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Explaining the difference in income-related health inequalities among the elderly in European countries using SHARE-data

– A cross-country comparison

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Abstract

This study provide insights into the sources of differences in the degree of income-related inequalities in self-assessed health in 10 European countries using data on an older population (aged 50 and above) from the *Survey of Health, Ageing and Retirement in Europe* (SHARE, 2004). The aim of this study is to compare the inequalities of this older population with a younger population used in van Doorslaer & Koolman (2004). The aim is also to look into the contributors of the measured degree of income-related health inequality. Therefore, this study replicates the methods used in van Doorslaer & Koolman (2004) as much as possible, i.e. measuring health by using an interval regression, cardinalisation of the health variable using the same cut-off points and decomposing the measured degree of income-related inequalities in health into its contributions.

Significant income-related inequalities in health favouring the higher income-groups emerge in all countries except Austria. Although, the income inequality is only significant for three countries, suggesting that other factors beside income are more relevant to explain the measured degree of income-related health inequalities. This is confirmed by the decomposition procedure which shows that factors such as higher education, retirement and economic inactive are the major contributors behind the total income-related health inequality.

This study also finds that, in general, health inequalities for the older population is higher compared to the younger population in van Doorslaer & Koolman (2004) but that the difference is maybe less than one would expect. Possible explanations to this could be differences in reference group, selective survivorship or the fact that institutionalised individuals are not among the target population in the SHARE survey.

Keywords: health inequality, self-reported health, decomposition, income inequality, interval regression

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1. Introduction

This chapter gives a background to why it is important to investigate inequalities in health for an older population. The purpose of this study, previous research and limitations are also presented.

1.1 Background

Western European countries have during the past 50 years witnessed considerable improvements in health – yet health inequalities related to socio-economic factors persist, e.g. between the better-off and worse-off (Masseria, et. al. 2006:2). These differences in health by socio-economic status have also quite recently been put at the forefront of the European Union's National Action Plans, as agreed upon at the Lisbon European Council (van Doorslaer & Koolman, 2004:609). It has also been stressed, for example in the World Bank's 2006 World development Report *"Equity and Development"*, that inequalities in health also affect and reinforce inequalities in other domains; together they act as a brake on economic growth (World Bank, 2006:29).

Also, over the past 50 years the number of individuals aged 60 and above has tripled worldwide and it is expected to triple again over the next 50 years. It has been calculated that for Europe in the year 2030, people aged 75 and above will account for 12 % of the population. This has naturally generated a concern related to health expenditure and the sustainability of national pension systems. (Rueda et. al., 2008:492)

Put it differently, by 2050 it is expected to be one elderly (defined as aged 65 and above) for every two people of working age (defined as aged 15-64) and the proportion of people aged 80 and above is expected to rise from today's (2004) 4 % in the EU-27 to over 11 % in 2050 (European Commission 2008:94).

A less unequal distribution of self-reported health by income quintiles (i.e. lesser income-related inequalities) therefore seems to be an important task for many European countries to tackle. Research specifically targeted to the older population also seems highly relevant, since it could help evaluate health care systems for the elderly in terms of its capacity to reduce income-related inequality (van Ourti, 2003:219). For example, knowing whether there are income-related inequalities in health among the elderly could help policy makers formulate health care policies.

1.2 Purpose and problem formulation

As noted in the previous section, it is expected that Europe will have a higher share of older individuals in the future compared to today.

With this background, the purpose of this study is to

Replicate van Doorslaer & Koolman's (2004) article using the same countries and methods, but using an older population to analyze what inequality is in an older population and investigate what explains inequality in this population

Three important questions arise from the above purpose, namely: (1) What are income-related inequality in self-assessed health (SAH) in an older population? (2) What explains the income-related inequality in health in this population? And (3) What is the difference between a younger and an older population?

These questions are investigated by replicating the methods in van Doorslaer & Koolman (2004). Questions (1) and (2) are investigated by means of interval regression, concentration indices, decomposition of health inequality and investigations into the different determinants' contributions to the measured degree of income-related health inequality. Underlying the empirical method is the theory of health production, introduced by Grossman (1972). The last question is investigated by comparing the results found in this study with van Doorslaer & Koolman (2004)

The data that are used is taken from *The Survey of Health, Ageing and Retirement in Europe (SHARE)*, wave 1, release 2.3.1.

The study is organized as follows: chapter 2 presents the concept of equity and how it can be measured, chapter 3 introduce the methods and the empirical model, chapter 4 describes the data and the variables created, chapter 5 presents the results and chapter 6 concludes.

1.3 Previous research

As this study investigates inequalities in self-reported health by socio-economic status (SES), it is therefore interesting to take a closer look at past research in this area.

There are numerous studies finding a positive relation between socio-economic status (SES)-health gradient[1] (see for example Wagstaff and van Doorslaer, 1994; van Doorslaer et al., 1997; Kakwani et al., 1997; Humphries and van Doorslaer, 2000; van Doorslaer & Koolman, 2004); so many that the relationship has come to be known as “the gradient” (Deaton, 2003). All of these studies are concerned with the overall population. As can be seen, there has been a vast research conducted on inequalities in health among the overall population but not much research can be found exclusively on the older population; e.g. with respect to social determinants of health (Rueda et. al. 2008:492).

There are however several methodological issues to tackle when analyzing the social determinants of health. The focus here will be on the health variable, namely the widely used measure of self-assessed health (SAH). Briefly, SAH is usually measured on a five-point scale, thus making it an ordinal variable[2]. This variable has shown to create problems measuring inequality in health using standard inequality indices (Madden 2010:244). Inequality in turn is usually measured by the concentration index[3] (*C*, hereafter) which requires information on health either in the form of a continuous or a dichotomous variable (van Doorslaer & Jones, 2003:62). The problem is called the ordinal scale problem. Therefore, one must either dichotomize the health variable (e.g. into a healthy/non-healthy variable) or by imposing some sort of assumption on the scaling.

Wagstaff and van Doorslaer (1994), van Doorslaer et. al. (1997) and Humphries and van Doorslaer (2000) uses a scaling approach to investigate inequalities in health. Van Doorslaer et. al. (1997) finds evidence on income-related inequalities in SAH in nine industrialized countries where inequalities favoured the higher income groups. Humphries and van Doorslaer (2000) applies the methods of Wagstaff and van Doorslaer (1994) to investigate and measure the presence of income-related inequalities in self-reported ill-health in Canada and they find significant inequalities favouring the higher income groups.

[1] A gradient is referred to as the relationship between health and income (Deaton, 2002:14)
[2] This is further investigated in the methods section
[3] The concentration index and its variants will be discussed in chapter 2

Gerdtham et. al. (1999) calculates health concentration indices from Swedish data and calculates the indices using three different health measures (Wagstaff and van Doorslaer's approach, rating scale method and a time trade-off method). The CI does not change much for these measures, thus supporting and validates Wagstaff and van Doorslaer's approach of constructing a continuous health measure to be used in the analysis of health inequality.

Van Doorslaer & Jones (2003) assess the internal validity of using the health utility index (HUI) "Mark III"[4] to scale the responses on the typical SAH-question: "How would you say your health is in general?". Their work is interesting since they compare different methods to impose cardinality on these ordinal[5] responses. They compare methods like: OLS, ordered probit and interval regression and find that the interval regression approach outperforms the other methods with respect to that unconditional and conditional descriptive statistics as well as the magnitude of the CI are closer to those predictions based on actual HUI data (van Doorslaer and Jones, 2003:85).

Van Doorslaer & Koolman (2004) extends the work by van Doorslaer & Jones (2003) and investigates the difference in income-related health inequalities across European countries (a cross-country comparison) using an interval regression approach to measure and explain inequalities in SAH. They also examine the potential causes of cross-country differences in income-related health inequality by decomposition methods. The work by van Doorslaer & Koolman (2004) are interesting from several aspects: (i) scoring SAH levels by the instrument HUI to obtain an index for SAH scores as utilities in the interval [0,1], (ii) the interval regression approach and (iii) decomposing health inequality into its contributors; to name a few. Overall, they find significant inequalities in health in all countries, favouring the better-off. They also find that the positive correlation with income inequality *per se* is significant but weaker than in previous research. Their decomposition analysis shows that the income elasticises of the independent variables are more important than their unequal distribution by income when it comes to explaining the differences in income-related health inequality.

Quite recently, a new survey specifically targeted to the older individuals in Europe, called the *Survey of Health, ageing and Retirement in Europe (SHARE)*, has made it possible to take a closer look at the older population.

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[4] The HUI is a health status index developed at McMaster University. It measures both qualitative and quantitative aspects of health (see Humphries and Doorslaer, 2000:666)
[5] An ordinal ranking means that we can rank something with respect to some order (e.g. 1st, 2nd etc) whereas a cardinal measure can also quantify the ranking (e.g. 1.5, 1.2, 1.0)

Tsimbos (2010) uses wave 1 from SHARE to analyze socio-economic (measured by income, wealth and education) inequalities in SAH among people aged 50 and over in Greece, Italy and Spain. This study dichotomizes the health variable and makes use of a logit regression to find that socio-economic position of individuals' declines with age and individuals with lower socio-economic status experience worse health in all instances.

Jürgens (2010) compares income-, wealth-, and education-related health inequalities in 11 European countries combining data from HRS 2002, ELSA 2002 and wave 1 from SHARE 2004. He uses the concentration index as the measure of socio-economic health inequality. The health variable used is a continuous physical health index. He also uses equivalent current annual household income as a stratifying variable. He finds that age-sex standardized CI:s for income-related inequalities in health is positively significant for all countries but two, namely Austria and Switzerland. He also finds that wealth-related inequalities in health are greater than the income-related inequalities in health.

A very recent study by Tubeuf & Jusot (2011) investigate wealth-related inequalities in health on data from SHARE wave 1 on 10 European countries by the use of an interval regression and by decomposition. The health variable used is SAH where they use cut-points from Jürges (2007). They find that wealth-related inequalities in health are present and that wealth itself is the most important factor for the measured degree of wealth-related inequalities in health.

1.4 Limitations

Naturally, this study is limited to the methods used in van Doorslaer & Koolman (2004). Though, bootstrapping techniques will not be used due to the time frame. Also, there are other variants of the popular concentration index (which is used in this study) that could be used. For example, there has been a lively debate in *Journal of Health Economics* lately where Erreygers suggest a correction of the concentration index and Wagstaff replies[6]. Also, as a final note; this study is limited to a static view[7] and therefore, no causal interpretations can be made.

[6] See *Journal of Health Economics* vol. 28 (2009)
[7] Due to the nature of the study being a cross-sectional analysis and that the models used are not derived from a structural model of health.

2. Equity and inequality

In this chapter the concepts of equity and inequality will be discussed briefly. This chapter serves as an introduction to the understanding of the importance of research focused on socio-economic inequalities in health.

Equity, or *fairness*, in health and health care is a major policy objective in almost every country but the definition of equity might very well differ across countries. The meaning and importance of equity depends on factors such as attitudes and cultural beliefs. Equity can for example be measured as equity in the finance of health care or equity in distribution, where the latter often concerns distribution in health care, health or utility. Since the focus of this study is inequalities in health, this chapter will mainly cover equity in distribution; and equity in the distribution of health in particular.

Equity in the distribution of health care concerns optimal ways of organising health care systems and the production of specific health care goods and services. But, as Grossman (1972) argues, health care is mainly demanded because of its impact and effect on an individual's *health*. It can therefore be argued that concerns about the distribution of health care arise from concerns about the distribution of health (Morris et. al, 2007:202).

When speaking of equity in the distribution of health, which focuses on health inequalities, we need some way to measure and define inequality.

The concentration index, *C*, is a widely used method for evaluating socio-economic inequalities in health (see Kakwani, 1980 and Wagstaff et. al. 1991). Extensions and corrections to this index have been proposed over the years. One is the *generalized* concentration index, *V* (see Wagstaff et. al. 1991), a second is the Wagstaff normalization, *W* (see Wagstaff, 2005), and most recently an index (*E*, hereafter) proposed by Erreygers (see Erreygers, 2009a and Erreygers, 2009b). It is however outside the scope of this study to go into details into these different versions of *C*; instead, some general facts will be presented. Also, *C*, will be described more in-depth in the following chapter.

C is a measure of *relative* socio-economic inequalities with respect to a health variable, where *C* is defined as twice the area between the concentration curve[8] and the diagonal. *V* on the other hand is a measure of *absolute* inequalities and it is equal to *C* multiplied by the mean of the health variable (Kjellsson & Gerdtham, 2011:5).

Erreygers propose a corrected version of the original concentration index and its variants, which he argues is superior to all the others (see Erreygers, 2009a and Erreygers, 2009b). Without going into details, Erreygers argue that his index is the only one which satisfies four desirable properties, namely: *transfer*, *mirror*, *level independence*[9] and *cardinal invariance*; where *W* satisfies all but level independence, *V* satisfies all but cardinal invariance and *C* satisfies only the transfer property. A recent working paper by Kjellsson & Gerdtham (2011) find that the property of level independence is desirable if there is a high risk of reporting heterogeneity. They also find that the choice of index matters in the sense that it affects the magnitude of measured inequalities and also internal rankings between countries.

For those interested in a more in-depth discussion between Wagstaff and Erreygers and the suggested corrections of the concentration index, we refer to *The Journal of Health Economics* (2009), vol. 28.

The health concentration index can be decomposed into the contributions of explanatory factors; thereby allowing for an analysis of what factors that contribute the most to the measured degree of income-related inequalities in health (measured by the health concentration index).

As noted in the introduction, a less unequal distribution of health by income quintiles seems to be an important task to tackle. It is also argued that inequalities in health affect and reinforce inequalities in other domains. And since the proportion of elderly individuals is ever growing, it is interesting to see what factors contribute the most to the measured degree of inequality in an older population; since it could help policy-makers to formulate both short-run policies (e.g. redistribution of income) and long-run policies (e.g. policies aimed at reducing inequalities in education) aimed at closing the gap of income-related inequalities in health for both the elderly and in the population as a whole.

[8] The concentration curve plots the cumulative proportion of the population, ranked by income beginning with the lowest incomes, against the cumulative proportion of health.
[9] Refers to that an equal increment of health for all individuals does not affect the value of the index

3. Methods and model specification

This chapter serves to introduce the methods for the measurement of health, inequality and decomposition. The empirical model is also presented.

3.1 Methods

3.1.1 Measurement of health

Health can be measured on an ordinal scale, or in some cases, on a cardinal scale. The most widely used measure on health relates to the commonly used question in surveys: "How is your health in general?" Which usually contains five response categories, such as: "very bad, bad, fair, good and very good". This measure of self-assessed health (SAH) is ordinal (Madden, 2010:244). An example of a cardinal measure of health is the body mass index (BMI).

The SAH-measure with its five response categories is a categorical variable. This type of measure has shown to create a problem when measuring inequality in health. The concentration index (which is the subject for section 3.1.2) requires information on health either in the form of a continuous or a dichotomous variable (van Doorslaer & Jones, 2003:62).

Thus, one can deal with the ordinal scale problem by either dichotomizing the health variable into a healthy/non-healthy distinction or by imposing some sort of assumption on the scaling. The dichotomization approach has well-known disadvantages; mainly because not all information in the self-assessed health-variable (SAH) is used which in turn makes comparisons of inequality over time or across populations unreliable. (Van Doorslaer & Jones, 2003:62)

Van Doorslaer & Koolman (2004:611) use information on the empirical distribution of a generic health measure, such as the Canadian Health Utility Index (HUI) Mark III. By scoring the SAH levels with a generic health measure a more 'natural' index for SAH scores are obtained as utilities between 0 and 1. Their approach is therefore to use the empirical distribution function (EDF) of HUI scores in the 1994 Canadian *National Population Health Survey* sample obtained in van Doorslaer & Jones (2003) to scale the intervals of SAH for all

European countries. To do this, they assume there is a stable mapping from HUI to the variable that determines reported SAH and that this applies to every individual and not only to Canadians.

Van Doorslaer & Koolman (2004) compute the cumulative frequency of observations for each category of self-assessed health and then find the thresholds μ_j of the empirical distribution function (EDF) for HUI that matches these frequencies. Formally, it can be shown that

$$\mu_j = F^{-1}(G_j) \qquad (1)$$

where $F^{-1}(.)$ is the inverse of the EDF of HUI and G_j is the cumulative frequency of observations for category j of SAH (van Doorslaer & Koolman, 2004:611).

In the SHARE-survey, one measure of SAH is available with an identical wording of question and response categories. Therefore a restrictive assumption, like a latent self-assessed health variable with a skewed, standard lognormal distribution, is redundant. In this respect, the SHARE-survey is similar to the data used in van Doorslaer & Koolman (2004) and therefore the same method as they employ can be used in this study, i.e. the same thresholds will be used to scale the intervals of the SAH categories.

There are also other important problem-aspects in the measurement of health besides that of the scaling problem; namely reversed causality and reporting bias.

Reversed causality refers to that there is a possibility that the dependent variable, y_i, has an impact on the independent variable, x_i (Verbeek, 2008:138). Take for example the relationship between health and income where the health variable is the dependent variable and income is the independent variable. It is assumed that income affects ones health (e.g. with a higher income you can afford healthier food), but it could also be the case that health affect your income; for example, if you are home sick your income will be reduced and thus health has an impact on your income at the same time income has an impact on your health. This is an endogeneity problem which gravely complicates an analysis of causal effects.

Reporting bias refers to individuals with the exact same ‘true health’ systematically reports different cut-point levels in their SAH (Jones et.al, 2007: 53f). For example, someone in Germany might report that his health is “good” and someone in Italy with the exact same health might report that his health is “fair”. One way of dealing with this reporting heterogeneity is to use so called “vignettes questions”. These are questions about hypothetical individuals in a particular situation which respondents are asked to evaluate[10]. In the SHARE-survey, vignette samples are available but due to the time frame, no health measure purged from this potential bias is created. Though, van Doorslaer & Gerdtham (2003) uses Swedish data and investigates if inequality in SAH predict inequality in survival by income and find that the effect of SAH on mortality risk declines with age, but does not seem to differ by indicators of socio-economic status; suggesting that SAH is unlikely to be biased by reporting error.

3.1.2 Measurement of inequality

As noted in the previous section, to obtain summary inequality index from ordinal data one must either: (a) employ an index that is specifically designed to deal with ordinal data, or (b) transform the data into cardinal data and then use a standard index (Madden, 2010:244). A review of method (b) and the different approaches (OLS, ordered probit and interval regression) is presented in van Doorslaer & Jones (2003) and according to them; interval regression outperforms the other approaches.

A widely used method for the measurement of inequality is the concentration curve, denoted $L(s)$, which plots the cumulative proportion of the population, ranked by income beginning with the lowest incomes, against the cumulative proportion of health. If $L(s)$ lies above the diagonal, inequalities in health favour the poorer members of society and if $L(s)$ lies below the diagonal, inequalities in health favour the richer individual's in society (van Doorslaer & Koolman, 2004:611). This relationship can be seen in figure 3.1 below.

Note also, that the further from the diagonal $L(s)$ lies, the greater the degree of inequality. One problem that can arise is if the health concentration curve coincides with the inequality line and if it does that in the median, then the concentration index (described below) will be zero; even though there are inequalities present in different income-groups. Therefore, it is good to complement the concentration index with the health concentration curve.

[10] To read more about vignettes, see for example http://www.compare-project.org/

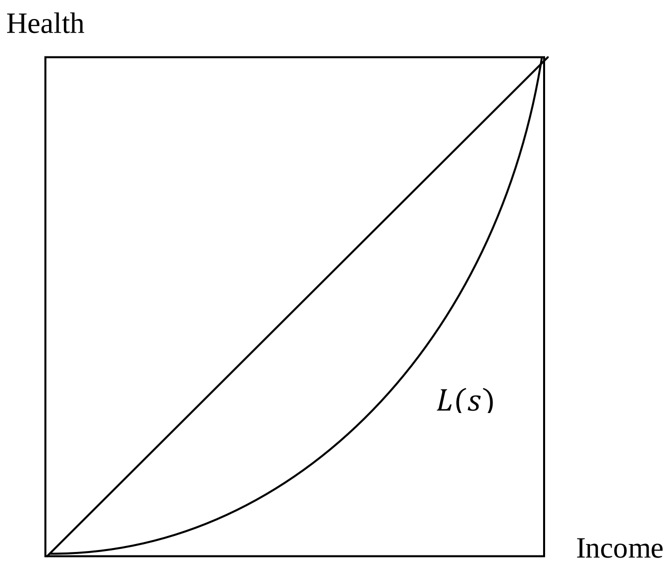

Figure 3.1: Health concentration curve

A closely related measure is the *health concentration index*, C, which is defined as twice the area between $L(s)$ and the diagonal (the 45 degree line). The index takes values between [-1, 1]. The index is equal to 0 when it coincides with the diagonal and takes a positive (negative) value when $L(s)$ lies below (above) the diagonal (ibid). This index is a measure of *relative* income-related health inequality.

C can be computed straightforwardly on individual-level data according to

$$C = \frac{2}{N\mu}\sum_{i=1}^{N} w_i y_i R_i - 1 \qquad (2)$$

where

$$\mu = \frac{1}{N}\sum_{i=1}^{N} w_i y_i \qquad (3)$$

is the (weighted) mean health of the sample, w_i is the sampling weight, N is the sample size and R_i is the fractional rank of the *i*th individual. R_i is defined as

$$R_i = \frac{1}{N}\sum_{j=1}^{i-1} w_j + \frac{1}{2} w_i \; where \; w_0 = 0 \qquad (4)$$

which indicates the weighted cumulative proportion of the population up to the midpoint of each individual weight.

Another way of computing C is by using the weighted covariance (denoted cov_w) of μ and the fractional rank as

$$C = \frac{2}{N\mu}\sum_{i=1}^{N} w(y_i - \mu)\left(R_i - \frac{1}{2}\right) = \frac{2}{\mu}cov_w(y_i, R_i) \qquad (5)$$

3.1.3 Decomposing inequality

The proposed way of decomposing the measured degree of health inequality into the contributions of explanatory factors is derived from a linear additive regression model of health, such as:

$$y_i = \alpha + \sum_k \beta_k x_{ki} + \varepsilon_i \qquad (6)$$

where y_i is the health measure, x_{ki} are health determinants (dependent variables) and ε_i is the usual disturbance term. The above specification can be thought of as a reduced form of a demand for health equation. Given the above, the concentration index for y (health), denoted C, can be written as:

$$C = \sum_k (\beta_k \bar{x}_K/\mu)C_k + GC_\varepsilon/\mu \qquad (7)$$

where μ is the mean of y, $\bar{x}_K$ is the mean of x_k and GC_ε is the generalized CI for ε_i. The first part, $\beta_k \bar{x}_K/\mu$, measures the health elasticity of variable k. This elasticity can be defined as:

$$\widehat{\eta_k} \equiv \widehat{\beta_k} \bar{x}_K/\mu \qquad (8)$$

An important thing to note here is that the residual component, GC_ε/μ, cannot be computed with the interval regression approach whereas the decomposition is reduced to the first term in equation 7. The residual component captures the inequality in health that is not explained by systematic variations across income groups in x_k. By inserting equation 8 into equation 7, the decomposition can be rewritten as:

$$\hat{C} = \sum_{\boldsymbol{k}} \widehat{\eta_{\boldsymbol{k}}} \widehat{C_{\boldsymbol{k}}} \qquad (9)$$

Total health inequality can be partitioned into avoidable and unavoidable inequality. This is done by *standardization*. The aim of standardization is to describe the SES conditional on other factors, e.g. age and sex. Note however, that the purpose of standardization is not to build a structural or causal model of health determination. The analysis remains descriptive, but the description between health and SES is more refined. There are two ways of standardizing: (1) direct and (2) indirect standardization. In the case for this study, as well as in van Doorslaer & Koolman (2004), the indirect standardization method will be used and presented. In each of the cases, one can standardize for either the full or the partial correlations of the variables of interest with the standardizing variables. van Doorslaer & Koolman (2004) standardize for the partial correlations so that is what will be done in this study as well.

Indirect standardization is performed by estimating a health regression such as:

$$y_i = a + \sum_j \beta_j x_{ji} + \sum_k \gamma_k z_{ki} + \varepsilon_i \qquad (10)$$

where y_i denotes the health variable, x_{ji} are the confounding variables for which we want to standardize (in this case it is *age* and *sex*[11]), the z_{ki} denotes the nonconfounding variables for which we do not want to standardize but to control for in order to estimate the partial correlations with x_{ji} (if we were to exclude the z_{ki} we would standardize for the full correlations) and a, β and γ are parameter vectors. (O'Donnell et. al. 2008:60f)

The reason for using the partial correlations instead of the full correlation is that the risk of running into omitted variable bias is reduced (see Gravelle, 2003). If we would regress y_i only on the basis of age and sex and if age is correlated with education and both of them are correlated with income then the estimated coefficient on age will reflect the joint correlation with education, and thus we would also be standardizing for education.

[11] The age/sex dummy variables will be used

3.1.4 Empirical model selection: Interval regression

What seems to be the most commonly used econometric approaches in estimating SAH on a set of independent variables are: (1) OLS, (2) Probit/logit regression, (3) Ordered probit/logit regression and (4) Grouped data or interval regression.

But which of these methods would be most appropriate from a theoretical and empirical perspective? Since the aim of this study is to investigate inequalities in health and also try to derive what factors that have a large impact on these inequalities, an appropriate econometric method need to be used.

As noted before, the health measure is ordinal and then cardinality is imposed by using the HUI thresholds. This imposes limitations to the choice of method. Using a linear regression (e.g. OLS) on an essentially categorical dependent variable would be inappropriate since, for example, the probabilities are not guaranteed to lie within the [0, 1] interval. Also, the error term has a highly non-normal distribution (Verbeek 2008:200).

As for the case with the HUI scores they have been shown to be truncated at the upper limit of 1 and therefore indicate that it is a problem with misspecification when OLS is applied to the data for HUI. Especially since the skewness and kurtosis statistics for an OLS regression on the HUI data shows non-normality. (Jones et. al, 2007:37)

From an empirical point of view, OLS has been shown to be outperformed both by the ordered probit/logit model as well as the interval regression approach; which outperforms all other methods[12] (van Doorslaer & Jones, 2003).

The ordered probit/logit model is used to capture a discrete dependent variable that takes ordered multinomial outcomes for each individual i. Let y_i denote this dependent variable. In this model, y_i take values in the form: $y_i = 1,2 \dots, m$. The model can be expressed as

$$y_i = j \; if \; \mu_{j-1} < y_i^* \leq \mu_j, \quad j = 1, \dots, m$$

Where y_i^* represents a latent variable which is assumed to be a linear function of a vector of socioeconomic variables x, plus a random error term ε:

$$y_i^* = x_i\beta + \varepsilon_i, \quad \varepsilon_i \sim N(0,1)$$

[12] See chapter 1.3

and $\mu_0 = -\infty,\ u_j \leq \mu_{j+1}, \mu_m = \infty$. Thus, given the assumption that ε_i is normally distributed, the probability of observing a particular value of y is:

$$P_{ij} = P(y_i = j) = \phi(\mu_j - x_i B) - \phi(\mu_{j-1} - x_i \beta)$$

where $\phi(.)$ is the standard normal distribution function. (Jones et. al, 2007:38)

The ordered probit/logit model applies when the threshold values (μ) are unknown (Jones 2009:22). If, on the other hand, the μ's are known the interval regression can be used. This method provides a more efficient estimate of β and it is possible to identify the variance of the error term σ^2 and the scale of y^* (Jones et. al., 2007:45).

The interval regression fits a model of

$$y = [dependent\ variable\ 1, \qquad dependent\ variable\ 2]$$

on a set of independent variables where y for each observation is point data, interval data, left-censored data, or right-censored data. The dependent variables are created from the cut-off points used van Doorslaer & Jones (2003); see also chapter 4 where the construction of the different variables are presented.

As noted in chapter *3.1.1* HUI thresholds are used to scale SAH and because of this, the linear index $x_i\beta$ for the interval regression gives a prediction of each individual's level of health utility as derived from the observed SAH level. It is the predicted level of HUI knowing that an individual has characteristics x (van Doorslaer & Koolman, 2004:611). The predictions are both continuous and linear in the $x's$ which is a useful property which implies that CI's calculated using the predictions are suitable for decomposition analysis.

Also note that the empirical analysis that will follow is static in its nature and the models estimated are not derived from a formal model of health production and investment. Instead, as van Doorslaer & Koolman (2004:617) points out, the models can be thought of as a reduced-form of a static model of the demand for health. It is static since the data is cross-sectional in its nature, i.e. different individuals are observed at a certain point in time. This implies that it is impossible to say anything about dynamics in health.

Based on the above, the interval regression approach seems like the most appropriate method both from a theoretical and empirical point of view when examining inequalities in health.

3.1.5 Multiple imputations

In every statistical inference setting, missing data is a significant problem. In SHARE, the problem is mostly concerned with unit nonresponse related to income and health questions. These nonresponse may very well cause selection bias (e.g. is typically thought that individuals with very low or very high income refuse to answer questions about their income) which renders the analysis inconsistent if not dealt with.

To deal with this problem, SHARE provides five different datasets (since there are five imputed values for each missing value, thus creating five datasets). Therefore, when making inference, descriptive analysis etc, all datasets should be used. No single dataset is preferable to the others since each represent different draws from the distribution of missing values (SHARE, 2010:28). For a more complete treatment of multiple imputations and missing values in general, see Little and Rubin (2002).

To estimate the correct means, regression coefficients and such, the following procedure will be used: Let $m = 1, \dots, M$ index the imputation draw (which is five for the SHARE data) and let $\hat{\beta}_m$ be the estimate of interest. The estimation using all M implicate datasets is the average of the M separate datasets[13]:

$$\overline{\beta}_M = \frac{1}{M} \sum_{m=1}^{M} \hat{\beta}_m$$

Next thing needed is the variance of this estimate. It consists of two parts. Let V_m denote the variance estimated from the m^{th} implicate dataset. Now, estimate the average of all M variances according to:

$$WV_m = \frac{1}{M} \sum_{m=1}^{M} V_m$$

The above is the "within-imputation" variance. The second part consists of the "between-imputation" variance, which is given by:

$$BV_m = \frac{1}{M-1} \sum_{m=1}^{M} \left(\hat{\beta}_m - \overline{\beta}_M\right)^2$$

[13] This procedure is taken from SHARE guide release (2009:28ff) and Christelis et. al. (2009:374f)

Combining WV_m and BV_m in the following way will yield the total variance:

$$V_M = WV_m + \frac{M+1}{M} BV_m$$

Taking the (positive) square root of V_M will yield the standard deviation of the estimate.

4. Data and variable definition

This chapter introduces the data that this study builds upon. The data itself, as well as the sample selection procedure is presented in detail. Also, this chapter presents how variables are created and defined. A summary of created variables can be found in the appendix.

4.1 The data

This study uses data from the *Survey of Health, Ageing and Retirement in Europe* (SHARE, 2004) wave 1 release 2.3.1 as of July 29th 2010. SHARE collects micro-data[14] on a numerous range of variables including demographics, economic variables (current work activity, job characteristics, opportunities to work past retirement age, sources and composition of current income, wealth and consumption, housing, education), family network, health, life-satisfaction, social support (e.g. assistance within families, transfers of income and assets) and so forth. Wave one includes twelve countries. The data is analyzed using the econometric software STATA 9.2 special edition.

The target population in SHARE is defined both in terms of individuals and households. The target population for individuals, following the definition of Börsch-Supan & Jürgens (2005:30), is as follows:

"All individuals born in 1954 or earlier, speaking the official language of the country and not living abroad or in an institution such as a prison during the duration of field work, and their spouse/partner independent of age"

And the target population for households, again following Börsch-Supan & Jürgens (2005:30):

"All households with at least one member born in 1954 or earlier, speaking the official language of the country and not living abroad or in an institution such as a prison during the duration of field work"

[14] Data collection for wave 1 was made in 2004 and 2005.

4.1.1 Sample selection

The full dataset of release 2.3.1 contains approximately 32,000 individual observations. Since the target population for individuals and households differ a bit there are some individuals aged <50. For the purpose of this study, which is to study the older population (aged 50 and above) these observations are dropped. The sample also contains a lot of ineligible individuals, and these observations are dropped as well. Since this study aim is to replicate van Doorslaer & Koolman (2004) the following countries are dropped: Israel and Switzerland. Sweden, even though not present in van Doorslaer & Koolman (2004), will be kept out of interest. The final sample is thus reduced to 27,492 observations. The breakdown of the sample for each country is presented in the table below.

Country	**Observations**
Germany	3,196
Denmark	1,664
Netherlands	3,031
Belgium	3,730
France	2,902
Italy	2,596
Greece	2,441
Spain	2,590
Austria	1,959
Sweden	3,383
Sum	27,492

Table 4.1: Total number of individuals

In the empirical analysis later, the sample will be a bit smaller due to the fact that if an individual has a missing value on one or more variable, that individual will be dropped completely from the sample.

4.2 Variable construction and definition

4.2.1 Health variables

The health measure used in this study is the European version of self reported health which is the answer to the question: ”Would you say your health is…” rated on five categories (very bad, bad, fair, good and very good). The relative frequencies of this study response, as well as van Doorslaer & Koolman (2004) and the Canadian 1994 NPHS are reported in the table below. The relative frequencies are quite close to the NPHS despite the different wording.

	SHARE	Canadian 1994 NPHS	van Doorslaer & Koolman (2004)
Very good	17.1	24.8	23.0
Good	43.7	37.2	42.2
Fair	29.1	27.0	24.3
Bad	8.1	8.6	7.9
Very bad	2.1	2.4	2.4

Table 4.2: Relative frequencies of individuals' in different health status

Also note that the difference in distribution across SAH categories may have an impact on the measured degree of inequality which will be estimated later.

The wording in the Canadian 1994 NPHS study differs a bit from the SHARE survey and van Doorslaer & Koolman (2004). The different wordings used are displayed in the table below.

Category	SHARE	Canadian 1994 NPHS	van Doorslaer & Koolman (2004)
1	Very good	Excellent	Very good
2	Good	Vvery good	Good
3	Fair	Good	Fair
4	Bad	Fair	Poor
5	Very bad	Poor	Very poor

Table 4.3: Wording of the health categories in the different studies

The reason for choosing the European version of SRH in the SHARE data is to come as close to van Doorslaer & Koolman (2004) as possible.

For the interval regression, two new variables (*sah1* and *sah2*) are created by using the thresholds (the cut-off points) in van Doorslaer & Koolman (2004). *Sah1* represents the lower bound of interval and *sah2* represents the upper bound of interval. They take on the following values:

If response equal:	sah1	sah2
Very bad	0	0.428
Bad	0.428	0.756
Fair	0.756	0.897
Good	0.897	0.947
Very good	0.947	1

Table 4.4: Lower and upper bounds

Sah1 and *sah2* thus represent the dependent variables used in the interval regression.

4.2.2 Income variables

The income variable used in this study is the *total gross household income per equivalent adult in PPP*, using the modified OECD equivalence scale to take into account different household size.

Total household income includes all the gross monetary income received by the household members during the reference year (which is 2003 for the 2004 share wave 1). It includes income from work (employment and self-employment), income from pensions, income from private transfers, income from long-term care[15], the sum of gross incomes of other household members and benefits and capital asset income.

Formally, let:

$$Y_{DIP} = gross\ individual\ income\ from\ employment$$
$$Y_{IND} = gross\ individual\ income\ from\ self - employment$$
$$Y_{PENS} = gross\ individual\ income\ from\ pension$$
$$Y_{REG} = gross\ individual\ income\ from\ private\ regular\ transfers\ (e.g. alimony)$$
$$Y_L = gross\ individual\ income\ from\ long - term\ care$$
$$Y_{BEN} = sum\ of\ the\ gross\ incomes\ of\ other\ household\ members\ and\ benefits$$
$$Y_{AS} = capital\ asset\ income\ (income\ from\ bank\ accounts, from\ bonds, from\ stocks\ or\ shares\ and\ from\ mutual\ funds$$

Then define:

[15] These variables so far sums up to the *gross individual income*

$$Y_{Ri} = Y_{DIP} + Y_{IND} + Y_{PENS} + Y_{REG} + Y_L$$
$$\equiv gross\ total\ individual\ income\ of\ respondent\ i$$
$$Y_{HH} = \sum Y_{Ri} + Y_{BEN} + Y_{AS} \equiv gross\ total\ household\ income$$

The next step is to weigh the gross total household income by household size. This study uses the modified OECD equivalence scale in the same way as van Doorslaer & Koolman (2004) does, i.e. the first adult is given a weight of 1.0, the second adult and each subsequent individual in the household aged 14 and above is given a weight of 0.5 and each individual aged under 4 in the household is given a weight of 0.3. Thus, *total gross household income per equivalent adult in Euros* can be defined as:

$$Equalised\ Y_{HH} = \frac{\sum Y_{Ri} + Y_{BEN} + Y_{AS}}{household\ weight}$$

Now, this income measure is converted to a common reference unit, i.e. the purchasing power standard and the final step is to take the natural logarithm of the income variable to obtain *log total gross income per equivalent adult in PPP*.

4.2.3 Educational variables

SHARE uses the 1997 International Standard Classification of Education (ISCED-97) as a way to make educational attainment comparable among countries[16]. In the SHARE-dataset, ISCED-97 codes 1 – 6 are used and individuals with no education, individuals still in school and another category "other" are also reported. This study follows as much as possible the methodology used by van Doorslaer & Koolman (2004) where they have coded as follows:

- Less than second stage of secondary education (ISCED code 0 – 2)
- Second stage of secondary education (ISCED code 3)
- Recognized third level education (ISCED code 5 – 7)

Thus, the educational variables have been constructed in the following way: (1) less than second stage of secondary education (ISCED code 0 – 2), (2) second stage of secondary education (ISCED code 3) and (3) recognized third level education (ISCED code 4 – 6).

[16] For further details on ISCED-97 coding please visit
http://www.uis.unesco.org/ev.php?ID=3813_201&ID2=DO_TOPIC

Based on this, dummies for these three different levels of education are created taking the value 1 if the statement is true and 0 otherwise. One reference category (less than second stage of secondary education) is of course omitted in the forthcoming regression analysis to avoid perfect multicollinearity.

4.2.4 Activity variables

SHARE provides information on current occupation. Respondents are asked to describe their current job situation where the response categories are as follows: (i) retired, (ii) employed or self-employed, (iii) unemployed, (iv) permanently sick or disabled, (v) homemaker and (vi) other. As opposed to van Doorslaer & Koolman, this study does not take into account individuals still in school, derived from the educational variable. These individuals have been dropped since the numbers of observation is extremely small[17].

Based on this information, dummies for these activity variables are created taking the value 1 if the statement is true and 0 otherwise. Again, one reference category (employed or self-employed) will be omitted in the regression analysis.

4.2.5 Marital status variables

SHARE provides information on marital status. The response categories are as follows: (i) married and living together with spouse, (ii) registered partnership, (iii) married, living separated from spouse, (iv) never married, (v) divorced and (vi) widowed.

Based on this information, dummy variables are created in the following way: (i) married[18], (ii) divorced, (iii) widowed and (iv) unmarried; taking the value 1 if the statement is true and 0 otherwise. Again, one reference category (married) will be omitted in the regression analysis.

[17] Only seven observations with individuals still in school were observed

[18] By combining the response categories (i), (ii) and (iii)

4.2.6 Region of residence variables

SHARE uses the EU's NUTS 1 level (*Nomenclature of Statistical Territorial Units*) for deriving each individual's region of residence. In the SHARE-dataset, not all regions for the different countries have been reported (France and Italy). Also, for Italy, the region ITF Sud has been dropped in the analysis since it is not used in van Doorslaer & Koolman (2004). A table for the region of residence can be found in appendix 2.

Based on this information, dummies for these regions of residence variables are created taking the value 1 if the statement is true and 0 otherwise. The omitted region is region 1, which is usually the capital region.

4.2.7 Age/sex variables

Age/sex dummy variables have been constructed for the following categories: males aged 50-54, males aged 55-59, females aged 50-54, females aged 55-59, males aged 60-69, females aged 60-69, males aged 70 and above and females aged 70 and above; taking the value 1 if the statement is true and 0 otherwise. Males aged 50-54 will be used as the reference category and thus omitted from the regressions.

5. Results

This chapter presents all the results, starting with some descriptive statistics and then going over to interval regression, concentration indices and health inequality contributors. The results are also compared with the study by van Doorslaer & Koolman (2004). Thus, this chapters' objective is to answer the three questions in the purpose of this study.

5.1 Descriptive statistics

Table 5.1: Means of variables per country below provide an interesting base for simple cross-country comparisons. The predicted HUI means have been created from the different interval regressions, presented in *table 5.4* and show average health utility values ranging from 0.8407 (Spain) to 0.8928 (Netherlands). Netherlands, Sweden and Denmark have the highest gross income per equivalent adult. These countries, along with Belgium, are the countries with the highest mean health.

The countries' demographic structure, illustrated by the age-sex dummies, ranges from 65.1 % (Denmark) of the population aged 60 and above to 75.5 % for Italy. Naturally, many individuals in this sample are retired, which is also confirmed by looking at the retirement variable; the exceptions being Spain (39.6 %) and Netherlands (40.3 %). In every other country, at least 50 % of the population is retired.

With this background, one would therefore expect this population to show lower mean health than the population in van Doorslaer & Koolman (2004). A simple comparison between this study's population and theirs with respect to mean health is shown in *table 5.2* below. Every country in SHARE, except for France, shows a lower mean health compared to the younger population in van Doorslaer & Koolman (2004). These findings fit with the well established fact that health status falls with age, which implies that the mean health declines as the population grows older. It is therefore somewhat surprising that France with a share of 68.5 % of the population aged 60 and above has a higher mean health compared to the findings in van Doorslaer & Koolman (2004) where France only has a share of 26.2 % of the population aged 60 and above. The difference between SHARE and van Doorslaer & Koolman (2004) might also seem a bit low if taking into account the big difference in the share of the population aged 60 and above between the two populations. One explanation for these small differences in health between the two populations might be due to differences in the reference groups[19]. Older individuals might report better health status than younger individuals, given that they both share the same “true” health.

	Germany	Denmark	Netherlands	Belgium	France	Italy	Greece	Spain	Austria	Sweden
HUI pred	0.8557	0.8839	0.8928	0.8862	0.8722	0.8507	0.8766	0.8407	0.8757	0.8797
Log income	9.9626	10.0317	10.0634	9.6541	9.9082	9.3096	9.1440	9.1810	9.8340	10.0441
M55-59	0.0655	0.0967	0.1003	0.0882	0.0885	0.0824	0.0646	0.0734	0.0912	0.0902
M60-69	0.1681	0.1365	0.1389	0.1434	0.1226	0.1509	0.1469	0.1407	0.1449	0.1467
M70+	0.1203	0.1338	0.1253	0.1543	0.1553	0.1539	0.1516	0.1682	0.1221	0.1504
F50-54	0.0705	0.0663	0.0694	0.0522	0.0599	0.0379	0.0522	0.0648	0.0626	0.0630
F55-59	0.0713	0.1037	0.1005	0.0890	0.1020	0.0846	0.0535	0.0731	0.0885	0.0845
F60-69	0.1872	0.1598	0.1649	0.1645	0.1446	0.1785	0.1928	0.1454	0.1759	0.1519
F70+	0.2345	0.2211	0.2228	0.2468	0.2629	0.2657	0.2631	0.2725	0.2386	0.2444
Second education	0.5603	0.4258	0.2220	0.2415	0.2671	0.1684	0.2011	0.0735	0.4860	0.2488
Higher education	0.2311	0.3187	0.1890	0.2221	0.1688	0.0580	0.1145	0.0781	0.2080	0.1938
Unemployed	0.0463	0.0456	0.0192	0.0423	0.0319	0.0165	0.0163	0.0283	0.0304	0.0221
Housework	0.1021	0.0167	0.2250	0.1706	0.1096	0.2198	0.2622	0.3344	0.1142	0.0093
Economic inactive	0.0253	0.0335	0.0866	0.0400	0.0240	0.0116	0.0156	0.0408	0.0150	0.0279
Retired	0.5666	0.5587	0.4034	0.5561	0.5982	0.5947	0.5055	0.3955	0.6527	0.5879
Divorced	0.0807	0.1298	0.0709	0.0671	0.0903	0.0249	0.0441	0.0337	0.0867	0.1238
Widowed	0.2080	0.1864	0.1842	0.1820	0.1970	0.2269	0.2514	0.2270	0.2255	0.1759
Unmarried	0.0839	0.0735	0.0669	0.0440	0.0684	0.1156	0.0618	0.1023	0.0991	0.0812
Born other Euro	0.1833	0.0271	0.0235	0.0616	0.0632	0.0104	0.0193	0.0072	0.0909	0.0715
Born non-Euro	0.0017	0.0135	0.0376	0.0098	0.0657	0.0058	0.0068	0.0101	0.0020	0.0100
Region 2	0.1451		0.1530	0.5979			0.2222	0.1202	0.1792	
Region 3	0.0109		0.4615	0.3726	0.1473	0.2084	0.3872	0.0779	0.3388	
Region 4	0.0353		0.2288				0.1020	0.1550		
Region 5	0.0120				0.1706	0.2053		0.2335		
Region 6	0.0116				0.1210			0.2420		
Region 7	0.0932				0.1841					
Region 8	0.0203				0.1113					
Region 9	0.1009					0.2021				
Region 10	0.2242									
Region 11	0.0489									
Region 12	0.0106									
Region 13	0.0645									
Region 14	0.0322									
Region 15	0.0476									
Region 16	0.0280									
n	2 693	1 485	2 510	3 217	2 563	2 000	2 097	1 852	1 681	2 755
% pop 60+	71.0	65.1	65.2	70.9	68.5	74.9	75.5	72.7	68.2	69.3
% higher education	79.1	74.5	41.1	46.4	43.6	22.6	31.6	15.2	69.4	44.3

Table 5.1 Descriptive statistics

[19] The reference group in this study is males aged 50-54 while the reference group in van Doorslaer & Koolman (2004) is males aged 16-29

Since this study measure income in gross units, one would suspect that the reported income would be higher compared to van Doorslaer & Koolman (2004) but, since a larger proportion of the population is retired and thus assumed to receive pensions instead of salary from work one would expect the income to be lower. It is therefore ambiguous to make a straightforward comparison. Though, it can be seen from *table 5.2* below that the income in every country in SHARE exceeds that of the population in van Doorslaer & Koolman (2004) but the difference is not that big, suggesting that if the income variable would be measured in *net* units it would probably be lower compared to van Doorslaer & Koolman (2004).

	SHARE HUI	D&K HUI	Difference in HUI	SHARE income	D&K income	Difference in income
Spain	0.8407	0.8822	-0.0415	9.1810	8.9365	0.2445
Germany	0.8557	0.8851	-0.0294	9.9626	9.4491	0.5135
Italy	0.8507	0.8668	-0.0161	9.3096	9.0058	0.3038
Austria	0.8757	0.8983	-0.0226	9.8340	9.5084	0.3256
France	0.8722	0.8692	0.0030	9.9082	9.3738	0.5344
Sweden	0.8797	-	-	10.0441	-	-
Greece	0.8766	0.9077	-0.0311	9.1440	8.7821	0.3619
Denmark	0.8839	0.9077	-0.0238	10.0317	9.4927	0.5390
Belgium	0.8862	0.9027	-0.0165	9.6541	9.4261	0.2280
Netherlands	0.8928	0.904	-0.0112	10.0634	9.384	0.6794

Table 5.2: Predicted HUI and income differences[20]

Another important thing to examine here is how many individuals are still in the sample. Note that the individuals included in the descriptive analysis are those who have no missing value on any variable. Therefore, as mentioned before in section 4.1.1, an individual that has a missing value on at least one variable will be completely dropped. The relationship is shown in *table 5.3* below.

As the number of observations are reduced so are the accuracy of the results if we want to say something about the population under study since we lose information. It is especially problematic if the ‘drop-outs’ are non-random (e.g. if those with low income and/or those with bad health refuse to answer those questions then they will be dropped and we will have a bias). Since the technique with multiple imputations is used, the share of the final sample relative to the full sample is quite high.

[20] Source: van Doorslaer & Koolman (2004) table 1, page 615

Country	Final sample	Full sample	% of full sample
Germany	2,693	3,196	84.3
Denmark	1,485	1,664	89.2
Netherlands	2,510	3,031	82.8
Belgium	3,217	3,730	86.2
France	2,563	2,902	88.3
Italy	2,000	2,596	77.0
Greece	2,097	2,441	85.9
Spain	1,852	2,590	71.5
Austria	1,681	1,959	85.8
Sweden	2,755	3,383	81.4
Sum	22,853	27,492	83.1

Table 5.3: Final sample compared to full sample

5.2 Interval regression results

The results from the interval regressions are presented in *table 5.4* below. The results from the interval regression can help answering the first question in the purpose of this study, namely 'What is health inequality in an older population?". The coefficients in the interval regression are measured on the same scale as the cut-points, so they can be interpreted in terms of changes in HUI with respect to the reference category. The coefficients are also directly comparable between countries since both health and income are measured in the same units.

The reference (omitted) category are the employed, low educated, married males aged 50-54 born in the country in question and, if applicable, living in the omitted region which is usually the capital region.

One important thing needs to be said before interpreting the results from the regressions is that no causal interpretation can be given to the coefficient estimates, since the model is not based on a structural model of health and the data only provide a static view.

Numbers in bold represents a significance where $\rho < 0.05$.

	Germany	Denmark	Netherlands	Belgium	France	Italy	Greece	Spain	Austria	Sweden
Constant	**0.9023**	**0.7571**	**0.9170**	**0.9134**	**0.8570**	**0.8872**	**0.9199**	**0.8508**	**0.9359**	**0.7845**
Log income	-0.0005	**0.0137**	-0.0002	0.0006	**0.0041**	0.0029	0.0006	0.0021	**-0.0057**	**0.0132**
M55-59	-0.0123	-0.0108	0.0067	-0.0029	0.0107	0.0016	-0.0175	0.0293	0.0015	-0.0106
M60-69	**-0.0229**	**0.0322**	0.0018	-0.0024	-0.0007	-0.0142	-0.0159	**0.0334**	0.0144	0.0023
M70+	**-0.0579**	0.0253	**-0.0198**	-0.0153	**-0.0383**	**-0.0376**	**-0.0534**	0.0075	-0.0153	**-0.0238**
F50-54	-0.0012	-0.0022	-0.0017	0.0057	-0.0085	-0.0101	-0.0085	0.0212	0.0198	0.0001
F55-59	-0.0066	-0.0045	0.0035	-0.0085	0.0099	-0.0111	-0.0176	0.0264	0.0141	**-0.0261**
F60-69	-0.0038	**0.0306**	0.0085	0.0003	0.0022	-0.0236	**-0.0293**	0.0080	0.0084	-0.0076
F70+	**-0.0498**	**0.0312**	**-0.0161**	**-0.0248**	-0.0184	**-0.0493**	**-0.0631**	**-0.0347**	**-0.0246**	**-0.0251**
Second education	**0.0300**	**0.0166**	0.0069	**0.0204**	**0.0224**	**0.0257**	**0.0280**	0.0159	**0.0373**	**0.0151**
Higher education	**0.0452**	**0.0245**	**0.0116**	**0.0317**	**0.0347**	**0.0328**	**0.0327**	**0.0235**	**0.0447**	**0.0318**
Unemployed	**-0.0323**	-0.0264	**-0.0242**	**-0.0204**	0.0028	-0.0380	**-0.0374**	-0.0301	-0.0247	-0.0080
Housework	**-0.0379**	-0.0102	**-0.0142**	**-0.0152**	-0.0128	**-0.0306**	-0.0084	**-0.0317**	-0.0071	-0.0099
Economic inactive	**-0.1474**	**-0.2076**	**-0.1153**	**-0.1607**	**-0.1852**	**-0.2036**	**-0.2137**	**-0.1417**	**-0.2281**	**-0.1314**
Retired	**-0.0317**	**-0.0563**	**-0.0200**	**-0.0236**	**-0.0202**	**-0.0378**	**-0.0196**	**-0.0522**	**-0.0314**	**-0.0440**
Divorced	-0.0056	-0.0022	-0.0072	-0.0124	-0.0051	-0.0187	-0.0069	0.0101	**-0.0200**	-0.0091
Widowed	**-0.0175**	-0.0101	**-0.0095**	**-0.0150**	-0.0045	-0.0077	**-0.0154**	-0.0087	-0.0038	0.0052
Unmarried	-0.0021	0.0054	-0.0088	0.0032	-0.0018	-0.0075	0.0098	**0.0376**	-0.0027	-0.0024
Born other Euro	**-0.0186**	**-0.0528**	-0.0155	**-0.0148**	**-0.0313**	**-0.0527**	-0.0129	0.0318	0.0074	**-0.0466**
Born non-Euro	-0.0057	-0.0132	**-0.0298**	0.0042	**-0.0195**	0.0085	-0.0256	0.0130	0.0451	-0.0074
Region 2	0.0100		0.0094	0.0004			0.0008	**0.0329**	-0.0048	
Region 3	-0.0190		0.0062	**-0.0227**	**-0.0172**	0.0022	-0.0094	0.0119	-0.0061	
Region 4	**-0.0389**		-0.0041				0.0084	-0.0079		
Region 5	0.0034				-0.0061	**-0.0188**		0.0128		
Region 6	**-0.0404**				-0.0020			**-0.0278**		
Region 7	-0.0083				-0.0069					
Region 8	-0.0311				-0.0101					
Region 9	-0.0048					**-0.0192**				
Region 10	-0.0128									
Region 11	-0.0041									
Region 12	0.0377									
Region 13	**-0.0320**									
Region 14	**-0.0490**									
Region 15	-0.0082									
Region 16	**-0.0300**									
n	2,693	1,485	2,510	3,217	2,563	2,000	2,097	1,852	1,681	2,755

Table 5.4: Interval regression results

Looking at the demographics, i.e. the age-sex variables one would expect that the health status decreases with increased age, but for some countries like Denmark, Spain and Sweden the health status increase with increased age compared to the reference group. One would also expect to find women in worse health compared to men but again, this is not the case in Denmark for example, where females aged 60-69 and 70 and above have a statistically higher health status compared to the reference group which is males aged 50-54. These strange results may be due to the fact that the age intervals are quite broad which may lead to problems due to the well known fact that the income-effect vary with age. The results might also have been different if the reference group were changed. Tubeuf & Jusot (2011) for example, also employ an interval regression approach to the SHARE data and uses a continuous age variable and uses women as the reference category and find that increasing age has a significantly negative effect on health.

The income variable is statistically significant and positive for Denmark, France and Sweden. For Austria though, the variable is statistically negative. The variable is also negative but not significant for Germany and Netherlands. These results are quite different compared to those in van Doorslaer & Koolman (2004) where the income variable was statistically positive for every country.

For every country, higher education is statistically associated with better health. The results are also significant for second education except for Netherlands and Spain. Netherlands is also the country showing the lowest ‘health return’ to education.

Those individuals being divorced, widowed or unmarried generally show lower health status than married couples. But there are some variations here across countries. In Spain for example, being divorced or unmarried is associated with higher health status compared to being married (the partial association is only significant for unmarried though)

Every activity status variable except for unemployment in France is associated with a negative sign for every country, where economic inactive has the worst association with health. Lastly, the effect of region of residence on health doesn’t seem to be that high.

Overall, the results here are quite similar as those found in van Doorslaer & Koolman (2004), except for the income variable and the age/sex variables. Their results are much closer to empirically verifying the theory that health status is declining with age and also that women in general have worse health than men. The association between the variables ‘born other Euro’/’born non-Euro’ and health status also differs. The educational variables show similar results with the difference that the coefficients in this study are in general higher. Another difference is in the unemployment variable which almost always show a statistically significant negative association with health status in Doorslaer & Koolman’s (2004) study, whereas in this study the variable seem to be of lesser importance for the health status. The other activity variables show similar results. Also, the marital status variables show similar results.

5.3 Concentration indices results

The concentration indices results are calculated by using equation 5 in chapter 3 and presented in the table below. Positive values represent the concentration of individuals with high income and vice versa.

In every country except for Austria, self-reported health is unequally distributed favouring the higher income groups. The results are statistically significant for all countries but Austria. Denmark is the country with the highest income-related health inequality (0.0157) and Austria being the country in which health is most equally distributed (-0.0004). Netherlands, Italy and Spain also show low health inequality.

The income inequality, as measured by the variable log income, is expected to be low for countries with low income-related health inequality (measured by the CI of HUI) and vice versa. But that does not always seem to be the case. For example, Denmark is the country with the highest income-related health inequality but the income inequality is even lower than Austria which has the lowest income-related health inequality. The income inequality is only significant for Belgium, Italy, Spain and Austria, suggesting it is not the income that is most important for the measured degree of income-related health inequalities. Instead, higher education seems to be a much more important factor, where the higher educated are strongly concentrated in the higher income-groups in every country but especially in Italy, Greece and Spain and the lowest concentration being in Austria. The results are statistically significant for every country.

In terms of age groups, younger men and women are concentrated in higher income-groups, with a few exceptions. Even men aged 60-69 are concentrated in the higher income groups. Men and women aged 70 and above are concentrated in the lower income groups, except for males aged 70 and above in Austria. The men rank lowest in income in Denmark and Sweden and the women rank lowest in Denmark, Sweden and Germany.

Individuals that are unemployed are concentrated in the lower income groups in every country (especially in Austria, Italy and Greece). Housework and retired show similar sign but not as strong as unemployed. Individuals being economic inactive are strongly concentrated in the lower income groups.

Divorced, widowed and unmarried individuals are generally concentrated among the lower income groups, except for divorced in Greece and Spain as well as unmarried in Greece.

Immigrants from non-European countries are especially worse off in Denmark and Austria and immigrants from other European countries are especially worse off in Germany and Belgium.

	Germany	Denmark	Netherlands	Belgium	France	Italy	Greece	Spain	Austria	Sweden
HUI predicted	**0.01184**	**0.01573**	**0.00484**	**0.00641**	**0.01060**	**0.00879**	**0.00998**	**0.00897**	-0.00037	**0.01560**
Log income	0.0498	0.0398	0.0455	**0.0505**	0.0487	**0.0658**	0.0624	**0.0674**	**0.0582**	0.0351
M55-59	**0.1917**	**0.3172**	**0.1425**	**0.1878**	**0.1370**	**0.0804**	**0.1951**	0.0017	**0.0682**	**0.2616**
M60-69	0.0190	0.0921	0.0229	0.0151	0.0379	**0.0751**	**0.1125**	0.0446	**0.0653**	0.1629
M70+	-0.0807	**-0.3005**	-0.0450	**-0.0716**	**-0.0681**	**-0.0565**	**-0.1086**	**-0.0777**	**0.0640**	-0.1474
F50-54	**0.2590**	**0.2725**	**0.1445**	**0.1764**	**0.0851**	0.0206	**0.2324**	**0.1399**	**-0.0854**	0.1092
F55-59	0.1048	**0.3210**	**0.0977**	**0.1042**	**0.1154**	0.0544	**0.0946**	**0.0756**	-0.0109	0.2036
F60-69	-0.0475	0.0388	-0.0399	**-0.0353**	-0.0139	**0.0669**	-0.0001	0.0363	**-0.0441**	0.1159
F70+	**-0.1926**	**-0.3891**	**-0.1510**	**-0.1243**	**-0.1214**	**-0.1011**	**-0.1905**	**-0.1074**	**-0.0576**	**-0.3492**
Second education	-0.0069	-0.0057	**0.0763**	**0.0662**	**0.1098**	**0.2641**	**0.2100**	**0.3318**	0.0329	0.1055
Higher education	**0.2310**	**0.2753**	**0.3711**	**0.2909**	**0.4072**	**0.6033**	**0.4991**	**0.4362**	**0.1680**	**0.3357**
Unemployed	**-0.3065**	-0.0294	**-0.0511**	**-0.1910**	**-0.1155**	**-0.4452**	**-0.4243**	-0.0350	**-0.4726**	-0.0301
Housework	-0.0664	-0.1997	**-0.1003**	**-0.1916**	**-0.2345**	**-0.2230**	**-0.1391**	**-0.1168**	**-0.2071**	**-0.3669**
Economic inactive	**-0.2456**	**-0.2535**	**-0.1537**	**-0.1717**	**-0.2195**	**-0.2331**	**-0.1726**	**-0.1170**	**-0.1271**	0.0275
Retired	-0.1185	**-0.2382**	**-0.0673**	-0.0122	-0.0291	0.0167	-0.0373	0.0064	0.0408	-0.1822
Divorced	-0.1205	-0.1226	-0.0057	**-0.0395**	**-0.0797**	-0.0150	0.0189	**0.2704**	**-0.1818**	-0.2216
Widowed	**-0.2018**	**-0.3663**	**-0.1514**	**-0.0802**	**-0.1655**	**-0.1180**	**-0.1313**	**-0.0604**	**-0.0995**	**-0.3502**
Unmarried	-0.0118	-0.1275	**-0.0582**	**-0.1141**	**-0.1474**	**-0.0563**	**0.0936**	**-0.0539**	**-0.1655**	**-0.2846**
Born other Euro	**-0.1438**	0.0690	**-0.0553**	**-0.1244**	**-0.1053**	**0.1406**	**-0.2271**	**0.2035**	-0.0018	-0.0782
Born non-Euro	**0.1756**	**-0.3099**	**-0.0865**	**0.2860**	**-0.1441**	**-0.1037**	**0.1234**	**0.1140**	**-0.2831**	-0.0049
Region 2	-0.1060		**-0.1129**	-0.0127			**-0.1096**	**0.0984**	**-0.1253**	
Region 3	-0.0224		**0.0523**	0.0151	**-0.1843**	-0.0190	0.0414	**0.2314**	0.0389	
Region 4	**-0.1765**		-0.0221				-0.0092	**-0.1076**		
Region 5	**0.2889**				-0.0475	**0.1846**		**0.0699**		
Region 6	0.1200				0.0177			**-0.1029**		
Region 7	-0.0509				-0.0155					
Region 8	**-0.4068**				**-0.1134**					
Region 9	0.0963					**-0.2187**				
Region 10	**0.1446**									
Region 11	0.1136									
Region 12	**-0.1982**									
Region 13	**-0.2065**									
Region 14	**-0.1530**									
Region 15	0.0384									
Region 16	-0.0521									

Table 5.5: Concentration indices results

The regional dummies show which are relatively wealthy and which are worse-off, but the interpretation is somewhat ambiguous, especially for Germany.

In the table below, a comparison of the countries different rankings of the concentration index of health (the income-related health inequality) between this study, van Doorslaer & Koolman (2004) and Jürges (2010) are made. Note that the numbers in parenthesis in the table below represent the coefficient value.

Country	Ranking SHARE	Ranking D&K (2004)	Ranking Jürges (2010)
Austria	1 (-0.00058)	5 (0.00583)	1 (0.0034)
Netherlands	2 (0.00403)	1 (0.00372)	5 (0.0117)
Belgium	3 (0.00545)	4 (0.00579)	-
Greece	4 (0.00614)	8 (0.00805)	3 (0.0071)
Spain	5 (0.00718)	3 (0.00558)	4 (0.0075)
Italy	6 (0.00742)	6 (0.00617)	2 (0.006)
Germany	7 (0.00887)	2 (0.00461)	8 (0.0142)
France	8 (0.00923)	7 (0.00788)	9 (0.0181)
Sweden	9 (0.01346)	-	7 (0.0133)
Denmark	10 (0.01983)	9 (0.01062)	6 (0.0124)

Table 5.6: Age-sex standardized concentration indices for predicted HUI. [21]

The income-related health inequalities found here are larger compared to those found in van Doorslaer & Koolman (2004), except for Belgium, Greece and Austria. The income-inequalities (see *table 5.5*) are larger for every country in this study except for Austria.

It may be somewhat surprising at first to see such small income-related inequalities in health among an older population compared to the younger population in van Doorslaer & Koolman (2004), but Jürges (2010) results also show small income-related inequalities in health. Jürges (2010) results are also quite similar to those found in this study. Jürges (2010) as well as Tubeuf and Jusot (2011) also look at wealth-related inequalities in health using data from SHARE wave 1, and the coefficients for wealth-related inequalities are higher than their respective income-related inequalities in health. This might suggest that income itself plays a less important role for inequalities in health in this older population, compared to wealth. Also, according to Becket (2000), many previous cross-sectional studies show that socio-economic inequalities in health are largest at early adulthood or middle-ages and smaller again at older ages. One possible explanation, beside the possibility that income is less important compared to wealth, to these low income-related health inequalities in this study, as well as in Jürges (2010) could be sample-selection due to the fact that institutionalized individuals are not included in the SHARE dataset. Another could be selective survivorship. And a third explanation could be due to differences in the reference groups, as discussed in *section 5.1*, where older individuals might report better health status than younger individuals, given that they both share the same “true” health. If this is the case, then the estimated inequalities in this study are lower than the “true” values.

[21] Sources: van Doorslaer & Koolman (2004) table 4, page 619-620 and Jürges (2010) table 2, page 89

5.4 Health inequality contributions results

The results of the health inequality contributions are presented in the table below. The health inequality contributions of regressors has been calculated by using the interval regression to obtain estimates for β_k. The mean of variable k, $\bar{x}_K$, is taken from *table 5.1* and the concentration indices for the k regressors, C_k are taken from *table 5.5*. With this information, equation 9 in chapter 3 can easily be computed. And by dividing that result with the concentration index for HUI predicted and then multiply by 100, the relative share in % of the estimated health inequality for each regressor are given. This is presented in *table 5.7* below.

These estimates can help answering the second questions in the purpose of this study, namely: 'What explains inequality in this population?', i.e. which of these determinants are most and least important for the observed income-related health inequalities.

Table 5.7 is to be interpreted as follows: A positive x % contribution of variable X means that, *ceteris paribus*, income-related health inequality would be x % lower if the variable X were equally distributed across the income range, or if the variable had a zero health elasticity.

The estimation of potentially avoidable inequality, I^*, is measured by $I^* = C - C^*$ where C denotes the concentration index of HUI predicted (values given in *table 5.5*) and C^* is measured by running an interval regression with the age/sex-variables as well as the nonconfounding variables. Then, health inequality contributions for age and sex will be measured using equation 9 in chapter 3. The sum of these health inequality contributions is then denoted by C^*, which will be subtracted from C to obtain I^*. These estimates are the health inequalities that are not due to demographics (i.e. age and sex), i.e. it is the degree of inequality that would be observed if age and sex were equally distributed by income in a particular country (or had no effect on health); hence potentially avoidable inequality.

One potential problem with this standardization is that one does not standardize for the fact that the age and sex structure differ between countries (the standardization is only made for within countries). This complicates the interpreting of the avoidable health inequalities between countries.

The strange results for Austria may be due to its lack of any income-related inequality in health, measured by the concentration index of HUI predicted.

It can be seen from the table below that income itself plays quite an important role for the measured degree of income-related health inequalities. For France, Italy, Sweden and Denmark income contribute to 21.6 to 39.2 % of all measured health inequality. Income has the highest contribution of the measured degree of inequality in the following countries: Italy, Spain and Sweden, whereas in the other countries, variables such as higher education, retirement or economic inactive plays a more important role to the contribution of total inequality (for Germany, Netherlands, Belgium, France and Greece, higher education contribute more compared to income of the measured degree of inequality). Some explanations to these results are presented in *chapter 5.3*.

	Germany	Denmark	Netherlands	Belgium	France	Italy	Greece	Spain	Austria	Sweden
CI HUI predicted	**0.01184**	**0.01573**	**0.00484**	**0.00641**	**0.01060**	**0.00879**	**0.00998**	**0.00897**	-0.00037	**0.01560**
I = C - C**	0.00887	0.01983	0.00403	0.00545	0.00923	0.00742	0.00614	0.00718	-0.00058	0.01346
Log income	-2.2	39.2	-2.0	5.1	21.6	23.7	3.8	17.0	998.5	33.8
M55-59	-1.5	-2.4	2.2	-0.8	1.4	0.1	-2.5	0.0	-2.9	-1.8
M60-69	-0.7	2.9	0.1	-0.1	0.0	-2.2	-3.0	2.8	-42.2	0.4
M70+	5.5	-7.3	2.6	3.0	4.4	4.4	10.1	-1.3	36.9	3.8
F50-54	-0.2	-0.3	-0.4	0.9	-0.5	-0.1	-1.2	2.6	32.7	0.0
F55-59	-0.5	-1.1	0.8	-1.4	1.3	-0.7	-1.0	1.9	4.2	-3.3
F60-69	0.3	1.4	-1.3	0.0	0.0	-3.8	0.0	0.6	20.2	-1.0
F70+	22.2	-19.3	12.5	13.4	6.4	17.7	36.2	13.5	-104.5	15.6
Second education	-1.1	-0.3	2.7	5.7	7.1	15.3	13.5	5.1	-183.9	2.9
Higher education	23.8	15.5	18.9	36.1	25.8	15.3	21.4	10.6	-482.1	15.1
Unemployed	4.5	0.3	0.6	2.9	-0.1	3.7	3.0	0.4	-109.6	0.0
Housework	2.5	0.2	7.4	8.7	3.6	20.1	3.5	16.4	-51.8	0.2
Economic inactive	9.1	12.7	35.5	19.4	10.5	7.4	6.6	9.0	-134.5	-0.7
Retired	21.0	53.8	12.6	2.8	3.8	-5.0	4.2	-1.7	257.8	34.3
Divorced	0.5	0.2	0.1	0.6	0.4	0.1	-0.1	1.2	-97.3	1.8
Widowed	7.3	4.9	6.2	3.9	1.6	2.8	5.8	1.6	-26.5	-2.3
Unmarried	0.0	-0.4	0.8	-0.3	0.2	0.7	0.6	-2.7	-13.7	0.4
Born other Euro	4.8	-0.7	0.5	2.0	2.3	-1.0	0.6	0.6	0.4	1.9
Born non-Euro	0.0	0.4	2.2	0.2	2.0	-0.1	-0.2	0.2	7.8	0.0
Region 2	-1.5		-3.8	-0.1			-0.2	5.2	-33.0	
Region 3	0.0		3.5	-2.3	5.1	-0.1	-1.7	2.8	25.0	
Region 4	2.4		0.5				-0.1	1.7		
Region 5	0.1				0.5	-9.5		2.8		
Region 6	-0.6				0.0			9.2		
Region 7	0.4				0.2					
Region 8	2.5				1.4					
Region 9	-0.5					11.3				
Region 10	-4.1									
Region 11	-0.2									
Region 12	-0.8									
Region 13	4.2									
Region 14	2.4									
Region 15	-0.1									
Region 16	0.4									

Table 5.7: Health inequality contribution results

Another possible explanation is that of risky behaviour, where less educated individuals might be more prone to risky health behaviour (such as smoking and drinking for example) compared to higher-educated individuals. Also, more education may enhance productivity in health production. It is also interesting to note that higher education contribute more to the measured degree of income-related health inequality compared to van Doorslaer & Koolman (2004) in every country except for Denmark, Netherlands and Spain.

The different activity variables' contributions to the measured degree of inequality differ quite a lot between the countries. In Denmark for example, the health of the retired is the main contributor for the total inequality with a contribution of 53.8 % whereas in Belgium, retirement only contribute to 2.8 %. Instead, the health of the economic inactive is a more important source. As noted by van Doorslaer & Koolman (2004), these differences may be due to differences in social security schemes.

Older males and females (aged 70 and above) generally contribute to higher health inequality. Being divorced, widowed or unmarried play in general only a minor role for the contribution of total health inequality. This is also true for region and immigrant status.

Lastly, let us turn to the measurement of the 'potentially avoidable inequality', measured by I^*. It is always smaller than C (except for Denmark and Austria), meaning that the health distribution of age and gender can only decrease the observed inequality. So, if age and sex were equally distributed, the measured degree of income-related health inequality would be lower in every country but Denmark and Austria. In van Doorslaer & Koolman's (2004) study I^* is smaller than C in every country except Germany, Denmark and France.

6. Discussion, conclusions and suggestions to further research

This chapter discuss and concludes the general findings and suggest what could be done in the future with respect to investigations in income-related health inequalities among the elderly and how this study could be improved even further.

6.1 Discussion and conclusions

The purpose of this study was threefold:

(i) What are income-related inequality in self-assessed health (SAH) in an older population?

(ii) What explains the income-related inequality in health in this population?

(iii) What is the difference between a younger and an older population?

This was investigated by replicating the study by van Doorslaer & Koolman (2004). Questions (i) and (ii) were investigated by means of interval regression, decomposition of health inequality and investigations into the different determinants' contributions to the measured degree of inequality. Underlying the empirical method is the theory of health production, introduced by Grossman (1972). The last question was investigated by comparing the results found here with van Doorslaer & Koolman (2004)

This study find that the health of this older population is lower compared to the health of the younger population in van Doorslaer & Koolman (2004) but that the difference in health status between the two populations are quite low. The same is true for the measured degree of income-related health inequality, measured by the concentration index of HUI. This study also finds that income-related inequalities in health are present and statistically significant for all countries but Austria. Some possible suggestions to why these concentration indices for health are quite low is related to selective survivorship, the exclusion of institutionalized individuals, difference in reference group where older individuals might report better health than young, given that they share the same "true" health. It might also be the case that income is not the best suitable measure of socio-economic position of elderly individuals since income is highly related to employment and reflects the socio-economic position over a defined time period (in this case one particular year). Instead, wealth might be a better indicator of socio-economic position since it reflects accumulations over the life-cycle (measured in one particular point in time). Also, older individuals are often found to have little income but substantial wealth (see Duncan et. al, 2002).

The main contributor to the total health inequality is, opposed to van Doorslaer & Koolman (2004), *not* income itself. The income inequality is only significant for Belgium, Italy and Austria and it is only in Italy, Spain and Sweden where the income has the highest contribution to the measured degree of total inequality. The result for Sweden is not statistically significant though. Instead, factors such as higher education, retirement and economic inactive plays a more important role for explaining the total income-related health inequality. The fact that education plays such an important role might be related to accumulated risky behaviour, where less educated individuals might be more prone to risky health behaviours compared to well-educated individuals. Also, more education may enhance health production. The fact that higher education contributes more to the measured degree of income-related health inequality for this older population might also reflect that education has become more equitable over the years. In van Doorslaer & Koolman (2004) the main contributor to the measured degree of income-related health inequality was income itself, but also education, labour force status and region are the other prime contributors to health inequality.

A comparison between this study, van Doorslaer & Koolman (2004), Jürges (2010) and Tubeuf & Jusot (2011) suggests that income itself plays a less important role for an older population in explaining the income-related health inequalities compared to a younger population. One could also say that this is confirmed in Tubeuf & Jusot (2011), where the wealth variable is the most important contributor to wealth-related health inequality.

Based on the above results, a possible policy implication for this older population could be to focus on income redistribution, e.g. policies focused on individuals who are retired and economic inactive. Focusing on education would not have an effect for this specific population since it takes time until such policies take effect. It is hard though to give precise policy recommendations based on this study since it has several limitations; which will be discussed below. Instead, one could say that this study contributes to the identification of what factors that are important for income-related inequalities in health and thus points to where the greatest potential for inequality reduction for this older population lies.

This study has its share of limitations. First of all, as noted in chapter 1.4 no causal interpretation can be made, thus policy recommendations should be taken fairly lightly. Secondly, there are other variants of the concentration index that could be used, which may be more appropriate; *E* for example, especially if there is cultural differences in the reporting of health, since it satisfies the level independence property (Kjellsson & Gerdtham, 2011:19). Another threat to the study concerns the external validity of using the thresholds found in Doorslaer & Jones (2003). According to Tubeuf & Jusot (2011) it is questionable to use the Canadian thresholds on European countries due to the cultural differences in the way people report less-than-good health; this study has not tried to correct for reporting differences using vignette samples. Though, as noted in *section 3.1*, van Doorslaer & Gerdtham (2003) find that SAH is unlikely to be biased due to reporting error.

6.2 Suggestion to further research

Further research on this study could be to check the robustness of the results using different measures of SES, as suggested by Jürges (2010). And to be able to make an even better comparison between the results of this study and those found in van Doorslaer & Koolman (2004) one could try and derive a measure of *net* equalised household income, instead of *gross* equalised household income as this study use. It would also be interesting to test different measures of inequality, e.g. the measure suggested by Erreygers (2009). Furthermore, it would also be interesting to use different cut-points for the cardinalisation of the health variable, e.g. using Jürges (2007) procedure as done in Tubeuf & Jusot (2011). Another important task would be to more in-depth considerations of the choice of inequality index. In a recent working paper, written by Kjellsson & Gerdtham (2011), they find that the property of *level independence* in Erreygers index is desirable if there is a high risk of reporting heterogeneity. They also find that the choice of index matters in the sense that it affects the magnitude of measured inequalities and also internal rankings between countries.

But, more interestingly in general would be further research aimed to measure causal relationships between income and health, not the least from a policy perspective point of view. Causal research could help unravel the underlying causal pathways which generate the pattern of income-related health inequalities. Also, policies could be targeted towards these underlying mechanisms instead. There is evidence on persistence in economic outcomes over generations so reforms trying to reduce family background (e.g. study loans) may enhance both efficiency and equality and thereby closing the income-related health inequality gap.

Therefore, studies aimed to examine the causal relationship of intergenerational transmission of socio-economic status and education may help unravel the mechanisms further and help giving more precise policy recommendations on how to address inequalities. Methods able to predict exogenous variation in SES is therefore needed. Panel data using instrumental variables, fixed-effects using sibling data may be possible ways to try to control for unobserved family backgrounds.

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Appendix 1: Summary of variables created

Variables		Description
Dependent variable		
HUI	=	Derived from the variables *sah1* and *sah2*
Independent variables		
Socioeconomic variable		
log_eq_householdinc	=	The logarithm of equalized household income in PPP. Measured on a continuous scale
Age/sex variables		
M5559	=	1 if the respondent is a male aged 55-59, 0 otherwise
M6069	=	1 if the respondent is a male aged 60-69, 0 otherwise
M70plus	=	1 if the respondent is a male aged 70 and above, 0 otherwise
F5054	=	
F5559	=	1 if the respondent is a female aged 55-59, 0 otherwise
F6069	=	1 if the respondent is a female aged 60-69, 0 otherwise
F70plus	=	1 if the respondent is a female aged 70 and above, 0 otherwise
Educational varaibles		
second_education	=	1 if the respondent has obtained second stage of secondary education, 0 otherwise
higher_education	=	1 if the respondent has obtained recognized third level education
Activity variables		
unemployed	=	1 if the respondent is unemployed, 0 otherwise
housework	=	1 if the respondent is a homemaker, 0 otherwise
econ_inact	=	1 if the respondent is permanently sick or disabled, 0 otherwise
retired	=	1 if the respondent is retired from work, 0 otherwise
Marital status variables		
divorced	=	1 if the respondent is divorced, 0 otherwise
widowed	=	1 if the respondent is a widow, 0 otherwise
unmarried	=	1 if the respondent is unmarried, 0 otherwise
Country of birth variables		
bornothereuro	=	1 if the respondent is born in a European country which is different from the country the respondent is living in, 0 otherwise
bornnoneuro	=	1 if the respondent is born in a country outside Europe, 0 otherwise
Region of residence		

variables		
region2	=	1 if the respondent is living in region 2, 0 otherwise
region3	=	1 if the respondent is living in region 3, 0 otherwise
region4	=	1 if the respondent is living in region 4, 0 otherwise
region5	=	1 if the respondent is living in region 5, 0 otherwise
region6	=	1 if the respondent is living in region 6, 0 otherwise
region7	=	1 if the respondent is living in region 7, 0 otherwise
region8	=	1 if the respondent is living in region 8, 0 otherwise
region9	=	1 if the respondent is living in region 9, 0 otherwise
region10	=	1 if the respondent is living in region 10, 0 otherwise
region11	=	1 if the respondent is living in region 11, 0 otherwise
region12	=	1 if the respondent is living in region 12, 0 otherwise
region13	=	1 if the respondent is living in region 13, 0 otherwise
region14	=	1 if the respondent is living in region 14, 0 otherwise
region15	=	1 if the respondent is living in region 15, 0 otherwise
region 16	=	1 if the respondent is living in region 16, 0 otherwise
Reference variables		
M5054	=	1 if the respondent is a male aged 50-54, 0 otherwise
less_than_second	=	1 if the respondent has obtained less than second stage of secondary education, 0 otherwise
employed	=	1 if the respondent is employed (employed or self-employed), 0 otherwise
married	=	1 if the respondent is married (married and living together, married but living separated or registred partnership), 0 otherwise
bornincountry	=	1 if the respondent is born in the country the respondent is living in, 0 otherwise
region1	=	1 if the respondent is living in region 1 (usually the capital region), 0 otherwise

Appendix 2: Region of residence

Region\Country	Germany	Denmark	Netherlands	Belgium	France	Italy	Greece	Spain	Austria	Sweden
Region 1	Baden-Wuerttemberg	-	Noord-Nederland	Bruxelles-Brussel	Ile de France	Nord-Ovest	Voreia Ellada	Noroeste	Ostoesterreich	-
Region 2	Bayern	-	Oost-Nederland	Vlaams	-	-	Kentriki Ellada	Noreste	Suedoesterreich	-
Region 3	Berlin	-	West-Nederland	Wallonie	rd - Pas-de-Ca	Nord-Est	Attiki	nidad de N	Westoesterreich	-
Region 4	Brandenburg	-	Zuid-Nederland	-	-	-	isia Aigaiou, Kri	Centro(E)	-	-
Region 5	Bremen	-	-	-	Ouest	Centro(I)	-	Este	-	-
Region 6	Hamburg	-	-	-	Sud-Ouest	-	-	Sur	-	
Region 7	Hessen	-	-	-	Centre-Est	-	-	-	-	-
Region 8	ecklenburg-Vorpomme	-	-	-	Mediterranee	-	-	-	-	-
Region 9	Niedersachsen	-	-	-	-	Sud	-	-		-
Region 10	Nordrhein-Westfalen	-	-	-	-	-	-	-	-	-
Region 11	Rheinland-Pfalz	-	-	-	-	-	-	-	-	-
Region 12	Saarland	-	-	-	-	-	-	-	-	-
Region 13	Sachsen	-	-	-	-	-	-	-	-	-
Region 14	Sachsen-Anhalt	-	-	-	-	-	-	-	-	-
Region 15	Schleswig-Holstein	-	-	-	-	-	-	-	-	-
Region 16	Thuerigen	-	-	-	-	-	-	-	-	-