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Children's education and parents' mortality – Do parents with highly educated children live longer?

An analysis of the relationship between children's educational attainment and parents' longevity in Western Europe using longitudinal data from 2004-2017

by

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While there exists a large literature on mortality inequalities by an individual's level of education and other socioeconomic characteristics this thesis looks at the relationship between the children's level of education and parents' mortality, which has been relatively less studied. I use longitudinal data from the Survey of Health, Ageing and Retirement in Europe (SHARE) for the years 2004-2017 and conduct Cox proportional hazard regressions to assess how children's level of education affects parents' mortality risks. The included countries are Austria, Belgium, Denmark, France, Germany, Greece, Italy, Spain, Sweden, Switzerland and the Netherlands. The results show that having a child with post-compulsory education is significantly associated with lower mortality hazards for mothers and fathers even after controlling for the parent's own level of education and income. The relationship is stronger at a lower old age (50-74 years) and also for less educated parents. A potential mechanism behind these results could be the impact children may have on parents' health behaviours. In a cross-sectional analysis, it could be shown that children's education is significantly associated with an increased likelihood that a parent has quit smoking. While the analyses in this thesis do not imply causality, they do reveal some interesting relationships. Lastly, the role of the type of welfare regime was assessed, though with inconclusive results. However, some differences by the gender of the parent could be found depending on the type of welfare regime, which may be interesting to explore in future research.

Keywords: Mortality inequalities, socioeconomic gradient in health, children's education, socioeconomic status, SES, demography

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1 Introduction

Life expectancy at birth has on average increased by roughly 10 years from 1970 until 2019 in the countries of the European Union (EU) (World Bank, 2022). Europe's population is ageing and while this phenomenon was first driven by strong declines in fertility, a decline in mortality among the elderly has now become a driving factor as well (combined with a fertility rate that remains below replacement level) (Bengtsson & Scott, 2020). A common policy response to this has been to increase retirement ages in order to alleviate the effect an ageing population has on the pay-as-you-go pension systems (Eurostat, 2020). However, while life expectancy keeps increasing rapidly there exist some ambiguous results in the previous literature regarding whether healthy life expectancy is increasing at the same pace (Christensen et al., 2009). Healthy ageing has thus become a central policy goal for the European Union and its member states (European Commission, 2021). Previous literature has shown that there exist inequalities in mortality and health by socioeconomic status - usually defined by a person's level of education, occupational class and/or income and wealth (Elo et al., 2009) - in the contemporary Western World. This is also often referred to as a socioeconomic gradient in health (see for example Adler et al.,1994; Kunst & Mackenbach, 1994). A large part of the previous literature has focused on inequalities in mortality by educational level and they have found that mortality risks are higher for people with lower socioeconomic status (Kunst & Mackenbach, 1994; Elo et al., 2009). This gradient may be a fairly recent phenomenon as it may have developed only in the second half of the twentieth century (Bengtsson et al., 2020). However, the existence of it implies that increasing the retirement age might affect people differently by educational level and occupational class (Bronnum-Hansen, 2017). Furthermore, looking at inequalities in mortality may also provide important insights for future policies that aim to improve healthy ageing strategies.

Whilst most previous literature has focused on inequalities by one's own socioeconomic status, recent literature has started to look at the association between parents' longevity and the children's level of educational attainment. They found that children's level of education is also negatively associated with their parents' mortality even after accounting for the parent's own socioeconomic status (see for example Zimmer, 2002, 2007; Friedman & Mare, 2014, Torssander, 2013, Sabater et al., 2020). However, the literature on this topic is still quite small and most articles focus on single countries such as the United States, Sweden, Taiwan and Finland. While there is some suggestive evidence that health behaviours may be a driving factor behind the negative relationship between parents' mortality and children's level of education the results remain inconclusive (Friedman & Mare, 2014, Torssander, 2013, Zimmer, 2007, Elo et al., 2018).

This theis will look at the relationship in a Western European context using data from the Survey of Health, Ageing and Retirement in Europe (SHARE). It will pay special attention to differences by types of welfare regimes and children's gender. Previous literature has found that there are differences in overall population health by type of welfare regime type and there

are also differences in the size of health inequalities (Bergqvist et al., 2013). Therefore, it may also play a role when looking at mortality differences by the child's level of education. Welfare regimes differ for example in the degree they rely on familial support, the size of the transfers, and the degree of social redistribution (Ferrera, 1996; Eikemo et al., 2008). These factors may affect mortality inequalities directly but they may also affect the relationship between a child's level of education and the parent's mortality.

The gender of the child may play a role as previous research has found that the involvement in caring for elderly parents is still larger among daughters (see for example Verbakel et al., 2017). Additionally, it has been shown that the parent-child relationships are different for fathers and mothers depending on the gender of the child (Silverstein et al., 1997, Torssander, 2013), thus this might also affect the relationship between a child's education and the parent's mortality. I will furthermore test the association between smoking behaviour and children's educational attainment, thus contributing to previous literature that has identified behavioural factors as one potential mechanism that may be behind the relationship between children's level of education and parents' mortality (see for example Friedman & Mare, 2014; Elo et al., 2018).

This thesis is structured as follows: the second chapter will give a short overview of the previous literature on the relationship between one's own socioeconomic status and health and mortality and also describe previous research on the association between children's education and their parents' mortality. It will furthermore define potential mechanisms and channels of this association based on previous research. Lastly, it will define the research questions and the contribution of this thesis. The third chapter will describe the data and the variables. This will be followed by a section describing the chosen methodology (Cox proportional hazards regressions) and the specifications of the models. Chapter 5 will present some descriptive statistics and the main results of the different models that were specified in the methodology section. This will be followed by a short sensitivity analysis. After that, the results and potential limitations of the study will be discussed. Lastly, a conclusion will follow in the sixth chapter.

2 Theory

2.1 Previous Research

2.1.1 Socioeconomic Status and Health and Mortality

It has been established in previous literature that nowadays in the developed world there are large inequalities in health and mortality by socioeconomic status (SES). This relationship is also referred to as a gradient in health or mortality (Elo, 2009). As stated before, socioeconomic status is usually measured through either occupational class, income, education or a combination of these factors. While some studies look explicitly at health outcomes a large part of the literature uses mortality as a proxy for health as it can serve as a good index measure for health (see for example Vaupel, 2010).

Furthermore, it has been put forward that this gradient is only a fairly recent phenomenon. In a study on Southern Sweden, Bengtsson et al. (2020) found that it only emerged in the second half of the twentieth century (for women after 1950 and for men after 1970). It also emerged earlier for younger adults than for older age groups. Overall the authors state that their results suggest that lifestyle factors and psychosocial stress might be a potential reason for this fairly modern phenomenon (Bengtsson et al. 2020). Lower socioeconomic status is systematically related to higher mortality and lower health outcomes, the higher the socioeconomic position the higher the average life expectancy (Elo, 2009).

Previous research on the relationship between education and adult mortality has found a negative relationship between these two factors (see for example Kunst & Mackenbach 1994; Huisman et al., 2005). In a study from 2011 in the United States, Goldman and Smith stated that gains in health in connection to the level of education have increased since the 1990s. They also observed that higher educated people have better access to healthcare (which is a factor that might be less relevant in countries with universal health insurance). More highly educated people had also adopted better health behaviours (such as refraining from smoking and engaging in more exercise (Goldman & Smith, 2011).

However, as van Raalte et al. (2018) have pointed out, it is not only life expectancy which is lower for people with low education they also face a higher life-span variation which is increasing over time. Thus there is higher variation regarding the timing of death within the groups of people with lower educated people. This trend could not be observed for highly educated people. According to van Raalte et al. (2018), these diverging trends are mainly due to the fact that mortality reductions in early and midlife were either absent or did not happen at the same pace for people with lower socioeconomic status. This phenomenon has been observed in several Western countries (van Raalte et al., 2018). Bronnum-Hansen (2017) for

example looked at register data from Denmark and found that a compression of old-age mortality (meaning a shift to the right of the age-at-death distribution) has only occurred for the highest income quartile and not for the lowest income quartile in the past three decades.

Different explanations have been brought forward for the association between education and health. Some studies which used schooling reforms as exogenous variation regarding the length of schooling found that more schooling can lead to lower mortality although the evidence remains quite weak, as the results are often not robust (Eide and Showalter, 2011). On the other hand, there has been some research which has stated that childhood health may affect the level of education that will be reached hence there might be some reverse causality (see for example Case et al. 2005). Lastly, there is also the possibility that there are factors which influence both health and education which include cognitive ability, social background, and personality characteristics (Torssander, 2013).

Related literature has also put a focus on the relationship between a partner's socioeconomic status and one's own health and has found that a partner's level of education is negatively related to an individual's mortality. Skalická and Kunst (2008), for example, found that especially women's education is a strong predictor of their male spouse's mortality after adjusting for their own and their spouse's further socioeconomic characteristics. Another study has shown that the spouse's level of education is negatively related to the engagement in risky health behaviour such as smoking even after controlling for a person's own socioeconomic characteristics (Monden et al., 2003). Furthermore, it has been shown that marital status itself is also related to an individual's mortality. It has been established in previous literature that married individuals have lower mortality risks compared to non-married individuals among the elderly population in North America and Europe (Manzoli et al., 2007). Further literature has also looked at the relationship between the number of children and an individual's mortality and came to the conclusion that individuals without children face higher mortality risks compared to those with children (see for example Kendig et al., 2007; Modig et al., 2017).

2.1.2 The Relationship between Children's Education and Parents' Longevity

In more recent literature the relationship between children's education and their parents' mortality has been explored, taking it as a familial resource which might also potentially affect the mortality of the parents. Zimmer et al. (2002) were among the first who looked at the relationship between children's education on their elderly parents' health and mortality. They looked at the case of Taiwan and found that the level of education of an adult child had a positive relationship with their parents' physical functioning and it was negatively associated with their mortality and this association was especially pronounced for parents who already were affected by severe health issues at the beginning of the follow-up period (Zimmer, 2007).

Friedman and Mare (2014) analysed data from the United States and concluded that children's level of education is significantly associated with parents' mortality even if the parents' own socioeconomic status is accounted for. Furthermore, they suggested that this

association is partly due to the children's impact on their parents' health behaviours (i.e. physical activity). Using data from Sweden Torssander (2013) found that children's educational attainment is significantly negatively associated with their parents' mortality even if the socioeconomic status of both parents is accounted for. This association also held when employing a strategy that compares siblings in the parental generation in order to account for familial background. It has also been pointed out that the association between children's level of education and parents' mortality may be mediated by the age of the parents (Zimmer et al. 2016; Elo et al. 2018). Elo et al. (2018) tested the association for a lower and higher age group in Finland and found that it becomes much weaker above the age of 75.

Sabater et al. (2020) looked at several Western European countries and constructed a relative education measure of the parent and the child. They focused on the effect of having highly educated children on the longevity of parents with low educational attainment. In their study, they found that having adult children with a high level of education (post-compulsory) is associated with lower mortality risks for their parents if they have low educational attainment. They also found that this relationship is stronger for the lower old-age group (50-74 years) than for the higher group (75+ years). Furthermore, they pointed out that this relationship is partly explained by health behaviour (which was measured in physical activity and health status (measured as self-rated health) and the association was especially pronounced for fathers in early old age and for mothers regardless of age group (Sabater et al. 2020).

Most papers on this topic have mainly looked at the association between children's education and parents' mortality, however, Lundborg and Majlesi (2018) for example followed a causal approach and made use of a compulsory schooling reform which created exogenous variation in the amount of schooling a child received. Their instrumental variable coefficients did not end up being statistically significant, however, they did present some suggestive evidence that female schooling affects the longevity of fathers and this was especially pronounced for fathers with low socioeconomic status (Lundborg & Majlesi, 2018). One needs to take into account, however, that they looked at schooling reforms affecting compulsory schooling, while most other studies focus on the effect of post-secondary education.

Further articles related to this strand of research also explored other socioeconomic characteristics of children such as occupation and income. Elo et al. (2018) used register data from Finland and found that having more highly educated children is associated with lower mortality for parents at the ages of 50-74. However, this association is almost completely crowded out by the child's occupation and income. The relationship also becomes weaker at higher ages (75 and over) although education remains the most strongly associated factor at higher ages. They also found that mortality from cardiovascular diseases is significantly lower for parents who have at least one child that is educated in healthcare (Elo et al., 2018).

Torssander (2014) also looked at several socioeconomic indicators using data from Sweden and found that children's education has the largest association with parents' mortality when comparing it to children's occupational class or income. Thus, Torssander's and Elo et al.'s results differ in this aspect. According to Torssander, her finding may point to behavioural norms or knowledge being more plausible factors when looking for potential pathways for the relationship between children's education and parents' mortality in comparison to access to material resources. However, children's education might also capture unmeasured parental

characteristics to a larger degree than the income and occupational class of children (Torssander, 2014). The potential mechanisms and pathways of the relationship between children's level of education and parents' mortality will be described in more detail in the next chapter.

2.2 Theoretical Approach

2.2.1 Treatment Channels and Mechanisms

In general, it can be expected that children's education and their parents' health are associated with each other as the children's educational attainment may also reflect the socioeconomic resources of the parents. However, as has been described before in previous literature an association remains even after controlling for both of the parents' socioeconomic resources. Thus, in the following paragraphs, a few possible pathways for this association will be discussed.

As has been pointed out before, possible pathways for this relationship include a potential impact of the children on their parents' health behaviour (Friedman and Mare, 2014; Sabater et al. 2020). Children with higher education have a higher likelihood to be better informed about the benefits of healthy behaviours and might encourage parents to engage in more physical activities and to stop smoking, for example (Elo et al., 2018).

Further pathways include the transmission of health and technology knowledge and also financial transfers to the parents (Friedman & Mare, 2014) although the latter aspect may be less relevant in countries with universal health insurance (Torssander, 2013). Torssander (2013) suggested three potential pathways including social support, social influence and access to resources. Social support means that a child may influence a parent's health through emotional, instrumental and informational support. For this support, the frequency of contact may be important. Here, there may also be the possibility that highly educated children have less time for their parents, which would influence the relationship negatively. When it comes to informational support, however, higher education of the children may be beneficial for parents' health. This informational support may include educating their parents on health behaviours but also helping them find the best treatment options and specialists (Torssander, 2013).

Furthermore, it has been found that highly educated individuals are less likely to smoke and engage in other unhealthy behaviours (regarding diet and exercise for example (Goldsmith & Smith, 2011; de Walque, 2007). If children, who have reached a higher educational level than their parents, also adopt better health behaviours than their parents used to engage in, this might potentially influence the parents' habits. This can be termed social influence (Torssander, 2013). However, as will be discussed in more detail later on, smoking represents a special health behaviour as its reputation has changed since the mid-twentieth century, and while smoking used to be a common practice among higher classes it is now more

concentrated among people with lower socioeconomic status (Rogers et al., 1995; Friedman & Mare, 2014).

Access to greater resources for children with higher education may also play a role. Upward financial transfers are quite uncommon in Nordic countries but still play a role in Southern European countries (Torssander, 2013). Additionally, it is not only financial resources which may be higher with a higher level of education as it has been suggested that a higher level of education will enable people to understand health issues better and apply their health knowledge to their lifestyles (Cutler and Lleras-Muney 2010). Additionally, highly-educated children may be better informed regarding the newest health technologies than children with lower education and, as Friedman and Mare (2010) have stated, they may even be better informed about these than their highly-educated parents themselves.

Lastly, Torssander (2013) suggests that there also might be differences in how healthcare is utilised by parents with higher-educated children. These children may use their knowledge to push for the best and the fastest available care and they may have a larger potential to ensure that their parents will fully use all types of medical care that are available to them (Torssander, 2013). Zimmer et al. (2007) for example found that the association between children's education and parents' longevity is stronger for parents who already suffered from quite severe illnesses at baseline, which may suggest that more educated children potentially influence the access to healthcare resources and the decision on different treatment options (Zimmer et al, 2007, Elo et al. 2018). Elo et al. (2018) also specifically looked at children who are healthcare professionals (i.e. a doctor, nurse, or health aide) and found a strong relationship between having a child working in this field and a parent's mortality, especially from cardiovascular diseases. According to the authors, this result may be related to parents being more informed about treatment options and the benefits of a healthier lifestyle when having at least one child that is educated in healthcare (Elo et al., 2018).

However, as has been discussed earlier regarding the relationship between one's own socioeconomic status and health, reverse causality may also be behind the relationship between children's education and their parents' mortality. In that case, children's education might be affected by parental health and this might lead to lower education outcomes for their children (Torssander 2013). Other confounding factors might include genetic factors, the cognitive ability of the parents and their preferences regarding long-term investments. These preferences may influence behaviour regarding investments in both, their own health and their children's education (Torssander, 2013). It has been suggested that preferences for long-term investment may play a role in the relationship between one's own education and health although this has only received limited empirical support (Cutler & Lleras-Muney, 2010).

2.2.2 The Role of the Gender of the Child

Previous literature has shown that women are still more involved in caring for elderly parents than men even though the gap has gotten smaller in recent years (Verbakel et al., 2017). Additionally, there is evidence that daughters will play a larger role in their parents' care if they have brothers. This is especially pronounced in Southern European Countries (Vergauwen & Mortelmans, 2021). Therefore, the involvement of children in their parents'

care might also depend on the welfare system. Additionally, gender differences are in general more pronounced in Southern European countries (Vergauwen & Mortelmans, 2021). It has also been pointed out that the parent-child relationships are different for fathers and mothers depending on the gender of the child (Silverstein et al., 1997; Torssander, 2013). This might also impact the relationship between a child's level of education and the parent's mortality.

2.2.3 The Role of the Welfare System

To explore the role of the welfare system, the different types of welfare regimes have to be defined first. There have been different classifications of welfare regimes in the literature. One of the most influential was the classification by Esping-Andersen (1990). He based his typology on three factors: decommodification (thus how much an individual's welfare is dependent on the market), social stratification (which refers to how welfare systems maintain or break down social stratification) and the private-public mix (the role of the state in relation to that of the family and that of the market regarding welfare provision. However, Esping-Andersen's typology has been criticised as it misclassified Southern European countries as having a less developed form of the Conservative regime for example, according to his critics (see Ferrera, 1996). A new typology was created which included four different types of regimes: the Scandinavian (Social Democratic) which includes all the Nordics, Anglo-Saxon (Liberal) which includes the United States, the United Kingdom, Bismarckian (Conservative) and the Southern countries (Ferrera, 1996; Eikemo et al. 2008). While Ferrera's typology is similar to Esping-Andersen's typology in a lot of aspects it focuses more on the way welfare is delivered instead of the quantity of welfare provided (Bambra, 2007). The additional Southern regime is characterised by a strong reliance on the family and charitable sector, a healthcare system that provides only partial or limited coverage and a highly institutionally fragmented provision of welfare that consists of diverse income maintenance schemes (Ferrera, 1996).

When it comes to socioeconomic inequalities in mortality and morbidity by different welfare regimes, the literature has presented mixed evidence. While most studies have found that overall population health is better in the Nordic countries, it has also been found that when it comes to inequalities in health, the Nordic countries do not seem to have the smallest (Bambra, 2007). Eikemo et al. (2008) for example found that South European welfare regimes showed the largest inequalities in health and Bismarckian (or Central European) welfare regimes the smallest. The remaining regimes ranked quite closely to each other. Nevertheless, significant differences could be found also among these types with the Scandinavian regime ranking slightly lower than the Anglo-Saxon and the East European when measuring the size of health inequalities (Eikemo et al. 2008). Most papers find that there are differences in the size of health inequalities by type of welfare regime but results vary with the chosen type of health outcome, gender and cohort, thus no general conclusion could be drawn about which regime performs the best or the worst (Bergqvist et al., 2013).

Nevertheless, there seem to exist differences in the size and type of socioeconomic health inequalities by the type of welfare regimes, which makes it an interesting variable to include in this study. However, the potential pathways of the relationship between one's own socioeconomic status and health may not be necessarily the same as the pathways between

children's education and their parents' longevity. The type of welfare regime might also play a role in the relationship between children's education and parents' mortality, as the welfare regimes for example differ in the extent to which they rely on familial support and the degree of social redistribution. While the Southern and the Bismarckian are characterised by a stronger reliance on familial support this is not the case for the Nordic (or Social Democratic) system. The degree of social redistribution is also higher in the Nordic system compared to the other two systems (Esping-Andersen, 1990; Ferrera, 1996, Eikemo et al., 2008). These factors may affect mortality inequalities directly but they may also affect the relationship between a child's level of education and the parent's mortality.

2.2.4 The Role of Health Behaviours Using the Example of Smoking

Previous literature has suspected that health behaviours might be behind the association between children's education and parents' mortality. These claims were based on results which reported a stronger association between children's level of education and parents' mortality for causes of death that can be related to health behaviour such as lung cancer, heart diseases and lower respiratory diseases (Friedman & Mare, 2014, Torssander, 2014, Elo et al. 2018). Furthermore, the association of children's education with certain health behaviours of their parents has been tested. Friedman and Mare (2014) for example looked at parents' smoking behaviour and the amount of physical exercise they engage in using data from the United States. They found that having children with a tertiary education will decrease the probability that a person currently smokes and increases the probability that the parent has quit smoking (Friedman & Mare, 2014).

As has been stated before children might exert a social influence or provide informational support to their parents regarding health behaviours (Torssander, 2013). The case of smoking is an interesting case to look at as here children with tertiary education might have the highest chance to influence their parents' behaviour. While smoking used to be a status symbol and was common among people with a higher socioeconomic status this has changed beginning in the 1960s when health concerns emerged and people in the upper classes were the first people to react to these concerns which lead to smoking being more common among people with lower socioeconomic status (Rogers et al., 1995). According to Friedman and Mare (2014), the habit of smoking is usually developed in the late teenage years or early twenties, therefore, changes in smoking might be dependent on the age at which socioeconomic characteristics change. Overall this change in the link between smoking and level of education increases the likelihood that highly educated parents who were young when smoking was still common among the upper classes have highly educated children who are non-smokers. This distinguishes smoking from other health behaviours as the generational divide may not be as pronounced for other health behaviours such as dietary habits or using preventative medicine for example, as these will usually be the same among all members of a family with a high level of education (Friedman & Mare, 2014).

2.2.5 Research Questions

Building on these previous results this study will look at data from several Western European countries collected between the years 2004 and 2017 through the SHARE survey and it will focus on the following research questions:

Are higher levels of education in children associated with lower mortality risks for their fathers and mothers in Western European countries?

In this study, higher levels of education refer to an educational level that is at least higher than compulsory education according to the International Standard Classification of Education (ISCED) (UNESCO 1997/2006). Even though some of the previous literature has also included other factors of children's socioeconomic status, which might express the socioeconomic status a bit more accurately such as occupation or income, this study will only focus on the factor of education. This is partly due to data availability reasons (as the data set used for this study only contains information on children's education) but also because one might argue that education is a fundamental part of a person's socioeconomic status as it may determine both income and occupation (Eikemo et al., 2008). The decision to focus on mortality is due to the fact that it is an easily available and reliable measure and it has been termed to be the most reliable index of health (Vaupel, 2010).

Furthermore, based on Chapter 2.2.3 and Chapter 2.2.4, I will explore two sub-research questions:

Does the type of welfare regime affect this relationship?

Does the education of the child affect the likelihood that a parent has quit smoking at the time of the interview?

3 Data

3.1 Data Set Description

The data for this study was derived from the Survey of Health, Ageing, and Retirement in Europe (SHARE) (Börsch-Supan, 2022a-f). SHARE is the largest pan-European social science panel. I will use waves 1, 2, and 4-7. Wave 3 was not included as it only collected retrospective information and thus the variables differed from other waves. Wave 7 was also partly conducted as a special wave that did not use the regular questionnaire, thus only the data on deaths were taken from this wave. The baseline survey was conducted in the year 2004 and the follow-ups took place in 2007, 2011, 2013, 2015 and 2017. The data was collected through computer-assisted personal interviewing (CAPI). This means that the interviews were conducted face-to-face with the help of a laptop, which had the CAPI instrument installed. The questionnaires are ex-ante harmonised meaning that one generic questionnaire was translated into the different national languages. The sampling procedure is based on sample frames that are selected based on data from population registers (or registers for specific use). This is done to achieve a high degree of representativeness of the survey sample compared to the actual population in the participating countries. Additionally, there are sampling design weights to account for unequal selection probabilities (Börsch-Supan et al., 2013, Bergmann et al., 2019).

I constructed the dataset for this study by choosing the relevant thematic cross-sectional files from the SHARE database (including demographic variables, information on children, information on household income, information on health, and information on occupation and pensions). I first combined them into cross-sectional datasets for each wave and then into one longitudinal data set. The respondents are aged 50 and older (respondents below the age of 50 were dropped from the sample). All countries that were part of the original baseline survey in 2004 were included. These include Austria, Belgium, Denmark, France, Germany, Greece, Italy, Spain, Sweden, Switzerland and The Netherlands (Börsch-Supan et al., 2013). People without children were excluded from the sample. Furthermore, following previous literature (Friedman & Mare, 2014; Sabater et al., 2020) only children who had reached the age of 25 were included as it is assumed that educational attainment will remain stable from this point onwards. The final sample size is 28557.

3.2 Description of Variables

A parent's death is the event of interest in this study. The deaths were captured by conducting end-of-life interviews. If a respondent had died the interviewer conducted an interview with a

proxy respondent (usually a relative or another person of the closer social network of the deceased respondent). Information was collected on the respondent's last year of life and the circumstance of death (month and year of death and cause of death) (Bergmann et al., 2019). Due to the small number of captured deaths (relative to the number of included years and countries), I will focus on all-cause mortality. The final study sample contains 4119 deaths.

The main independent variable will be the educational level of the child. Education is measured in the form of codes taken from the International Standard Classification of Education (ISCED). This classification makes it easier to compare educational degrees across countries. In order to compare educational levels across all waves the classification from 1997 was used (UNESCO 1997/2006). The six original categories were regrouped into three categories which include the following: No education to compulsory (primary/lower secondary), upper secondary to non-tertiary, and tertiary education (both first and second stage). The first two groups will be referred to as "compulsory" and "upper secondary" for brevity reasons. Different measures of the children's education were constructed. Following previous literature a dominance approach was used in which the child with the highest education was selected and if there were several children with the same level of education the eldest child was taken (Sabater et al., 2020; Torssander, 2014). According to Torssander (2014), the dominance approach is preferable (compared to only taking the oldest child) as it captures parents' access to resources in the younger generation in a more accurate way. This will be the main variable, however, a second variable will be tested which also looks at the child with the highest education, however in the case of several children with the same level of education, the child with the closest geographic proximity to the parents was taken, as highly educated children who live closer to their parents may also have higher chances of influencing their health.

One of the main covariates includes the type of welfare regime. I follow the typology of Ferrera (1996) to categorise the participating countries into different welfare regime types. Ferrera's typology is one of the most used welfare regime typologies in the previous literature on health inequalities and welfare state types (Bergqvist et al., 2013) and it has also been found to be one of the most accurate (Bambra, 2007). For this study, the countries will be grouped into three categories: the Bismarckian/Conservative (including Austria, Belgium, France, Germany, Switzerland, and the Netherlands), the Scandinavian/Social Democratic (including Denmark and Sweden), and the Southern (including Greece, Italy, and Spain). There will be no Anglo-Saxon (liberal) category as no country belonging to this group has participated in the original baseline survey in 2004. The Bismarckian/Conservative will be referred to as the Central European group, the Scandinavian/Social Democratic will be referred to as the Nordic group and the Southern type will be referred to as the Southern European group.

Additionally, the level of education of the respondent will be included. This variable is coded the same way as the educational levels of the children. Following previous literature I will also include a covariate measuring the number of children as it has been shown that the number of children is associated with both the parents' mortality and children's level of education (Torssander, 2013). Some specifications will also include the gender of the child as this may also play a role when it comes to parents' mortality as relationships may be different

depending on the gender of the parent and the gender of the child as has been described before (Silverstein et al., 1997, Torssander, 2013).

Furthermore, time-varying controls for household net income and household net wealth (specified in the survey as "household net worth") will be included. These are also supposed to capture the respondent's socioeconomic status. The household net income is an added measure of annual net earnings from employment or self-employment, public and private pensions, social security payments, income from rent and income from interest or dividends from banks, accounts, bonds, stocks, and mutual funds. The household net worth is a combined measure of financial and housing assets including net stock value, mutual funds, bonds and savings and the value of the primary residence (net of the mortgage), the value of further real estate, and the value of owned businesses and cars. The data on income and wealth was converted into euros and adjusted for differences in purchasing power across the included countries (SHARE, 2022). Following previous literature (Hairi et al., 2010; Sabater et al., 2020), the income and wealth measures are divided by the square root of the number of household members in order to account for different household sizes. Furthermore, the household income and household wealth variable was split up into quintiles as this will enable a more meaningful interpretation of these variables in the analysis. The quintiles are numbered from 1 to 5 with 1 being the lowest income or wealth group and 5 being the highest.

Unfortunately, the income and wealth measures suffered from a high rate of non-response (around 65%) therefore, imputed values were used in order to maximise the size of the usable sample. These were taken from SHARE's imputations module (Börsch-Supan, 2022a-f). The values were imputed using the fully conditional specification (FCS) method developed by van Buuren et al. (1999). Although this method is lacking rigorous theoretical justification it has become one of the most popular multivariate imputation procedures as it is very flexible when it comes to handling complicated data structures and it will preserve the correlation of imputed variables (van Buuren et al., 2007). For each missing value, there were five imputed values in order to capture the distribution of the missing value of a certain variable (which is conditional on the observed values of other variables) (SHARE, 2011). Therefore, three different versions of the variables containing the imputed values were constructed capturing the minimum, the maximum, and the average of the imputed values for each respondent. These were tested in preliminary analyses, which showed that the different specifications did not change the final results. Therefore, the variable which is portraying the average values will be used for the main analysis.

3.3 Descriptive Statistics

Table 3.1 shows the descriptive statistics at baseline (first interview of a respondent). The mean age was 66.12 years (the age variables are based on calculated ages based on the month and year of birth). The mean age at death among the people whose deaths were captured in an end-of-life interview was 81.63 years. Around 42 per cent of the sample is male and 57.7 per cent are female. Most respondents have only completed compulsory education (46.4 per cent),

while around 21 per cent of the respondents in the sample have tertiary education. The respondents had on average 2.47 children. The average household income was around 41,031 € and the average household net worth was about 331,900 €. Regarding the distribution of the people across the different welfare regimes, it can be seen that the Central European type makes up the largest part of the sample (54.8 per cent) followed by the Southern European (26 per cent) and then the Nordic type (19.2 per cent).

Table 3.1 Descriptive Statistics of parents at baseline (first interview)

Variable	Respon-dents	Percentage/ Mean	Std. Dev.	Min	Max
Age (at first interview)	28557	66.12	10.347	49.667	103.5
Age at death	4119	81.631	9.905	52	107.167
Gender	.	.	.	.	.
Male	12066	.423	.494	0	1
Female	16491	.577	.494	0	1
Education respondent	.	.	.	.	.
Compulsory	13238	.464	.499	0	1
Upper secondary	9260	.324	.468	0	1
Tertiary	6059	.212	.409	0	1
Nr of children	28557	2.469	1.282	1	17
Total household income	28557	41031.617	47792.213	0	1652871.3
Total household net worth	28557	331900.03	7940714.5	-718856.31	1,337,000 000,000
Welfare	.	.	.	.	.
Central European	15647	.548	.498	0	1
Nordic	5472	.192	.394	0	1
Southern	7438	.26	.439	0	1

Table 3.2 shows the summary characteristics for the variables concerning the children of the respondents. The first part concerns the variables which were selected through a dominance approach looking at the child with the highest degree and if children have the same educational level, the eldest child with the highest education degree. The second part shows the statistics for the second variable which was selected by taking the child with the highest degree first and then choosing the child with a lower distance to the parent if educational levels were the same. The second variable will be used for a sensitivity analysis later on.

Table 3.2 Descriptive Statistics children at baseline

Variable	Respondents	Percentage	Std. Dev.	Min	Max
Child's education (dominance approach)	28557				
Compulsory	3313	.116	.32	0	1
Upper secondary	10880	.381	.486	0	1
Tertiary	14364	.503	.5	0	1
Gender of the child (dominance approach)	28557				
Male	14278	.5	.5	0	1
Female	14279	.5	.5	0	1
Child's education (proximity approach)	26027				
Compulsory	3071	.118	.323	0	1
Upper secondary	10046	.386	.487	0	1
Tertiary	12910	.496	.5	0	1
Child's gender (proximity approach)	26027				
Male	13065	.502	.5	0	1
Female	12962	.498	.5	0	1

It can be seen that the distribution of the children across educational levels differs quite strongly from the distribution of the parents. 11.6 per cent only completed compulsory schooling while 50.3 per cent acquired tertiary education. This distribution also means that there is an increased likelihood for the respondents in this sample that their children have reached a higher level of education than their parents. The share of children with tertiary education appears to be quite high for example in relation to the average share of people with tertiary education (in the age group 25-34 years) in the countries of interest (see Eurostat, 2022). However, this may partially be due to the way the variable was constructed, as it captures the child with the highest level of education in a family, thus the share of children with tertiary education may be higher compared to the general population. Nevertheless, there remains the possibility that parents who have at least one child with tertiary education may also be slightly overrepresented in this study sample. There are equal amounts of male and female children in the study sample when looking at the children who were selected through a dominance approach. The distribution across educational levels for children who were selected through the proximity approach is similar to the distribution of the children that were selected through the dominance approach. The gender distribution is also roughly similar although there are slightly more male children.

3.4 Limitations of the Data

As with most analyses using survey data, there always remains uncertainty about the reliability of the answers (regarding whether respondents have answered correctly or

truthfully for example) (Coughlan et al., 2013). This analysis is also prone to a bias introduced by non-response. While the response rates were quite low for each of the waves (usually around or below 50 per cent) it has been stated that the overall response rate of SHARE is fairly high in comparison to other European and quite recent U.S. survey studies. Furthermore, analyses of the response behaviour of subgroups based on age and sex have shown that there were only small differences regarding initial survey participation and also panel retention (Börsch-Supan et al. 2013; Bergmann et al., 2019). Panel attrition (meaning that a person who has participated in previous wave(s) does not respond anymore in further follow-up surveys) is a very common issue in the SHARE data and there is a high probability that it also affects the number of deaths that are recorded. Therefore, the number of deaths that was taken from the end-of-life interviews is very likely to be underestimated (Schulz & Doblhammer, 2010; Sabater et al., 2020). Kneip et al. (2015) have analysed the attrition patterns in the SHARE data and have found that only the oldest-old respondents exhibit a higher likelihood of non-response. Therefore, attrition at these ages might be due to mortality rather than refusing to participate in follow-up surveys (Kneip et al., 2015; Sabater et al., 2020).

The issue of non-response may introduce a selectivity bias and also a loss of precision (De Luca et al., 2015; SHARE, 2022). In this analysis, the monetary variables suffered from a high amount of item non-response. As described before the missing values were imputed using the FCS method of van Buuren et al. (1999). Therefore, this analysis might also suffer from a bias introduced by the imputation method of the values. As all the monetary variables were usually collected by asking retrospective and open-ended questions and they concern a sensitive topic, there might also be a potential bias due to the unreliability of the answers as respondents might not answer truthfully (SHARE, 2022).

4 Methodology

The data will be analysed using Cox Proportional Hazard regression models. The outcome in these models is the time to an event. The event in this case is death. With contemporary survival data and especially if it was collected through conducting a survey there is often an issue of incomplete observation regarding the time variable, meaning that it can only be observed that an individual was still alive at a certain point in time (usually the end of the study period) and it is not observed when this individual will ultimately die. Individuals might also drop out of the survey earlier and thus their survival time can only be observed until the time of the last interview. In both cases, the observations will be right-censored, which means that the studied event (in this case death) has not taken place until the end of the observation period (Cleves et al., 2010; Andersen, 2022).

The underlying data set for this study contains both of these cases as not all individuals have been part of all waves and the latest possible observation could be made in the year 2017. Therefore, Cox Proportional Hazard regression models are more suitable than for example Ordinary Least Squares (OLS) or linear regression, as they can better account for these characteristics (Andersen, 2022). Additionally, this type of regression does not assume a normal distribution of the residuals (which is the case for OLS regression models). When studying time to death the assumption of a normal distribution may be very unreasonable as has been pointed out by Cleves et al. (2010), thus Cox proportional hazard regression is the preferred method for this type of research. The functional form of the model is presented in Equation 1.

$$h(t|x_j) = h_0(t) \exp(\beta_i x_j) \quad (1)$$

$h(t|x_j)$ is the hazard of death for respondent j at duration t (measured in months) conditional on the value of the explanatory variables (covariates) x_j. The time variable is age in months. The time clock starts at study entry and ends in the event of death (event=1) or right-censoring (event=0) if the respondent was still alive in his most recent interview. $h_0(t)$ captures the baseline hazard which is the hazard for a respondent having the value 0 on all covariates. β_i is a vector for the coefficients of the individual covariates, that are captured by the vector x_j. These include the previously described variables measuring the educational level of the child (which is the main independent variable), the educational level of the respondent, the gender of the child, the number of children a respondent has, the household income, and the household wealth.[1]

Cox proportional hazards models are based (as already stated in the name) on the assumption of proportional hazards over time throughout the study period (Cox, 1972). This will be tested using a formal test available in STATA (*estat phtest*), which is testing the null hypothesis that the hazards are proportional. Based on the reported p-value this hypothesis will be rejected or not. If the null hypothesis needs to be rejected the proportional hazards assumption is violated (Cleves et al., 2010). The tests were run after each model had been fitted. Based on the reported p-values the null hypothesis was not rejected.

In the past Cox proportional hazard models have been criticised that the estimated hazard ratios do not have a causal interpretation (Martinussen et al., 2020) Nevertheless, if treatment is randomly allocated there is the potential that the estimates may be causally interpreted (Andersen, 2022). In this study, however, the treatment (child's level of education) is not randomly allocated, thus the models will only be able to measure associations.

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[1] As has been described in previous chapters, marital status and the partner's level of education have also been shown to be associated with an individual's mortality. Due to insufficient data availability, these were not included in the analysis. The marital status was in most cases only measured at baseline and assuming that it stayed the same over the study period would introduce a potential bias to the estimates.

The mortality hazards will be estimated based on the verified deaths from the end-of-life interviews. In the remaining cases, it will be assumed that respondents have survived until the end of the observation period. The individual parent is the unit of analysis. The models will be run separately for fathers and mothers. As previous research on the relationship between children's education and parents' mortality has shown that the association may be affected by age (see Zimmer et al., 2007, 2016; Elo et al., 2018; Sabater et al., 2020), I will also run separate models for two different age groups: low old age (50-74 years) and high old age (75 years and older). These age groups were constructed based on the age in the most recent observation of a respondent.

Furthermore, following previous literature (Friedman & Mare, 2014; Sabater et al. 2020) the baseline hazards will be allowed to vary by the country of residence. This relaxes the underlying assumption of Cox proportional hazard models that the combined effects of the main independent variable and all covariates are the same among all countries in the analysis. This step is taken to prevent bias which may arise from a non-proportionality in the survival curves. Additionally, standard errors will be adjusted for clustering of respondents at the household level.

Model 1 will only include children's educational attainment as an independent variable. Model 2 will additionally include the respondent's education. In Model 3 the child's gender and the number of children a respondent has will be added. Model 4 will additionally include the square root of total net household income and the square root of total household net worth. The models will first be run for all age groups and then for the lower age group (50-74.99 years) and the higher old age group (75+ years) separately. Additionally, the main models will be run separately for each welfare regime type. They are tested separately to capture potential interaction effects and to uphold a better model fit, as this way, the models can still be stratified by country and thus the proportionality assumption is not violated.

Lastly, logistic regressions will be performed on a subsample which only includes people who had observations on their smoking behaviour. The binary outcome variable will measure whether parents who reported that they used to smoke are not doing so anymore at the point of the interview (thus the binary outcome variable will equal one if the parent has quit smoking). Thus these regressions are only performed on a subsample which used to smoke at some point throughout their life. Unfortunately, the data set only contains observations on the current smoking behaviour if the respondents answered that they have smoked at some point in their life. Thus no comparisons regarding the current smoking behaviour can be made among all people in the study sample.

This is not conducted as a time-varying analysis as the data set did not provide a sufficient amount of information on people who changed their smoking status throughout the study period. I will follow an approach which has also been used by Friedman and Mare (2014) who have used logistic regression models to test the association between children's education and parent's smoking behaviour for mothers and fathers in the United States.

I will also follow a stepwise approach similar to the way the Cox proportional hazard models are set up. In this case, however, the gender of the respondent is only included as a control variable, thus the analysis is performed on a sample containing both genders. Model 1

includes the parent's and the child's education and the gender of the respondent. Model 2 additionally includes the child's gender and the number of children of the respondent. In Model 3 variables on household income and household wealth are added (in this case as continuous variables). Standard errors are clustered at the individual level to account for multiple years of data (following Friedman & Mare, 2014). All models are also adjusted for country of residence.

This additional analysis is supposed to provide insights into the relationship between behavioural factors and children's education in this case focusing on smoking behaviour as previous literature has for example found stronger associations between children's education and causes of death that are related to behavioural factors such as lung cancer and chronic lower respiratory disease compared to other types of diseases which are less related to behavioural factors (Zimmer et al. 2007; Friedman & Mare 2014; Elo et al., 2018).

5 Empirical Analysis

5.1 Main Results

In the table below (Table 5.1) the results for fathers of all ages are shown. The table shows hazard ratios for all included variables. The education of the respondent and the education of the children have a highly significant relationship with the mortality of the parents for all models. The reference categories are shown in brackets. When looking at Model 4 it can be seen that if the child with the highest education level has more than compulsory schooling this is associated with a mortality hazard that is on average about 28% lower for respondents having a child with upper secondary schooling and 23% lower for respondents having a child with tertiary schooling. When comparing the models it can be seen that adding variables measuring household income and household wealth (Model 4) will slightly reduce the strength of the relationship (meaning that the hazard ratios are a bit higher in this model). The gender of the child is also significantly associated with the mortality hazard for fathers. As the reference group is male children, the hazard ratio reports that if the oldest child of the children with the highest educational level is female, this is associated with a hazard that is about 88 per cent of the hazard when the child's gender is male.

In Table 5.2 the fathers are split up into the low age group and the high age group. The upper part reports the results for the low-age group. Again all education variables are significantly associated with the fathers' mortality. The relationship is stronger compared to the estimates for fathers of all ages (meaning that the hazard ratios are lower). It is also important to note that in this case, the hazard ratio is lower for respondents who have at least one child that has completed tertiary education compared to respondents whose child has only upper secondary education. The hazard ratio for a child's gender is only significant at the 10% level for this age group but the strength of the association remains similar compared to the sample that includes all ages. Furthermore, household income is not significantly associated with fathers' mortality anymore, only the estimates for wealth (household net worth) remain significant (estimates not shown).

For the group of fathers in higher old age (see Table 5.2 (bottom half)), it is noticeable that the hazard ratios are a lot larger, hence differences in mortality hazards by educational level of the child (and also the respondent’s own educational level) are smaller. Furthermore, the significance levels have changed, the estimate for having a child whose highest educational level is upper secondary education is not significantly different anymore compared to having a child whose highest educational level is compulsory schooling. The estimates for having a child with tertiary education are still significant except for model 4. Here, the estimates for the educational level of the child and also the father’s own level of education are all

insignificant. The gender of the child is not significantly associated with fathers' mortality in all models in which this variable is included.

Table 5.1 Mortality hazard ratios for fathers (all ages included)

VARIABLES		**Model 1**	**Model 2**	**Model 3**	**Model 4**
Child's level of education	(Compulsory)	.	.	.	.
	Upper Secondary	0.645***	0.693***	0.695***	0.724***
		(0.0448)	(0.0481)	(0.0483)	(0.0505)
	Tertiary	0.567***	0.699***	0.704***	0.770***
		(0.0384)	(0.0483)	(0.0486)	(0.0539)
Father's education	(Compulsory)		.	.	.
	Upper secondary		0.589***	0.593***	0.643***
			(0.0355)	(0.0358)	(0.0389)
	Tertiary		0.506***	0.505***	0.614***
			(0.0371)	(0.0371)	(0.0464)
Child's gender	(Male child)			.	.
	Female child			0.885***	0.889***
				(0.0401)	(0.0404)
Number of children				1.033*	1.016
				(0.0184)	(0.0184)
Household net income	(1st quintile)				.
	2nd quintile				1.129*
					(0.0748)
	3rd quintile				1.034
					(0.0745)
	4th quintile				0.825**
					(0.0679)
	5th quintile				0.592***
					(0.0582)
Household net worth	(1st quintile)				.
	2nd quintile				0.846**
					(0.0575)
	3rd quintile				0.703***
					(0.0512)
	4th quintile				0.720***
					(0.0552)
	5th quintile				0.668***
					(0.0574)
Nr of respondents		12,066	12,066	12,066	12,066
Nr of deaths		1,978	1,978	1,978	1,978

Robust standard errors in parentheses: *** p<0.01, ** p<0.05, * p<0.1
Notes: All models are stratified by country. Standard errors are clustered at the household level.

Table 5.2 Mortality hazard ratios for fathers – by age group

Fathers - low old age (50-74 years) VARIABLES		**Model 1**	**Model 2**	**Model 3**	**Model 4**
Child's level of education	(Compulsory)	.	.	.	.
	Upper secondary	0.606***	0.645***	0.647***	0.704***
		(0.0691)	(0.0739)	(0.0745)	(0.0817)
	Tertiary	0.484***	0.579***	0.586***	0.683***
		(0.0556)	(0.0683)	(0.0693)	(0.0822)
Father's level of education	(Compulsory)		.	.	.
	Upper secondary		0.682***	0.682***	0.723***
			(0.0676)	(0.0676)	(0.0716)
	Tertiary		0.561***	0.557***	0.655***
			(0.0671)	(0.0668)	(0.0807)
Child's gender	(Male child)			.	.
	Female child			0.869*	0.869*
				(0.0647)	(0.0649)
Number of children				1.004	0.976
				(0.0316)	(0.0313)
Nr of respondents		9,607	9,607	9,607	9,607
Nr of deaths		751	751	751	751

Fathers - high old age (75+ years) VARIABLES		**Model 1**	**Model 2**	**Model 3**	**Model 4**
Child's level of education	(Compulsory)	.	.	.	.
	Upper secondary	0.891	0.900	0.896	0.900
		(0.0731)	(0.0737)	(0.0734)	(0.0740)
	Tertiary	0.824**	0.869*	0.866*	0.891
		(0.0667)	(0.0718)	(0.0714)	(0.0747)
Father's level of education	(Compulsory)		.	.	.
	Upper secondary		0.874*	0.876*	0.906
			(0.0678)	(0.0679)	(0.0720)
	Tertiary		0.790**	0.789**	0.874
			(0.0737)	(0.0735)	(0.0860)
Child's gender	(Male child)			.	.
	Female child			0.917	0.918
				(0.0499)	(0.0501)
Number of children				1.018	1.017
				(0.0198)	(0.0198)
Nr of respondents		4,161	4,161	4,161	4,161
Nr of deaths		1,227	1,227	1,227	1,227

Robust standard errors in parentheses: *** p<0.01, ** p<0.05, * p<0.1

Notes: All models are stratified by country. Model 4 is additionally adjusted for household income and household wealth (for the full output see Table A.1 and A.2 in Appendix A). Standard errors are clustered at the household level.

Table 5.3 shows the hazard ratios for mothers of all ages included in the study sample. The differences in mortality hazards between having a child whose highest educational level is compulsory schooling (reference group) compared to children who have more than compulsory schooling is larger for mothers than for fathers. In Model 4 the death hazard is for example about 36 per cent lower for mothers who have a child with post-compulsory schooling compared to mothers who have a child with only compulsory schooling. In this case, the estimate for the gender of the child is already insignificant for mothers of all ages. The estimate for the number of children is only significant in Model 4 when the income and wealth variables are added.

When the sample is restricted to mothers in lower old age (Table 5.4) only the estimates for having a child with tertiary education remain significantly different from having a child with only compulsory education (reference group). Furthermore, adjusting for household income and household wealth increases the hazard ratio for having a child with tertiary education, hence the relationship becomes weaker. Overall, the hazard ratios for mothers in the low old age group are in this case not smaller compared to the estimates for all ages, as it had been the case for the group of fathers.

For the group of mothers in high old age (also Table 5.4 (bottom half)), the estimates for having a child with upper secondary education and for having a child with tertiary education are both highly statistically significant again. Having a child with tertiary education slightly reduces the mortality hazard for mothers in high old age compared to having a child with upper secondary education. As could already be seen in previous analyses, having children with post-compulsory education is associated with lower mortality hazards overall. In comparison to the subsample of mothers in low old age, the relationship is weaker for mothers in high old age when looking at the estimates for having a child with tertiary education.[2] Furthermore, adding variables on household income and household wealth (Model 4)

[2] As the estimates for having a child with upper secondary education were not significant for the group of mothers in low old age, comparisons can only be made between the estimates for having a child with tertiary education.

decreases the strength of the relationship. Lastly, the number of children is significantly related to a mother's mortality in all models in which this variable is included. This was not the case for mothers in the low old age group meaning that a higher number of children is only significantly related to lower mortality for mothers at a high old age.

Table 5.3 Mortality hazard ratios for mothers (all ages included)

VARIABLES		**Model 1**	**Model 2**	**Model 3**	**Model 4**
Child's level education	(Compulsory)	.	.	.	.
	Upper secondary	0.553***	0.587***	0.586***	0.635***
		(0.0355)	(0.0371)	(0.0371)	(0.0408)
	Tertiary	0.446***	0.563***	0.564***	0.638***
		(0.0289)	(0.0360)	(0.0360)	(0.0419)
Mother's education	(Compulsory)		.	.	.
	Upper secondary		0.476***	0.473***	0.521***
			(0.0290)	(0.0289)	(0.0322)
	Tertiary		0.342***	0.339***	0.422***
			(0.0300)	(0.0298)	(0.0383)
Child's gender	(Male child)			.	.
	Female child			0.988	0.977
				(0.0431)	(0.0428)
Number of children				0.981	0.965**
				(0.0167)	(0.0165)
Household net income	(1st quintile)				.
	2nd quintile				1.073
					(0.0637)
	3rd quintile				0.919
					(0.0665)
	4th quintile				0.721***
					(0.0646)
	5th quintile				0.664***
					(0.0717)
Household net worth	(1st quintile)				.
	2nd quintile				0.692***
					(0.0425)
	3rd quintile				0.605***
					(0.0398)
	4th quintile				0.639***
					(0.0478)
	5th quintile				0.631***
					(0.0532)
Nr of respondents		16,491	16,491	16,491	16,491
Nr of deaths		2,120	2,120	2,120	2,120

Robust standard errors in parentheses: *** p<0.01, ** p<0.05, * p<0.1
Notes: All models are stratified by country. Standard errors are clustered at the household level.

Table 5.4 Mortality hazard ratios for mothers – by age group

Mothers – low old age (50-74 years) VARIABLES		**Model 1**	**Model 2**	**Model 3**	**Model 4**
Child's level of education	(Compulsory)	.	.	.	.
	Upper secondary	0.793*	0.822	0.823	0.857
		(0.111)	(0.114)	(0.114)	(0.119)
	Tertiary	0.575***	0.668***	0.676***	0.728**
		(0.0818)	(0.0957)	(0.0966)	(0.104)
Mother's education	(Compulsory)		.	.	.
	Upper secondary		0.700***	0.686***	0.706***
			(0.0739)	(0.0730)	(0.0760)
	Tertiary		0.525***	0.515***	0.576***
			(0.0762)	(0.0749)	(0.0870)
Child's gender	(Male child)			.	.
	Female child			0.966	0.958
				(0.0819)	(0.0813)
Number of children				0.942	0.934
				(0.0403)	(0.0398)
Nr of respondents		12,774	12,774	12,774	12,774
Nr of deaths		564	564	564	564

Mothers – high old age (75+) VARIABLES		**Model 1**	**Model 2**	**Model 3**	**Model 4**
Child's level of education	(Compulsory)	.	.	.	.
	Upper secondary	0.742***	0.749***	0.743***	0.770***
		(0.0509)	(0.0512)	(0.0510)	(0.0535)
	Tertiary	0.682***	0.725***	0.725***	0.767***
		(0.0475)	(0.0505)	(0.0505)	(0.0549)
Mother's education	(Compulsory)		.	.	.
	Upper secondary		0.785***	0.777***	0.815**
			(0.0615)	(0.0610)	(0.0649)
	Tertiary		0.663***	0.657***	0.706***
			(0.0762)	(0.0757)	(0.0832)
Child's gender	(Male child)			.	.
	Female child			1.011	1.011
				(0.0489)	(0.0493)
Number of children				0.968**	0.960**
				(0.0153)	(0.0155)
Nr of respondents		5,870	5,870	5,870	5,870
Nr of deaths		1,556	1,556	1,556	1,556

Robust standard errors in parentheses: *** p<0.01, ** p<0.05, * p<0.1

Notes: All models are stratified by country. Model 4 is additionally adjusted for household income and household wealth (for the full output see Table A.3 and A.4 in Appendix A). Standard errors are clustered at the household level.

5.2 Results by Type of Welfare Regime

To assess the role of potential confounding factors which are due to the different characteristics of the welfare regimes (such as the extent to which the welfare system relies on familial support and the degree of social distribution) the regressions were run again for each type of welfare regime separately. In Table 5.5 the results are shown for mothers and fathers separately. The regressions were run using the full specification from the previous analyses.[3] However, only the estimates for the parents' and the children's education are shown. The models were run on the whole study sample (including all age groups). While all estimates for the education of the parent are significant, the education of the child is not significantly associated anymore with the fathers' mortality hazards in countries with a Central European welfare regime. Additionally, the estimate of having a child with tertiary education is not significantly different from the reference category (compulsory education) for fathers in countries with a Nordic welfare regime.

For the group of mothers, the association between the child's education and the mother's mortality is the strongest for respondents from Southern European countries when looking at the hazard ratio of having a child with upper secondary education. When looking at tertiary education the differences in the hazard ratios are not very large, although respondents living in a Central European country have the lowest hazard ratio. Overall it can be seen that the welfare regime type seems to affect the associations differently for mothers and fathers. When looking at the estimates for having a child with upper secondary education, it can be seen that the difference in hazard ratios is quite small in the Nordic countries but quite large in the Southern European countries (this is however not the case for having a child with tertiary education). Additionally, while there are significant differences by the educational level of the

[3] The number of children and the gender of the child were not included as preliminary analyses reported very high p-values for those estimates.

child for mothers in Central European countries, this is not the case for the group of fathers in these countries.

Table 5.5 Mortality hazard ratios for fathers and mothers by welfare regime type

		Central European		Nordic		Southern European	
VARIABLES		**Fathers (1)**	**Mothers (2)**	**Fathers (3)**	**Mothers (4)**	**Fathers (5)**	**Mothers (6)**
Child's level of education	(Compulsory)	.	.	.	.	.	.
	Upper - Secondary	0.814	0.701***	0.655**	0.625***	0.722***	0.609***
		(0.105)	(0.0854)	(0.131)	(0.102)	(0.0691)	(0.0543)
	Tertiary	0.864	0.631***	0.824	0.661**	0.658***	0.647***
		(0.113)	(0.0785)	(0.161)	(0.107)	(0.0654)	(0.0602)
Parent's education	(Compulsory)	.	.	.	.	.	.
	Upper - Secondary	0.668***	0.571***	0.605***	0.600***	0.635***	0.328***
		(0.0572)	(0.0485)	(0.0752)	(0.0701)	(0.0777)	(0.0532)
	Tertiary	0.588***	0.470***	0.719**	0.478***	0.558***	0.380***
		(0.0622)	(0.0587)	(0.107)	(0.0723)	(0.0939)	(0.0986)
Nr of respond.		6,634	9,013	2,420	3,052	3,012	4,426
Nr of deaths		818	826	406	433	754	861

Robust standard errors in parentheses: *** p<0.01, ** p<0.05, * p<0.1

Notes: All models are stratified by country and adjusted for household income and household wealth (estimates not shown – for full output see Table B.1 in Appendix B). Standard errors are clustered at the household level.

Lastly - even though this is not the focus of this study - it is worth highlighting that the parents' level of education is not just more strongly related to their mortality than their children's level of education (which is not surprising based on results from previous research), there are also quite large differences by gender (especially when looking at the estimates for tertiary education). The size of these differences varies by type of welfare regime and level of education. In the Nordic countries, they only seem to exist for having tertiary education. Overall, the association between one's own level of education and mortality is the strongest for mothers in countries with a Southern European welfare regime. Having tertiary education is for example associated with a mortality hazard that is only 38 per cent of the mortality hazard of women with only compulsory education (reference group) in this group of countries.

5.3 Results for the Relationship between Children's Education and Smoking Behaviour

In Table 5.6 the results of the logistic regression models regarding smoking behaviour are reported. The sample size is smaller in this case as only respondents who had smoked at some point in their life were included. Having a child with post-compulsory education is positively associated with the likelihood that a parent gave up smoking. The relationship is strongest and significant at the 1 per cent level for parents whose child has tertiary education. The parents' own level of education is associated with a decreased likelihood of having quit smoking for

parents with upper secondary education in comparison to the reference group of parents with only compulsory education. Having tertiary education will however increase the likelihood again although the coefficients are a lot smaller compared to the coefficients of having a child with tertiary education. Adding variables on the financial situation of the household (household net income and net wealth) will slightly decrease the size of the coefficient for having a child with tertiary education but it remains highly significant.

Table 5.6 Logistic regression coefficients – Children's education and current smoking behaviour among parents who have ever smoked

VARIABLES		(1) quitsmoking	(2) quitsmoking	(3) quitsmoking
Child's level of education	(Compulsory)	.	.	.
	Upper secondary	0.123*	0.123*	0.113*
		(0.0685)	(0.0685)	(0.0685)
	Tertiary	0.470***	0.468***	0.442***
		(0.0696)	(0.0697)	(0.0700)
Parent's level of education	(Compulsory)	.	.	.
	Upper secondary	-0.120**	-0.121**	-0.140***
		(0.0478)	(0.0481)	(0.0484)
	Tertiary	0.144**	0.144**	0.0963*
		(0.0565)	(0.0566)	(0.0582)
Gender of respondent	(Male)	.	.	.
	Female	-0.577***	-0.578***	-0.567***
		(0.0389)	(0.0390)	(0.0390)
Gender of child	(Male child)		.	.
	Female child		0.0428	0.0426
			(0.0383)	(0.0383)
Number of children			-0.00530	-0.00259
			(0.0159)	(0.0160)
Household net income				1.82e-06***
				(6.27e-07)
Household net worth				1.69e-07*
				(8.69e-08)
Constant		0.370***	0.364***	0.322***
		(0.0939)	(0.104)	(0.104)
Observations		12,390	12,390	12,390

Robust standard errors in parentheses: *** p<0.01, ** p<0.05, * p<0.1
Notes: Standard errors are clustered at the individual level to account for multiple years of data. All models are adjusted for country of residence (estimates not shown).

5.4 Sensitivity Analysis

As a sensitivity analysis, the main independent variable measuring the education of the child was changed to the version following the proximity approach, which was described in the data section above. Thus, in this case, the child with the highest educational level was selected and in the case of two children with the same level of education, the child with the lower distance to the mother or the father respectively was selected. The models were run for fathers and mothers separately and include all ages.

All variables measuring the level of education (both of the parent and the child) are again statistically significant in all cases. For fathers, no clear differences in hazard ratios could be observed in comparison to the main analysis (see Table C.1 in Appendix C). For the group of mothers (see Table 5.7), however, a stronger association could be observed in comparison to the main analysis. This indicates that the proximity of the child may play a larger role for the group of mothers than it does for the group of fathers.

Table 5.7 Mortality hazard ratios for mothers - child with highest level of education and closest proximity

VARIABLES		**Model 1**	**Model 2**	**Model 3**	**Model 4**
Child's level of education	(Compulsory)	.	.	.	.
	Upper secondary	0.499***	0.536***	0.534***	0.580***
		(0.0381)	(0.0404)	(0.0402)	(0.0442)
	Tertiary	0.398***	0.508***	0.510***	0.580***
		(0.0307)	(0.0390)	(0.0391)	(0.0455)
Mothers's level of education	(Compulsory)		.	.	.
	Upper secondary		0.482***	0.476***	0.522***
			(0.0364)	(0.0361)	(0.0400)
	Tertiary		0.334***	0.330***	0.413***
			(0.0381)	(0.0377)	(0.0487)
Child's gender	(Male child)			.	.
	Female child			1.017	1.005
				(0.0553)	(0.0549)
Number of children				0.959*	0.945**
				(0.0219)	(0.0216)
Household net income	(1st quintile)				.
	2nd quintile				1.075
					(0.0785)
	3rd quintile				0.960
					(0.0863)
	4th quintile				0.686***
					(0.0769)
	5th quintile				0.749**
					(0.0968)
Household net worth	(1st quintile)				.
	2nd quintile				0.649***
					(0.0479)
	3rd quintile				0.575***
					(0.0470)
	4th quintile				0.612***
					(0.0560)
	5th quintile				0.546***
					(0.0606)
Nr of respondents		16,460	16,460	16,460	16,460
Nr of deaths		1,364	1,364	1,364	1,364

Robust standard errors in parentheses: *** p<0.01, ** p<0.05, * p<0.1
Notes: All models are stratified by country. Standard errors are clustered at the household level.

As a second sensitivity analysis, I restricted the sample to low educated parents (parents with only compulsory education). This is done as previous research has shown, that the relationship may be stronger among this group (Sabater et al. 2020). Furthermore, the potential for upward transfers of the children may be the highest for this group. The regressions were run for both age groups separately. The results are shown in Table 5.8. Only the estimates for the full specification (with all control variables included) are shown for mothers and fathers separately (the estimates for household income and wealth are not shown; for the full table see Table C.2 and C.3 in Appendix C).

Table 5.8 Mortality hazard ratios for fathers and mothers with low education - by age group

Low old age group (50-74 years)			
		Fathers	**Mothers**
VARIABLES		**(1)**	**(2)**
Child's level of education	(Compulsory)	.	.
	Upper secondary	0.683***	0.824
		(0.0936)	(0.128)
	Tertiary	0.639***	0.677**
		(0.0957)	(0.113)
Child's gender	(Male child)	.	.
	Female child	0.950	1.045
		(0.0985)	(0.116)
Number of children		0.999	0.930
		(0.0392)	(0.0495)
Nr of respondents		3,385	5,742
Nr of deaths		385	329

High old age group (75+ years)			
		Fathers	**Mothers**
VARIABLES		(1)	(2)
Child's level of education	(Compulsory)	.	.
	Upper secondary	0.888	0.757***
		(0.0785)	(0.0542)
	Tertiary	0.814**	0.720***
		(0.0773)	(0.0549)
Child's gender	(Male child)	.	.
	Female child	0.901	1.026
		(0.0622)	(0.0557)
Number of children		1.016	0.960**
		(0.0237)	(0.0163)
Nr of respondents		2,151	4,157
Nr of deaths		777	1,267

Robust standard errors in parentheses: *** p<0.01, ** p<0.05, * p<0.1

Notes: All models are stratified by country and adjusted for household income and household wealth (for full output see Table C.2 and C.3 in Appendix C). Standard errors are clustered at the household level.

For the low old age group, it can be seen that the estimates for the children's level of education are significant at the 1 per cent level for the group of fathers. Compared to the original model for fathers at low old age (see Model 4 in Table 5.2), the hazard ratios are slightly lower. This may indicate a stronger relationship between the child's education and the father's mortality for fathers with only compulsory education. The difference between the estimates of the restricted and the original model is larger for having a child with tertiary education compared to having a child with upper secondary education.

For the group of mothers in low old age, only the estimate for having a child with tertiary education is significantly different from the estimate for having a child with only compulsory education (reference group). The estimate is about 5 percentage points lower than the corresponding estimate in the original model (see Model 4 in Table 5.4). This indicates that the association between having a child with tertiary education and a mother's mortality is stronger for mothers with only compulsory education.

For the high old age group, the relationship is weaker for the group of fathers compared to the group of mothers. This has already been the case in the original analysis. However, in this case, the estimate for having a child with tertiary education is significant at the five per cent level while in the original full specification, it was insignificant for both having a child with upper secondary and with tertiary education (see Table 5.2 (bottom half)). Thus, for fathers at a high old age (75+ years) only the mortality of fathers with low education is significantly associated with having a child with tertiary education.

For the group of mothers in high old age, the estimates for the child's level of education are highly significant (which they were as well in the original model) and the hazard ratios are also slightly smaller (indicating a stronger relationship) than in the original model (see Model 4 in Table 5.4 (bottom half)). The difference between the estimates is again larger for having a child with tertiary education. Overall, the results need to be interpreted with caution however, as the sample size of parents with only compulsory education (and especially the number of deaths) was quite small, which may impact the reliability of the results.

5.5 Discussion

The results of this study confirm previous results that there remains a significant association between a children's level of education and the parents' mortality even after controlling for the parent's own education and income. In most cases the strength of the relationship becomes weaker when adding the controls for parent's own education, household income and household wealth which suggests that children's level of education also partly captures parent's socioeconomic characteristics when measuring the association only between children's educational attainment and parents' mortality. Therefore, it could be shown that the children's level of education is significantly associated with their parent's mortality for mothers and fathers in the studied Western European countries (Austria, Belgium, Denmark, France, Germany, Greece, Italy, Spain, Sweden, Switzerland, and the Netherlands) even after controlling for some of the parents' own socioeconomic characteristics.

The relationship between children's educational attainment and parents' mortality was weaker for the high old age group for both, mothers and fathers. This is also in line with previous research that has found that higher ages will mediate the relationship between those two factors (see Elo et al., 2018, Sabater et al. 2020). Therefore, the role of education may be more relevant for mortality at lower old age. Only very few studies have looked at different age groups yet but always reported similar results. Zimmer et al. (2016) suggested mortality selection and thus increased homogeneity among people in high old age to be a potential reason for these results. This selection process may limit the possibility of upward health transfers and thus explain the weaker associations for parents in old age. Elo et al. (2018) also stated that chances for children to impact the health of their parents may become more limited at higher old age.

Furthermore, previous literature has also stated that health inequalities among parents reach their peak in lower old age. At this point in life, behavioural and psychosocial and also material factors have a larger influence on health than age (Ploubidis et al., 2011; Sabater et al., 2020). This can also be connected to Van Raalte et al.'s (2018) findings that the diverging trends in life-span variation are due to smaller reductions in midlife mortality among the low educated people, hence this is where inequalities are the greatest and there is the highest potential that children's education might make a difference.

Furthermore, the results for mothers and fathers differed in terms of the size of the relationship. For the group of mothers, the mortality risks when having a child with post-compulsory education were lower than those for the group of fathers when looking at all age groups. However, when focusing only on the low old age group and the estimates for having a child with tertiary education, mortality risks were lower for fathers than for mothers indicating that the association is stronger for fathers in this age group. For the high old age group, the mortality risks are again lower for the group of mothers. While this could point to differential relationships for mothers and fathers depending on the age group, these results may also be partly driven by the number of end-of-life interviews that have been filled out for each gender and age group. The sample size is in general a bit smaller for fathers and especially for fathers in high old age, which decreases the statistical power and the reliability of the estimates. The small sample size of fathers in high old age might also be partly due to the fact that women live on average longer than men (Eurostat, 2019). Previous literature did not report strong differences by the gender of the parent (Torssander, 2013; Elo et al., 2018; Sabater et al. 2020). According to Torssander (2013), one might expect stronger differences in mortality by the level of education of the child for mothers than for fathers as mother-child relationships are expected to be closer (Silverstein et al., 1997). While this aspect might have changed in recent decades due to an increasing involvement of fathers in childcare (Sullivan et al., 2014), emotional and physical proximity may not be the only important factor which can affect the relationship between the child's level of education and the parent's mortality as children may, for example, give the same help to mothers and fathers in case of severe illness (Torssander, 2013). Nevertheless, looking at the child with the highest education and the closest proximity did increase the strength of the relationship for mothers (but not for fathers) which indicates that proximity might play a role in the relationship between children's education and mother's mortality.

When restricting the sample to low educated parents (parents who have only compulsory education), the gender patterns remained the same as in the main analysis, however, the sample size was even smaller in this case. However, this sensitivity analysis revealed that the relationship is stronger for low educated parents which is in line with some of the previous research (see for example Sabater et al, 2020). The potential for children's education to affect their parent's mortality may be the largest for this group. It was visible that the strength of the relationship especially changed for the estimates of having a child with tertiary education. Here, the difference between the parent's and the child's level of education is the largest, thus there might be a larger knowledge gap regarding health behaviours and also treatment options, which increases the possibility for upward knowledge transfers. This would be in accordance with the hypothesis that having children with tertiary education could mitigate the independent effect of parents' low socioeconomic status on their mortality (Sabater et al., 2020). However, there also exist competing theories. Friedman and Mare (2014), for example, did not find statistically significant differences by the education of the parent. They argued, that while there is a large potential that low educated parents may benefit from their more highly educated children, highly educated parents may also be better able to adopt new health behaviours and new health knowledge more quickly from their children (Friedman & Mare, 2014). However, the results are not directly comparable as the authors used different approaches when measuring the level of education and the studies were conducted in different geographical contexts (the former in Europe and the latter in the U.S.) which may also explain the different results. Further research may be needed regarding this aspect.

The estimates for the gender of the child were only significant for fathers of both age groups and fathers in the low old age group. Therefore, the gender of the child may only play a role in the father's mortality at low old age. If the child with the highest education and the dominant age is female the death hazard was only around 87 per cent of the hazard when the child is male. That the death hazard is lower for having a female child may be related to daughters having closer ties to the parents and them being more likely to provide social and other kinds of support (Silverstein et al., 1997, Grundy & Read, 2012). Lundborg and Majlesi (2018) also found an especially strong relationship between a female child's education and a father's mortality when analysing historical data from Sweden. However, other studies could not find strong differences by the gender of the child. Torssander (2013), for example, could only find a stronger relationship when the parent's only child was a girl instead of a boy. However, for parents with several children the estimates for the gender of the child were not significant anymore (Torssander, 2013). Therefore further research might be needed to investigate these patterns.

The results of the models that were split up by type of welfare regime were a bit inconclusive. For the models looking at fathers, not all estimates measuring the child's level of education were significant. For the group of mothers having children with post-compulsory education is significantly associated with lower mortality. However, the welfare regime type in which the relationship is the strongest differs by the level of the education of the child. Therefore, no clear conclusions can be drawn. Overall, there is some indication that the differences by gender and the size of the gender differences differ by each type of welfare regime. For fathers living in countries with a Central European welfare regime, no significant differences in mortality hazards by the child's level of education could be found while this was not the case for the group of mothers. In the Nordic countries, the hazard ratios for a child with upper

secondary education were of a similar size for mothers and fathers while there is a relatively large difference when comparing mothers and fathers in Southern European countries, Here the hazard ratio for women is a lot smaller indicating that the relationship is stronger for women (this does however not hold for having a child with tertiary education). It needs, however, to be noted that the sample size for Nordic countries overall and for fathers in Southern European countries is rather small which may impact the accuracy and the reliability of the estimates.

The results regarding smoking behaviour follow the same pattern as the research conducted by Friedman and Mare (2014) on data from the United States. The higher the highest educational level of the children the higher the likelihood that a parent has quit smoking. This lends support to the hypothesis that behavioural factors may partly be behind this association. Smoking has been shown to decrease life expectancy by 8-9 years on average (Jha et al., 2013). Previous research has also found stronger relationships between children's education and parents' mortality for deaths caused by lung diseases that are associated with smoking (Friedman & Mare, 2014; Torssander, 2014; Elo et al., 2018).

Therefore, one likely mechanism that is driving the association between children's education and parents' mortality might be social influence, as has been suggested by Torssander (2014). Highly educated children may be better informed about health behaviours but they are also subject to different societal norms compared to the norms their parents were subjected to when they were young (Friedman & Mare, 2014; Elo et al., 2018). However, another explanation for the relationship between children's education and parents' mortality could also be that characteristics such as cognitive abilities and ambitions (or aspirations) are impacting both factors (Torssander, 2013). Overall, quite a lot of potential confounding factors could not be included in this analysis, thus the question of causality and the potential mechanism behind this relationship remains open. This aspect and further limitations will be discussed in the next section.

5.6 Limitations of the Study

This analysis only considered children's education as an indicator of socioeconomic status due to a lack of data on other indicators. Some previous articles have indicated that children's occupation mediates the relationship between children's education and parents' mortality (Elo et al., 2018), while others found that education remains more strongly associated even when looking at other indicators of children's socioeconomic status (Torssander, 2014). These papers were limited to single countries Finland and Sweden) therefore, in future research, it may be interesting to explore further indicators of children's socioeconomic status using data from several countries. Another limitation of using children's education as the main independent variable might also be that children's education might capture unmeasured parental characteristics to a greater extent than income or occupational category (Torssander, 2014).

A further limitation is, as mentioned before, that the captured number of deaths may be biased as there is a high likelihood that there does not exist an end-of-life interview for every person that died throughout the study period. Furthermore, if this is not happening randomly (for example if there is a higher likelihood that an end-of-life interview will be filled out for a certain gender or age group) it will introduce a bias to the estimates.

Another limitation includes that this analysis only looked at all-cause mortality. This was due to the low number of mortality observations for each country. As stated before, previous literature has found stronger associations between children's educational level and parents' mortality for causes of death that are related to behavioural factors such as heart and lung diseases (Friedman & Mare, 2014, Torssander, 2014, Elo et al., 2018). While looking at all-cause mortality still provides important insights regarding the general relationship between children's level of education and parents' longevity it is less precise and less informative when it comes to potential underlying mechanisms behind the measured associations.

Additionally, the educational level of the spouse could not be included in this analysis due to insufficient data availability. Therefore, the estimates for the children's level of education might also partly capture unaccounted socioeconomic characteristics of the respondent's partner and this might also be the case for the estimates of the educational level of the respondent. Furthermore, marital status (which has been shown to affect mortality (see Manzoli et al., 2007)) could not be included in the analysis. Therefore, the association between children's education and parents' mortality is likely to be weaker when including marital status and partner's educational level. In future research, it would be interesting to see to which extent it will affect the estimates.

Furthermore, this analysis only measures associations and not causal effects which may also be considered to be a limitation. Thus, when building on these results one has to keep in mind that they only measure a relationship and not an effect. There may still be other unobserved characteristics which could not be accounted for in this analysis and which may impact both, the educational level of the adult children and the parents' health and thus mortality. There might be confounding factors such as that parents who enable their children to achieve high levels of education also have a high self-motivation to maintain a healthy lifestyle (Sabater et al. 2020). Reverse causality cannot be completely ruled out. As stated before, healthier parents may also be able to create a better environment for their children to achieve high academic levels (Torssander, 2013).

There exist some results on causal effects (see Lundborg & Majlesi, 2018), however, as mentioned before they only looked at a secondary schooling reform in a historical context. In future research, it might be interesting to study an event that created exogenous variation regarding the uptake or completion of tertiary schooling. This study, however, had the aim to look at data from several European countries to make use of a larger sample size and to generate results that are potentially more generalizable.

Nevertheless, a causal approach could reveal interesting new insights. Another approach to explore potential mechanisms has been to look at the association between parents' health behaviours and children's education. This paper only looked at one behavioural factor which limits the informative value, thus in the future, it may be more beneficial to include several

measurements of different health behaviours in order to compare the strength of the relationships. This also ties into the research which looks at different causes of mortality that have been discussed in previous chapters.

Lastly, the analysis concerning smoking behaviour was conducted as a logistic regression. Therefore, it does measure changes over time. This decreases the informative value and the precision of the analysis. As there is no time indicator when the person has stopped smoking it may also be possible that the parent has stopped smoking before the child had finished their education (or before the children were even born). Therefore, the educational attainment of the children might also only reflect parental characteristics or circumstances that impact the probability of the person smoking or quitting smoking (Torssander, 2014). Additionally, the estimates for the parents who have quit smoking are measured on quite a small sample which may also decrease the meaningfulness of the results. Nevertheless, it could measure associations that can act as a base for future research which can address behavioural factors more closely and especially their role in the relationship between children's educational attainment and their parents' longevity.

6 Conclusion

This thesis looked at the relationship between children's level of education and parents' mortality. Data from the Survey of Health, Ageing, and Retirement in Europe (SHARE) was analysed using Cox proportional hazard regression models. The countries included were Austria, Belgium, Denmark, France, Germany, Greece, Italy, Spain, Sweden, Switzerland and the Netherlands. The aim of this study was to analyse whether there is a relationship between children's education and parents' mortality for this group of countries, whether it differs by low old age and high old age and what role the welfare regime and the gender of the child are playing. Furthermore, smoking was analysed as one potential behavioural factor that may be partly causing the association between children's level of education and parental mortality. Due to insufficient data availability, this was only done by conducting logistic regression models.

For the first research question, regarding whether higher levels of education of children are associated with lower mortality risks for their fathers and mothers in Western European countries, the results showed that having a child with post-compulsory education is significantly associated with lower mortality hazard for mothers and fathers. The relationship is stronger for the low old age group which was in line with previous research on this topic. Additionally, the association appeared to be stronger for parents with only compulsory education. Previous literature has presented ambiguous results on this aspect (see Friedman & Mare 2014; Sabater et al., 2020), thus this factor may be further explored in future research. The second research question regarding the role of the welfare states cannot be answered conclusively. The results regarding the welfare regime types were a bit mixed, however, it might be interesting to explore gender differences by welfare regimes a bit further in future research. Overall, the gender of the child does not seem to play an important role.

For the third research question ("Does the education of the child affect the likelihood that a parent has quit smoking at the time of the interview?") some meaningful results could be found. The analysis regarding the relationship between the children's education and the likelihood that a parent has quit smoking revealed that if the age-dominant child with the highest education has tertiary education this will strongly and significantly increase the likelihood that a parent has stopped smoking even when controlling for a parent's own education and income. This was in line with previous results that were found in single-country studies for example in a study on the United States (Friedman & Mare, 2014). However, further research is needed which ideally includes time-varying variables measuring smoking behaviour and also puts a focus on diseases or causes of death that are related to smoking.

In future research, it may also be interesting to take more of a causal approach and also look more closely into the role of behavioural factors. Furthermore, it may be interesting to investigate whether the measured links between children's education and parents' mortality are

more of an ex-ante or ex-post relationship, thus, looking into whether the education of the children affects the likelihood of developing certain diseases in the first place or whether it affects how these diseases are treated. The latter may be more connected to the hypothesis that the level of education of the children will affect the way the healthcare system is utilised (Torssander, 2013; Elo et al. 2018), while the former would be more in line with the hypothesis of children affecting their parents' health behaviour (Friedman & Mare, 2014).

Coming back to the points that were raised in the introduction of this study, mortality inequalities - not just by own educational level but also by the educational level of the child – may play a central role when it comes to implementing healthy ageing policies. If future research can identify part of these associations between the child's educational level and parents' mortality as causal this could mean that the ongoing educational expansion in Europe may have a decreasing effect on mortality inequalities among parents.

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Appendix A

Table A.1 Mortality hazard ratios for fathers - low old age (full output)

VARIABLES		Model 1	Model 2	Model 3	Model 4
Child's level of education	(Compulsory)	.	.	.	.
	Upper secondary	0.606***	0.645***	0.647***	0.704***
		(0.0691)	(0.0739)	(0.0745)	(0.0817)
	Tertiary	0.484***	0.579***	0.586***	0.683***
		(0.0556)	(0.0683)	(0.0693)	(0.0822)
Father's level of education	(Compulsory)		.	.	.
	Upper seconary		0.682***	0.682***	0.723***
			(0.0676)	(0.0676)	(0.0716)
	Tertiary		0.561***	0.557***	0.655***
			(0.0671)	(0.0668)	(0.0807)
Child's gender	(Male child)			.	.
	Fermale child			0.869*	0.869*
				(0.0647)	(0.0649)
Number of children				1.004	0.976
				(0.0316)	(0.0313)
Household net income	(1st quintile)				.
	2nd quintile				1.223*
					(0.137)
	3rd quintile				1.086
					(0.132)
	4th quintile				1.007
					(0.132)
	5th quintile				0.781
					(0.119)
Household net worth	(1st quintile)				.
	2nd quintile				0.817*
					(0.0879)
	3rd quintile				0.511***
					(0.0617)
	4th quintile				0.580***
					(0.0704)
	5th quintile				0.548***
					(0.0747)
Nr of respondents		9,607	9,607	9,607	9,607
Nr of deaths		751	751	751	751

Robust standard errors in parentheses: *** p<0.01, ** p<0.05, * p<0.1
Notes: All models are stratified by country. Standard errors are clustered at the household level.

Table A.2 Mortality hazard ratios for fathers - high old age (full output)

VARIABLES		Model 1	Model 2	Model 3	Model 4
Child's level of education	(Compulsory)	.	.	.	.
	Upper secondary	0.891	0.900	0.896	0.900
		(0.0731)	(0.0737)	(0.0734)	(0.0740)
	Tertiary	0.824**	0.869*	0.866*	0.891
		(0.0667)	(0.0718)	(0.0714)	(0.0747)
Father's level of education	(Compulsory)				
	Upper seconary		0.874*	0.876*	0.906
			(0.0678)	(0.0679)	(0.0720)
	Tertiary		0.790**	0.789**	0.874
			(0.0737)	(0.0735)	(0.0860)
Child's gender	(Male child)			.	.
	Fermale child			0.917	0.918
				(0.0499)	(0.0501)
Number of children				1.018	1.017
				(0.0198)	(0.0198)
Household net income	(1st quintile)				.
	2nd quintile				1.025
					(0.0876)
	3rd quintile				0.983
					(0.0917)
	4th quintile				0.880
					(0.0960)
	5th quintile				0.830
					(0.112)
Household net worth	(1st quintile)				.
	2nd quintile				0.837**
					(0.0718)
	3rd quintile				0.884
					(0.0778)
	4th quintile				0.842*
					(0.0798)
	5th quintile				0.758***
					(0.0814)
Nr of respondents		4,161	4,161	4,161	4,161
Nr of deaths		1,227	1,227	1,227	1,227

Robust standard errors in parentheses: *** p<0.01, ** p<0.05, * p<0.1

Notes: All models are stratified by country. Standard errors are clustered at the household level.

Table A.3 Mortality hazard ratios for mothers - low old age (full output)

VARIABLES		**Model 1**	**Model 2**	**Model 3**	**Model 4**
Child's edcuation	(Compulsory)	.	.	.	.
	Upper secondary	0.793*	0.822	0.823	0.857
		(0.111)	(0.114)	(0.114)	(0.119)
	Tertiary	0.575***	0.668***	0.676***	0.728**
		(0.0818)	(0.0957)	(0.0966)	(0.104)
Mother's education	(Compulsory)		.	.	.
	Upper secondary		0.700***	0.686***	0.706***
			(0.0739)	(0.0730)	(0.0760)
	Tertiary		0.525***	0.515***	0.576***
			(0.0762)	(0.0749)	(0.0870)
Child's gender	(Male child)			.	.
	Female child			0.966	0.958
				(0.0819)	(0.0813)
Number of children				0.942	0.934
				(0.0403)	(0.0398)
Household net income	(1st quintile)				.
	2nd quintile				1.149
					(0.142)
	3rd quintile				1.142
					(0.154)
	4th quintile				0.918
					(0.142)
	5th quintile				0.877
					(0.156)
Household net worth	(1st quintile)				.
	2nd quintile				0.743**
					(0.0916)
	3rd quintile				0.709***
					(0.0906)
	4th quintile				0.725**
					(0.0997)
	5th quintile				0.687**
					(0.104)
Nr of respondents		12,774	12,774	12,774	12,774
Nr of deaths		564	564	564	564

Robust standard errors in parentheses: *** p<0.01, ** p<0.05, * p<0.1

Notes: All models are stratified by country. Standard errors are clustered at the household level.

Table A.4 Mortality hazard ratios for mothers - high old age (full output)

VARIABLES		**Model 1**	**Model 2**	**Model 3**	**Model 4**
Child's edcuation	(Compulsory)	.	.	.	.
	Upper secondary	0.742***	0.749***	0.743***	0.770***
		(0.0509)	(0.0512)	(0.0510)	(0.0535)
	Tertiary	0.682***	0.725***	0.725***	0.767***
		(0.0475)	(0.0505)	(0.0505)	(0.0549)
Mother's education	(Compulsory)		.	.	.
	Upper secondary		0.785***	0.777***	0.815**
			(0.0615)	(0.0610)	(0.0649)
	Tertiary		0.663***	0.657***	0.706***
			(0.0762)	(0.0757)	(0.0832)
Child's gender	(Male child)			.	.
	Female child			1.011	1.011
				(0.0489)	(0.0493)
Number of children				0.968**	0.960**
				(0.0153)	(0.0155)
Household net income	(1st quintile)				.
	2nd quintile				1.009
					(0.0707)
	3rd quintile				0.925
					(0.0797)
	4th quintile				0.928
					(0.101)
	5th quintile				1.102
					(0.142)
Household net worth	(1st quintile)				.
	2nd quintile				0.790***
					(0.0540)
	3rd quintile				0.701***
					(0.0523)
	4th quintile				0.730***
					(0.0623)
	5th quintile				0.718***
					(0.0701)
Nr of respondents		5,870	5,870	5,870	5,870
Nr of deaths		1,556	1,556	1,556	1,556

Robust standard errors in parentheses: *** p<0.01, ** p<0.05, * p<0.1

Notes: All models are stratified by country. Standard errors are clustered at the household level.

Appendix B

Table B.1 Mortality hazard ratios for fathers and mothers by welfare regime type (full output)

		Central European		Nordic		Southern European	
VARIABLES		Fathers (1)	Mothers (2)	Fathers (3)	Mothers (4)	Fathers (5)	Mothers (6)
Child's education	(Compulsory)	.	.	.	.	.	.
	Upper Secondary	0.814	0.701***	0.655**	0.625***	0.722***	0.609***
		(0.105)	(0.0854)	(0.131)	(0.102)	(0.0691)	(0.0543)
	Tertiary	0.864	0.631***	0.824	0.661**	0.658***	0.647***
		(0.113)	(0.0785)	(0.161)	(0.107)	(0.0654)	(0.0602)
Parent's education	(Compulsory)	.	.	.	.	.	.
	Upper Secondary	0.668***	0.571***	0.605***	0.600***	0.635***	0.328***
		(0.0572)	(0.0485)	(0.0752)	(0.0701)	(0.0777)	(0.0532)
	Tertiary	0.588***	0.470***	0.719**	0.478***	0.558***	0.380***
		(0.0622)	(0.0587)	(0.107)	(0.0723)	(0.0939)	(0.0986)
Household net income	(1st quintile)	.	.	.	.	.	.
	2nd quintile	1.024	1.265**	1.242	0.759*	1.095	0.924
		(0.127)	(0.133)	(0.288)	(0.123)	(0.0974)	(0.0842)
	3rd quintile	0.994	1.207*	0.943	0.429***	1.009	1.035
		(0.122)	(0.136)	(0.218)	(0.0716)	(0.114)	(0.129)
	4th quintile	0.893	1.025	0.540***	0.274***	1.038	0.971
		(0.114)	(0.130)	(0.128)	(0.0534)	(0.149)	(0.178)
	5th quintile	0.664***	0.981	0.346***	0.205***	1.022	1.285
		(0.0906)	(0.139)	(0.0902)	(0.0475)	(0.263)	(0.357)
Household net worth	(1st quintile)	.	.	.	.	.	.
	2nd quintile	0.820*	0.706***	0.875	0.795*	0.894	0.671***
		(0.0916)	(0.0754)	(0.125)	(0.0991)	(0.0996)	(0.0643)
	3rd quintile	0.671***	0.650***	0.714**	0.604***	0.768**	0.606***
		(0.0738)	(0.0687)	(0.118)	(0.0905)	(0.0928)	(0.0620)
	4th quintile	0.673***	0.652***	0.652**	0.579***	0.853	0.700***
		(0.0750)	(0.0734)	(0.109)	(0.103)	(0.117)	(0.0852)
	5th quintile	0.623***	0.607***	0.651**	0.664**	0.769*	0.711**
		(0.0788)	(0.0757)	(0.116)	(0.116)	(0.118)	(0.106)
Nr of respond.		6,634	9,013	2,420	3,052	3,012	4,426
Nr of deaths		818	826	406	433	754	861

Robust standard errors in parentheses: *** p<0.01, ** p<0.05, * p<0.1

Notes: All models are stratified by country. Standard errors are clustered at the household level.

Appendix C

Table C.1 Mortality hazard ratios for fathers - child with highest level of education and closest proximity

VARIABLES		Model 1	Model 2	Model 3	Model 4
Child's level of education	(Compulsory)	.	.	.	.
	Upper secondary	0.642***	0.696***	0.699***	0.725***
		(0.0526)	(0.0571)	(0.0574)	(0.0598)
	Tertiary	0.574***	0.709***	0.714***	0.769***
		(0.0464)	(0.0584)	(0.0590)	(0.0646)
Fathers's level of education	(Compulsory)		.	.	.
	Upper seconary		0.586***	0.590***	0.635***
			(0.0420)	(0.0423)	(0.0457)
	Tertiary		0.501***	0.501***	0.600***
			(0.0444)	(0.0444)	(0.0549)
Child's gender	(Male child)			.	.
	Fermale child			0.916	0.911*
				(0.0493)	(0.0492)
Number of children				1.023	1.009
				(0.0216)	(0.0217)
Household net income	(1st quintile)				.
	2nd quintile				1.202**
					(0.0937)
	3rd quintile				1.152*
					(0.0965)
	4th quintile				0.827**
					(0.0794)
	5th quintile				0.602***
					(0.0696)
Household net worth	(1st quintile)				.
	2nd quintile				0.871*
					(0.0696)
	3rd quintile				0.676***
					(0.0593)
	4th quintile				0.741***
					(0.0681)
	5th quintile				0.760***
					(0.0767)
Nr of respondents		12,066	12,066	12,066	12,066
Nr of deaths		1,394	1,394	1,394	1,394

Robust standard errors in parentheses: *** p<0.01, ** p<0.05, * p<0.1
Notes: All models are stratified by country. Standard errors are clustered at the household level.

Table C.2 Mortality hazard ratios for fathers and mothers with low education - low old age (full output)

Low old age group (50-74 years)			
VARIABLES		**Fathers (1)**	**Mothers (2)**
Child's level of education	(Compulsory)	.	.
	Upper secondary	0.683***	0.824
		(0.0936)	(0.128)
	Tertiary	0.639***	0.677**
		(0.0957)	(0.113)
Child's gender	(Male child)	.	.
	Female child	0.950	1.045
		(0.0985)	(0.116)
Number of children		0.999	0.930
		(0.0392)	(0.0495)
Household net income	(1st quintile)		
	2nd quintile	1.059	1.088
		(0.144)	(0.164)
	3rd quintile	0.894	1.082
		(0.149)	(0.192)
	4th quintile	0.867	0.964
		(0.159)	(0.206)
	5th quintile	0.876	0.887
		(0.197)	(0.242)
Household net worth	(1st quintile)		
	2nd quintile	0.985	0.755*
		(0.143)	(0.117)
	3rd quintile	0.586***	0.721**
		(0.0993)	(0.118)
	4th quintile	0.599***	0.722*
		(0.112)	(0.134)
	5th quintile	0.822	0.799
		(0.166)	(0.171)
Nr of respondents		3,385	5,742
Nr of deaths		385	329

Robust standard errors in parentheses: *** p<0.01, ** p<0.05, * p<0.1
Notes: All models are stratified by country. Standard errors are clustered at the household level.

Table C.3 Mortality hazard ratios for fathers and mothers with low education – high old age (full output)

High old age group (75+ years)			
		Fathers	**Mothers**
VARIABLES		(1)	(2)
Child's level of education	(Compulsory)	.	.
	Upper secondary	0.888	0.757***
		(0.0785)	(0.0542)
	Tertiary	0.814**	0.720***
		(0.0773)	(0.0549)
Child's gender	(Male child)	.	.
	Female child	0.901	1.026
		(0.0622)	(0.0557)
Number of children		1.016	0.960**
		(0.0237)	(0.0163)
Household net income	(1st quintile)	.	.
	2nd quintile	1.047	1.009
		(0.101)	(0.0753)
	3rd quintile	0.940	0.980
		(0.106)	(0.0926)
	4th quintile	0.800	0.957
		(0.127)	(0.123)
	5th quintile	1.194	0.986
		(0.216)	(0.163)
Household net worth	(1st quintile)	.	.
	2nd quintile	0.797**	0.800***
		(0.0815)	(0.0591)
	3rd quintile	0.830*	0.694***
		(0.0903)	(0.0569)
	4th quintile	0.884	0.744***
		(0.108)	(0.0710)
	5th quintile	0.646***	0.751**
		(0.0936)	(0.0881)
Nr of respondents		2,151	4,157
Nr of deaths		777	1,267

Robust standard errors in parentheses: *** p<0.01, ** p<0.05, * p<0.1
Notes: All models are stratified by country. Standard errors are clustered at the household level.