netherlands



Source: Authors' calculations for CBS Health Interview Surveys, 1983-2000. Sample weights applied.

According to Case and Deaton (2005), occupations may impact differentially on health through physical and mental strain – and this will result in different life-cycle profiles of health by occupation.

Theory indeed predicts that those with physically demanding jobs, resulting in higher depreciation rates, have a higher relative health decline over the life cycle. Occupation is less predetermined than education, but is more so than income, offering another opportunity to explore whether the pronounced widening of the income gradient in health over the life cycle may be strongly influenced by the impact of health on work activity.

Using the CBS Health Interview Surveys, we distinguish between manual and non-manual occupations. In order to compare the health of individuals in the most and least physically demanding jobs, we assign those working in industrial, craft and transport occupations to the manual category, and executives and specialists to the non-manual.[22] For individuals who are retired, their last occupation is coded, but this is not true for the last four cross-sections, which were excluded. We restrict our attention to males, for whom the manual vs. non-manual distinction is likely to be more crucial in identifying work of different levels of physical effort.

The profiles for reported health and disability, presented in figure 13, show a widening of the occupational gradient in health up to late middle age, which is comparable to that observed for education but, as anticipated, is less stark than that observed for the income gradient. In early adulthood, differences in health and disability by occupation are evident but not marked. Given that little time has passed at this stage of the life cycle for occupation to exert an influence on health, the observed differences presumably derive from earlier childhood experiences that impact on both occupational choice and health. But the steeper health trajectories experienced by manual workers mean that, by age 45, 10% of them report variable or bad health – whereas non-manual workers reached this prevalence of ill health only at the age of 60. Similarly, one-fifth of manual workers report at least one severe disability by their late forties, while this rate of disability among non-manual workers is not approached until the age of 70.

22 About 87 percent of the sample reports an occupation, of which 39 percent can be classified as manual, and 26 percent as non-manual (executive jobs). We repeated the analysis expanding the non-manual category to include service, administrative and commercial occupations, and manual to include fishermen. The resulting life-cycle profiles were very similar to those reported.

Figure 14: Self-reported health by age, split according to work status and gender, the Netherlands

Source: Authors' calculations for CBS Health Interview Surveys, 1983-2000. Sample weights applied.

While these differences are consistent with health being worn down more rapidly in manual occupations, they certainly do not confirm the hypothesis.

4.5 How much does labor-force status matter?

Difference across the indicators of socioeconomic status in the extent to which disparities in health widen over the life course are interesting – suggesting, for example, that part of the trend observed in the income-health gradient is due to the increasing impact of health on income. But the fact that the widening is observed for all three indicators is not unexpected, given the strong correlation between them. One of the indicators may, perhaps, be driving the pattern seen in the relationship of all three with health. For example, combining the arguments of Case and Deaton (2005) with those of Smith (2005b, 2007), one explanation of the evidence is that education increasingly affects health (either directly or indirectly through choice of occupation, as individuals age), and that the deterioration of health leads to labor-force withdrawal and a decline in income of the already least economically advantaged groups. To gain further insight into the plausibility of this hypothesis, we now compare directly the evolution of health with age across workers and non-workers. The CBS Health Interview Surveys provide information on whether individuals are currently working (about 41,000 observations) or not (about 39,000 observations) up to the age of 70. The age profiles of the prevalence of reported bad health for these two groups are given in figure 14. As the findings on disability largely mirror those for morbidity, they are reported in figure A.4 in the appendix.

The first striking observation is the rather flat profile of reported bad health for those working at each age. Practically no males in early adulthood report variable or bad health; the proportion begins to increase from age 30, but approaches 10% only by age 60. In contrast, already before the age of 30 more than 10% of non-working males report bad health, and the proportion rises very steeply with age, such that 45% of non-working men report bad health at the age of 50. Non-working men are always in poorer health, and the widening differential suggests that health progressively becomes a more important reason for not working until age 50. The decline after age 50 in the prevalence of reported ill health amongst non-workers must be due to the growing importance of non-health reasons for not working – principally, voluntary retirement. The fact that ill health continues to rise among those that carry on working over this age range is consistent with this explanation. To the extent that income is determined by labor-force status (consistent with the US evidence), these graphs suggest that

the observed widening and then narrowing of the income gradient in health over the life cycle may be driven by the varying effect of health on employment. Figure A.3, presented in the Appendix, confirms that income is strongly correlated with work status; the non-participation rate is highest in the lowest income quartile, and this correlation peaks in middle age and falls substantially at older ages.

The pattern in the profile for non-working women is quite different. The prevalence of ill health among non-working women does not rise steeply with age, and never differs so markedly from the prevalence among working women. These differences reflect the lower participation rate of women and the relatively lower importance of ill health as a reason for non-participation. This adds further support to the hypothesis that the effect of health on employment is an important determinant of the life-cycle variation in the income gradient of health, which is more pronounced for males than for females.

To better gauge the relative importance of work status versus socioeconomic status in determining the life-cycle profile of health, figure 15 presents the prevalence of bad health for the low- and high-education category – but conditioned on those currently working. The respective profiles conditional on non-participation are given in figure 16. Apparently, most of the life-cycle variation in health, and about half of the difference across education categories – evident from a comparison with figure 12 – vanishes after conditioning on those currently working. For non-workers, the age variation in reported ill health remains, rising steeply to age 50 and falling equally rapidly thereafter, but this is now equally apparent for low- and high-education groups. Consequently, there is no widening of the education gradient in health.[23] This suggests that the increasing gradient observed in figure 12 may be attributable to vulnerability to health conditions that interfere with employment rising with age more steeply for the low educated. It could also be that the low educated are more likely to withdraw from the labor force as they age, and report poor health as justification for this.

23 There is quite some uncertainty concerning this result, since the number of high-educated non-workers is very small in some age ranges, making it difficult to estimate the profile with accuracy.

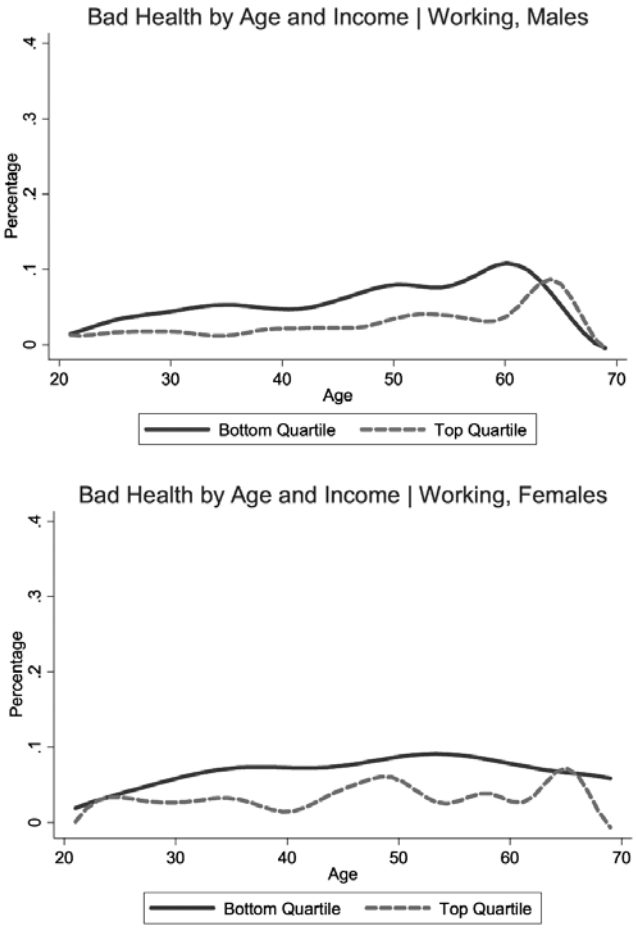
Figure 15: Self-reported health among workers by age, split according to education and gender, the Netherlands

Source: Authors' calculations for CBS Health Interview Surveys, 1983-2000. Sample weights applied.

Figure 16: Self-reported health among non-workers by age, split according to education and gender, the Netherlands

Source: Authors' calculations for CBS Health Interview Surveys, 1983-2000. Sample weights applied.

Figure 17: Self-reported health among workers by age, split according to income and gender, the Netherlands



Source: Authors' calculations for CBS Health Interview Surveys, 1983-2000. Sample weights applied.

Figure 18: Self-reported health among non-workers by age, split according to income and gender, the Netherlands

Source: Authors' calculations for CBS Health Interview Surveys, 1983-2000. Sample weights applied.

We have argued that the widening income gradient in ill health may be at least partly attributable to an increasing impact of health on work, and thus on income. To gauge the force of this mechanism, we plotted the health profiles by income group separately for workers and non-workers. For workers (figure 17), there is some evidence of an increasing income gradient (however slight) with age, which is consistent with the health impact on work being a strong contributor to the widening income gradient in the full sample. For non-workers (figure 18), this widening is still apparent. While this is consistent with some impact of income (or a correlated socioeconomic characteristic) on health after controlling for employment status, it may also be true that low-income non-workers are more likely to be inactive for health reasons.

Summing up, the health profiles by work status and those by education/income conditional on work status are suggestive of a large part of the widening of the socioeconomic gradient in health being due to health impacting on work status, but also of a non-negligible impact of education on the life-cycle evolution of health. While the analysis is far from definitive with respect to these conclusions, it is consistent with US evidence on socioeconomic differences in health over the life cycle (Case and Deaton 2005; Smith 2005a, 2007). It is also supported by stronger causal evidence on the importance of health in retirement decisions (e.g Bound *et al*. 1999; Disney *et al*. 2006; Hagan *et al*. 2006; Lindeboom and Kerkhofs 2008) and of education effects on health (Grossman and Kaestner 1997; Smith 2007).

5. Summing up and lessons learnt

In the Netherlands, as in other European countries and the US, health profiles by socioeconomic status do not move in a parallel fashion over the life cycle. The health gap generally widens through late middle age (by which time a substantial proportion of individuals have retired) and narrows thereafter. While the decline in health inequalities in old age is an inevitable consequence of the ageing process (with biological determinants of health dominating socioeconomic ones), this decline – at least in early old age – probably reflects the survival of only the fittest members of the more disadvantaged socioeconomic groups. Hence, the narrowing of observed health inequalities in old age is itself the result of socioeconomic disparities in mortality at younger ages. We confirmed the existence of such mortality disparities by income in the Netherlands, using administrative data that links death registers with tax files.

More interesting than the decline in health inequality in old age is its increase from early adulthood until late middle age. While this pattern is evident for all indicators of socioeconomic status, it seems that the causal mechanisms, and the direction of causality, differ. US evidence suggests that education affects health, and health impinges on work status and consequently income. Differences in health by education appear to result, at least in part, from socioeconomic disadvantages increasing the onset of health problems. Once cohort effects and (to the greatest extent possible) selective mortality are controlled for, there is substantial evidence that the health penalty of a low education accumulates with age. In other words, on average, the health of the less educated deteriorates more rapidly with age. There is much less evidence that financial dimensions of SES exert a similar independent effect on health trajectories. Indirect evidence suggests that the income gradient in health, and particularly its variation with age, derives in large part from a reverse effect of health on work capacity. Since health shocks have their largest impact on work in middle age, this may explain the peaking of the income-health gradient in this period of life. Some of the observed effect of health on work (and subsequently income) may be overstated as a result of non-workers justifying their status by ill health, but analyses based on the onset of health conditions prior to changes in labor-market status, which are less vulnerable to this bias, seem largely to confirm these effects.

While the direction of causality in the education-health relationship appears to be the reverse of that in the income-health gradient, the

two relationships can be integrated into a unified theory of cumulative advantage over the life course. This would start with early-life conditions and parental background affecting education. We have not reviewed the literature on the lifetime economic and health consequences of early childhood conditions here, but the evidence base to support causal effects is growing (see e.g. van den Berg and Lindeboom 2007). Education strongly influences the choice of occupation, and thereby the extent to which an individual's physical health determines his productivity, but also the health consequences of work itself. Someone with little or no education has virtually no option but to enter into heavy manual labor, which is likely to exert a greater toll on his health; that person is also more likely to be laid-off once health problems begin to impede productivity. So, the health-related earnings losses that are partly responsible for the income-health gradient are themselves, to some extent, the result of socioeconomic differences in lifetime opportunities and their impact on health.

Overturning these processes of cumulative advantage represents a major challenge to social policy. The potential rewards are, however, immense. Getting closer to a goal of equality of opportunity could raise national wealth by breaking the connection between low education, poor health and early labor force exit. There could also be substantial savings on expenditures on health care. Of course, breaking the cycle requires identifying the specific causal mechanisms that link education with later life health outcomes but, at present, there is very little robust evidence. Much of the education effect appears to operate through health-related lifestyle choices. But we do not know why better educated people choose more healthy lifestyles. Perhaps they have better access to information on the health effects of smoking, drinking, diet, etc. Alternatively, they may be more cognitively able, which would allow them to process health information more effectively. Perhaps there is no causal effect of education, but simply a situation in which individuals with lower time discount rates invest more in both education and health. Designing policies that are effective in breaking the link between education and health is contingent on acquiring significantly better evidence on which of these competing hypotheses is most responsible for the relationship.

Besides interventions in education, policies aimed at improving health conditions at work (particularly for those in low-skilled occupations) are important in preventing health-related labor-force

exits, thereby extending working lives and maintaining the financial sustainability of pension systems. Given the moral hazard effects that are inevitably created by financial protection against health-related loss of employment, it seems crucial to enact policies in the workplace that can both prevent the development of health problems and reduce the impact of those problems on work capacity by providing appropriate support to partially disabled workers. By encouraging reintegration of partially disabled workers, the 2006 reform of the Dutch disability benefit scheme[24] is consistent with this approach.

While we have not attempted to identify any causal impact of socioeconomic indicators on health outcomes using Dutch data, our descriptive analysis reveals patterns that are largely consistent with those observed in US data, and suggests that broadly similar mechanisms are operating. It seems that countries with very different social welfare and health insurance systems end up displaying not quite identical, but nonetheless remarkably similar profiles. It is hardly surprising that health-related exit from the labor force is an important causal mechanism linking health and socioeconomic status at middle age in the US, a country with relatively limited social protection mechanisms. It is perhaps more surprising that the same holds for a country like the Netherlands, known for its generous social protection, disability insurance and retirement schemes. But this generosity can itself increase the observed correlation between income and health, if individuals with chronic health problems are encouraged to withdraw from the labor force, and if replacement rates, although generous, are less than 100%.

The increase in the income-health gradient is even steeper in the Netherlands than it is in the US, peaking at an age of around 50, and appears to be driven largely by differential employment rates. The steep decline in the reporting of ill health beyond the age of 55, which is most pronounced at the bottom of the income distribution and absent at the top, suggests that a substantial part of the income-health gradient before this age is attributable to the reporting of ill health as a justification for not working. This is plausible, given that a sizable share of the

24 The old scheme (WAO = Wet Arbeidsongeschiktheid) was replaced on 1 January 2006 by the WIA (Wet Werk en Inkomen naar Arbeidsvermogen), which includes a partial disability and reintegration component (WGA = Werkhervattingsregeling Gedeeltelijk Arbeidsgeschikten) and a permanent disability component (IVA = Inkomensvoorziening Volledig Arbeidsongeschikten).

Dutch (male) population was receiving disability benefits during much of the period covered by the empirical analysis. Kapteyn *et al*. (2007) demonstrated that more than half of the much higher rate of reported disability in the Dutch working population compared to that of the US could be explained by differential reporting of specific health conditions. This suggests that the generosity of Dutch disability insurance and the readiness for this to be used as a route out of work into retirement has exerted a considerable bias on the income-health gradient and its life-cycle profile. To a certain extent, this is a relic from the past, given the measures that have been introduced in recent years to tighten up on access to disability benefits, most recently in the 2006 reform. Preliminary feedback suggests that this reform has reduced the inflow into disability (Berendsen *et al*. 2007). Future research should evaluate this reform more rigorously and investigate whether it has affected the life-cycle profile of the income-health gradient.

The fact that the work decision seems to be central to the income-health gradient and its life-cycle evolution suggests that a conceptual understanding of this relationship requires modeling health and retirement behavior simultaneously. The Grossman model does not do this. While work hours can respond continuously to sickness time, there is no option to withdraw completely from work. One possible way of extending the model to capture socioeconomic differences more effectively in the life-cycle evolution of health would be to introduce distinct periods of working life and retirement, and to allow both the consumption and investment benefits of health to vary across these. Investment benefits are obtained only during working life, while the value of the consumption benefits — the marginal utility of time spent in good health — may change on reaching retirement, due to the increase in leisure. To date, the demand for health, and its life-cycle evolution, has been examined under either one or the other version (investment or consumption) of the model. But the relative weight of the investment and consumption benefits clearly varies across the life cycle. A fruitful approach to deriving the life-cycle profile of health may therefore be to build a model with two periods of life—work and retirement—with investment benefits obtained only in the first period and consumption benefits in both.

The development of appropriate conceptual models will be useful in specifying and interpreting future empirical analysis, which is desperately

needed to provide better evidence on the causal mechanisms responsible for the observed dynamic associations between health and indicators of SES. To guide policy, we need to know the extent to which physically demanding working conditions lead to a depletion of adult health, and how this compares to health gaps that widen as a result of differences in unhealthy lifestyles. Moreover, in this study socioeconomic status is measured as a one-dimensional and static measure, whereas obviously there may be interactions between the different dimensions of SES and labor force status and incomes change over the course of life. Finally, we did not consider the potentially important distinction between physical and mental health, with possibly very different educational effects and feedbacks to work over the life cycle. The Netherlands does not have a long-running panel like the US Panel Study on Income Dynamics, which collects detailed longitudinal information on health, income and working conditions. However, to address some of many research questions identified above, a potentially powerful new data source is the CBS linked health data files, covering health interview surveys, hospital discharge data, mortality data, pension fund data and income tax statistics. These data present new opportunities to address pertinent policy questions concerning the relationships between socioeconomic status, health and work over the life cycle.

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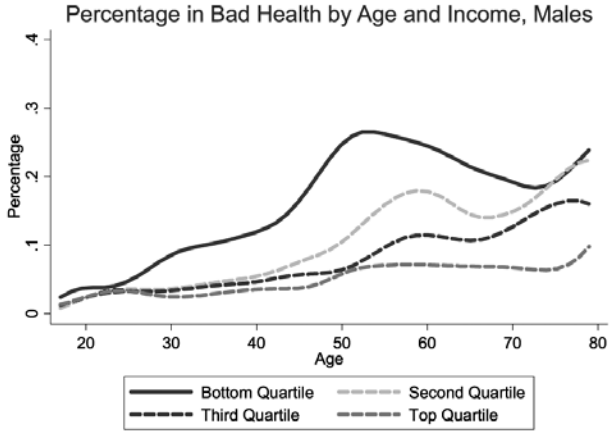
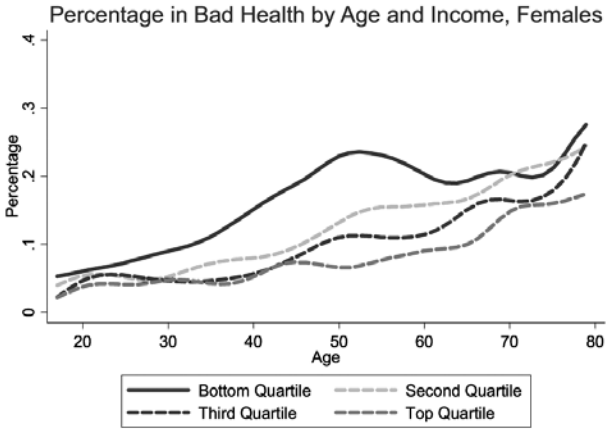
APPENDIX

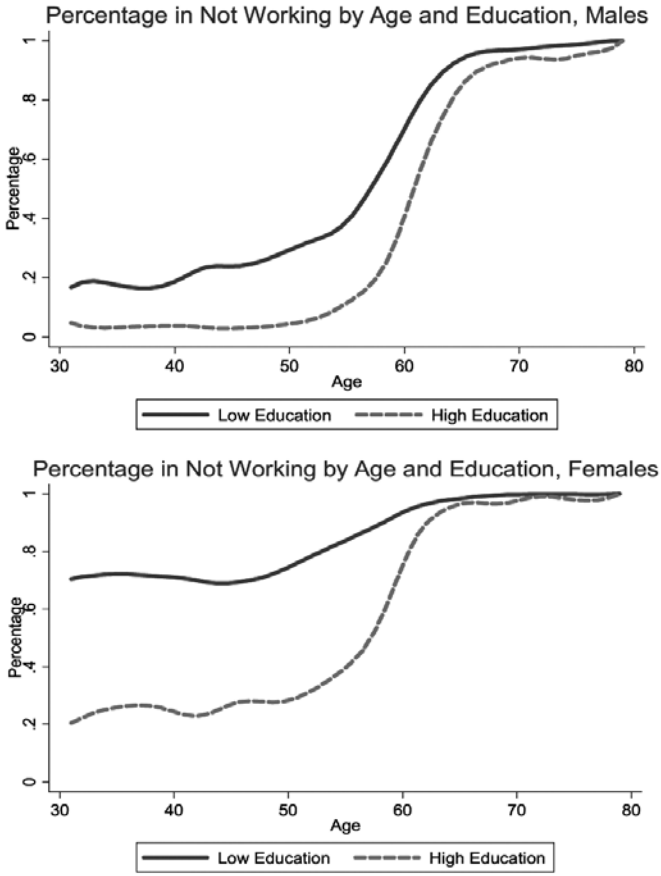
Figure A.1: Prevalence of morbidity over the life cycle, by gender and income quartile in the Netherlands





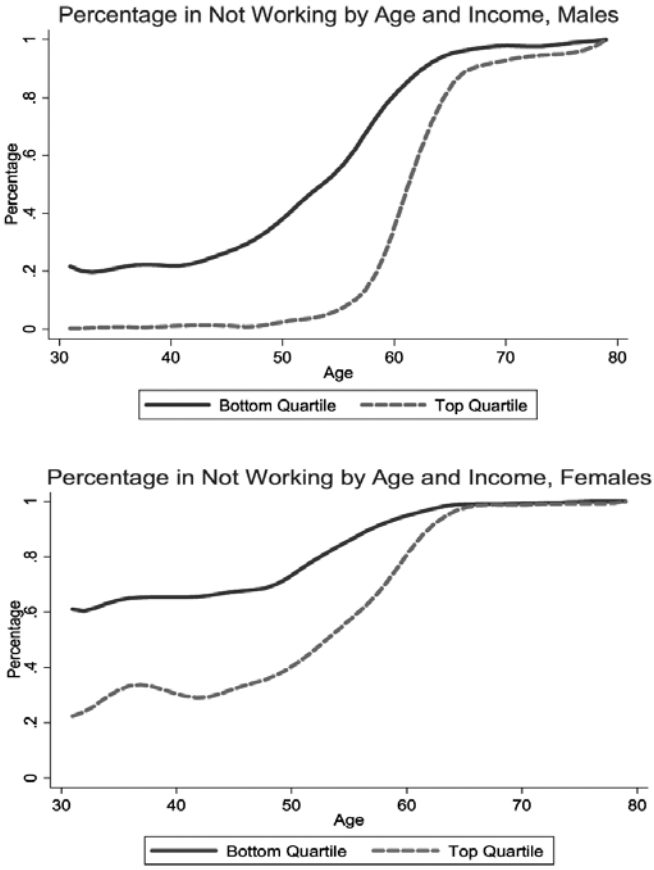
Source: Authors' calculations for CBS Health Interview Surveys, 1983–2000

Figure A.2: prevalence of population working over the life cycle, by gender and educational category in the Netherlands



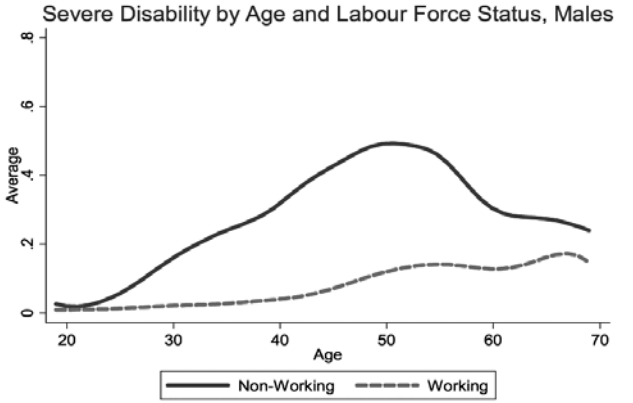
Source: Authors' calculations for CBS Health Interview Surveys, 1983–2000

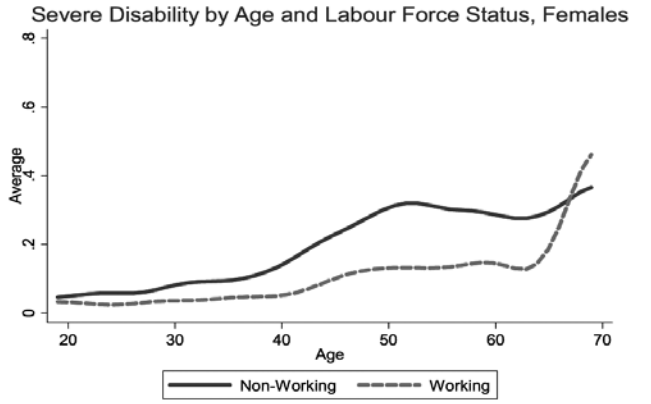
Figure A.3: prevalence of population working over the life cycle, by gender and income quartile in the Netherlands



Source: Authors' calculations for CBS Health Interview Surveys, 1983-2000

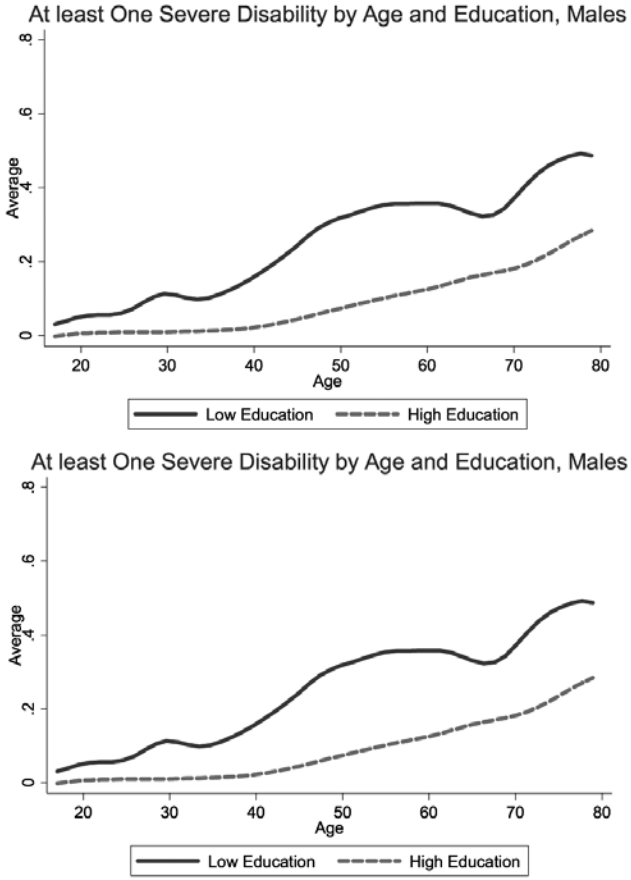
Figure A.4: prevalence of disability over the life cycle, by gender and working versus non-working in the Netherlands





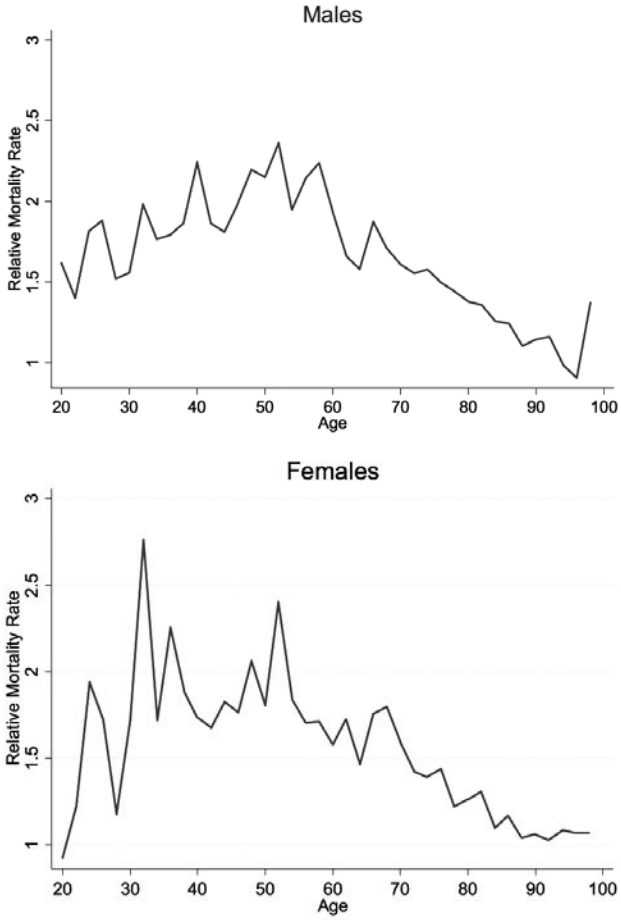
Source: Authors' calculations from CBS Health Interview Surveys, 1989-2000

Figure A.5: Prevalence of disability by age, split by education and gender, the Netherlands



Source: Authors' calculations from CBS Health Interview Surveys, 1989-2000

Figure A.6: Relative Mortality Rate by age, split according to gender, the Netherlands



Source: Authors' calculations from linked Dutch administrative data, 1999-2001 & 2003-05. The vertical axis shows the ratio of the mortality rate for the bottom quartile and the mortality rate of the top quartile.

SUMMARY OF DISCUSSION

By David Hollanders

Socioeconomic differences in health over the life cycle: Evidence and explanations
By Eddy van Doorslaer, Hans van Kippersluis, Owen O'Donnell and Tom Van Ourti

Discussants: Federica Teppa (De Nederlandsche Bank) and Anton Kunst (Erasmus MC Rotterdam)

Netspar panel: October 18, 2008

The discussion
The first discussant, **Federica Teppa**, began with a short summary of the paper. The main question of the paper is whether and how the socioeconomic gradient in health changes over the life cycle. There are a lot of things addressed in the paper. After an extensive, detailed summary of the international literature, the paper assesses the consistency of the findings with economic theory. New evidence from the Netherlands is then presented. The socioeconomic pattern in the life-cycle profile of health in the Netherlands does not differ much from that observed in the US. As these countries are characterized by different health care and welfare systems, this puzzles the authors. A turning point in the life cycle occurs at the age of 65. A widening of the gradient characterizes the first phase; after the age of 65, the gap between high- and low socioeconomic status narrows. This coincides with a drop in consumption at retirement age. This suggests a possible link with income and health. This relates to what the paper does not do. It does not actually look at causality. This is important because assessing causality is a prerequisite for policy advice. All the same, Teppa concluded that the paper provides a nice, detailed and well-written overview and is a wonderful example of interdisciplinary research.

The second discussant, **Anton Kunst**, an epidemiologist, expressed the hope of providing some new and independent insights. He found it hardly surprising, in principle, that health and socioeconomic status are related in a cross-section, as the two are known to influence each other. What the paper adds (particularly to the Dutch case) is, first, a detailed description of how the relationship changes over the life cycle. Second, the paper offers further insights and clues on the mechanisms that can explain the persistent relationship. This is a notable achievement, in Kunst's opinion. Kunst then made several suggestions for further work: on what could have been done, and what could still be done.
First, the research objectives might be made more specific; as stated in the paper, the objectives were rather broad. Kunst suggested that the authors concentrate on particular phases of life and on specific mechanisms– for example, a focus on health as a determinant of labor participation. An alternative would involve focusing on inequalities in chances for living longer in good health. This would enable the paper to shift from description to explanatory research.
Second, health measurements are now cross-section, but measures change over time. If an old person reports being healthy, it is not the same as a young person stating the same. The paper also has an economist's perspective, where health is considered as part of human capital, in which people invest. Epidemiology involves a focus on getting a particular health problem and recovering or dying from that condition. This relates to the third point, the role of mortality. The paper is the very first to differentiate mortality rates with respect to both income and age for the Netherlands. Mortality comes with a selection problem, however, as people drop out of the sample. How important is that? Kunst regarded it as less important, but pointed out that this needs to be established. Also, mortality could be an integral part of the health analysis. Finally, the data allow a look at the effects of policy changes from the 1980s onwards. Kunst suggested taking a look at period effects, rather than cohort effects, which are less important and relevant. All in all, he considered it to be a 'beautiful' dataset, which could lead to beautiful papers.

Arthur van Soest (Tilburg University) had three questions. First, the focus in the paper is on the response category of 'very bad health', while there are five possible categories. Is all the action in the tails? Second, the impression from the literature is that the influence of socioeconomic

status on health is a long-term effect, whereas health influences socioeconomic position in the short-term. The long-term effects are now consequently missing. Third, health is an aggregate measure. Assessment of causality may call for a distinction between, for example, mental and physical health.

Authors' reply

Eddy van Doorslaer responded that he was glad to have the opportunity to explain what they are doing when they are not writing panel papers. Why, for example, select the "very-bad" response categories? It is true that differences are more pronounced in that case, but using other categories as cutoff point shows similar patterns. He said that their choice makes the study more comparable with other studies. Indeed, the paper does not determine to what extent selective mortality accounts for these results. It is also true that the effect of socioeconomic status on health takes a lifetime to materialize, whereas the opposite effect materializes immediately. The paper does not test a causal model; it can only provide some indications. This does not mean that they are not doing that in other work (using panel-data and individual changes in health status). However, such analyses come at the cost of making the work less generalizable. When analyzing specific shocks, causality applies only to that group. It is then harder to base general statements of causality on the resulting outcomes. All in all, a panel paper is a different paper for a different purpose. What the authors wanted to do was to take a step back from the literature and make some interpretations.

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