Health after mid-life: the role of adult children's education for older parents' frailty in Europe

Abstract:

With increasing longevity in Western societies, the transmission of socio-economic resources between generations becomes bidirectional, from parents to children and vice versa. However, while the impact of family background on children's life opportunities has been the topic of much research, less is known about the reverse influence of children's education on parental health. This study investigates the association between adult children's educational attainment and parental health, considering heterogeneity by gender, age, and societal context. We use eight waves of panel data from the Survey of Health, Ageing and Retirement in Europe (SHARE) spanning 2004-2022, tracking 86,500 parents across 27 countries. We estimate random intercept and growth curve models on a Frailty Index with inverse probability weighting for multivalued treatments to address selection and endogeneity bias. The results show that parents – particularly mothers – with highly educated children have lower frailty. The beneficial role of child education is strongest for older mothers and more pronounced in Southern and Eastern Europe than in Northern Europe, where both cultural traits and universal welfare systems may mitigate educational disparities. We interpret these results in terms of generational equity, suggesting that investments in younger generations' education also benefit older generations' health, particularly in countries with weaker welfare systems and strong family ties.

Keywords: Intergenerational relations; Spillover effects; Frailty; Ageing.

Introduction

An unforeseen consequence of population aging is the bidirectional transmission of social (dis)advantages between generations, from parents to children and from adult children to their older parents (Friedman & Mare, 2014; Mare, 2011). As family sizes shrink, family resources become concentrated among fewer offspring, enabling children to receive a larger share of inheritances, inter-vivo transfers, and other forms of parental investment that promote their economic success, health, and life chances (Arránz Becker & Loter, 2021; Umberson & Thomeer, 2020). Concurrently, rising life expectancies extend the period during which adult children can serve as crucial sources of social, practical, and informational support for their aging parents (Bengtson, 2001). Studies have acknowledged the influence of the "social foreground" (Torssander, 2013), which parallels that of family background, highlighting the increasing role of adult children's social and economic resources in shaping health inequalities in later life (Friedman & Mare, 2014; Mare, 2011; Torssander, 2013, 2014; Wolfe et al., 2018; Zhang & Silverstein, 2023; Zimmer et al., 2016). However, while the influences of family background on children's life opportunities have been the topic of much research (e.g., Umberson & Thomeer, 2020), less straightforward are the intergenerational consequences of adult children's social and economic resources on their parents' health in later life (De Neve & Kawachi, 2017).

Research on the intergenerational effects of children's education on parental health faces three challenges. First, previous studies often rely on single-country analyses with limited health assessments, typically single-item measures, yielding mixed findings on self-reported general health (Jiang, 2019; Liu, 2021; Thoma et al., 2021), mental well-being (Dennison & Lee, 2021; Ma, 2019), cognitive functioning (Lee, 2018; Lundborg & Majlesi, 2018; Ma et al., 2021; Torres et al., 2021; Yahirun et al., 2020), physical health (Lee, 2018; Zimmer et al., 2002) and mortality (Elo et al., 2018; Friedman & Mare, 2014; Torssander, 2013, 2014; Wolfe et al., 2018). These contradictions may reflect differences in study design across countries, sample composition, and measures of health

Formatted: French (France)

employed. As a result, knowledge remains partial and fragmented, as specific health measures are studied in isolation from the broader physical and mental systems that shape vulnerability and dependency in later life.

Second, little attention has been given to potential heterogeneity across the life course, genders, and country contexts. Over the life course, the flow of intergenerational support reverses, with parental roles shifting from "net providers" to "net receivers" (Kalmijn, 2019). As parents age and have fewer resources to cope with external stressors, their children's socio-economic resources – defined here through education – become increasingly important for supporting health care needs and promoting healthy behaviors (Lee, 2018; Leopold, 2018, 2019; Pais, 2014; Rossi & Rossi, 1990). These family life courses are presumably highly gendered, with older women having longer life expectancies, stronger intergenerational ties, and greater family responsibilities compared to men (Rossi & Rossi, 1990). Mothers may be more affected than fathers, both positively and negatively, by their children's education, given their greater investments and emotional attachment to family ties (Fingerman et al., 2012; Kalmijn, 2007). Additionally, the influence of children's education on parental health could vary across countries due to differences in welfare state characteristics, cultural norms, and healthcare systems (Albertini & Kohli, 2013; Torssander, 2013). These variations underscore the need for comparative data and analyses across a wide range of individual characteristics and societal contexts.

Third, while theoretical perspectives suggest an "upward" influence of children's education on older parents' health, this relationship may be influenced by endogeneity and unobserved confounders, as parents with higher socioeconomic status are often more capable of providing resources and support for their children's education and tend to experience better health conditions (Elo et al., 2018). To reduce the potential sources of bias, recent studies have used propensity score matching and instrumental variable approaches exploiting policy changes that increase schooling age (e.g., Liu et al., 2022; Zhang & Silverstein, 2023). However, the empirical evidence remains mixed on whether children's education causally affects parental physical and mental health (Liu, 2022;

Potente et al., 2023; Torres et al., 2022). For instance, Torres et al. (2022) show that an additional year of schooling had minimal or no impact on parents' depressive symptoms. Similarly, Potente et al. (2023) found that the causal evidence remains inconclusive, as their quasi-natural experiment exploiting the 1972 educational reform in England and Wales – which raised the minimum school-leaving age from 15 to 16 – showed no substantive causal effects on children's education on parental self-reported health and long-standing illness. Conversely, using inverse probability of treatment weighting to account for selection bias, Zhang and Silverstein (2023) show that children's economic success is associated with the better self-reported health of their parents. These mixed findings suggest that the impacts of children's education on parental health may depend on how accurately pre-existing confounding and selection factors are captured in different empirical approaches.

This study aims to contribute to the literature on the upward transmission of advantages across generations by addressing the three abovementioned challenges. Unlike earlier studies focusing on single health items, we used a 40-deficit Frailty Index as the health outcome. Frailty is a holistic concept of health, defined as a clinically identifiable condition of diminished physiological reserve and increased vulnerability to a wide range of adverse health outcomes (Kim & Rockwood, 2024), including general health deterioration, hospitalization, and mortality (Romero-Ortuno & Kenny, 2012; Vermeiren et al., 2016). Since frailty involves a progression from robustness to general health decline in a dynamic (i.e., preventable or delayable) and relatively reversible process, adult children may serve as a latent "safety net" that can bolster the physical, mental, and social reserves of aging parents, promoting feelings of reassurance even before serious health needs arise (Antonucci et al., 2014; Tosi & Grundy, 2019).

We also address key shortcomings in the literature by examining heterogeneity across parental life course, gender, and country context. Inequalities in health and the need for support are expected to accumulate with age due to the compounding consequences of stressors and resource deficits over time (DiPrete & Eirich, 2006; Leopold, 2018; Willson et al., 2007). However, age effects are rarely analyzed systematically in previous studies, which only provide limited insights into how the

influence of children's education can evolve as parents age. Similarly, gender differences are often treated as secondary, despite theoretical expectations regarding distinct gendered dynamics in intergenerational exchanges (Rossi & Rossi, 1990). Lastly, differently from most previous studies examining a single country such as the United States (e.g., Friedman & Mare, 2014), United Kingdom (Potente et al., 2023), Mexico (Torres et al., 2021), or Asian countries (e.g., Jiang, 2019; Liu et al., 2022 [China]; Thoma et al., 2021 [India]; Zimmer et al., 2002, 2007, 2016 [Taiwan]), we investigate the association between child educational attainment and older parents' health across multiple European countries, where healthcare access and cultural norms around family ties vary remarkably. Leveraging the longitudinal and cross-national comparability of the Survey of Health, Ageing and Retirement in Europe (SHARE), covering 27 European countries over eight waves (2004-2022), we offer a robust framework for understanding how the broader societal context moderates the role of children's education on parental health (Torssander, 2013).

Finally, our study addresses key methodological challenges by using a "doubly robust" inverse probability of treatment weighting approach to reduce biases from selection and endogeneity (Austin, 2011; Rosenbaum & Rubin, 1983, 1984). We apply this approach to the context of multiple treatments, specifically different levels of children's education (Imbens, 2000; Linden et al., 2016; Słoczyński & Wooldridge, 2018; Uysal, 2015). Approximating experimental conditions, this method reduces the risk of selection and omitted variable bias, thus responding to the longstanding critiques of previous studies for their limited causal validity to evaluate intergenerational spillover effects of education.

Theoretical Framework and Hypotheses

Adult Children's Education and Parents' Health

The family life course perspective (Elder et al., 2003) provides a framework for examining how adult children's education affects their parents' health status. This framework suggests that family members

live "linked lives", where characteristics and life events in one generation influence the health and well-being of other family generations (Elder et al., 2003). Consistent with this, the evidence supports "upward" spill-over effects from children to parents, with parents of better-educated children experiencing better physical and mental health (Dennison & Lee, 2021; Liu et al., 2022), compared with parents whose children have lower educational attainment.

The theoretical pathways through which children's education may affect parents' health outcomes can be grouped into health promotion and support-related mechanisms. Health promotion mechanisms suggest that highly educated children hold positive attitudes towards health habits, such as engaging in physical activity and avoiding drinking and smoking, and influence their parents to adopt healthier lifestyles by exposing them to these behaviors (Christakis & Fowler, 2008; Jiang, 2019; Lee, 2018). Highly educated children directly influence healthier habits in their parents by discouraging harmful behaviors and promoting a health-conscious lifestyle (Mirowsky & Ross, 2003, 2015). For example, parents with highly educated children are less likely to smoke and more likely to engage in physical exercise, which can partly explain their better health compared to those with less educated children (Friedman & Mare, 2014). Highly educated children also promote cognitive-stimulating activities and social engagement in their parents, potentially reducing the risks of depression (Dent et al., 2019; Lee et al., 2017) and other factors linked to frailty (Sang et al., 2023). Conversely, adult children with lower levels of education are less likely to engage their parents in socially and mentally stimulating activities, to promote health-conscious lifestyles, and tend to be more exposed to negative life events, such as union dissolution, unemployment, and financial hardships (Ma, 2019; Ma et al., 2021). Due to the emphatic nature of parent-child ties, these life challenges can place additional strain on parents' physiological systems and contribute to harmful health behaviors (Albertini & Piccitto, 2023; Milkie et al., 2008; Pillemer et al., 2017; Tosi & Albertini, 2019). This may affect frailty indicator including not only physical diagnoses but also psychological states, such as feelings of depression and sadness, and physical health, such as body weight related to eating disfunctions.

Support-related mechanisms link higher education to both the resources children acquire and the investments they receive from parents earlier in life. According to the norm of reciprocity, family obligations instilled by parents in childhood translate into the expectation that "any gift should be repaid" both in the short (Leopold & Raab, 2011) and the long term (Silverstein et al., 2002, 2006). Consequently, parental investments in children's education are expected to yield substantial long-term health benefits for parents. Children with higher levels of education are better equipped to reciprocate through access to "flexible resources" like knowledge and material and economic resources (Phelan et al., 2010). Health-related knowledge can enable the highly educated to offer more effective health-related advice and assist in navigating welfare systems (Torres, Yang, Rudolph, & Courtin, 2022; Torssander, 2013; Zimmer et al., 2007, 2016). Highly educated children are more likely to support their parents in managing diagnoses, facilitating medical visits, and engaging with healthcare technologies, particularly online healthcare services that are typically difficult to manage for older generations, that may promote health and well-being outcomes (Dent et al., 2019; Hoogendijk et al., 2019). In practical and material terms, with the economic advantages that education provides, highly educated children are better equipped to offer financial support to their parents, either through direct transfers or by covering healthcare costs. In middle- and low-income countries, these financial transfers partially explain why parents of well-educated children have better physical and mental health outcomes (De Neve & Fink, 2018; Ma, 2019). However, in Western countries, where financial transfers from children to parents are rare (Albertini & Kohli, 2013), other forms of support are likely to drive the link between children's education and parental health. For instance, highly educated children are more likely than their less educated counterparts to provide their older parents with knowledge support in financial management, future planning (e.g., assisting with personal care arrangements), and health care management (e.g., helping with health care costs) (Jiang & Kaushal, 2020). This suggests that although better-educated children may have less frequent contact and provide less frequent practical support (Kalmijn, 2006), they can provide more effective and higher-quality support than their less-educated counterparts.

Both health-promotion and support-related mechanisms suggest that children's education can foster parental health by increasing the physical, mental, and social reserves of ageing parents. With respect to frailty, adult children may play a crucial role in reversing frailty among middle-aged and older parents who are not severely frail, as evidence shows that frailty is reversible among individuals without multimorbidity, polypharmacy, or functional dependency (Serra-Prat et al., 2025). Children can function as safety nets, slowing health deterioration or facilitating the reversal of frailty trajectories before the onset of severe health limitations in later life. Guided by the above theoretical arguments, we hypothesize that *a child's level of education is negatively associated with parents' frailty* (**Hypothesis 1**).

Parental Characteristics: Gender and Age

The influence of children's education on parental health may depend on the parent's gender and age. Women typically live longer than men and are more affected by their children's life course events (Rossi & Rossi, 1990), such as illness, union dissolution, or unemployment (Fingerman et al., 2012; Kalmijn & de Graaf, 2012; Pillemer et al., 2012). Their heightened involvement in child-rearing and in bonding families together may increase mothers' empathy for the joy and sorrow of their children's lives, including the adverse consequences of children's educational disadvantage (Fingerman et al., 2012; Milkie et al., 2008). Mothers, who often have closer relationships and more frequent contact with their adult children than fathers (Kalmijn, 2007) may benefit from their children's socioeconomic resources through health-related advice, support, or exposure to healthier behaviors. Moreover, the theory of resource substitution (Ross & Mirowsky, 2006, 2011) suggests that individuals with fewer socioeconomic resources compensate for their disadvantages by relying more on alternative resources of support and fulfillment. This may explain why they derive greater health benefits from their children's education than their more advantaged counterparts (Lundborg & Majlesi, 2018). Given that older mothers, on average, have lower educational attainment and fewer economic resources than fathers, they may benefit more from their children's education, particularly

in later life, when they are more likely to experience widowhood, economic vulnerability, and worsening health conditions. However, empirical findings are mixed, with some studies finding no gender differences (Lee, 2018; Lee et al., 2017 [mental health and well-being]), others reporting larger benefits for mothers (Torres et al., 2021 [health and health behaviors]), and yet others showing stronger associations for fathers (Friedman & Mare, 2014; Lee, 2018; Potente et al., 2023 [mental health]). Considering mothers' emotional ties with children and greater socioeconomic vulnerability compared to fathers, we hypothesize that *mothers benefit more from children's higher educational attainment due to the compensatory mechanism of children's education on parental health* (**Hypothesis 2**).

Socioeconomic inequalities in health conditions tend to increase with age due to cumulative exposure to stressors (Leopold, 2018, 2019; Pais, 2014; Willson et al., 2007). Adult children in lower socioeconomic strata are more likely to face challenges, such as unemployment and union dissolution, that progressively erode their material and social reserves and resources that enable them to support older parents (Cullati et al., 2018; Mirowsky & Ross, 2015). Concurrently, as parents age, the flow of intergenerational support shifts from parents to children, reflecting increased parental dependency on their children for social, practical, and informational support (Kalmijn, 2019). This mechanism of "reversal of support flow" becomes particularly important as older parents face cognitive decline, chronic health conditions, unfamiliarity with modern medical practices, and the need for assistance in navigating increasingly complex healthcare systems (Aslan et al., 2024; Little & Morley, 2022; Ma et al., 2023; Schwarz et al., 2022). As they face health challenges and support needs, their children's resources become crucial, and those with less educated children may receive insufficient support in coping with adverse events (Lee, 2018). Thus, we test the hypothesis that *the association between children's education and parental health strengthens as parents age, reflecting the increasing need for support in managing health challenges and navigating complex healthcare systems* (**Hypothesis 3**).

Societal Context and Intergenerational Relationships

Intergenerational dynamics are deeply influenced by societal contexts, including cultural norms, welfare regimes, and broader institutional arrangements. In Southern and Eastern European countries – characterized by a sub-protective and fragmented system of welfare provision with a higher reliance on family support as a form of welfare provision (Albertini & Kohli, 2013; Esping-Andersen, 1999; Mair, 2013) – children's socioeconomic resources may play a crucial role in older adults' health. According to Eurostat, in 2023 the share of GDP devoted to social protection was lowest – between 10 and 15 percent – in several Eastern European countries (e.g., Estonia, Latvia, and Bulgaria) and Southern European countries (e.g., Malta and Cyprus), particularly with respect to spending on sickness and health care benefits (around 4-5%). In Eastern Europe, public support systems for older people have been substantially eroded since the collapse of the Soviet Union and remain generally weak. Southern European countries are often characterized as "familialism by default" systems, in which publicly provided alternatives to family care are scarce (Keck et al., 2009; Saraceno, 2016). By contrast, Northern European countries rely on comprehensive welfare systems that reduce older adults' dependence on family-based support, potentially weakening the link between children's education and parents' health outcomes (Torssander, 2013). In these contexts, universal healthcare systems often replace family-provided assistance, and studies show that intergenerational support is less intense and has a complementary role to institutional welfare systems (Albertini & Kohli, 2013). Nonetheless, even in well-resourced welfare states, children's education can indirectly improve parents' health by facilitating social navigation, enhancing health literacy, and advocating within complex healthcare systems (e.g., Dennison & Lee, 2021; Potente et al., 2023; Torres et al., 2022). Western countries, such as France and Germany, typically occupy an intermediate position between Southern and Northern Europe, with generous pension benefits and a relatively limited provision of public social services (Esping-Andersen, 1999).

Cultural expectations and social norms further shape these dynamics. In collectivist societies, such as Southern and Eastern European ones, where family obligations are normative and traditional

family norms prevail, children may feel a stronger sense of duty to support aging parents, potentially translating into greater health benefits for parents with highly educated children (Jiang, 2019; Zimmer et al., 2002). Children's socioeconomic resources are likely to be especially important in these contexts characterized by strong supportive obligations, close geographic proximity and frequent daily interactions among family members (Hank, 2007). Additionally, in Eastern Europe extensive migration fluxes – particularly of highly educated children – have increased the spatial separation between family generations but also increased opportunities of receiving financial support for older parents living at greater distances (Botev, 2012; Tosi & Grundy, 2019). . By contrast, Northern European countries are societies where individual autonomy tends to prevail over family dependency and supportive obligations (Daatland et al., 2011; Reher, 1998). Thus, the socioeconomic resources of adult children – including not only practical support such as providing health-related advice, engaging parents in cognitively and socially stimulating activities, and helping them navigate welfare systems, but also their capacity to influence parental lifestyles – may be less consequential for older adults in Northern Europe, where filial obligations are weaker and parent–child interactions are less frequent. Considering the variations in welfare regimes, cultural norms, and institutional support systems across Europe, we hypothesize that *the positive association between children's education and parents' health is stronger in Southern and Eastern Europe, where family-based welfare predominates, than in Northern Europe, where state-provided welfare reduces dependency on intergenerational support, with Western European countries occupying an intermediate position* (**Hypothesis 4**).

Commented [T1]: Questo forse non ci sta

Data and methods

Sample

This study used eight waves of panel data from the Survey of Health, Ageing and Retirement in Europe (SHARE), spanning from 2004 to 2022. SHARE is a multidisciplinary longitudinal survey

representative of the non-institutionalized population aged 50 and over in Europe, collecting data on health, social, economic, and living conditions across the life course (Börsch-Supan et al., 2013). SHARE offers a unique opportunity to investigate the intergenerational consequences of children's education on health at older ages as they provide panel data on subjective and objective health measures for respondents and their partners, as well as detailed information on their biological (91.44 percent in Wave 1) and adopted children (8.56 percent in Wave 1).

The initial raw sample included 580,136 person-year observations from 261,532 parent-child dyads (107,503 parents). In this study, we used only records of parents who met the original SHARE sample criteria, i.e., 50 years of age or older (884 parents excluded, 0.82%), and who had at least one child aged 25 or older (4,662 parents removed, 4.34%) to ensure that children were older enough to conclude their educational path. We excluded parents who were under 16 years old at the time of the child's birth, as early parenthood may introduce selectivity bias and unique complexities in intergenerational relationships (180 parents, 0.17%). We further restricted the sample to parents and children with complete information on all the variables of interest (10,026 parents, 9.32%) and excluded Israel and Ireland from the analysis, as these countries are difficult to classify within our intergenerational regime typology (2,909 parents, 2.71%). We also excluded 897 fathers and 1447 mothers aged 85+ to address potential survivor bias resulting from the disproportionate mortality of lower-educated parents among the "oldest-old". From this set of parent-child dyads, we selected the child with the highest level of education at each wave, assuming that the highest-educated children are the most important in influencing the health of their aging parents (see also Liu et al., 2022; Ma, 2019; Zimmer et al., 2007). In cases where multiple children had the same educational level, a random selection was made to retain only one child per parent. Supplementary Table A1 describes the steps taken to select the analytical sample.

After this selection, the final analytic sample included 35,948 fathers and 50,552 mothers, totaling 183,325 parent-year observations across eight waves. The third wave (SHARELIFE), conducted in 2008-2009, was excluded from the analyses because it focuses on retrospective life histories, and its

questionnaire and variables differ significantly from the core dataset. The sample covers 27 countries: Austria, Belgium, Bulgaria, Croatia, Cyprus, Czech Republic, Denmark, Estonia, Finland, France, Germany, Greece, Hungary, Italy, Latvia, Lithuania, Luxembourg, Malta, Netherlands, Poland, Portugal, Romania, Slovakia, Slovenia, Spain, Sweden, and Switzerland. Notably, countries entered the survey at different points in time, with most Western (i.e., Austria, Germany, France, Switzerland and Belgium), Northern (i.e., Denmark and Sweden) and Southern (i.e., Italy and Spain) countries being observed across the entire study period, whereas Eastern European countries only began data collection in later waves (e.g., Latvia, Lithuania, Bulgaria, Romania and Slovakia available from wave 7). Supplementary Tables A2 and A3 report descriptive statistics about the number of waves per individual and the frequency of distinct participation patterns across SHARE waves.

Measures

The study uses a 40-item Frailty Index (FI) as the outcome variable (Romero-Ortuno & Kenny, 2012), which reflects the accumulation of deficits in various health domains and is a strong predictor of adverse health outcomes, including mortality (Kim & Rockwood, 2024; Vermeiren et al., 2016). Following Romero-Ortuno and Kenny (2012), we constructed the FI based on various health deficits (cf. Supplementary Table A4 for a detailed description of the 40 items). Each respondent's deficit points were summed, divided by the total number of deficits assessed (40 in this case), and multiplied by 100 to calculate the FI, which ranges from 0 (no deficits present) to 100 (all deficits present). For example, a respondent with one deficit would have an FI value of 2.5 (1/40 × 100). Higher FI values reflect a greater number of health problems and, consequently, greater levels of frailty (Cronbach's alpha = 0.84).

The primary independent variable is the child's education level, as reported by the parent at each SHARE wave. This measure, based on the International Standard Classification of Education 1997 (ISCED-97), reflects the highest education attained. We categorize education as "low" (ISCED 0-2,

below upper secondary), “medium” (ISCED 3-4, upper secondary), and “high” (ISCED 5-6, tertiary or college degree).

All regression models control for characteristics linked to both children’s education and parental frailty. At the parental level, controls include age (50-103, mean-centered), number of children (“1”, “2”, “3”, “4”, “5+”), gender (“father”, “mother”), marital status (“married” or partnered, “not currently married” or partnered, and “widowed”), education – classified using the same ISCED-97-based categorization (i.e., “low”, “medium”, and “high”), household wealth quartiles, and country of residence. At the offspring level, models adjust for birth cohort (“1930-1965”, “1966-1971”, “1972-1975”, “1976-1981”, “1982-1985”, “1986-1997”) and gender (“son”, “daughter”).

To test country differences with reasonable statistical power, countries are classified into four groups: Northern (Denmark, Finland, and Sweden), Southern (Cyprus, Greece, Italy, Malta, Portugal, and Spain), Western (Austria, Belgium, France, Germany, Luxembourg, the Netherlands, and Switzerland), and Eastern Europe (Bulgaria, Croatia, Czech Republic, Estonia, Hungary, Latvia, Lithuania, Poland, Romania, Slovakia, and Slovenia). Additionally, a control variable is included for SHARE waves (“[1] 2004–05”, “[2] 2006–07”, “[4] 2011–12”, “[5] 2013”, “[6] 2015”, “[7] 2017”, “[8] 2019–20”, “[9] 2022”). Descriptive statistics for the study sample, including all variables of interest, are presented in Table 1.

Analytic strategy

Inverse probability weighting for multivalued treatments (IPWMT)

To address potential selection bias in the relationship between children’s education and parental health, we used the method of inverse probability weighting for multivalued treatments (IPWMT) (Feng et al., 2012; Imbens, 2000). IPWMT is a propensity score-based method that adjusts for endogenous confounders in observational studies where random assignment is not feasible. The propensity score – originally introduced by Rosenbaum and Rubin (1983) and later extended to accommodate multiple treatment levels (Imbens, 2000) – is defined as the conditional probability of

receiving a specific (level of) treatment given a set of pre-treatment factors. This method approximates the conditions of a randomized experiment (Austin, 2011; Rosenbaum & Rubin, 1984). When applied to children's education as a predictor of parents' health, this approach produces estimates that can be interpreted as causal, provided that the propensity score model is correctly specified and accurately captures the selection process of the treatment variable (Imbens, 2000; Rosenbaum & Rubin, 1983).

To calculate weights for our multivalued treatment (i.e., children's education levels), we estimated two multinomial logistic regression models (Imbens, 2000; Linden et al., 2016; Słoczyński & Wooldridge, 2018; Uysal, 2015) – one for fathers and one for mothers – categorizing parents into three groups based on the education level of their most educated child: (1) those with at least one child who attained tertiary education, (2) those with a child with upper secondary education, and (3) those whose all children had an education level below upper secondary. These models controlled for key (time-varying) confounders, namely parental age, educational attainment, number of children, marital status, wealth quartiles, country of residence, and the gender and birth cohort of the offspring. Additionally, these models accounted for the SHARE wave and included clustered standard errors at the individual level. In the analysis on country differences, we estimate a multinomial model for each country cluster (Northern, Western, Southern, and Eastern Europe) to (at least partly) account for the heterogeneity of educational systems across Europe. Detailed results are presented in Supplementary Tables A5-A9 .

For each observation, we computed weights as the inverse of the predicted probabilities from these models and applied them in the multivariable analysis. The use of IPWMT as a method to adjust for endogeneity reweighs the sample so that the distribution of observed confounders becomes independent of children's education, effectively balancing parental socio-demographic characteristics across the three educational groups and reducing selection bias in the estimation of parental health outcomes.

Regression analysis

Our regression analysis consisted of four steps. First, we presented summary statistics for the unweighted and weighted samples to assess how well different confounders were balanced in relation to the assumed causal relationship between children's education and parents' health (Table 2). We expect to find no substantial variations in socio-economic confounders – measured through parental education and wealth – between high-, medium- and low-educated parents after weighting the three subgroups.

Second, to test Hypothesis 1, we examined the association between education and parents' health using random intercept linear regression models for repeated year-person observations nested within parents (Table 3). We report both unweighted and weighted estimates to assess how the coefficients for children's education change before and after applying IPWMT. If weighting by the inverse probability of receiving the multivalued treatment accounts for some of the selection and confounding bias, these coefficients should decrease in the weighted models, while standard errors should increase, though they remain conservative in the (weighted) "doubly robust" estimations (Imbens, 2000; Linden et al., 2016; Słoczyński & Wooldridge, 2018; Uysal, 2015). Models were estimated separately for fathers and mothers, and gender differences were tested using interaction terms (Hypothesis 2), as shown in the bottom panel of Table 3 (full models in Table A10 in the Supplementary Materials).

Third, we tested Hypothesis 3 using random-effects group-specific growth curve models (GCMs) with IPWMT. These models estimate changes in fathers' and mothers' frailty scores as a function of their age and their children's education level (Halaby, 2003). We specified the GCMs by interacting children's education with both linear and quadratic terms for parental age, enabling a comparison of frailty trajectories across different levels of children's education. This model setup accounts for individual variations in frailty trajectories rather than assuming a uniform trajectory for all individuals. An unstructured covariance matrix was estimated to allow for correlations among the random parameters. Predicted frailty values from the GCMs are presented in Figure 1, with full estimates reported in Supplementary Tables A11-A13.

Fourth, we estimated random intercept linear regression models with IPWMT for each country cluster to test Hypothesis 4, which suggests that child education has a greater impact in Southern than in Northern European countries. Cross-national differences were formally tested through interaction terms, as detailed in Table A14 of the Supplementary Materials.

Results

Sample characteristics before and after IPWMT

We used multinomial logistic models to calculate the IPWMT and create three balanced comparison groups for parents whose children have different educational levels (Supplementary Tables A5-A9). Table 2 presents differences in parental education and wealth across the three groups derived from the child's educational level before and after weighting. We focus on the balancing of these groups with respect to parental education and wealth, as these are critical stratification factors affecting children's educational attainment (e.g., Breen & Jonsson, 2005; Pfeffer, 2018). Among fathers with highly educated children, 36.5% are highly educated themselves, and 38.0% belong to the wealthiest wealth quartile. In contrast, among fathers with lower-educated children, only 4.8% are highly educated, and 15.2% are in the richest wealth quartile. A similar pattern is observed among mothers, with the group of highly educated children showing higher proportions of highly educated (30.4%) and affluent (30.6%) mothers compared to the group of lower-educated children (4.3% and 12.0%, respectively).

These differences observed in the unweighted sample diminish significantly in the weighted sample, indicating that after applying the IPWMT approach, the groups are well-balanced with respect to parental education and wealth. This is further supported by the Pearson chi-squared tests, which show no statistically significant differences in parental education ($p=0.201$ for fathers, $p=0.147$ for mothers) and wealth ($p=0.799$ for fathers, $p=0.239$ for mothers) across the three child education groups after weighting. In the weighted sample, the proportions of highly educated parents and those

in the wealthiest quartile are almost identical across child education levels, suggesting that the inverse probability weighting successfully balanced the characteristics of the three groups.

[TABLE 2 ABOUT HERE]

Child education and parents' frailty

Table 3 presents the results of random-intercept linear regression models, estimated separately for fathers and mothers in the unweighted (Models 1 and 3) and weighted samples (Models 2 and 4). For fathers, having a highly educated child is associated with a Frailty Index (FI) score approximately 2 points lower in the unweighted model (Model 1; b = -1.891; 95% CI: -2.227, -1.554). Fathers with children with a medium education level exhibit an intermediate FI, approximately 1 point lower than those with lower-educated children (b = -1.018; 95% CI: -1.342, -0.694). However, the association between child education and paternal frailty attenuates when accounting for the propensity of having a highly educated child in the IPWMT weighted model (Model 2). The FI of fathers with at least one highly educated child is 1.1 points lower than the FI of those with lower-educated children (b = -1.070; 95% CI: -1.734, -0.406), while the difference between fathers with lower- and medium-educated children become statistically insignificant (b = -0.566; 95% CI: -1.244, 0.111).

For mothers, the unweighted model (Model 3) shows that having a highly educated child is associated with a FI 3 points lower than having children with less than upper secondary education (b = -2.898; 95% CI: -3.207, -2.589). This association reduces to 1.7 points in the FI in the weighted model (Model 4; b = -1.661; 95% CI: -2.212, -1.109), but remains statistically significant. For mothers with medium-educated children, the FI is 1.5 points lower in the unweighted model (Model 3; b = -1.552; 95% CI: -1.847, -1.257) and narrows to 0.6 points in the weighted model (Model 4; b = -0.584; 95% CI: -1.117, -0.050).

For both fathers and mothers, the magnitude of the association between having a highly educated child and frailty is comparable to the difference between widowed and married parents. Widowed

mothers show a FI 1.2 points higher than married mothers (Model 4; *b* = 1.215; 95% CI: 0.583, 1.846), and those with lower educated children have a FI 1.7 points higher than mothers with highly educated children. The magnitude of this coefficient is also equivalent to approximately 4.5 years of aging (Model 4; *b* = 0.363; 95% CI: 0.330, 0.396). Similarly, widowed fathers exhibit a frailty score 1.4 points higher than married fathers (Model 2; *b* = 1.405; 95% CI: 0.395, 2.415), which is comparable to the frailty disadvantage of fathers with lower educated children (1.1 points). Therefore, the results show that, even after accounting for selection and endogeneity bias using the "doubly robust" IPWMT approach, having a highly educated child is associated with lower levels of frailty for both fathers and mothers – in line with Hypothesis 1. The coefficients associated with child education appear to be more pronounced for mothers than for fathers, as the one related to having a highly educated child is approximately 54% larger. To formally test for gender differences (Hypothesis 2), we included interaction terms between child education and parental gender (the bottom panel of Table 3). The results indicate that mothers experience an additional 1.8-point reduction (95% CI: -2.204, -1.3330) in frailty compared to fathers when their child attained a higher level of education in the unweighted model. In the weighted model, the reduction is 0.8 points and statistically significant at the 5% level (*b* = -0.830; 95% CI: -1.624, -0.036, full models in Supplementary Table A10).

[TABLE 3 ABOUT HERE]

Parents and children over the life course

In the second stage of our analysis, we estimated a series of random-effects group-specific growth curve models (GCMs) using the IPWMT approach. These models allow individual frailty trajectories to differ in their starting levels (random intercepts) and rates of change over time (random slopes). Figure 1 presents the predicted frailty trajectories for fathers and mothers according to their children's education levels. For fathers and mothers, frailty trajectories generally exhibit an upward trend after age 65, with a steeper increase after age 75. The confidence intervals widen for both fathers and

mothers over age 80, likely due to selectivity in having a child who completed their education in their 50s and surviving into older ages.

The gaps in frailty between fathers with lower- and higher-educated children increase after age 60 and diminish after age 75 (Figure 1). At age 60, fathers with highly educated children have a predicted frailty score of 9.26, compared to 10.10 for those whose children have low education. Chi-squared tests (Supplementary Table A13) indicate statistically significant differences between these two groups (difference = -0.837; 95% CI: -1.616, -0.058; $p<0.05$). A similar pattern emerges at age 65, with frailty scores of 10.10 and 11.10, respectively (difference = -1.00; 95% CI: -2.08, 0.07; $p<0.10$). By age 75, the FI scores converge at 14.99 and 14.91.

For mothers, the difference between parents with highly and lower educated children tends to increase with age. At age 65, mothers with highly educated children have a predicted FI of 12.41, compared to 13.64 for those whose children have lower education (difference = -1.23; 95% CI: -2.22, -0.24 $p<0.01$). This gap in frailty increases at age 80, with scores of 21.17 and 23.02, respectively, for high and low levels of children's education (difference = -1.85; 95% CI: -3.98, 0.27; $p<0.10$). It further increases at age 85 with a difference between mothers with lower and higher educated children equal to -2.04, despite it does not reach the standard significance level. Overall, these results indicate that having highly educated children is associated with lower frailty, particularly for older mothers, providing support to our Hypothesis 3..

[FIGURES 1 ABOUT HERE]

Country differences

Table 4 presents the results of random-intercept linear regression models examining the association between child education and parental frailty across different country clusters. The models are estimated separately for each cluster, with fathers and mothers pooled together to ensure sufficient sample size, particularly in the Northern European countries, where only few parents have all children

with lower levels of education (n = 873; 3.5%). In the Northern European cluster, no statistically significant association is found between child education and parental frailty (*b* = -0.660, 95% CI: -1.690, 0.369, for high education). Conversely, in the Western European cluster having a child with medium levels of education (upper secondary degree) is associated with a reduction in the FI of approximately 0.8 points (95% CI: -1.607, -0.093), while those with highly educated children exhibit a reduction in frailty of about 1.6 points (95% CI: -2.341, -0.826). Similarly, the Southern cluster of countries shows a statistically significant reduction in frailty for parents with at least one highly educated child (*b* = -1.384; 95% CI: -2.075, -0.694). Finally, for the Eastern countries, the results indicate that parents with a highly educated child exhibit a frailty score approximately 1.3 points lower than those with lower-educated children (95% CI: -2.099, -0.564). In sum, the results indicate that, except for the Northern cluster, having a highly educated child is associated with significantly lower frailty for parents. To further substantiate these findings, we included interaction terms between country clusters and children's education in a separate regression model for all older adults combined (at the bottom of Table 4 and Supplementary Table A14). The results show some evidence of the differences between Northern and Southern/ Eastern European countries at a 10% significance level, indicating that having a highly educated child matters more for Southern and Eastern European parents than for their Northern counterparts. Because these contextual differences may be related to both cultural and institutional factors, we conduct an additional analysis to explore whether the protective association between children's education and parental health varies with levels of welfare generosity. Welfare generosity is measured by the share of GDP devoted to social policies, housing and social exclusion, sickness and disability benefits, old-age and survivors' benefits, and pro-family policies – measures derived from Eurostat database (see Supplementary Figures A1-A8). The results based on a meta-analysis approach (Liefbroer & Zoutewelle-Terovan, 2021) suggest that the association between children's education and parental health tends to weaken in countries with higher levels of welfare generosity; however, this pattern reaches statistical significance only for expenditures on housing and social exclusion and on sickness and disability benefits. The evidence

for a moderating role of welfare generosity in the association between children's education and parental frailty is only partial, and the remaining variation not accounted for by welfare arrangements is plausibly attributable to cultural norms shaping intergenerational relationships.

[TABLE 4 ABOUT HERE]

Discussion

In this study, we add to the growing literature on intergenerational "upward" spillover effects of children's education on parental health by adopting a holistic conceptualization of health, investigating heterogeneity by gender, age, and country, and using a "doubly robust" approach based on inverse probability weighting for multivalued treatments to address selection and endogeneity. Our findings show that both mothers and fathers experience lower frailty levels when they have at least one highly educated child, which is consistent with our Hypothesis 1 and some previous studies on physical and mental health (Dennison & Lee, 2021; Ma, 2019; Lee, 2018a; Zimmer et al., 2002). Applying "doubly robust" estimates to adjust for pre-existing parental propensities to have children with different levels of education (Słoczyński & Wooldridge, 2018), the associations reduced but remained substantively significant. This highlights the importance of the upward intergenerational transmission of socioeconomic advantage from adult children to older parents (Ma et al., 2021; Zhang & Silverstein, 2023; Zimmer et al., 2007), particularly in mitigating the risk of later-life frailty, a comprehensive condition reflecting vulnerability in both physical and mental health domains. Adult children's resources serve as an active safety net in times of need, fostering a sense of security that influences health-related behaviors and subjective well-being even when such support is not actively needed (e.g., Antonucci et al., 2014). Highly educated children, in particular, may provide higher-quality interactions and support by offering more effective health-related advice, encouraging socially

and cognitively stimulating activities, and assisting parents in navigating welfare systems; all of which may contribute to lower levels of parental frailty.

Our study offers three key contributions to understanding the impact of the "social foreground" on parental health from mid-life to late life (Torssander, 2013). First, our findings indicate that the protective role of having a highly educated child against frailty is more prevalent among mothers than fathers (*Hypothesis 2*). This result, which aligns with some studies (e.g., Torres, 2021) but contrasts with others (e.g., Friedman & Mare, 2014; Lee, 2018; Potente et al., 2023), supports the resource substitution hypothesis suggesting that older women – who typically have fewer socioeconomic resources than men – tend to offset their health disadvantages through support from their family networks (Mirowsky & Ross, 2003; Ross & Mirowsky, 2006, 2011). Middle-aged and older mothers often play the role of "kinkeepers", maintaining connections with their adult children (Kalmijn, 2007), and are more likely than fathers to receive greater benefits from their highly educated children in terms of cognitive stimulation, social support, or technological and medical advice. Highly educated children may have a stronger influence on their mothers' habits and health behaviors than on their fathers', given the typically closer bonds and greater involvement in each other's lives. One alternative explanation is that mothers may benefit more from having a highly educated child because they tend to invest more in child-rearing, socialization practices, and fostering a sense of obligation toward reciprocity. It is also plausible that observed gender differences are related to weaker father-child relationships following divorce, as fathers are more likely than mothers to become non-residential parents and to remarry.

Second, the results show that the beneficial role of child education increases with age among mothers. This is consistent with our *Hypothesis 3* suggesting that as parents become "net receivers" with age and need more support from their networks, children's socio-economic resources are increasingly more relevant. As parents age, they increasingly face health challenges, such as cognitive decline and unfamiliarity with contemporary medical practices, and require greater assistance with household tasks, mentally and socially stimulating activities, and navigating healthcare systems

(Aslan et al., 2024; Little & Morley, 2022; Ma et al., 2023). Highly educated children are generally better equipped to provide such support, given their greater cognitive, social, and informational resources. By contrast, lower-educated children may be less able to support their parents in later life, as they are more likely to experience life-course challenges, such as unemployment, that progressively erode both their material resources and their capacity to provide support to ageing parents (Cullati et al., 2018; Mirowsky & Ross, 2015). However, the results for fathers reveal a different pattern, with larger differences between fathers with highly educated and less-educated children emerging between ages 60 and 75.According to an "age-as-leveler" perspective, disparities in mental health linked to a child's education decrease as parents age, due to selective mortality among fathers with less-educated children (Lee et al., 2017). A similar selection mechanism may account for the weak differences observed among fathers in their 50s, as they are influenced by differential fertility timing and the likelihood of having a child who has completed his/her educational path. In the transition from work to pension, older adults may have more time to interact with adult children, thus receiving support in terms of health-care advices and controlling health behaviors.

Commented [T2]: Forse no

Third, country differences highlight the role of the broader institutional and cultural context in shaping intergenerational returns to education. In Northern Europe, where individual autonomy is culturally valued and strong welfare systems provide extensive support – thereby making children's role supplement public services (Albertini & Kohli, 2013) –, no association is found between child education and parental frailty. By contrast, in Western, Southern, and Eastern Europe, having a highly educated child is linked to lower frailty levels, with the strongest associations in Eastern and Southern countries. Consistent with our Hypothesis 4, these findings suggest that in European regions with weaker formal support and strong attitudes about familial responsibility (Reher, 1998), highly educated children may have a greater role in promoting their parents' health, likely due to their deeper involvement in family life and the support they provide when parents are in need.

When interpreting the results of this study, two limitations should be acknowledged. First, the analysis of the impact of children's education on parental health requires careful consideration of the

possible bias in the estimation of causal effects. We use a “doubly robust” technique through an inverse probability weighting approach for multivalued treatments (Imbens, 2000); however, unobserved confounders, such as parental personality or intelligence, may still influence our results. Previous studies using an instrumental variable approach have been more effective in isolating and identifying the causal effect of years of schooling on parental health and mortality (Potente et al., 2023; Torres, Yang, Rudolph, Meza, et al., 2022). However, we consider educational attainment a better indicator of children’s socioeconomic resources compared to years of schooling (Connelly et al., 2016; Khalatbari-Soltani et al., 2022), as it is linked to signaling power and labor market returns as well as to health habits and lifestyles. Second, our analysis provides limited evidence on the mechanisms underlying the association between children’s education and frailty. Our theoretical reasoning suggests that highly educated children influence their parents’ health through both health promotion (e.g., encouraging healthier behaviors) and support-related mechanisms (e.g., providing knowledge and material resources), facilitated by close proximity and frequent contact. To examine these potential explanations, we incorporated two health behaviors – drinking and smoking – and two indicators of parent-child relationships – residential proximity and contact frequency – in our analysis (see Supplementary Table A18). The results indicate no substantive changes in the coefficients related to child education when these mediators are included, possibly due to measurement issues, such as inconsistencies in the comparability of indicators across SHARE waves (e.g., drinking behavior) or the challenges of capturing parent-child relationship quality, rather than quantity (e.g., quality vs. frequency of contact and support). Additionally, geographical proximity capturing migration patterns within and across European countries (e.g., Eastern European older parents left behind) does not explain why child education tends to be beneficial for older parents. Thus, a potential step for future research is to analyze the pathways through which child education is associated with parental health, by using detail information on activities shared by parents and their adult children (e.g., time-use data). Furthermore, a larger set of countries characterized by different social policy expenditures may

provide in-dept explanations of cross-national difference in the beneficial role of education for older parents' health.

Our findings have implications for understanding the two-way transmission of social (dis-) advantages between generations in the context of increasing diffusion of high education and rapid population aging. Regarding implications for policy and practice, our findings suggest that efforts to reduce frailty among older adults should also take children's education into account. Consequently, public investments in the education of younger generations are expected to produce benefits also for older generations. Contrary to the idea that younger and older generations have conflicting interests that are difficult to reconcile within welfare systems, investments in younger generations' education also benefit older generations, thereby suggesting a mechanism through which families redistribute resources to support and protect their older and more vulnerable members. In many Western societies, particularly those with less generous and universal welfare systems and strong family obligations, education expansion will potentially lead to advantages in preventing health deterioration among parents, particularly older mothers.

References

Albertini, M., & Kohli, M. (2013). The Generational Contract in the Family: An Analysis of Transfer Regimes in Europe. *European Sociological Review*, *29*(4), 828–840. https://doi.org/10.1093/esr/jcs061

Albertini, M., & Piccitto, G. (2023). Linked generations: Child's transition into unemployment and parents' mental well-being. *European Sociological Review*, *39*(4), 501–515. https://doi.org/10.1093/esr/jcac053

Antonucci, T. C., Ajrouch, K. J., & Birditt, K. S. (2014). The Convoy Model: Explaining Social Relations From a Multidisciplinary Perspective. *The Gerontologist*, *54*(1), 82–92. https://doi.org/10.1093/geront/gnt118

Arránz Becker, O., & Loter, K. (2021). Socio-Economic Family Background and Adult Children's Health in Germany: The Role of Intergenerational Transmission of Education. *European Sociological Review*, *37*(4), 588–606. https://doi.org/10.1093/esr/jcaa063

Aslan, A., Mold, F., van Marwijk, H., & Armes, J. (2024). What are the determinants of older people adopting communicative e-health services: A meta-ethnography. *BMC Health Services Research*, *24*(1), 60. https://doi.org/10.1186/s12913-023-10372-3

Austin, P. C. (2011). An Introduction to Propensity Score Methods for Reducing the Effects of Confounding in Observational Studies. *Multivariate Behavioral Research*, *46*(3), 399–424. https://doi.org/10.1080/00273171.2011.568786

Bengtson, V. L. (2001). Beyond the Nuclear Family: The Increasing Importance of Multigenerational Bonds. *Journal of Marriage and Family*, *63*(1), 1–16. https://doi.org/10.1111/j.1741-3737.2001.00001.x

Börsch-Supan, A. H., Brandt, M., Hunkler, C., Kneip, T., Korbmacher, J., Malter, F., Schaan, B., Stuck, S., & Zuber, S. (2013). Data Resource Profile: The Survey of Health, Ageing and

Retirement in Europe (SHARE). *International Journal of Epidemiology*, *42*(4), 992–1001. https://doi.org/10.1093/ije/dyt088

Breen, R., & Jonsson, J. O. (2005). Inequality of Opportunity in Comparative Perspective: Recent Research on Educational Attainment and Social Mobility. *Annual Review of Sociology*, *31*(Volume 31, 2005), 223–243. https://doi.org/10.1146/annurev.soc.31.041304.122232

Christakis, N. A., & Fowler, J. H. (2008). The Collective Dynamics of Smoking in a Large Social Network. *New England Journal of Medicine*, *358*(21), 2249–2258. https://doi.org/10.1056/NEJMsa0706154

Connelly, R., Gayle, V., & Lambert, P. S. (2016). A review of educational attainment measures for social survey research. *Methodological Innovations*, *9*, 2059799116638001. https://doi.org/10.1177/2059799116638001

Cullati, S., Kliegel, M., & Widmer, E. (2018). Development of reserves over the life course and onset of vulnerability in later life. *Nature Human Behaviour*, *2*(8), 551–558. https://doi.org/10.1038/s41562-018-0395-3

Daatland, S. O., Herlofson, K., & Lima, I. A. (2011). Balancing generations: On the strength and character of family norms in the West and East of Europe. *Ageing & Society*, *31*(7), 1159–1179. https://doi.org/10.1017/S0144686X10001315

Dannefer, D. (2003). Cumulative Advantage/Disadvantage and the Life Course: Cross-Fertilizing Age and Social Science Theory. *The Journals of Gerontology Series B: Psychological Sciences and Social Sciences*, *58*(6), S327–S337. https://doi.org/10.1093/geronb/58.6.S327

De Neve, J.-W., & Fink, G. (2018). Children's education and parental old age survival – Quasi-experimental evidence on the intergenerational effects of human capital investment. *Journal of Health Economics*, *58*, 76–89. https://doi.org/10.1016/j.jhealeco.2018.01.008

De Neve, J.-W., & Kawachi, I. (2017). Spillovers between siblings and from offspring to parents are understudied: A review and future directions for research. *Social Science & Medicine*, *183*, 56–61. https://doi.org/10.1016/j.socscimed.2017.04.010

Dennison, C. R., & Lee, K. S. (2021). Adult Children's Educational Attainment and Parent Health in Mid- and Later-Life. *The Journals of Gerontology: Series B*, *76*(9), 1857–1869. https://doi.org/10.1093/geronb/gbab109

Dent, E., Martin, F. C., Bergman, H., Woo, J., Romero-Ortuno, R., & Walston, J. D. (2019). Management of frailty: Opportunities, challenges, and future directions. *The Lancet*, *394*(10206), 1376–1386. https://doi.org/10.1016/S0140-6736(19)31785-4

DiPrete, T. A., & Eirich, G. M. (2006). Cumulative Advantage as a Mechanism for Inequality: A Review of Theoretical and Empirical Developments. *Annual Review of Sociology*, *32*(1), 271–297. https://doi.org/10.1146/annurev.soc.32.061604.123127

Elder, G. H., Johnson, M. K., & Crosnoe, R. (2003). The Emergence and Development of Life Course Theory. In J. T. Mortimer & M. J. Shanahan (Eds.), *Handbook of the Life Course* (pp. 3–19). Springer US. https://doi.org/10.1007/978-0-306-48247-2_1

Elo, I. T., Martikainen, P., & Aaltonen, M. (2018). Children's educational attainment, occupation, and income and their parents' mortality. *Population Studies*, *72*(1), 53–73. https://doi.org/10.1080/00324728.2017.1367413

Esping-Andersen, G. (1999). *Social foundations of postindustrial economies*. Oxford Univ. Press.

Feng, P., Zhou, X.-H., Zou, Q.-M., Fan, M.-Y., & Li, X.-S. (2012). Generalized propensity score for estimating the average treatment effect of multiple treatments. *Statistics in Medicine*, *31*(7), 681–697. https://doi.org/10.1002/sim.4168

Fingerman, K. L., Cheng, Y.-P., Birditt, K., & Zarit, S. (2012). Only as Happy as the Least Happy Child: Multiple Grown Children's Problems and Successes and Middle-aged Parents' Well-being. *The Journals of Gerontology: Series B*, *67B*(2), 184–193. https://doi.org/10.1093/geronb/gbr086

Friedman, E. M., & Mare, R. D. (2014). The Schooling of Offspring and the Survival of Parents. *Demography*, *51*(4), 1271–1293. https://doi.org/10.1007/s13524-014-0303-z

Halaby, C. N. (2003). Panel Models for the Analysis of Change and Growth in Life Course Studies. In J. T. Mortimer & M. J. Shanahan (Eds.), *Handbook of the Life Course* (pp. 503–527). Springer US. https://doi.org/10.1007/978-0-306-48247-2_23

Hoogendijk, E. O., Afilalo, J., Ensrud, K. E., Kowal, P., Onder, G., & Fried, L. P. (2019). Frailty: Implications for clinical practice and public health. *The Lancet*, *394*(10206), 1365–1375. https://doi.org/10.1016/S0140-6736(19)31786-6

Imbens, G. (2000). The role of the propensity score in estimating dose-response functions. *Biometrika*, *87*(3), 706–710. https://doi.org/10.1093/biomet/87.3.706

Jiang, N. (2019). Adult Children's Education and Later-Life Health of Parents in China: The Intergenerational Effects of Human Capital Investment. *Social Indicators Research*, *145*(1), 257–278. https://doi.org/10.1007/s11205-019-02109-9

Jiang, N., & Kaushal, N. (2020). How children's education affects caregiving: Evidence from parent's last years of life. *Economics & Human Biology*, *38*, 100875. https://doi.org/10.1016/j.ehb.2020.100875

Kalmijn, M. (2007). Gender Differences in the Effects of Divorce, Widowhood and Remarriage on Intergenerational Support: Does Marriage Protect Fathers? *Social Forces*, *85*(3), 1079–1104. https://doi.org/10.1353/sof.2007.0043

Kalmijn, M. (2019). The Effects of Ageing on Intergenerational Support Exchange: A New Look at the Hypothesis of Flow Reversal. *European Journal of Population*, *35*(2), 263–284. https://doi.org/10.1007/s10680-018-9472-6

Kalmijn, M., & de Graaf, P. M. (2012). Life Course Changes of Children and Well-being of Parents. *Journal of Marriage and Family*, *74*(2), 269–280. https://doi.org/10.1111/j.1741-3737.2012.00961.x

Khalatbari-Soltani, S., Maccora, J., Blyth, F. M., Joannès, C., & Kelly-Irving, M. (2022). Measuring education in the context of health inequalities. *International Journal of Epidemiology*, *51*(3), 701–708. https://doi.org/10.1093/ije/dyac058

Kim, D. H., & Rockwood, K. (2024). Frailty in Older Adults. *New England Journal of Medicine*, *391*(6), 538–548. https://doi.org/10.1056/NEJMra2301292

Lee, C. (2018). Adult Children's Education and Physiological Dysregulation Among Older Parents. *The Journals of Gerontology. Series B, Psychological Sciences and Social Sciences*, *73*(6), 1143–1154. https://doi.org/10.1093/geronb/gbx044

Lee, C., Glei, D. A., Goldman, N., & Weinstein, M. (2017). Children's Education and Parents' Trajectories of Depressive Symptoms. *Journal of Health and Social Behavior*, *58*(1), 86–101. https://doi.org/10.1177/0022146517690200

Lee, Y. (2018). Adult children's educational attainment and the cognitive trajectories of older parents in South Korea. *Social Science & Medicine*, *209*, 76–85. https://doi.org/10.1016/j.socscimed.2018.05.026

Leopold, L. (2018). Education and Physical Health Trajectories in Later Life: A Comparative Study. *Demography*, *55*(3), 901–927. https://doi.org/10.1007/s13524-018-0674-7

Leopold, L. (2019). Health Measurement and Health Inequality Over the Life Course: A Comparison of Self-rated Health, SF-12, and Grip Strength. *Demography*, *56*(2), 763–784. https://doi.org/10.1007/s13524-019-00761-x

Leopold, T., & Raab, M. (2011). Short-Term Reciprocity in Late Parent-Child Relationships. *Journal of Marriage and Family*, *73*(1), 105–119. https://doi.org/10.1111/j.1741-3737.2010.00792.x

Liefbroer, A. C., & Zoutewelle-Terovan, M. (2021). Meta-analysis and meta-regression: An alternative to multilevel analysis when the number of countries is small. In Social background and the demographic life course: Cross-national comparisons (pp. 101-123). Cham: Springer International Publishing.

Linden, A., Uysal, S. D., Ryan, A., & Adams, J. L. (2016). Estimating causal effects for multivalued treatments: A comparison of approaches. *Statistics in Medicine*, *35*(4), 534–552. https://doi.org/10.1002/sim.6768

Little, M. O., & Morley, J. E. (2022). Healthcare for older adults in North America: Challenges, successes and opportunities. *Age and Ageing*, *51*(10), afac216. https://doi.org/10.1093/ageing/afac216

Liu, Y., Ma, Y., & Smith, J. P. (2022). Adult Children's Education and Older Parents' Chronic Illnesses in Aging China. *Demography*, *59*(2), 535–562. https://doi.org/10.1215/00703370-9766973

Liu, Z. (2021). Children's Education and Parental Health: Evidence from China. *American Journal of Health Economics*, *7*(1), 95–130. https://doi.org/10.1086/711704

Lundborg, P., & Majlesi, K. (2018). Intergenerational transmission of human capital: Is it a one-way street? *Journal of Health Economics*, *57*, 206–220. https://doi.org/10.1016/j.jhealeco.2017.12.001

Ma, M. (2019). Does children's education matter for parents' health and cognition? Evidence from China. *Journal of Health Economics*, *66*, 222–240. https://doi.org/10.1016/j.jhealeco.2019.06.004

Ma, M., Yahirun, J., Saenz, J., & Sheehan, C. (2021). Offspring Educational Attainment and Older Parents' Cognition in Mexico. *Demography*, *58*(1), 75–109. https://doi.org/10.1215/00703370-8931725

Ma, X., Liu, Y., Zhang, P., Qi, R., & Meng, F. (2023). Understanding online health information seeking behavior of older adults: A social cognitive perspective. *Frontiers in Public Health*, *11*. https://doi.org/10.3389/fpubh.2023.1147789

Mair, C. A. (2013). Family Ties and Health Cross-Nationally: The Contextualizing Role of Familistic Culture and Public Pension Spending in Europe. *The Journals of Gerontology*

Series B: Psychological Sciences and Social Sciences, *68*(6), 984–996. https://doi.org/10.1093/geronb/gbt085

Mare, R. D. (2011). A Multigenerational View of Inequality. *Demography*, *48*(1), 1–23. https://doi.org/10.1007/s13524-011-0014-7

Milkie, M. A., Bierman, A., & Schieman, S. (2008). How Adult Children Influence Older Parents' Mental Health: Integrating Stress-process and Life-course Perspectives. *Social Psychology Quarterly*, *71*(1), 86–105. https://doi.org/10.1177/019027250807100109

Mirowsky, J., & Ross, C. E. (2003). *Education, social status, and health*. A. de Gruyter.

Mirowsky, J., & Ross, C. E. (2015). Education, Health, and the Default American Lifestyle. *Journal of Health and Social Behavior*, *56*(3), 297–306. https://doi.org/10.1177/0022146515594814

Pais, J. (2014). Cumulative Structural Disadvantage and Racial Health Disparities: The Pathways of Childhood Socioeconomic Influence. *Demography*, *51*(5), 1729–1753. https://doi.org/10.1007/s13524-014-0330-9

Pfeffer, F. T. (2018). Growing Wealth Gaps in Education. *Demography*, *55*(3), 1033–1068. https://doi.org/10.1007/s13524-018-0666-7

Phelan, J. C., Link, B. G., & Tehranifar, P. (2010). Social Conditions as Fundamental Causes of Health Inequalities: Theory, Evidence, and Policy Implications. *Journal of Health and Social Behavior*, *51*(1_suppl), S28–S40. https://doi.org/10.1177/0022146510383498

Pillemer, K., Munsch, C. L., Fuller-Rowell, T., Riffin, C., & Suitor, J. J. (2012). Ambivalence Toward Adult Children: Differences Between Mothers and Fathers. *Journal of Marriage and the Family*, *74*(5), 1101–1113. https://doi.org/10.1111/j.1741-3737.2012.01004.x

Pillemer, K., Suitor, J. J., Riffin, C., & Gilligan, M. (2017). Adult Children's Problems and Mothers' Well-Being: Does Parental Favoritism Matter? *Research on Aging*, *39*(3), 375–395. https://doi.org/10.1177/0164027515611464

Potente, C., Präg, P., & Monden, C. W. S. (2023). Does Children's Education Improve Parental Health and Longevity? Causal Evidence from Great Britain. *Journal of Health and Social Behavior*, 00221465221143089. https://doi.org/10.1177/00221465221143089

Reher, D. S. (1998). Family Ties in Western Europe: Persistent contrasts. *Population and Development Review*, *24*(2), 203–234. https://doi.org/10.2307/2807972

Romero-Ortuno, R., & Kenny, R. A. (2012). The frailty index in Europeans: Association with age and mortality. *Age and Ageing*, *41*(5), 684–689. https://doi.org/10.1093/ageing/afs051

Rosenbaum, P. R., & Rubin, D. B. (1983). The Central Role of the Propensity Score in Observational Studies for Causal Effects. *Biometrika*, *70*(1), 41–55. https://doi.org/10.2307/2335942

Rosenbaum, P. R., & Rubin, D. B. (1984). Reducing Bias in Observational Studies Using Subclassification on the Propensity Score. *Journal of the American Statistical Association*, *79*(387), 516–524. https://doi.org/10.1080/01621459.1984.10478078

Ross, C. E., & Mirowsky, J. (2006). Sex differences in the effect of education on depression: Resource multiplication or resource substitution? *Social Science & Medicine*, *63*(5), 1400–1413. https://doi.org/10.1016/j.socscimed.2006.03.013

Ross, C. E., & Mirowsky, J. (2011). The interaction of personal and parental education on health. *Social Science & Medicine (1982)*, *72*(4), 591–599. https://doi.org/10.1016/j.socscimed.2010.11.028

Rossi, A., & Rossi, P. (1990). *Of Human Bonding: Parent-Child Relations across the Life Course*. New York: Aldine de Gruyter. https://www.taylorfrancis.com/books/9781351328913

Sang, N., Li, B.-H., Zhang, M.-Y., Wei, M., Fang, R.-X., Liu, W.-J., Huang, L.-E., Zhang, J., & Wu, G.-C. (2023). Bidirectional causal relationship between depression and frailty: A univariate and multivariate Mendelian randomisation study. *Age and Ageing*, *52*(7), afad113. https://doi.org/10.1093/ageing/afad113

Saraceno, C. (2016). Varieties of familialism: Comparing four southern European and East Asian welfare regimes. Journal of European Social Policy, 26(4), 314-326.

Schwarz, T., Schmidt, A. E., Bobek, J., & Ladurner, J. (2022). Barriers to accessing health care for people with chronic conditions: A qualitative interview study. *BMC Health Services Research*, *22*(1), 1037. https://doi.org/10.1186/s12913-022-08426-z

Serra-Prat, M., Borsot, A. F., Burdoy, E., Cuevas, À. L., Ortiz, L. M., & Cabré, M. (2025). Frailty reversal and its main determinants: a population-based observational and longitudinal study. Family Medicine and Community Health, 13(2), e003250.

Silverstein, M., Conroy, S. J., Wang, H., Giarrusso, R., & Bengtson, V. L. (2002). Reciprocity in Parent–Child Relations Over the Adult Life Course. *The Journals of Gerontology: Series B*, *57*(1), S3–S13. https://doi.org/10.1093/geronb/57.1.S3

Silverstein, M., Gans, D., & Yang, F. M. (2006). Intergenerational Support to Aging Parents: The Role of Norms and Needs. *Journal of Family Issues*, *27*(8), 1068–1084. https://doi.org/10.1177/0192513X06288120

Słoczyński, T., & Wooldridge, J. M. (2018). A general double robustness result for estimating average treatment effects. *Econometric Theory*, *34*(1), 112–133. https://doi.org/10.1017/S0266466617000056

Thoma, B., Sudharsanan, N., Karlsson, O., Joe, W., Subramanian, S. V., & De Neve, J.-W. (2021). Children's education and parental old-age health: Evidence from a population-based, nationally representative study in India. *Population Studies*, *75*(1), 51–66. https://doi.org/10.1080/00324728.2020.1775873

Torres, J. M., Yahirun, J. J., Sheehan, C., Ma, M., & Sáenz, J. (2021). Adult child socio-economic status disadvantage and cognitive decline among older parents in Mexico. *Social Science & Medicine*, *279*, 113910. https://doi.org/10.1016/j.socscimed.2021.113910

Torres, J. M., Yang, Y., Rudolph, K. E., & Courtin, E. (2022). Increased adult child schooling and older parents' health behaviors in Europe: A quasi-experimental study. *SSM - Population Health*, *19*, 101162. https://doi.org/10.1016/j.ssmph.2022.101162

Torres, J. M., Yang, Y., Rudolph, K. E., Meza, E., Glymour, M. M., & Courtin, E. (2022). Adult Child Schooling and Older Parents' Cognitive Outcomes in the Survey of Health, Aging and Retirement in Europe (SHARE): A Quasi-Experimental Study. *American Journal of Epidemiology*, *191*(11), 1906–1916. https://doi.org/10.1093/aje/kwac151

Torssander, J. (2013). From Child to Parent? The Significance of Children's Education for Their Parents' Longevity. *Demography*, *50*(2), 637–659. https://doi.org/10.1007/s13524-012-0155-3

Torssander, J. (2014). Adult children's socioeconomic positions and their parents' mortality: A comparison of education, occupational class, and income. *Social Science & Medicine*, *122*, 148–156. https://doi.org/10.1016/j.socscimed.2014.10.043

Tosi, M., & Albertini, M. (2019). Does Children's Union Dissolution Hurt Elderly Parents? Linked Lives, Divorce and Mental Health in Europe. *European Journal of Population*, *35*(4), 695–717. https://doi.org/10.1007/s10680-018-9501-5

Tosi, M., & Grundy, E. (2019). Intergenerational contacts and depressive symptoms among older parents in Eastern Europe. *Aging & Mental Health*, *23*(6), 686–692. https://doi.org/10.1080/13607863.2018.1442412

Umberson, D., & Thomeer, M. B. (2020). Family Matters: Research on Family Ties and Health, 2010-2020. *Journal of Marriage and the Family*, *82*(1), 404–419. https://doi.org/10.1111/jomf.12640

Uysal, S. D. (2015). Doubly Robust Estimation of Causal Effects with Multivalued Treatments: An Application to the Returns to Schooling. *Journal of Applied Econometrics*, *30*(5), 763–786. https://doi.org/10.1002/jae.2386

Vermeiren, S., Vella-Azzopardi, R., Beckwée, D., Habbig, A.-K., Scafoglieri, A., Jansen, B., Bautmans, I., Bautmans, I., Verté, D., Beyer, I., Petrovic, M., De Donder, L., Kardol, T., Rossi, G., Clarys, P., Scafoglieri, A., Cattrysse, E., de Hert, P., & Jansen, B. (2016). Frailty and the Prediction of Negative Health Outcomes: A Meta-Analysis. *Journal of the American Medical Directors Association*, *17*(12), 1163.e1-1163.e17. https://doi.org/10.1016/j.jamda.2016.09.010

Willson, A. E., Shuey, K. M., & Elder, G. H. (2007). Cumulative Advantage Processes as Mechanisms of Inequality in Life Course Health. *American Journal of Sociology*, *112*(6), 1886–1924. https://doi.org/10.1086/512712

Wolfe, J. D., Bauldry, S., Hardy, M., & Pavalko, E. K. (2018b). Multigenerational socioeconomic attainments and mortality among older men: An adjacent generations approach. *Demographic Research*, *39*, 719–752.

Yahirun, J. J., Vasireddy, S., & Hayward, M. D. (2020). The Education of Multiple Family Members and the Life-Course Pathways to Cognitive Impairment. *The Journals of Gerontology: Series B*, *75*(7), e113–e128. https://doi.org/10.1093/geronb/gbaa039

Zhang, W., & Silverstein, M. (2023). Does the Economic Status of Adult Children Influence Self-Rated Health Among Older Adults in China? *The Journals of Gerontology: Series B*, *78*(9), 1604–1616. https://doi.org/10.1093/geronb/gbad078

Zimmer, Z., Hanson, H. A., & Smith, K. R. (2016). Offspring Socioeconomic Status and Parent Mortality Within a Historical Population. *Demography*, *53*(5), 1583–1603. https://doi.org/10.1007/s13524-016-0502-x

Zimmer, Z., Hermalin, A. I., & Lin, H.-S. (2002). Whose education counts? The added impact of adult-child education on physical functioning of older taiwanese. *The Journals of Gerontology. Series B, Psychological Sciences and Social Sciences*, *57*(1), S23-32. https://doi.org/10.1093/geronb/57.1.s23

Zimmer, Z., Martin, L. G., Ofstedal, M. B., & Chuang, Y.-L. (2007). Education of adult children and mortality of their elderly parents in Taiwan. *Demography*, *44*(2), 289–305. https://doi.org/10.1353/dem.2007.0020

Tables and Figures

Table 1. Description of the variables used in the analyses, by parental gender.

	Fathers		Mothers		Total	
	N (mean)	% (SD)	N (mean)	% (SD)	N (mean)	% (SD)
Frailty Index	11.79	(9.74)	14.48	(11.44)	13.41	(10.88)
Child's level of education						
Low	4,648	6.40	7,757	7.00	12,405	6.80
Medium	27,177	37.20	44,055	40.00	71,232	38.90
High	41,293	56.50	58,395	53.00	99,688	54.40
Parent's level of education						
Low	24,196	33.10	45,350	41.10	69,546	37.90
Medium	30,433	41.60	42,956	39.00	73,389	40.00
High	18,489	25.30	21,901	19.90	40,390	22.00
Respondent's age at interview	67.40	(8.56)	66.84	(8.94)	67.07	(8.80)
Child's cohort						
1930-1965	11,778	16.10	23,954	21.70	35,732	19.50
1966-1971	12,929	17.70	20,916	19.00	33,845	18.50
1972-1975	11,344	15.50	16,410	14.90	27,754	15.10
1976-1981	17,482	23.90	23,830	21.60	41,312	22.50
1982-1985	8,943	12.20	11,890	10.80	20,833	11.40
1986-1997	10,642	14.60	13,207	12.00	23,849	13.00
Child's gender						
Son	35,778	48.90	52,816	47.90	88,594	48.30
Daughter	37,340	51.10	57,391	52.10	94,731	51.70
Country cluster						
Nordic	10,527	14.40	13,162	11.90	23,689	12.90
Western	29,964	41.00	39,851	36.20	69,815	38.10
Mediterranean	13,517	18.50	19,361	17.60	32,878	17.90
Eastern	19,110	26.10	37,833	34.30	56,943	31.10
Parent's number of children						
1	13,049	17.80	22,458	20.40	35,507	19.40
2	34,282	46.90	50,986	46.30	85,268	46.50
3	16,175	22.10	23,437	21.30	39,612	21.60
4	5,932	8.10	8,235	7.50	14,167	7.70
5+	3,680	5.00	5,091	4.60	8,771	4.80
Parent's marital status						
Married	58,037	79.40	63,365	57.50	121,402	66.20
Not Currently Married	8,223	11.20	16,892	15.30	25,115	13.70
Widowed	6,858	9.40	29,950	27.20	36,808	20.10
Parent's wealth						
First quartile	12,883	17.60	26,637	24.20	39,520	21.60
Second quartile	17,280	23.60	28,574	25.90	45,854	25.00
Third quartile	20,303	27.80	28,479	25.80	48,782	26.60
Fourth quartile	22,652	31.00	26,517	24.10	49,169	26.80

Source: Survey of Health, Ageing and Retirement in Europe (SHARE), waves 1-9 (2004-2022).
Note: Unless otherwise indicated, values are reported in percentages.

Table 2. Distribution of the treatment (children's education levels) by key parental characteristics, before and after applying IPWMT weights, by parental gender.

	Fathers					**Mothers**				
	Child's education			Pearson test		Child's education			Pearson test	
	Low	Medium	High	chi2	p	Low	Medium	High	chi2	p
Parent's education										
Unweigthed										
Low	76.83	40.99	22.97			81.04	50.27	28.97		
Medium	18.37	47.29	40.51	>100	0.000	14.67	41.07	40.63	>100	0.000
High	4.80	11.73	36.52			4.29	8.66	30.40		
Weigthed										
Low	29.75	33.06	33.23			38.91	41.29	41.15		
Medium	41.10	41.58	41.56	153.75	0.201	37.75	39.01	38.98	191.03	0.147
High	29.16	25.36	25.20			23.34	19.70	19.87		
Wealth quartiles										
Unweigthed										
First quartile	35.11	22.22	12.62			39.35	29.66	18.01		
Second quartile	28.61	27.25	20.69	>100	0.000	28.77	28.40	23.69	>100	0.000
Third quartile	21.08	27.54	28.67			19.90	24.49	27.65		
Fourth quartile	15.19	22.98	38.02			11.98	17.45	30.65		
Weigthed										
First quartile	16.84	17.73	18.15			22.57	24.31	24.36		
Second quartile	23.02	23.69	23.59	24.33	0.799	25.97	25.95	25.84	107.20	0.239
Third quartile	28.76	27.86	27.65			24.94	25.92	25.79		
Fourth quartile	31.38	30.72	30.60			26.52	23.82	24.02		

Source: Survey of Health, Ageing and Retirement in Europe (SHARE), waves 1-9 (2004-2022).

Table 3. Random intercept linear regression estimates of the association between child's education and older parents' health (unweighted and weighted models), by parental gender.
Source: Survey of Health, Ageing and Retirement in Europe (SHARE), waves 1-9 (2004-2022).

	Fathers						Mothers					
	Model 1 (Unweighted)			Model 2 (Weighted)			Model 3 (Unweighted)			Model 4 (Weighted)		
	b	95% CIs		b	95% CIs		b	95% CIs		b	95% CIs	
Child's level of education (ref. Low)												
Medium	-1.018***	-1.342	-0.694	-0.566	-1.244	0.111	-1.552***	-1.847	-1.257	-0.584*	-1.117	-0.050
High	-1.891***	-2.227	-1.554	-1.070**	-1.734	-0.406	-2.898***	-3.207	-2.589	-1.661***	-2.212	-1.109
Parent's level of education (ref. Low)												
Medium	-1.642***	-1.874	-1.409	-1.936***	-2.246	-1.626	-2.244***	-2.459	-2.030	-2.676***	-2.948	-2.403
High	-2.709***	-2.979	-2.440	-3.119***	-3.456	-2.782	-3.579***	-3.848	-3.310	-4.186***	-4.513	-3.859
Parent's age (centered)	0.272***	0.257	0.287	0.280***	0.252	0.309	0.370***	0.355	0.384	0.363***	0.330	0.396
Child's birth cohort (ref.: 1930-1965)												
1966-1971	-0.721***	-0.991	-0.452	-0.546+	-1.113	0.021	-0.674***	-0.911	-0.438	-0.298	-0.749	0.153
1972-1975	-0.850***	-1.162	-0.538	-0.267	-1.048	0.515	-0.716***	-1.002	-0.431	-0.065	-0.754	0.623
1976-1981	-1.158***	-1.489	-0.827	-0.756*	-1.496	-0.015	-0.979***	-1.285	-0.672	-0.745*	-1.460	-0.030
1982-1985	-1.299***	-1.692	-0.906	-0.956*	-1.725	-0.188	-0.961***	-1.330	-0.593	-0.648	-1.553	0.257
1986-1997	-1.604***	-2.031	-1.177	-1.426***	-2.272	-0.580	-0.869***	-1.275	-0.464	-0.723	-1.672	0.226
Child's gender (ref.: Son)												
Daughter	0.090	-0.049	0.228	0.222	-0.094	0.537	0.011	-0.117	0.138	-0.103	-0.418	0.211
Number of children (ref.: 1)												
2	-0.020	-0.243	0.203	0.505+	-0.084	1.094	0.150	-0.053	0.354	-0.016	-0.711	0.680
3	0.459***	0.202	0.716	0.941*	0.224	1.658	0.389**	0.148	0.629	-0.054	-1.016	0.909
4	0.833***	0.500	1.167	0.760	-0.437	1.957	0.893***	0.572	1.215	0.459	-0.246	1.164
5+	1.805***	1.412	2.197	2.468***	1.550	3.385	1.809***	1.428	2.191	1.320**	0.421	2.220
Marital status (ref.: Married)												
Not Currently Married	0.730***	0.449	1.011	1.103*	0.220	1.987	0.830***	0.584	1.077	0.049	-1.149	1.247
Widowed	1.198***	0.930	1.466	1.405**	0.395	2.415	1.051***	0.871	1.232	1.215***	0.583	1.846
Wealth quartiles (ref.: First)												
Second	-1.147***	-1.333	-0.960	-0.674**	-1.126	-0.223	-1.394***	-1.544	-1.245	-0.713***	-1.061	-0.365
Third	-1.854***	-2.047	-1.661	-1.045***	-1.526	-0.564	-2.017***	-2.179	-1.856	-1.093***	-1.481	-0.705
Fourth	-2.320***	-2.523	-2.116	-1.661***	-2.192	-1.129	-2.487***	-2.666	-2.309	-1.292***	-1.734	-0.851
SHARE wave (ref.: [1] 2004-05)												
[2] 2006-07	0.031	-0.192	0.254	0.101	-0.334	0.536	0.004	-0.216	0.224	-0.011	-0.377	0.355
[4] 2011-12	0.810***	0.571	1.049	0.968***	0.486	1.450	0.507***	0.278	0.735	0.336	-0.110	0.783
[5] 2013	0.825***	0.577	1.072	0.995***	0.516	1.474	0.417***	0.179	0.654	0.443+	-0.042	0.928
[6] 2015	1.017***	0.753	1.280	1.267***	0.736	1.798	0.504***	0.254	0.755	0.455+	-0.073	0.983
[7] 2017	1.316***	0.972	1.660	1.761***	1.047	2.475	0.489**	0.166	0.811	0.749*	0.106	1.392

[8] 2019-20	1.239***	0.925	1.553	1.389***	0.736	2.042	0.189	-0.107	0.485	0.236	-0.406	0.877
[9] 2022	1.510***	1.179	1.841	1.884***	1.192	2.576	0.130	-0.182	0.443	0.400	-0.349	1.148
Country dummies	Yes			Yes			Yes			Yes		
Constant	15.082***	14.492	15.672	13.301***	12.293	14.308	18.012***	17.476	18.547	16.767***	15.869	17.666
Number of observations	73,116			73,116			110,208			110,208		
Number of parents	35,948			35,948			50,552			50,552		
SD (random-intercept)	7.346			8.511			8.449			9.581		
SD (residuals)	5.597			4.086			6.115			4.801		
Test for gender differences	Unweighted			Weighted								
Child's level of education X parents' gender												
Medium X Mother	-1.163***	-1.597	-0.728	-0.180	-1.018	0.658						
High X Mother	-1.767***	-2.204	-1.330	-0.830*	-1.624	-0.036						

Note: 95% confidence intervals in second column. Ref.: reference category; + p<0.10, * p<0.05, ** p<0.01, *** p<0.001.

Table 4. Random intercept linear regression estimates of the association between child's education and older parents' health (weighted models), by cluster of countries.
Source: Survey of Health, Ageing and Retirement in Europe (SHARE), waves 1-9 (2004-2022).

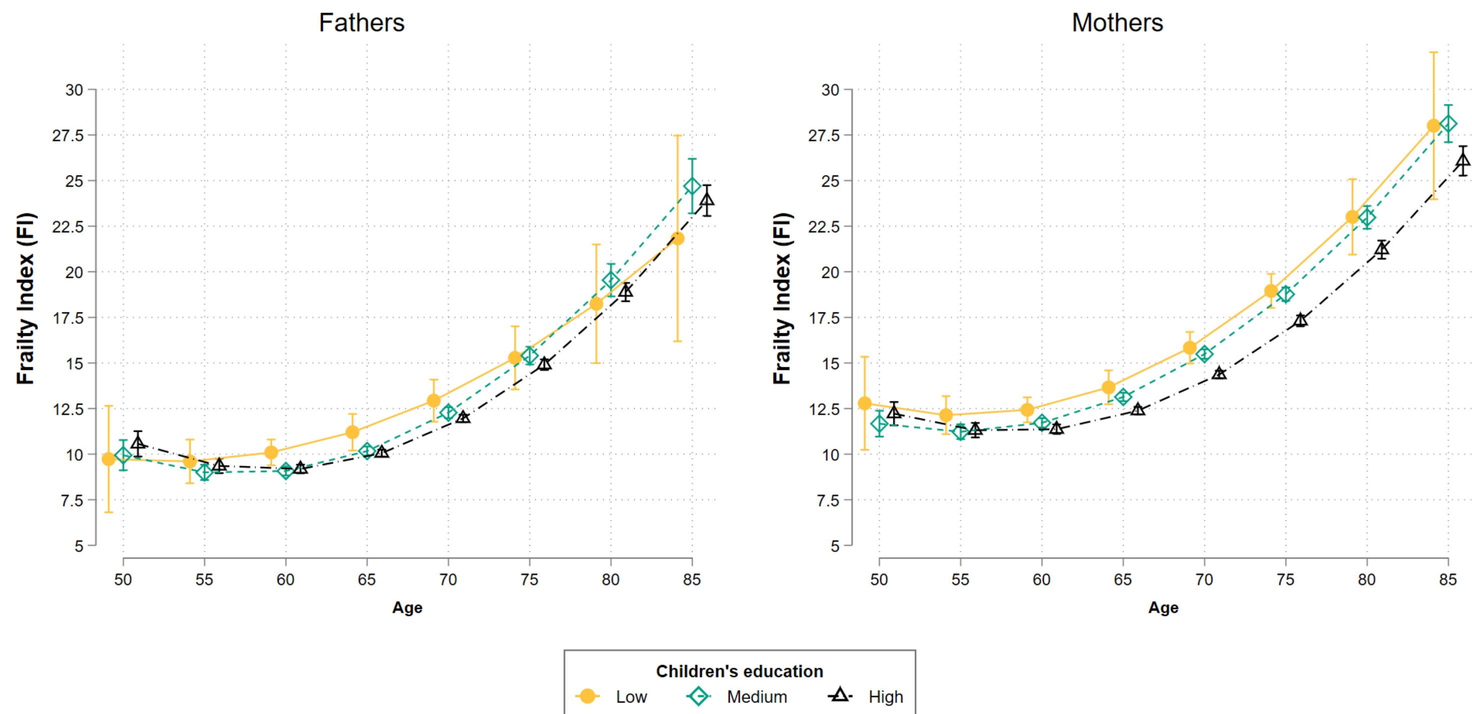
	Northern			Western			Southern			Eastern		
	b	95% CIs		b	95% CIs		b	95% CIs		b	95% CIs	
Child's level of education (ref. Low)												
Medium	0.194	-0.804	1.192	-0.850*	-1.607	-0.093	-0.545	-1.234	0.145	-0.477	-1.183	0.228
High	-0.660	-1.690	0.369	-1.583***	-2.341	-0.826	-1.384***	-2.075	-0.694	-1.332***	-2.099	-0.564
Parent's level of education (ref. Low)												
Medium	-1.038***	-1.609	-0.466	-2.042***	-2.390	-1.694	-1.970***	-2.429	-1.510	-3.211***	-3.598	-2.825
High	-2.386***	-2.956	-1.816	-3.248***	-3.617	-2.878	-3.199***	-3.757	-2.641	-5.317***	-5.853	-4.780
Parent's age (centered)	0.208***	0.154	0.263	0.275***	0.232	0.317	0.397***	0.361	0.433	0.412***	0.359	0.465
Child's birth cohort (ref.: 1930-1965)												
1966-1971	-1.028***	-1.609	-0.447	0.142	-0.501	0.784	-1.284***	-2.020	-0.547	0.223	-1.139	1.584
1972-1975	-0.365	-1.732	1.003	0.428	-0.676	1.532	-0.764+	-1.645	0.117	-0.142	-1.462	1.178
1976-1981	-2.413**	-3.923	-0.902	-0.044	-1.012	0.923	-1.201*	-2.125	-0.276	-0.322	-1.704	1.061
1982-1985	-1.723*	-3.165	-0.281	-0.390	-1.771	0.991	-1.821***	-2.799	-0.843	0.097	-1.507	1.700
1986-1997	-2.480***	-3.910	-1.051	-0.655	-1.869	0.559	-1.702**	-2.776	-0.628	-0.121	-1.786	1.544
Child's gender (ref.: Son)												
Daughter	0.493	-0.243	1.229	-0.241	-0.570	0.088	0.180	-0.173	0.533	0.148	-0.465	0.761
Number of children (ref.: 1)												
2	0.771	-0.372	1.914	-0.444	-1.008	0.119	0.605+	-0.037	1.248	0.579+	-0.072	1.230
3	1.628*	0.347	2.910	-0.462	-1.048	0.124	1.498**	0.596	2.400	0.413	-1.241	2.067
4	1.790**	0.597	2.983	-0.056	-0.789	0.677	1.544**	0.399	2.690	-0.107	-2.627	2.414
5+	1.298	-0.498	3.094	1.369**	0.425	2.314	4.973***	3.381	6.564	0.885	-0.199	1.968
Parent's gender (ref.: Fathers)												
Mothers	1.256***	0.857	1.655	1.540***	1.279	1.802	3.374***	3.027	3.720	1.905***	1.563	2.247
Marital status (ref.: Married)												
Not Currently Married	0.602	-0.733	1.937	-0.238	-1.696	1.220	1.289**	0.439	2.140	1.333*	0.208	2.458
Widowed	1.589*	0.085	3.093	1.365**	0.515	2.215	1.809***	1.168	2.450	1.115*	0.003	2.228
Wealth quartiles (ref.: First)												
Second	-1.005**	-1.623	-0.387	-0.915***	-1.381	-0.449	-0.769***	-1.199	-0.339	-0.535	-1.253	0.183
Third	-1.640***	-2.378	-0.903	-1.353***	-1.892	-0.813	-0.764**	-1.222	-0.306	-0.794*	-1.514	-0.074
Fourth	-1.550***	-2.317	-0.782	-1.832***	-2.403	-1.261	-1.370***	-1.890	-0.849	-1.394**	-2.364	-0.424
SHARE wave (ref.: [1] 2004-05)												
[2] 2006-07	0.325	-0.242	0.891	0.039	-0.339	0.417	-0.486*	-0.865	-0.108			
[4] 2011-12	0.473	-0.218	1.165	0.996***	0.518	1.475	0.178	-0.366	0.722	-0.770	-2.777	1.236
[5] 2013	0.927*	0.205	1.650	1.390***	0.779	2.002	0.254	-0.309	0.816	-1.171	-2.986	0.645
[6] 2015	1.735***	0.846	2.623	1.658***	0.988	2.328	-0.015	-0.575	0.544	-1.275	-3.074	0.524

[7] 2017	2.057***	0.844	3.269	1.780***	0.936	2.625	-0.064	-0.724	0.596	0.686	-1.372	2.744
[8] 2019-20	2.378***	1.255	3.500	1.961***	1.128	2.794	-0.429	-1.171	0.313	-1.807+	-3.686	0.071
[9] 2022	2.495***	1.168	3.821	2.323***	1.308	3.339	-0.192	-1.037	0.652	-1.733+	-3.574	0.109
Country (ref.: Sweden)												
Denmark	0.995***	0.579	1.412									
Finland	1.540***	0.690	2.390									
Country (ref.: Austria)												
Germany				1.729***	1.365	2.094						
Netherlands				-1.343***	-1.758	-0.929						
France				1.626***	1.254	1.998						
Switzerland				-2.660***	-3.046	-2.274						
Belgium				1.906***	1.540	2.273						
Luxembourg				0.473	-0.130	1.075						
Country (ref.: Spain)												
Italy							-0.923***	-1.338	-0.508			
Greece							-1.305***	-1.756	-0.853			
Portugal							4.393***	3.701	5.084			
Cyprus							0.509	-0.614	1.631			
Malta							0.543	-0.290	1.376			
Country (ref.: Czech Republic)												
Poland										3.544***	3.033	4.055
Hungary										4.216***	3.574	4.859
Slovenia										0.290	-0.178	0.758
Estonia										3.598***	3.142	4.054
Croatia										1.027***	0.479	1.574
Lithuania										5.054***	4.235	5.874
Bulgaria										2.304***	1.278	3.329
Latvia										0.635+	-0.080	1.350
Romania										2.259***	1.424	3.095
Slovakia										0.457	-0.444	1.357

Constant	11.168***	9.626	12.709	14.200***	13.232	15.168	14.526***	13.519	15.533	17.389***	15.516	19.261
Number of observations	23,688			69,816			32,877			56,943		
Number of parents	9,453			31,087			15,806			30,154		
SD (random-intercept)	8.284			8.594			9.305			9.764		
SD (residuals)	3.914			4.310			5.128			4.715		
Test for country differences												
Child's level of education X cluster												
Medium X Western	-0.958	-2.178	0.262									
Medium X Southern	-1.041+	-2.252	0.170									
Medium X Eastern	-0.788	-1.971	0.394									
High X Western	-0.741	-1.922	0.441									
High X Southern	-1.056+	-2.227	0.115									
High X Eastern	-1.083+	-2.241	0.074									

Note: 95% confidence intervals in second column. Ref.: reference category; + p<0.10, * p<0.05, ** p<0.01, *** p<0.001.

Figure 1. Random-effects group-specific growth curve model (GCM) estimates of the association between child's education and older parents' health (weighted models), by parental gender and children's level of education.



Source: Survey of Health, Ageing and Retirement in Europe (SHARE), waves 1-9 (2004-2022).
Note: 95% confidence intervals.