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Why a positive link between age and income-related health inequality?

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Abstract

This study uses Swedish data to analyze why the SES-health gradient increases with ageing. Since different measures of SES and health capture different aspects, we use this information to explore the age increase in health inequality and to discriminate between three types of explanations, namely: *i)* age increase in the causal SES effect; *ii)* reversed health effect on SES, and *iii)* lifecycle variation in the measurement errors in SES and health.

Thus, our analysis points in the direction that the age increase in health inequality is primarily caused by a reversed causality going from health to annual income, and the probable mechanism is health affecting the labour supply of the individual. In addition the study report that the age variation in health inequality seem to have increased over time, and during the 1980th the age variation was rather limited. The evidence in our study is not conclusive, but all evidence documented agrees and supports this conclusion.

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1. Introduction

Numerous studies report existence of a persistent socioeconomic status (SES)-health gradient in every country, and regardless of SES and health outcome measures (see for example; Baum and Ruhm, 2009; Buckely et al., 2004; Deaton and Paxton, 1998; Gerdtham and Johannesson 2000,2002, 2004; Smith, 2004; van Doorslaer et al.,1997; Wagstaff and van Doorslaer, 2000; van Doorslaer and Koolman, 2004). However despite undisputed existence of socioeconomic inequality in health and a long-standing debate about causal impact of different factors and also despite wide health policy concerns about the health inequality in a number of governments,[1] their remain little conclusive evidence about the underlying mechanisms behind the observed health inequality (e.g. Smith 1999; Deaton 2002; Cutler et al., 2008).

It is also well known from several studies that the unequal distribution of health between SES groups increases with age (Baum and Ruhm, 2009; Case and Deaton, 2005; Deaton and Paxton, 1998; Islam et al. 2009). For example, Case and Deaton (2005) demonstrate that for the US the SES-health gradient increases up to the age of 55 and narrows after that. But, again, less is known *why* the SES-health gradient increases with ageing and whether the gradient has changed over time. The effect of SES on individual health may of course causally increase with ageing, e.g. having a low education level and/or a low income makes one more prone to a risky lifestyle that gradually affects ones health. But the relationship could as well run in the opposite direction; from health to SES. As Deaton and Paxton (1998) suggest, if labour supply and income are adversely and cumulatively affected by health shocks, ageing could increase the relationship between health and income.[2] Recent studies support the argument that the SES-health gradient primarily runs from health to income (Banks et al, 2007; Case and Deaton, 2005; Van Kippersluis et al, 2009; Smith 2005),

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[1] A less unequal distribution of health is a targeted goal of the European Union.
[2] Heath inequality does generally also increase due to retirement behaviors affecting current income (the retired have a low health level and a low income). Thus the magnitude of health inequality in the population may partly depend on the design of the pension system as is exogenous to the individual, i.e. even if the SES-health gradient might decrease in the older age group due to that low health may not directly impact on income.

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and operates through employment. Moreover, Cutler et al. (2008) stress that one has to take the life-cycle into account when modelling causality of the SES-health gradient.

A third explanation could be that the positive age increase in the SES-health gradient is related to measurement errors in both the SES variable and the health variable. Few studies have explored the influence of measurement errors as a candidate for explaining the life cycle variation in health inequality. For example, for males in Sweden current income is around the age of 34 the best measure of lifetime income (Böhlmark and Lindquist, 2006).[3] In the case of health it is difficult to find a health measure that is useful over the entire adulthood (for a discussion see Deaton and Paxton, 1998). Therefore, due to lifecycle variation in the measurement errors in the SES and health variables the gradient, might vary with age.

This study uses Swedish data to explore and to disentangle between the three types of explanation for a positive relationship between age and health inequality, namely: *i)* age increase in the causal SES effect; *ii)* reversed health effect on SES, and *iii)* lifecycle variation in the measurement errors in SES and health. Since different measures of SES and health capture different aspects, we use this information to explore the age increase in health inequality and to discriminate between the three types of explanations, e.g. that annual income fluctuate over time while education generally remains stable. Hence, compared to other studies on the age increase in health inequality our study contributes with improved understanding by being one of the first studies to compare, in the same dataset, various SES and health outcome relationships.[4] We should point out that our aim is not to document whether the effects of SES on health are causal, but rather to identify what determines the *age increase* in health inequality.[5]

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[3] For a further discussion regarding the measurement error in income see for example Grawe (2006).
[4] Most similar to us is a study by Van Kippersluis et al. (2009).
[5] The underlying SES effect could of course still be an association that is overestimated due to a standard ability bias.

Firstly, since health shocks do not affect a fixed socioeconomic measure as final education level the relationship between final education level and health should not increase by ageing due to reverse causality between the variables.[6] Even if it is commonly believed that health inequality exists irrespectively of the SES measure few studies, who examine the life-cycle perspective in health inequality, focus on education as the SES measure. An exception is van Kippersluis et al. (2009) who find, when using educational attainment as their SES measure, for men (but not for women) in the Netherlands an age increase in health inequality. Moreover, for final education level the measurement error may be much smaller than for current income. Therefore for different age groups we estimate and compare the income[7] and education effects on health. Hence, if the age increase in socioeconomic health inequality is caused by reversed causality and/or measurement errors we expect the age increase to be much smaller for final education level than for current income. By also using permanent income[8] we further examine whether the age increase in socioeconomic health inequality might be related to measurement errors in the independent variable.

Secondly by using different health outcome indicators the measurement error in health is addressed. We primarily use a cardinal EQ-5D type health measure (see below)[9], BMI[10] and mortality, but to some extend we also investigate the relationship between SES and exercise/smoking. Whereas BMI is a health indicator that is plagued with measurement errors, mortality is per definition correctly measured (either you live or you are dead). Also, since the mechanism underlying the different health and SES relationships might vary we expect to

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[6] This is true at least for those who have reached final education level. The educational skills per se could however deteriorate due to poor health even if the level is unchanged.

[7] We use register data on income. For comparability between the SES measures we use individual income and not (as most other similar studies do) household income.

[8] Permanent income is the average income of, at least, three different yearly incomes.

[9] We have also used self-reported health. The result for self-reported health turns out to be very similar to the results for the EQ-5D-type measure and therefore we only focus on the latter measure. But it should not be neglected that self-reported health and EQ-5D measure provide similar results, which is, on its own, an interesting finding regarding the measurement error in the health variable. These results are available upon request.

[10] Here we have also looked at overweight and obesity. Whereas the risk of overweight gives identical results as BMI, the small fraction of obese individuals (especially in the younger age groups) hinders the analysis.

learn more about the age increase in health inequality. For example, financial constrains determining whether one can afford a healthy diet may be a relatively strong predictor of the person's BMI. As well, since dying is definite mortality cannot directly be a predictor of ones socioeconomic position.[11]

Since health seems to affect income through employment (Banks et al, 2007; Case and Deaton, 2005; Smith 2005; Van Kippersluis et al, 2009), by estimating the respective relationships for only the working population, i.e. by excluding unemployed, retired and early-retired individuals, we further address the issue with reversed causality. For example, if a health shock affects income through early-retirement this type of reversed association between health and income is ruled out.[12] However, when excluding the group with the lowest health, i.e. the early-retired, we analyze a subgroup of individuals for which the age-health inequality relationship could differ. By studying nonlinearity in the relationships we analyze whether this is a problem.

Finally, the study analyzes whether the age increase in health inequality has changed over time by estimating the SES-health relationship for the 1980th, the 1990th and the 2000s.

The study uses Statistics Sweden's Survey of Living Conditions (the ULF) which contains a random sample of adults, interviewed between 1980 and 2005. Thus, by using longitudinal data we control (along with other covariates) for both age and time fixed-effects.[13] By having longitudinal data we could estimate a panel data fixed effects model, but to analyze the age increase in health inequality this is not an appropriate specification since such a model would eliminate the effects of interest in this paper. Furthermore, by restricting the analysis to the ages 20 to 64 we try, in some sense, to limit potential channels for which

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[11] Mortality is, however, also a measure of past health which is of course a potential predictor of ones socioeconomic position.

[12] Since health shocks do not affect final education level excluding the unemployed, retired and early-retired should not affect the relationship between education and health.

[13] An alternative would be to control for cohort and time fixed-effects, but it is not possible to control for cohort, age and time simultaneously.

SES could affect the health of the individual, i.e. we isolate our focus to health inequality among the working ages.

2. Data

The study uses Statistics Sweden's Survey of Living Conditions (the ULF). The ULF is a survey of living conditions and contains a random sample of adults in the ages 16 to 84. Interviews had been carried out annually between 1980 and 2005 and with the waves 1980/81, 1988/89, 1996/97 and 2004/05 data provide us with a complete panel of individuals. About 3,875 individuals are present at the four waves and totally the ULF contains 119,019 individuals or 167,116 observations.

Our study restricts the sample to the working ages, i.e. 20 to 64, which decreases the sample to 87,701 individuals or 120,002 observations. For students the measurement error in final education level and current income (as a measure of lifetime income) is large. Hence, by excluding 10,776 students[14] the sample contains 80,206 individuals or 108,610 observations. Finally we exclude those with an annual income of zero with leaves the sample to 72,256 individuals or 98,556 observations.[15] Since everyone in Sweden has some means for consumption[16] an annual income of zero is in some sense peculiar, and indicates a measurement error of some kind. Information regarding BMI and exercise are only collected in the panel sample so for these outcomes we lose another 50 to 60 percent of the sample.[17]

Buckley et al. (2004) argue that a wealth variable is preferred to an annual income variable, because wealth captures the continuous influence of ones financial resources better. It is true that a wealth variable partly measure something else than annual income does, but since the financial argument is only, and not necessarily the most important, explanation for

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[14] Those doing military service, 616 observations or 378 individuals, are here also excluded.
[15] Also, 187 individuals or 274 observations are lost because there is missing values for the education variable.
[16] Either you receive a social security benefit or you have a partner who supports you.
[17] For the outcome non-smoking we lose less than one percent due to missing values.

health inequality we prefer the (in many respect more standard) annual income measure, which better predicts productivity and job status. Also, with the aim of estimating the income effect at different periods of life we use a measure that fluctuates, i.e. we want to keep the life-cycle variation. Since we want to compare the income-health relationship with the education-health relationship we want to use individual measures in both cases. Thus, in comparison to most other studies in the area we do not use household income but individual income.[18] Statistics Sweden provides us with an annual income measure that contains income from employment and business and transfers.[19]

However for analyzing whether the age increase in health inequality is caused by measurement errors we also use a permanent income measure, that is we compute an average of (at least) three yearly observations of the individual's annual income. This income measure is thus only calculated for the sample belonging to the panel.

Our educational attainment variable is constructed according to SUN (Swedish Educational Terminology), the standard system for classifying education in Sweden and contains the following years of schooling; eight, nine, eleven, twelve, fourteen, sixteen and eighteen. Since we exclude student we assume (at least for those above the age of 25) that the education measure is final education level.

Our main health variables are a cardinal EQ-5D type health measure, mortality and BMI. The cardinal health measure is obtained by mapping subjects' responses to selected ULF survey interview questions into the generic health-related quality of life instrument, the EQ-5D measure (EuroQol Group 1990). This procedure, which aimed to identify existing survey questions measuring the same dimensions of HRQoL as the generic instrument EQ-5D. For this exercise, we used the same algorithms as used in three recent studies by Burström and colleagues (Burström *et al.* 2001, 2003, and 2005) and also Islam et al. (2010),

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[18] The results for income do however not differ much when using household income instead of individual income.

[19] Transfers include pension payments, unemployment benefits, paid sick-leave and housing assistance etc.

for the Swedish population. After mapping respondents in the ULF survey to the five dimensions (mobility, self-care, usual activities, pain/discomfort, and anxiety/depression) of EQ-5D, we obtained a description of their health status along these dimensions. We then used scores of health-related quality of life derived from the UK EQ-5D value set to obtain values for the health states (1=full health, 0=dead), as there is no Swedish TTO value set for EQ-5D health states (Dolan. 1997). As the utilities were obtained through a mapping procedure, we refer to them here as *health scores* to distinguish them from standard EQ-5D value sets.

BMI is constructed according to the standard methodology, i.e. weight(kg)/height(m)². We could as well have looked at the probability of overweight (BMI over 25) and/or obesity (BMI over 30), but since overweight gives identical results as BMI and there are too few obese individuals we only focus on BMI.

Since the interviews in the panel are performed every eighth year the mortality indicator is constructed so that if one dies during the following eighth year the individuals is classified as deceased. By constructing such a mortality variable we exploit more of the variation in data compared to using an indicator variable measuring only whether the individual decease during the entire time period. The incident in the analysis is however the probability to survive the next period of eight years.

The respondents are asked if they are a daily smoker. But for the SES effect to go in the same direction as for the other dependent variables the outcome to study is (daily) non-smoking instead of (daily) smoking. The exercise outcome is ordered according to five (1 to 5) levels of exercise; no exercise, occasionally, regularly (1 time/week), regularly (2 times/week), often (at least 2 times/week).

Table 1 report summary statistics for the main variables used in the study. For finding out whether there are life cycle variations the statistics are reported separately for five-year

age groups. Table 1 show, as expected, that the health score measure decreased over the life cycle, and that BMI and the probability of deceasing increases with age.

Table 1. Descriptive statistics

					Age group:				
Male	*20-24*	*25-29*	*30-34*	*35-39*	*40-44*	*45-49*	*50-54*	*55-59*	*60-64*
N	4,594	5,703	6,403	6,556	6,364	6,001	5,489	5,017	3,986
%	9.2%	11.4%	12.8%	13.1%	12.7%	12.0%	10.95%	10.01%	7.95%
Health Score	.946	.94	.93	.929	.915	.902	.879	.858	.846
	.002	.002	.002	.002	.002	.003	.003	.004	.004
BMI	23.319	24.146	24.748	25.125	25.432	25.698	25.814	26.09	26.086
	.072	.068	.064	.066	.067	.066	.072	.076	.082
Mortality	.002	.003	.004	.006	.011	.016	.028	.043	.064
	.001	.001	.001	.001	.001	.002	.002	.003	.004
Non-smoking	.773	.776	.748	.745	.713	.722	.719	.735	.750
	.006	.006	.005	.005	.006	.006	.006	.006	.007
Exercise	3.251	3.213	3.013	2.929	2.931	2.891	2.864	2.893	2.863
	.031	.026	.024	.023	.023	.023	.024	.024	.027
Ln Income	7.212	7.525	7.625	7.671	7.711	7.724	7.703	7.619	7.232
	.011	.009	.01	.011	.011	.012	.013	.014	.021
Years of schooling	11.454	11.886	12.011	11.948	11.832	11.612	11.292	10.995	10.701
	.021	.026	.028	.03	.032	.034	.036	.038	0.043
Retired	.001	.003	.007	.01	.014	.026	.045	.089	0.372
	0	.001	.001	.001	.001	.002	.003	.004	0.008
Unemployed	.143	.078	.061	.048	.042	.043	.041	.038	0.053
	.005	.004	.003	.003	.003	.003	.003	.003	0.004
Women									
N	4,279	5,564	6,122	6,416	6,229	5,999	5,392	4,773	3,669
%	8.8%	11.5%	12.6%	13.2%	12.9%	12.4%	11.1%	9.9%	7.6%
Health Score	.923	.923	.911	.907	.89	.872	.853	.823	0.814
	.003	.002	.003	.003	.003	.003	.003	.004	0.005
BMI	22.057	22.568	22.992	23.32	23.755	24.141	24.607	25.123	25.359
	.082	.077	.077	.072	.077	.079	.081	.085	0.097
Mortality	.001	.003	.004	.004	.008	.011	.017	.026	0.034
	.001	.001	.001	.001	.001	.001	.002	.002	0.003
Non-smoking	.668	.71	.71	.7	.704	.699	.723	.758	0.8
	.007	.006	.006	.006	.006	.006	.006	.006	0.007
Exercise	3.096	3.034	2.954	2.961	2.989	3.016	3.06	2.93	2.867
	.029	.023	.022	.021	.021	.022	.022	.023	0.026
Ln Income	7.032	7.184	7.208	7.259	7.367	7.407	7.386	7.29	6.946
	.011	.01	.01	.01	.009	.009	.011	.013	0.019
Years of schooling	11.467	12.081	12.179	12.013	11.829	11.628	11.277	10.886	10.534
	.023	.027	.028	.029	.031	.033	.035	.037	.041
Retired	.003	.004	.011	.017	.031	.048	.079	.133	.366
	.001	.001	.001	.002	.002	.003	.004	.005	.008
Unemployed	.145	.089	.074	.058	.047	.048	.04	.047	.054
	.005	.004	.003	.003	.003	.003	.003	.003	.004

Notes: Standard deviations are shown below the means. The sample sizes are smaller for BMI, Non-smoking and Exercise.

For women the probability of being a non-smoker seems to increase with ageing, but for men non-smoking is least common for the mid-ages of life (the ages 40 to 54). Exercising is generally more common among young people even though women in the ages 45 to 54 also seem to engage largely in exercise. Furthermore, the income of both men and women increases up to the age of 49, and then the income gradually falls. Table 1 do in addition report that younger cohorts are more educated.[20] Finally, the probability of early-retirement or retirement does of course increase largely with ageing, whereas the level of unemployment is much higher for young cohorts (and somewhat higher for the oldest cohort).

3. Results

For analyzing the age increase in health inequality we estimate a health equation based on pooled cross sectional data[21] where we use separate income variables for each age group. That is, we estimate the following equation:

$$Health = \alpha_n Age_n + \lambda_j Year_j + \sum_{m=1}^{9} \delta_m \beta_m SES + \gamma X + \varepsilon \qquad (1)$$

where we create M dummy variables δ_m, where $m \in [1,...,9]$, one for each age group, and interact them with the SES measure. This means that for each age group we use a separate SES variable and β_m gives us the SES effect for each of the nine age groups. We allow for age and time differences in health by including age and time fixed-effects. With X we control for additional covariates.

The specification above is separately estimated for men and women and for each health-SES combination, i.e. where health score measure, BMI or mortality is regressed on either log

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[20] The youngest cohort is however relatively low educated, probably because these young individuals has still not reached final education level.
[21] Pooled in the meaning that we treat each individual-year observation as a single observation. We calculate clustered standard deviations.

annual income (and permanent annual income) or years of schooling. By using standardized[22] health variables we can easily compare the results for different relationships. The health-related variables exercise and smoking will as well be investigated.

The relationship between health and annual income

Figure 1, for men, and Figure 2, for women; illustrate the age variation in the (log)[23] income effect on different health outcomes. Together with Figure 3 and Figure 4 these figures report the main result of our study. For comparability we change sign of the income effects on BMI and mortality, otherwise these relationships go in the opposite direction compared to the health score measure.[24]

Before going into detail with the figures we start by studying Table A1 and Table A2. Table A1 and Table A2 report the age-specific income effects that are plotted in Figure 1 and Figure 2 (columns (3), (6) and (9)). In Table A1 and Table A2 different specifications of the model are reported, and the Figures use the income effects when estimating the relationships with a full set of covariates. When including covariates to the baseline models (with only age- and year-fixed effects) the income effects decrease, i.e. a negative intercept change occurs in the relationship between age and the income effect. This is true for both genders and the health score measure and BMI. For mortality the relationship is hardly affected by including covariates. However, it is primarily the education level of the individual that affect the income effect. Other studies also report that the income effect on health is relatively unaffected by the inclusion of covariates (see for example Buckley et al., 2004). Thus, observed characteristics do not seem to affect the age increase in health inequality.

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[22] That is, we normalize the variables by subtracting the mean and dividing by the standard error. For different health outcome the income or education effect are then comparable. Also, by using standardized variables ordinal computations of the health outcomes do not affect our results. The distinction between absolute and relative inequality is therefore inaccurate.

[23] As most other studies who use income as the independent variable we use the logarithm of annual income. This is however not all that important as we later find that the income effect is rather linear.

[24] Since a high BMI is, generally, negative (at least when above underweight) the income effect on BMI is accordingly negative.
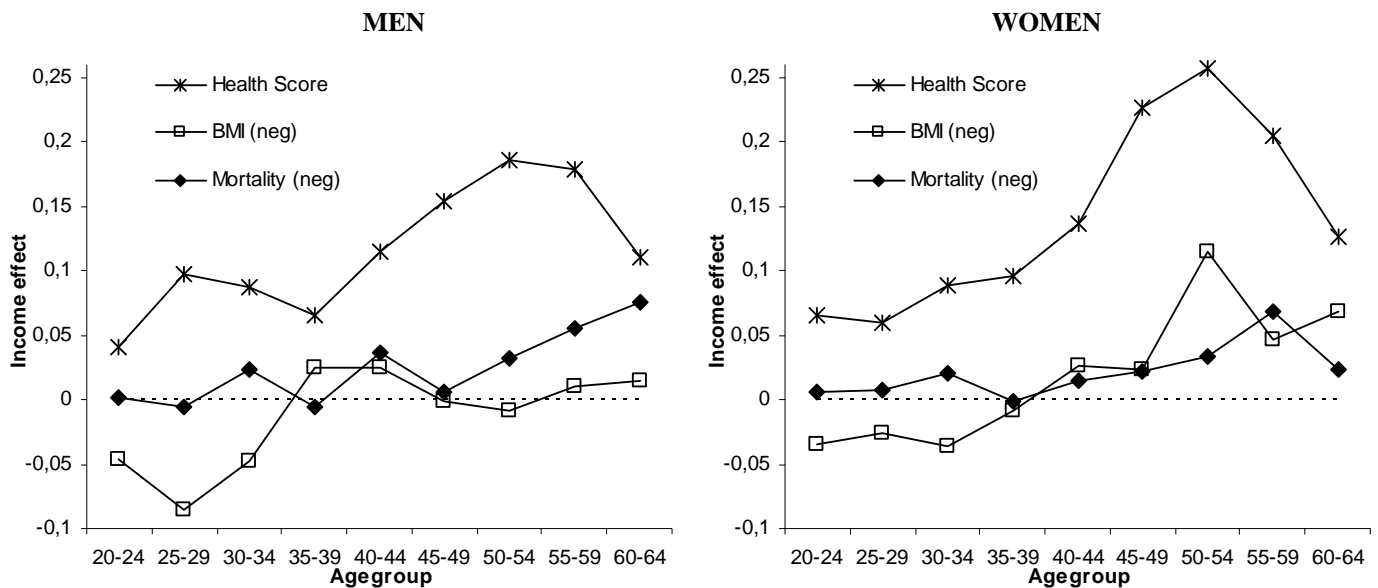
Figure 1 and 2. Illustrating the age variation in the relationship between income and health.

We head back to the results in Figure 1 and Figure 2 which are the main result of our study. The figures generally report that the expected age increase in health inequality is present (the income effect grows with age) and for health score measure the variation is particularly large.[25] For woman the age increase seems to be somewhat larger than for men. But there are clearly large differences in the relationships, and it is quite obvious that income affects the health score measure more than BMI and mortality.

But before comparing the health outcomes we further focus on the health score measure. Besides decreasing for the ages 60 to 64 (relatively the ages 45 to 59) the age increase in the income effects is substantial and fairly linear for the health score measure. The income effect is about four to five times higher for the ages 50 to 55 compared to the ages 20 to 29. The decrease in the income effect for the oldest cohort agrees with other results (see for example Case and Deaton, 2005), and the decrease is most likely linked to retirement behaviors[26] affecting current income. For men in the ages 25 to 34 there is a jump in the income effect.

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[25] For health score many of these income effects for different age groups are significant different from each other.

[26] That the most sick die of may also explain the low income effect for the oldest age group. For a subsample we are able to separate the retired and the early-retired, and by excluding the retired we find that the income effects are somewhat higher for the oldest age group.

What is causing the jump is unknown, but in the section *Time variation in health inequality* we find that it is totally related to things happening during the 2000s.

When focusing on BMI and mortality the income effects show a different pattern compare to the health score measure. Although few of the income effects are significant (or significant different from each other) for BMI the main picture is that there is, in particular, a difference in the income effects for the lower age groups (20 to 34 for men and 20 to 39 for women) compared to the higher age groups (35 to 64 for men and 40 to 64 for women). For women there is a tendency for a linear age increase in the income effect. For the lower age groups the income effects on BMI are negative,[27] which indicates that there is for younger cohort a positive relationship (since we have changed sign) between income and BMI and income and the probability of overweight.[28] In the case of mortality we find, particularly for men, significant income effect for the older age groups. But on overall the age variation in health inequality for mortality is very small.

A plausible mechanism for an age increase in health inequality (and health inequality at large) is that income may explain food expenditures, i.e. to afford a healthy diet ones need a high income. But if this was the driving mechanism for health inequality we would expect the age increase in the income effect on BMI to be as large (or larger) than the income effect on the health score. Since this is not the case the age increase in health inequality must primarily be due to some other explanation. By studying the education effects in health we pursue the task of finding the explanation.

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[27] It is only when controlling for education that the income effect on BMI turn negative for women.

[28] An explanation for this puzzling result concerns the measurement error in BMI. Since BMI is related to muscular mass a high BMI could partly be a proxy for exercise. Thus, according to this explanation the income effect in young ages goes (in relation to what is expected) in the opposite direction because BMI for young persons works as an indicator of good health instead of poor health. Since the negative income effect is larger (and only significant) for men, who often do more weight training than women, the explanation seem plausible. An alternative explanation concerns the labour supply and income of young cohorts. If persons with a low socioeconomic background pursue their working career instead of investing in higher education their income is relatively high at young ages. A high income at young age could therefore be negatively related to the individual's unobserved characteristics, and the income effect may in early ages turn up negative. But if this was the correct explanation we would expect a similar pattern for health score measure.

The relationship between health and education

Figure 3 and Figure 4 illustrate the lifecycle variation in the education effect on health.[29] The figures report no clear age increase in the relationship between years of schooling and health, [30] and in comparison to Figure 1 and Figure 2 (the income effects on health) there are apparent differences. On the other hand, Table A3 and A4 report that the education effects on the health score measure and BMI are significant. Hence, while education seems to determine the health of the individual the effect does not increase with age. The result divert from the result in Van Kippersluis et al. (2009) who find for men an education-health relationship that increase with ageing.
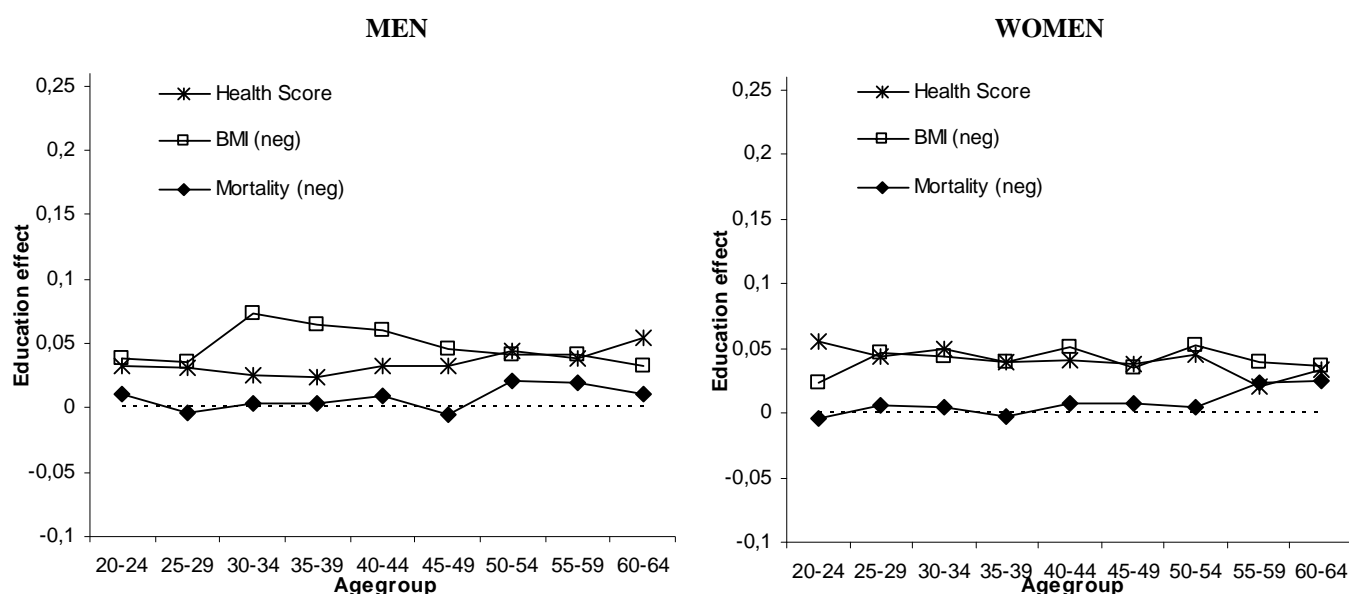
Figure 3 and 4. Illustrating the age variation in the relationship between education and health.

Exercise and non-smoking

If SES is affecting ones health behaviours the importance of SES might increase with age due to a cumulative SES effect where a risky lifestyle gradually affects ones health (Deaton, Cutler etc). Thus, in Figure 5 and Figure 6 we investigate if the SES effects on exercise and

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[29] Table A3 and Table A4 estimate the different education-health relationship with and without covariates. With covariates a small intercept decrease of the age-health inequality take place.
[30] For males' health score and mortality there might exist a very small age increase in the education effect.

non-smoking[31] increases with age. In Figure 5 we find the relationships between income and exercise/non-smoking and in Figure 6 we find it for education and exercise/non-smoking.

The figures show that there generally exists a positive SES-exercise/non-smoking gradient, which implicate that the SES effects on health may partly run through behavioural channels. Somewhat surprisingly we do however not find the SES associations to increase with ageing. Contrary, the SES effects, especially for non-smoking, seems to decrease with age. For women the income effect on non-smoking even turn significantly negative for those above 50, i.e. smoking is among the older cohorts of women more common in the higher part of the income distribution. Discovering that there is a more pronounced SES gradient in young age compared to old age, argue that the age increase in health inequality is not related to the fact that high SES groups tend to improve (they rather deteriorate) their health behaviours with ageing.

MEN   **WOMEN**
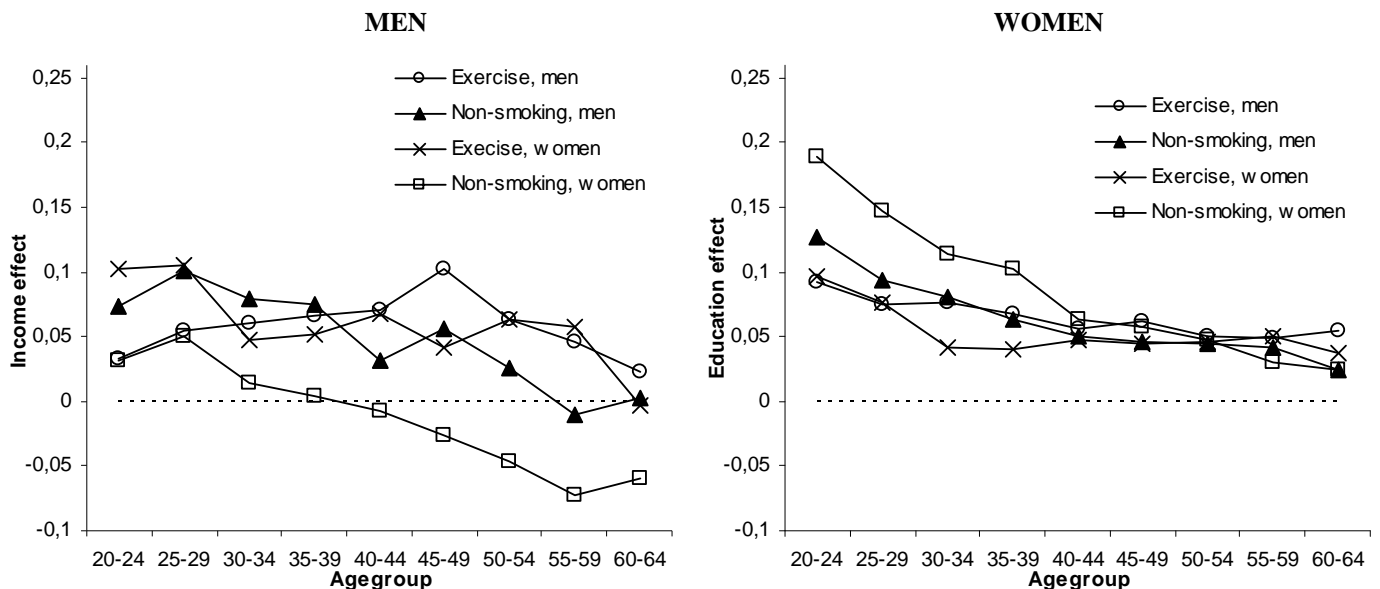
Figure 5 and 6. Illustrating the age variation in the relationship between SES and exercise/non-smoking.

Reversed causality or measurement error?

The result differences between income and education display that there is something quite different going on in the relationship between education and health relatively to the

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[31] By studying non-smoking instead of smoking the SES effect goes in the same direction as for the other dependent variables.

relationship between income and health.[32] By assuming that reversed causality[33] is not (or only marginally) affecting the education-health relationship and that the measurement error in final education level is minor we can draw two conclusions; *i)* the age increase in health inequality is either caused by reversed causality and/or lifecycle variation in the measurement error in current income, and *ii)* there is no causal age increase in health inequality.[34] An opposite age variation in health inequality for exercise and non-smoking, and no age increase in health inequality for mortality (as already mentioned dying is definite and cannot affect ones SES), also support the notion of reversed causality being the prime explanation behind the age increase in the income effect on health (health score measure).

To try to analyze whether reversed causality or lifecycle variation in the measurement error in current income is causing our (with age) increasing income effect we use permanent income (with less measurement error) instead of current income as our income measure. If the income effect when using permanent income increases for the young cohorts (for which the measurement error might be substantial) relatively to the older cohort it indicates that the age variation in health inequality is related to measurement errors in current income. Figure 7 (for men) and Figure 8 (for women) report that the lifecycle variation in income effects for the health score measure rather strengthens than diminishes when using permanent income instead of current income. The lifecycle variation in the income effects for BMI and mortality do however weaken. Hence, from this we conclude that measurement errors in the income variable do not seem to cause the age variation in health inequality.

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[32] Since health inequality primarily seems to be related to income, the rest of the analysis only focuses on the relationship between income and health.

[33] And as there is hardly any lifecycle variation in the education effect a health chock is probably not affecting the educational-skills either.

[34] However, these conclusions hinges on the assumption that the potential causal mechanisms behind the income effect and the education effect is the same. Since we find that the lifecycle variation in the income and education effects on exercise and non-smoking are comparable it indicate similar mechanisms.
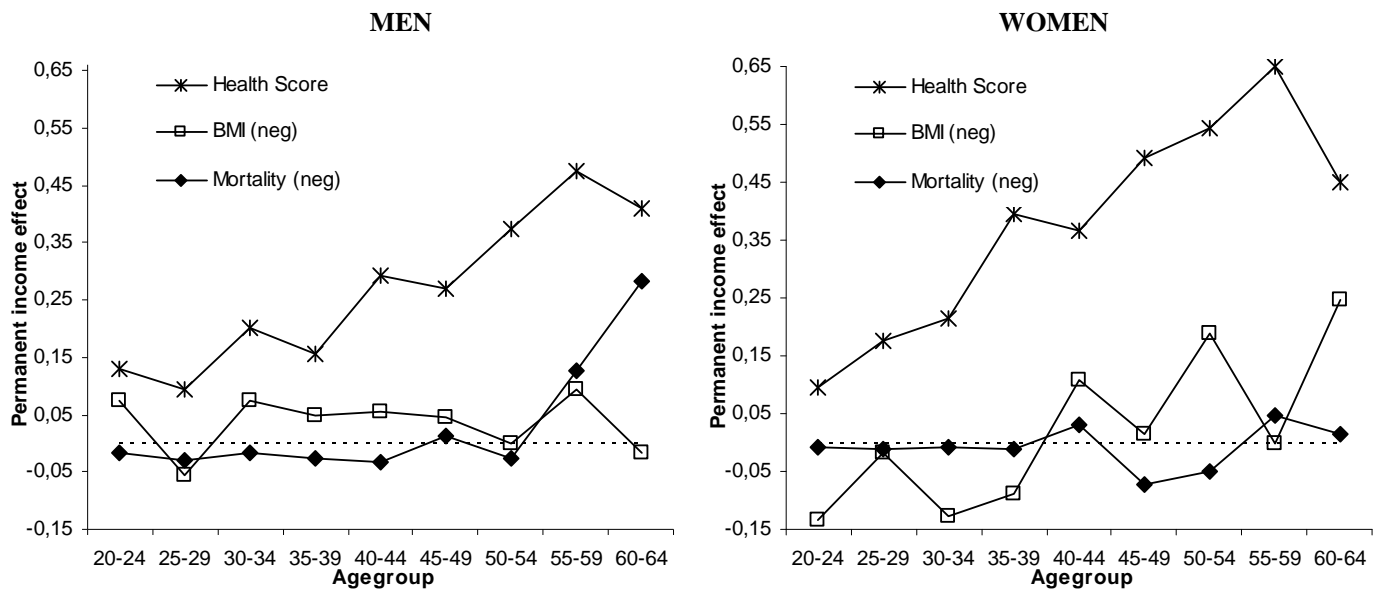
MEN

WOMEN

Figure 7 and 8. Illustrating the age variation in the relationship between permanent income and health.

Excluding the unemployed, retired and early-retired

Thus, so far our analysis has shown that the age increase in health inequality primarily seems to be related to reversed causality. This is an important and rather surprising result that needs to be further analyzed. The next step of the analysis is therefore to estimate the relationships for only the working population. When excluding the unemployed, the retired and the early-retired, the extent to which current income is affected by health shocks is constrained.[35] As pointed out, this analysis will be performed only for the income-health relationship since education is not in the same way as income affected by labour market status.[36]

In Figure 9 for men and Figure 10 for women, the age variation in the relationship between the health score measure and income are illustrated when excluding the unemployed, the retired and the early-retired. For comparability, the figures also contain the relationships for the entire population (the relationships illustrated in Figure 1 and 2). In the appendix, Figure A1 and Figure A2 contains the results for BMI and mortality. For health score measure we see that much of the age increase in health inequality vanishes when restricting the sample

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[35] Another way would be to control for these factors in the regression. Doing this provide very similar results as when excluding the unemployed, retired and early-retired.

[36] The relationship between health and education is almost unaffected by excluding the unemployed, the retired and the early-retired.

to the working population. It does not show from the figures, but the decrease in age variation is almost entirely caused by excluding the retired and the early-retired.[37] A similar decrease is not observed for BMI and mortality. But since weight problems are not directly related to the probability of retiring (and therefore ones income), reversed causality is reasonably not an important mechanism in the case of BMI. Together these findings are additional evidence for reversed causality being the primary explanation for the age increase in health inequality.
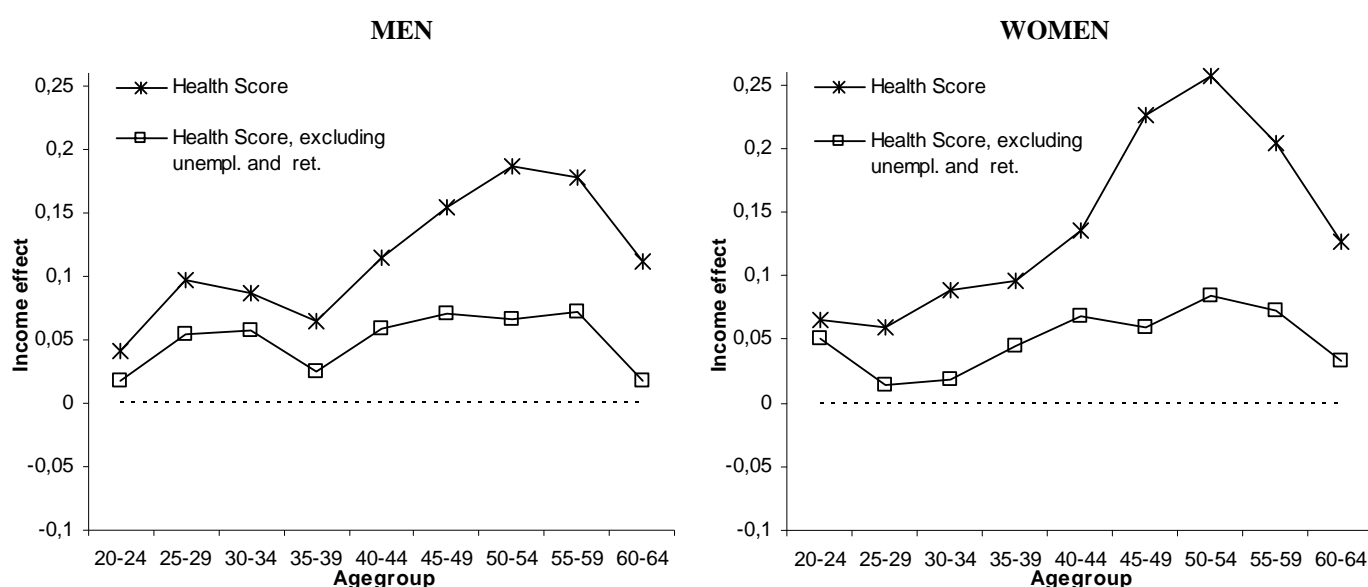
Figure 9 and 10. Illustrating the age variation in the relationship between health score and income when excluding the unemployed, retired and early-retired.

Nonlinear income effect

However, here we exclude the group with the lowest health and analyze a relatively healthy subgroup of individuals. With nonlinearities in the relationship between log income and health this might be a problem. Hence, in excluding the unemployed, the retired and the early-retired we might confuse the influence from reversed causality with the influence from a sample change. That is, for the working population we might, to a larger extend, measure the income effect at a higher segment of the income distribution compared to when including unemployed, the retired and the early-retired.

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[37] We cannot separate between the retired and the early-retired.

The next step is thus to investigate whether the income effect is linear and if a sample change could affect our results. Since BMI and mortality is unaffected by our restriction, we further narrow our analysis by only studying the relationship between income and health score measure. The method for analyzing the income effect nonlinearly is to construct ten dummy variables, each representing a decentile of the individuals' income distribution. The discrete income effects are estimated for the entire sample, i.e. we do not estimate separate effects for each age group.

Figure 11, for men, and Figure 12, for women, illustrate the estimated discrete income effects. The figures contain the discrete income effects on health score, for the total sample and for only the working population. When studying the results for the total sample we find that the income effects are more or less linear. It is only the health increase between the first and second income decentile for men, which seems to divert from the main picture. The conclusion is therefore that excluding subgroups should not affect the estimated income effects due to nonlinearities.
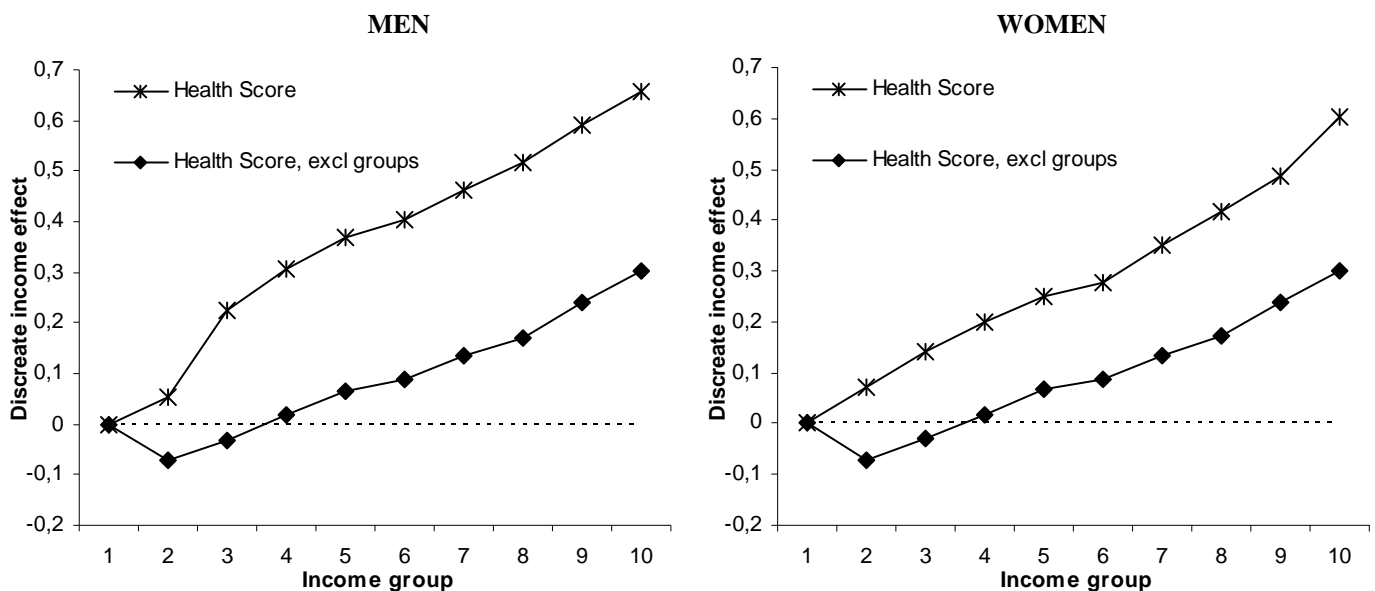

Figure 11 and 12. Illustrating the discrete income effect on health score.

However, when restricting the sample to the working population the discrete income effects decrease substantially. For the lower part of the income distribution the income effects turn up

small (and for men in some cases even negative), thus indicating that in the working population, there is only small health differences among the population belonging to the lower part of the income distribution.

Time variation in health inequality

Deaton and Paxton (1998) reports that health inequality has increased over time. As far as we know of, no one has studied whether there also has been an increase in the relationship between age and health inequality over time. By separately estimating the relationship between income and health for each decade; the 1980th, the 1990th and the 2000s, we examine if the age increase in the relationships varies over time.

Figure 13 for men and Figure 14 for women report the age variation in the income effects for each decade. The health inequality for health score does for both genders increase with time. During the 1980s the age increase in health inequality (for health score) is relatively small, but it increases with time, and during the 2000s the age increase in health inequality (for health score) is particularly large for women (and for women over 40 the income effects are significant higher during the 2000s compared to the 1980th). On the other hand, during the 2000s, health inequality (for health score) for men is rather constant (but significant higher than during the 1980th) over the ages (despite a negative income effect for the youngest age group).

Another interesting finding is that there is a relatively large income effect for the age group 30 to 34 during the 2000s. This is not observed for the earlier decades. So the relatively large income effect that we earlier found for men in the age groups 25 to 34 (Figure 1) exists also for women and is related to things happening during the 2000s.

MEN

WOMEN
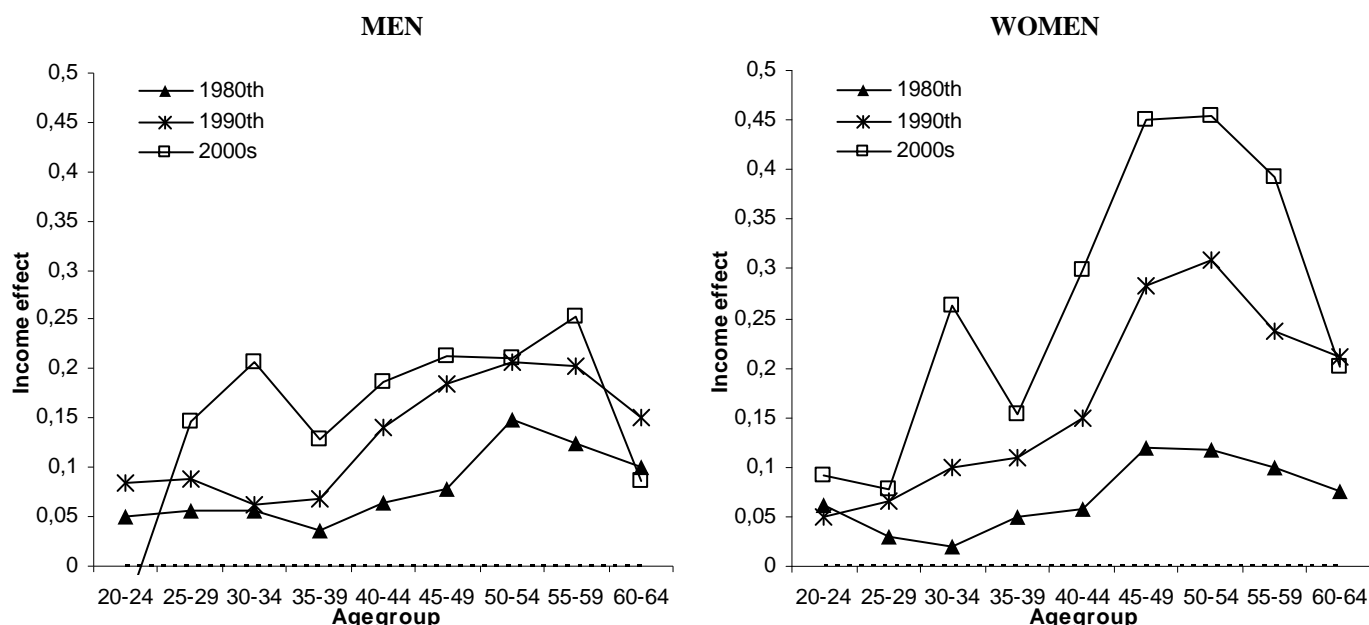
Figure 13 and 14. Illustrating the income effect on health score separately for the 1980th, the 1990th and the 2000s.

Conclusion

Our analysis points in the direction that the age increase in health inequality is primarily caused by a reversed causality going from health to annual income, and the probable mechanism is health affecting the labour supply of the individual. The evidence in our study is not conclusive, but all evidence documented agrees and supports this conclusion.

Firstly, since the age increase in health inequality does not exist for final education level, health inequality in Sweden do generally not seem to run from SES to health. Secondly, since the age variation does not seem to operate thought behavioural channels, or ones weight, the possible SES related channels for which SES might influence health is further limited. Also, we do not find any major increasing health inequality in mortality. These findings indicate that the age variation in health inequality is either caused by reversed causality or measurement errors in the income variable. However, the results when using a permanent income measure instead of current income report that measurement error in the income variable is not responsible for the age increase in health inequality. The final evidence indicating that it is health affecting income (and not the other way around), is that when

21

restricting the sample to the working population the age variation in health inequality decreases substantially, i.e. when excluding the sample where health, definitively, affects the income of the individual the age increase in health inequality is very small.

Still, the financial resources of the individual could obviously determine use of health care of the individual, but in Sweden with egalitarian health policies this is a rather unlikely mechanism for the age increase in health inequality (and a mechanism that, plausibly, would run also through the education level of the individual), even if there are some evidence of pro-rich distribution in doctors visit, i.e. despite the above mentioned egalilatarian policy goals (Gerdtham, 1997; Gerdtham and Trivedi, 2001; Doorslaer et al. 2006).

In addition the study report that the age variation in health inequality seem to have increased over time, and during the 1980th the age variation was rather limited. Our results including the latter finding have key policy interest for several reasons. One reason is that our result put emphasis of the effect of health on income in the explanation of the persistent socioeconomic health inequality as have been reported in an endless number of studies. This information is vital to policy makers in developing effective strategies to reduce socioeconomic inequalities in health (Deaton 2002). Another reason as may be more important to Swedish policy makers is that our report demonstrate that income and wealth consequences of ill-health and sickness appear to be more serious today than 25 years ago since the age trend in socioeconomic health inequality have increased over time which may be due to changes in the social security system over time.

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Table A1. Estimating the relationship between health and logarithmic income for different agegroups. Men.

Income effect for agegroup:	Health Score (1)	(2)	(3)	BMI (4)	(5)	(6)	Mortality (7)	(8)	(9)
20-24	0.043	0.044	0.041	0.050	0.050	0.046	-0.006	-0.006	-0.001
	(0.018)**	(0.018)**	(0.018)**	(0.028)*	(0.028)*	(0.028)	(0.009)	(0.009)	(0.009)
25-29	0.119	0.111	0.097	0.064	0.081	0.085	-0.002	0.000	0.005
	(0.019)***	(0.019)***	(0.019)***	(0.030)**	(0.030)***	(0.030)***	(0.006)	(0.006)	(0.006)
30-34	0.115	0.099	0.087	0.007	0.041	0.048	-0.030	-0.026	-0.024
	(0.017)***	(0.016)***	(0.016)***	(0.026)	(0.025)	(0.025)*	(0.015)**	(0.015)*	(0.015)
35-39	0.088	0.073	0.065	-0.061	-0.032	-0.025	-0.001	0.002	0.005
	(0.014)***	(0.013)***	(0.013)***	(0.027)**	(0.027)	(0.027)	(0.005)	(0.005)	(0.005)
40-44	0.140	0.123	0.115	-0.068	-0.030	-0.025	-0.043	-0.039	-0.037
	(0.016)***	(0.016)***	(0.015)***	(0.018)***	(0.017)*	(0.018)	(0.015)***	(0.015)***	(0.015)**
45-49	0.183	0.162	0.154	-0.052	-0.005	0.002	-0.013	-0.008	-0.006
	(0.018)***	(0.018)***	(0.018)***	(0.021)**	(0.021)	(0.021)	(0.014)	(0.014)	(0.014)
50-54	0.214	0.193	0.186	-0.034	0.003	0.008	-0.039	-0.035	-0.032
	(0.021)***	(0.021)***	(0.021)***	(0.029)	(0.030)	(0.030)	(0.019)**	(0.019)*	(0.019)*
55-59	0.199	0.184	0.178	-0.037	-0.016	-0.010	-0.062	-0.059	-0.056
	(0.021)***	(0.020)***	(0.020)***	(0.023)	(0.023)	(0.023)	(0.023)***	(0.023)**	(0.023)**
60-64	0.122	0.112	0.111	-0.039	-0.019	-0.016	-0.079	-0.077	-0.076
	(0.015)***	(0.015)***	(0.015)***	(0.022)*	(0.021)	(0.021)	(0.025)***	(0.025)***	(0.025)***
Schooling		0.030	0.027		-0.058	-0.050		-0.007	-0.006
		(0.002)***	(0.002)***		(0.003)***	(0.004)***		(0.002)***	(0.002)***
Married			0.131			0.002			-0.114
			(0.015)***			(0.022)			(0.017)***
Cohabiting			0.072			0.032			-0.084
			(0.013)***			(0.022)			(0.012)***
Children			-0.003			-0.003			-0.003
			(0.006)			(0.009)			(0.005)
Immigrant			-0.242			0.108			0.001
			(0.021)***			(0.029)***			(0.018)
Second gen. Imm (2)			-0.012			0.070			0.036
			(0.034)			(0.067)			(0.033)
Second gen. Imm (1)			-0.009			0.129			-0.033
			(0.022)			(0.042)***			(0.013)**
Region	no	no	yes	no	no	yes	no	no	yes
Parental background	no	no	yes	no	no	yes	no	no	yes
Observations	50,113	50,113	50,113	19,593	19,593	19,593	50,113	50,113	50,113
R-squared	0.09	0.09	0.10	0.09	0.11	0.12	0.03	0.03	0.03

Notes: Pooled regression models are estimated. The dependent variables are health score (columns (1) to (3)), BMI (columns (4) to (6)) and mortality (columns (7) to (9)). Age and year fixed effects are included in the specifications. Mortality is estimated with a linear regression model. Clustered standard errors are shown below the coefficients.

Table A2. Estimating the relationship between health and logarithmic income for different agegroups. Women.

	Health Score			BMI			Mortality		
	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)	(9)
Income effect for agegroup:									
20-24	0.077	0.071	0.066	0.024	0.035	0.036	-0.008	-0.007	-0.008
	(0.022)***	(0.021)***	(0.022)***	(0.030)	(0.030)	(0.030)	(0.007)	(0.007)	(0.007)
25-29	0.072	0.053	0.060	-0.022	0.009	0.029	-0.010	-0.005	-0.013
	(0.016)***	(0.016)***	(0.016)***	(0.025)	(0.025)	(0.025)	(0.012)	(0.012)	(0.013)
30-34	0.099	0.081	0.089	-0.012	0.023	0.039	-0.023	-0.018	-0.024
	(0.015)***	(0.015)***	(0.015)***	(0.026)	(0.025)	(0.026)	(0.017)	(0.017)	(0.018)
35-39	0.107	0.089	0.096	-0.024	0.000	0.010	-0.001	0.003	-0.001
	(0.015)***	(0.015)***	(0.015)***	(0.021)	(0.021)	(0.021)	(0.007)	(0.008)	(0.008)
40-44	0.149	0.128	0.136	-0.067	-0.036	-0.026	-0.018	-0.013	-0.015
	(0.019)***	(0.018)***	(0.018)***	(0.027)**	(0.026)	(0.026)	(0.012)	(0.012)	(0.012)
45-49	0.253	0.226	0.226	-0.070	-0.032	-0.024	-0.028	-0.021	-0.021
	(0.025)***	(0.024)***	(0.024)***	(0.027)***	(0.027)	(0.027)	(0.019)	(0.019)	(0.019)
50-54	0.283	0.254	0.257	-0.175	-0.127	-0.115	-0.039	-0.032	-0.034
	(0.025)***	(0.025)***	(0.024)***	(0.031)***	(0.030)***	(0.030)***	(0.031)	(0.032)	(0.031)
55-59	0.229	0.206	0.205	-0.098	-0.055	-0.047	-0.075	-0.069	-0.069
	(0.023)***	(0.023)***	(0.022)***	(0.029)***	(0.028)*	(0.027)*	(0.031)**	(0.031)**	(0.031)**
60-64	0.137	0.125	0.127	-0.097	-0.076	-0.069	-0.026	-0.023	-0.024
	(0.018)***	(0.018)***	(0.018)***	(0.023)***	(0.022)***	(0.022)***	(0.026)	(0.026)	(0.026)
Schooling		0.032	0.028		-0.052	-0.041		-0.008	-0.007
		(0.002)***	(0.002)***		(0.004)***	(0.004)***		(0.002)***	(0.002)***
Married			0.190			0.052			-0.058
			(0.013)***			(0.021)**			(0.014)***
Cohabiting			0.167			0.027			-0.053
			(0.014)***			(0.022)			(0.013)***
Children			0.027			0.007			-0.014
			(0.006)***			(0.009)			(0.004)***
Immigrant			-0.237			0.150			0.008
			(0.019)***			(0.030)***			(0.016)
Second gen. Imm (2)			-0.065			0.148			-0.016
			(0.042)			(0.063)**			(0.023)
Second gen. Imm (1)			-0.114			0.117			0.031
			(0.025)***			(0.040)***			(0.022)
Region	*no*	*no*	*yes*	*no*	*no*	*yes*	*no*	*no*	*yes*
Parental background	*no*	*no*	*yes*	*no*	*no*	*yes*	*no*	*no*	*yes*
Observations	48,443	48,443	48,443	18,884	18,884	18,884	48,443	48,443	48,443
R-squared	0.10	0.11	0.12	0.09	0.11	0.12	0.01	0.01	0.02

Notes: Pooled regression models are estimated. The dependent variables are health score (columns (1) to (3)), BMI (columns (4) to (6)) and mortality (columns (7) to (9)). Age and year fixed effects are included in the specifications. Mortality is estimated with a linear regression model. Clustered standard errors are shown below the coefficients.

Table A3. Estimating the relationship between health and education for different agegroups. Men.

	Health Score		BMI		Mortality	
	(1)	(2)	(3)	(4)	(5)	(6)
Education effect for agegroup:						
20-24	0.038	0.033	-0.049	-0.038	-0.009	-0.011
	(0.008)***	(0.008)***	(0.014)***	(0.014)***	(0.004)**	(0.004)**
25-29	0.038	0.031	-0.046	-0.036	0.005	0.004
	(0.005)***	(0.005)***	(0.010)***	(0.010)***	(0.003)	(0.003)
30-34	0.033	0.025	-0.083	-0.074	-0.006	-0.004
	(0.004)***	(0.004)***	(0.008)***	(0.008)***	(0.003)**	(0.003)
35-39	0.030	0.024	-0.074	-0.065	-0.006	-0.004
	(0.004)***	(0.004)***	(0.007)***	(0.007)***	(0.003)**	(0.003)
40-44	0.036	0.032	-0.069	-0.061	-0.011	-0.009
	(0.004)***	(0.004)***	(0.007)***	(0.007)***	(0.004)***	(0.004)**
45-49	0.036	0.032	-0.052	-0.046	0.003	0.005
	(0.005)***	(0.005)***	(0.007)***	(0.008)***	(0.005)	(0.005)
50-54	0.048	0.045	-0.048	-0.041	-0.022	-0.021
	(0.005)***	(0.005)***	(0.008)***	(0.008)***	(0.006)***	(0.006)***
55-59	0.042	0.039	-0.048	-0.041	-0.020	-0.019
	(0.006)***	(0.006)***	(0.008)***	(0.008)***	(0.008)***	(0.008)**
60-64	0.058	0.055	-0.038	-0.032	-0.013	-0.011
	(0.007)***	(0.007)***	(0.008)***	(0.009)***	(0.011)	(0.011)
Married		0.155		0.005		-0.119
		(0.015)***		(0.022)		(0.017)***
Cohabiting		0.086		0.035		-0.085
		(0.014)***		(0.022)		(0.012)***
Children		-0.006		-0.004		-0.002
		(0.006)		(0.009)		(0.005)
Immigrant		-0.269		0.106		0.007
		(0.021)***		(0.029)***		(0.017)
Second gen. Imm (2)		-0.012		0.071		0.037
		(0.034)		(0.067)		(0.033)
Second gen. Imm (1)		-0.012		0.129		-0.032
		(0.022)		(0.042)***		(0.013)**
Region	no	yes	no	yes	no	yes
Parental background	no	yes	no	yes	no	yes
Observations	50,113	50,113	19,593	19,593	50,113	50,113
R-squared	0.08	0.09	0.11	0.12	0.03	0.03

Notes: Pooled regression models are estimated. The dependent variables are health score (columns (1) to (2)), BMI (columns (3) to (4)) and mortality (columns (5) to (6)). Age and year fixed effects are included in the specifications. Mortality is estimated with a linear regression model. Clustered standard errors are shown below the coefficients.

Table A4. Estimating the relationship between health and education for different agegroups. Women.

	Health Score		BMI		Mortality	
	(1)	(2)	(3)	(4)	(5)	(6)
Education effect for agegroup:						
20-24	0.055	0.056	-0.038	-0.024	0.005	0.004
	(0.008)***	(0.008)***	(0.014)***	(0.014)*	(0.004)	(0.004)
25-29	0.046	0.043	-0.063	-0.046	-0.006	-0.006
	(0.005)***	(0.005)***	(0.009)***	(0.010)***	(0.004)	(0.004)
30-34	0.055	0.049	-0.056	-0.043	-0.006	-0.005
	(0.005)***	(0.005)***	(0.008)***	(0.008)***	(0.003)*	(0.004)
35-39	0.046	0.040	-0.053	-0.040	0.001	0.003
	(0.004)***	(0.004)***	(0.008)***	(0.008)***	(0.003)	(0.003)
40-44	0.046	0.041	-0.061	-0.051	-0.010	-0.008
	(0.004)***	(0.004)***	(0.008)***	(0.008)***	(0.004)**	(0.004)**
45-49	0.042	0.038	-0.044	-0.035	-0.010	-0.008
	(0.005)***	(0.005)***	(0.008)***	(0.008)***	(0.004)**	(0.005)*
50-54	0.047	0.045	-0.065	-0.053	-0.005	-0.004
	(0.005)***	(0.005)***	(0.008)***	(0.008)***	(0.006)	(0.006)
55-59	0.022	0.020	-0.051	-0.040	-0.024	-0.023
	(0.006)***	(0.006)***	(0.008)***	(0.008)***	(0.008)***	(0.008)***
60-64	0.034	0.034	-0.048	-0.036	-0.026	-0.025
	(0.008)***	(0.007)***	(0.010)***	(0.010)***	(0.011)**	(0.011)**
Married		0.182		0.054		-0.058
		(0.013)***		(0.021)**		(0.014)***
Cohabiting		0.169		0.031		-0.054
		(0.014)***		(0.022)		(0.013)***
Children		0.020		0.004		-0.012
		(0.006)***		(0.010)		(0.004)***
Immigrant		-0.250		0.150		0.012
		(0.019)***		(0.030)***		(0.016)
Second gen. Imm (2)		-0.071		0.150		-0.015
		(0.042)*		(0.063)**		(0.023)
Second gen. Imm (1)		-0.116		0.120		0.032
		(0.026)***		(0.040)***		(0.022)
Region	*no*	*yes*	*no*	*yes*	*no*	*yes*
Parental background	*no*	*yes*	*no*	*yes*	*no*	*yes*
Observations	48,443	48,443	18,884	18,884	48,443	48,443
R-squared	0.09	0.11	0.10	0.12	0.01	0.02

Notes: Pooled regression models are estimated. The dependent variables are health score (columns (1) to (2)), BMI (columns (3) to (4)) and mortality (columns (5) to (6)). Age and year fixed effects are included in the specifications. Mortality is estimated with a linear regression model. Clustered standard errors are shown below the coefficients.
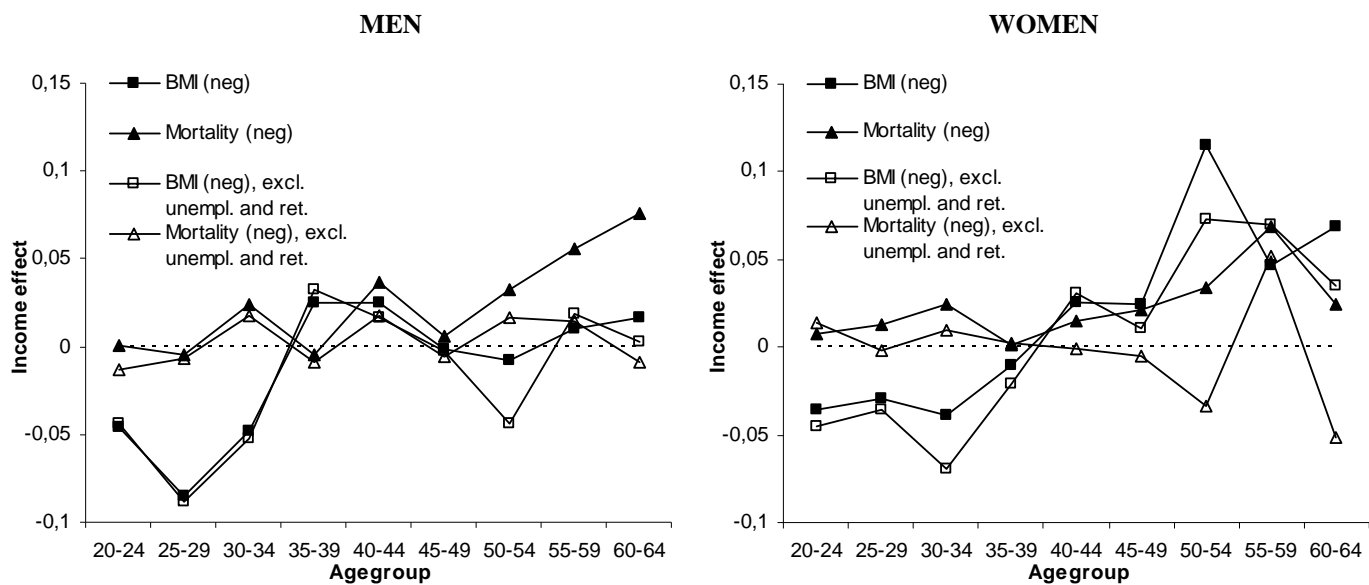
Figure A1 and A2. Illustrating the age variation in the relationship between BMI/mortality and income when excluding the unemployed, retired and early-retired.