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Rasmus Hoffmann

EUROPEAN UNIVERSITY INSTITUTE, FLORENCE
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Abstract

In many empirical studies mortality differences between socioeconomic groups (SES) decrease in the higher age groups. However, the mechanism behind this convergence is unknown. This study presents empirical evidence and possible explanations. Danish register data of all men in Denmark above age 58 between 1980 and 2002 (n=938.427) and event history analysis is used to study mortality differences between income groups, controlled for eight other variables. Interaction models with age or health status are used to describe the change of SES mortality differences with age. Mortality differences in Denmark are very large. The upper 75 percent of the income distribution have very similar mortality levels, but have approximately only 35 percent of the mortality risk of the poorest 10 percent. Mortality differentials are stable across age groups (controlled for health) but they converge completely when health is deteriorating. This study shows that instead of "age as leveler" it is "illness as leveler". The finding that SES only has a very small impact on the transition from poor health to death shows that SES mortality differences do not exist because ill people with low SES have poor access to intensive or expensive medical care. It rather suggests that SES differences in mortality originate in the period of prevention and early treatment. This is also the period where policy measures against health inequality are most promising.

Keywords

mortality, health, old age, income, socioeconomic status, SES, age as leveler, Denmark, register data, longitudinal analysis, event history analysis

I. Introduction

Differences in health and mortality between socioeconomic groups exist in all age groups but most studies find that relative differences decline in old age (Andersen and Laursen 1998; Martelin et al. 1998; Elo and Preston 1996). Increasing mortality differences in old age or increasing or stable health differences have only been found by Otterblad Olausson (1991), Huisman et al. (2004), Lynch (2003:24), Huisman et al. (2003:871) and Fox et al. (1985). The question if and why SES mortality differences decline in old age refers to a number of open-ended theoretical and methodological questions that cannot be addressed all in detail here, e.g. how does social inequality change in higher ages (Kohli 1990) and how is this related to health differences? This study will analyze social mortality differences over age empirically and then theoretically in greater detail. The list of arguments for and against convergence of SES mortality is presented in the following:

1. Physical decline works as a leveler of social differences because biological processes assume dominance over social determinants and eventually everybody must die, regardless of social class (Liang et al. 2002:295).
2. The welfare state reduces socioeconomic differences in old age through benefits and social policy that go in a major part to the elderly (Bassuk et al. 2002:522; Knesebeck et al. 2003).
3. The impact of past stratifying and health relevant experiences, e.g. working conditions, fades out at old age because in older ages most people disengage from the main stratifying systems (House et al. 1994:228).
4. Declining differences are observed only on the aggregate level because the surviving population is more homogeneous due to unobserved heterogeneity and selective mortality (Vaupel 2001). The methodological implications of this explanation are too complex to be addressed here (for a detailed theoretical and empirical analysis see Hoffmann 2008). However it is one possible explanation for why a convergence is observed while in fact the impact of SES on individual mortality could be stable or increasing, analogous to the explanation of the racial mortality crossover in old age (Nam 1995).
The list of arguments from above will be continued with arguments supporting a mortality divergence.
5. Vulnerability increases in old age and makes differential exposures more harmful (House et al. 1994:221; Stronks 1997:80ff).
6. Past experiences, e.g. education, accumulate and may interact with other factors, e.g. economic and social capital. The health outcome of this accumulation is incorporated into the "health stock". Dannefer elaborated this principle and described a social theory of cumulative advantage, also called the "Matthew effect" (Dannefer 1987, 2003; Beckett et al. 2002:194; Lynch 2003).
7. The impact of past unhealthy experiences, e.g. unhealthy working conditions or smoking, is postponed to older ages therefore implying a time lag between an experienced disadvantage and its effect on health (House et al. 1994; Lauderdale 2001).
The age pattern of SES mortality differences that can be observed empirically might be a net effect of several of the above mechanisms at work simultaneously. In the following, I will first show the pattern of SES mortality differentials over age for Denmark. Second, interaction models will further analyze whether it is increasing age ("age as leveler") or declining health ("illness as leveler") that drives the convergence. In the discussion some of the arguments listed above will be evaluated in light of the new findings and new interpretations and policy implications will be suggested.

II. Methods

Data sources

The data come from the Danish Demographic Database that combines different national registers from 1980 onwards. Danish registers can be linked by an individual person identification number, they cover the entire population and provide annual information (Petersen 2000). The dataset used here

includes 1.090.897 women and 938.427 men aged 59 years or older, who are observed from 1980 to 2002. Due to space limitations the results will only be on Danish men, but for women the results are similar.

The variables are the following: *Income* is the individual gross annual income measured in 6 percentiles groups. The limits of these groups are defined by concrete amounts of income in Danish Krones, calculated from the income distribution of each of the 23 years of observation. Because the income distribution changes much with age, I also used age adjusted income percentiles, but this had no effect on the results (results not shown). *Education* is measured in years of schooling and *Wealth* is measured in quartiles. *Occupational status* is measured in six categories based on manual vs. non-manual, skilled vs. unskilled, and self-employed. *Children* is an indicator for children living in the household. *Source of main income* gives information about the labor force status and *Marital status* is measured in the standard four categories. *Type of dwelling* and *Square meters per person* in the dwelling are additional control variables. The only available quantifiable health measure in the Danish registers is *Days in hospital. Age* is controlled for by using a Gompertz-shaped baseline risk function.

The models with an interaction with age use a piecewise constant baseline function instead. Income will be used as an indicator for SES. This decision is based on previous results from this data (Hoffmann 2008) that show, first, that by far the largest mortality differences exist between income groups and, second, that income is the only variable that is robust against the inclusion of other dimensions of SES in the model (results not shown).

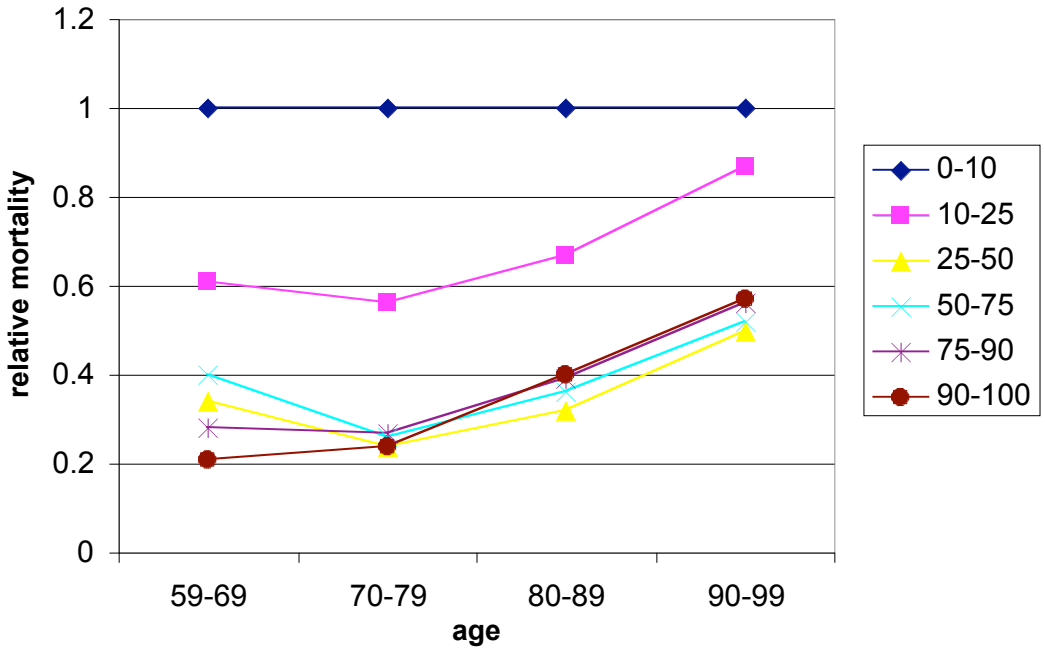
Data analysis

Event-history-analysis is applied with a model for the force of mortality as the outcome variable. The force of mortality is a hazard rate and can be understood as an instantaneous death rate at age x (Horiuchi and Wilmoth 1998:394). The models computed with Stata SE 10.1 identify rate ratios for the multiplicative impact of categorical variables on the baseline risk of dying. They include interaction effects between income and age or between income and health. The baseline for age covers the age range from 59 to the highest age, whereas the observation period is only 23 years (1980-2002) for Denmark. Thus, the cohorts are partly synthetic and cases coming under observation above age 59 are left-truncated. Stata can take this into account by distinguishing between "time under risk" (starting at age 59) and "time under observation" (starting at the individual age of entry) (Gutierrez 2002:42). In the result section, only the interaction effects will be shown but not the coefficients for all control variables. A bias due to period or cohort effects could not be detected.

III. Results

Figure 1 shows mortality differences between income groups for Danish men in interaction with age, all other variables controlled, except for health. First of all, we see very large mortality differentials: the upper 75 percent of the income distribution have a very homogenous mortality level that ranges between 40 and 80 percent lower than the poorest 10 percent (reference group). The second poorest group is in the middle. Only the poorest 25 percent of Danish elderly men have a mortality disadvantage but this disadvantage is an enormous gap in relation to the other groups. For the question of this study it is more important that these differences are clearly narrowing with increasing age.

Figure 1: Mortality with interaction between income and age, lowest income decile = 1



While the time axis in Figure 1 (age) expresses both increasing age and worsening health, the model for Figure 2 additionally includes the variables for days in hospital and by that controls the health status and health deterioration. The result is that the convergence disappears and mortality differences between income groups are stable across age groups. This means that increasing age alone, with the health status being controlled, is not converging SES mortality differences in old age.

Figure 2: Mortality with interaction between income and age, lowest income decile = 1, controlled for health

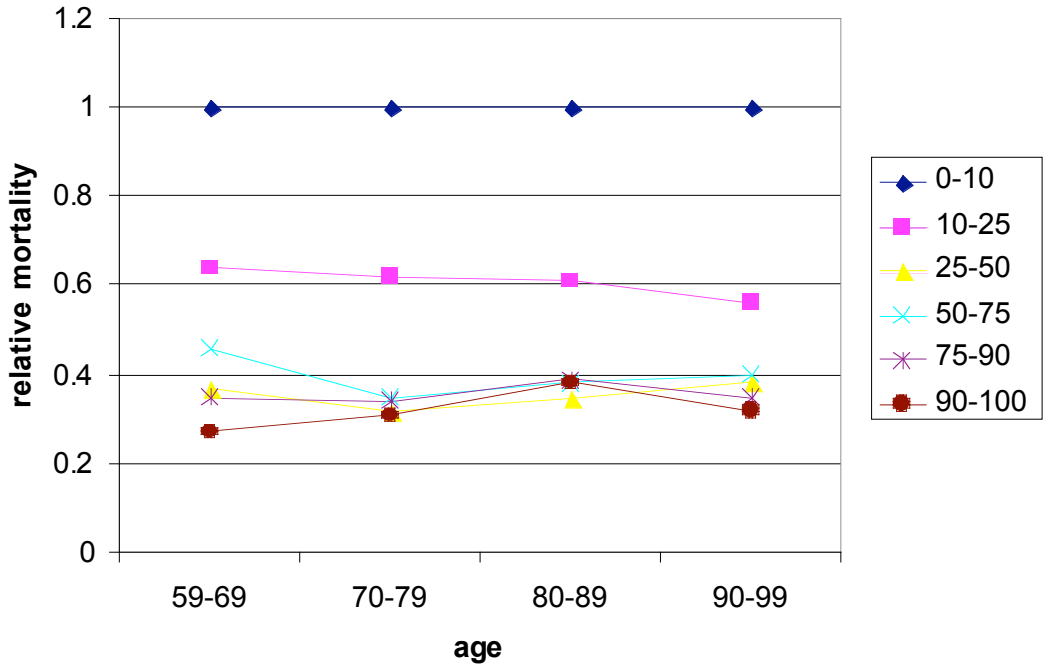
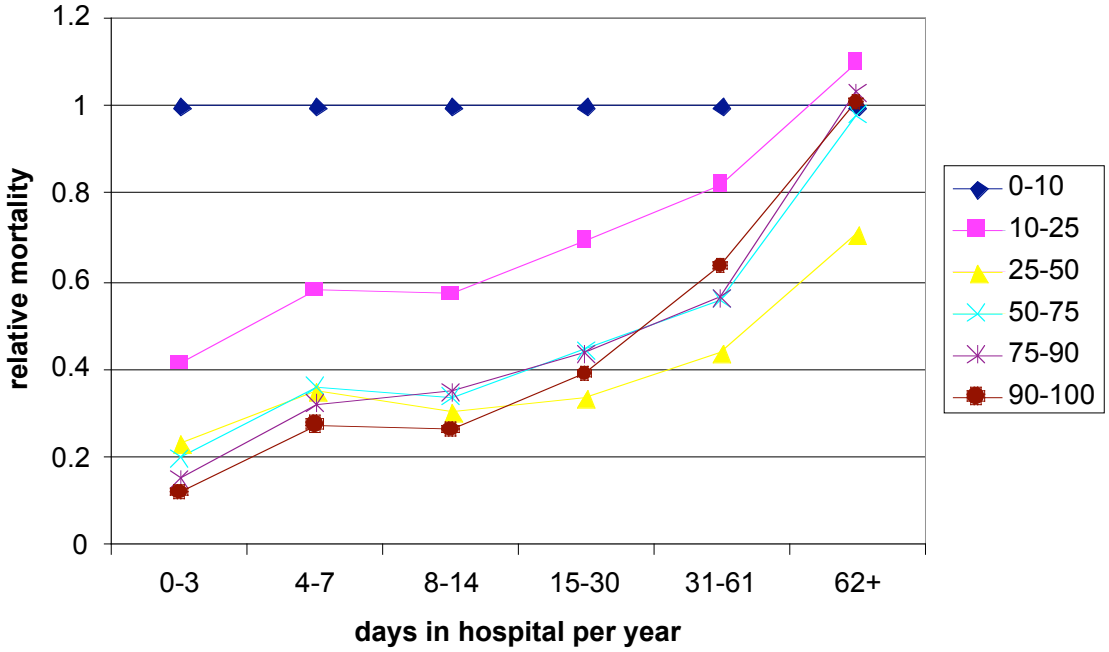


Figure 3 shows the complementary model, an interaction between income and health, that displays what happens when health declines: SES mortality differences converge with worsening health. The more a person is ill, the less impact the social status has on mortality. After separating the two dimensions of aging, increasing age and worsening health, it turns out that it is illness and not increasing age that is a leveler for SES mortality differences.

Figure 3: Mortality with interaction between income and health, lowest income decile = 1



IV. Discussion

This study shows, first, that mortality differences between income groups among elderly men in Denmark are very large and, second, that these differences narrow with increasing age. However, the actual factor behind this narrowing is the decline in health, not increasing age as such. In a poor health status income has almost no influence on the transition to death. A similar finding was presented by Klein and Unger (2001): the impact of income on mortality is much higher in a good health status than in poor health. The main implication of my finding is that the notion of "age as leveler" (Dowd and Bengtson 1978) is not specific enough, because it is not age that levels SES mortality differences, but illness. Even if it might be plausible to assume that increasing age is generally related to worsening health, it is worth keeping these two dimensions separate for analytical purposes. Age increases for everyone but health decline is very different for different social groups. Both of these aspects increase mortality but they have different consequences for the impact of social status on mortality. A thoughtful interpretation of this finding cannot be that worsening health generally levels social differences. This is because health decline is not exogenous, but it depends to a large extent on SES. This perspective invites us to regard declining health as a process that is open to social and other influences. But the more health deteriorates, the less it is influenced by SES. My finding do not confirm the plasticity of aging and mortality that has been claimed also for very high age groups by

Vaupel et al. (2003) who found that after the German reunification even people in the age group 90+ in Eastern Germany experienced a mortality improvement due to better nutrition, pensions and health care. However, Vaupel et al. also looked at age groups and not at health groups. It seems to be important to differentiate between high age and poor health when the impact of SES is analyzed.

As a limitation of this study I would like to mention the health indicator used here. Whereas the Danish register data generally belong to the best available datasets for mortality studies, days in hospital is not the best health indicator and other additional variables such as self-rated health or physical functions are desirable but unavailable in the Danish registers. However, tests and comparisons with data from the Health and Retirement Study (HRS) from the USA show that days in hospital are a sufficiently good health indicator. First, it strongly predicts mortality with and without control for SES and, second, the variable days in hospital in the HRS data shows results very similar to self-rated health and objective health measures based on functional limitations (results not shown).

My results allow a tentative evaluation of some of the arguments listed in the introduction. The effect of an equalizing welfare state policy on certain age groups or the temporal distance to unequal health experiences e.g. during work life (arguments 2 and 3 in the introduction) seem to be unrealistic in the light of my findings. But socioeconomic mortality differences do not increase with age either, as suggested by arguments 5 to 7. Instead they are stable across age and in fact poor health is the equalizer for social mortality differences, possibly as a result of a universal shift from social to biological determinants of mortality when health decreases (argument 1). It follows that arguments based on mere age as a leveling factor are not confirmed whereas the idea that once an illness is developed social differences are much less important seems to be correct. Admittedly, it is not possible to simply verify or rule out the listed arguments just by one empirical example. The mechanisms may not be mutually exclusive, for example accumulating social differences (argument 6) and the dominance of bad physical conditions over social conditions (argument 1) can be simultaneous and we observe the net effect of both mechanisms. But the clear difference between controlling and not controlling for health reveals at least the role of worsening health.

Two policy relevant conclusions can be drawn from this study: First, if SES does not have a large impact on ill people's mortality but we do observe large overall SES mortality differences, it means that SES has its effect earlier in the process of health deterioration. Socioeconomic differences in health and mortality originate in the period of prevention and the treatment of light illnesses, thus this is the time when interventions would be most promising. Or, back to the items actually measured in this study, namely income: salutary things that "money can buy" for healthy people in everyday life in order to stay healthy seem to be important. On the other hand, differences in the quality of medical services for serious illnesses and access to expensive treatment and high-tech solutions do not seem to play an important role for health inequality.

A second related interpretation of the results in Figure 3 refers to the role of the individual in the medical system; i.e. the way people behave and the way they are treated in the (Danish) medical system, depending on their health status: in the initial phase they rather have none or only a loose and voluntary contact to the medical services, because they are healthy or only have minor problems. At this stage, SES matters much for the process of health decline and for subsequent mortality because careful prevention and early treatment is not the standard case. The patient might have to ask for help and to pay for it. Only much later in the process of health decline do severely ill people with a high mortality risk finally get the full range of high quality services independent of their social class. This might be, first, because even non-compliant patients finally follow the necessary treatments, or, second, because health insurance only pays and the service providers only earn enough money when the patient is already very ill. This interpretation would imply a serious dysfunction of incentives and a misallocation of resources in the medical system.

In conclusion, this study reveals an important dimension for the impact of SES on health, namely the person's health status. Health deterioration is not only an important continuum for the medical perspective on physiological processes, where more advanced health deterioration seems to imply more independence from external factors. From a sociological perspective it is also a continuum that goes from private (healthy) life, where the individual is sovereign but, depending on social class, preventive resources might not be available, to severe illness and complete submission under an

intense variety of medical treatment and services. According to this study the explanation for SES health differences lies in earlier stages of this process. Future research should diversify and test the empirical basis and thereby examine the correctness of these conclusions.

Rasmus Hoffmann
Max Weber Fellow 2008-2009

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