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Intergenerational exchanges, children's education and parents' longevity in Europe

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ABSTRACT

The link between children's health and the education of their parents, especially mothers, is now well established. However, far less is known about the possible influence of the educational attainment of adult children on the health of their parents. This study investigates the relationship between the education of adult children and the longevity of older parents using individual-level longitudinal data for 11 countries from the Survey of Health, Ageing and Retirement in Europe (SHARE). Of particular interest is whether having well-educated adult children is associated with a health benefit for their parents. Cox proportional hazard models predict the risk of death for mothers and for fathers as a function of (a) adult children's education, and (b) the difference between the educational attainment of child and parent. Regional variation across Europe is also examined. The results indicate that adult children's educational attainment is independently related to parental mortality after controlling for possible confounders, and that having children with upper secondary or tertiary levels of education is associated with a significantly reduced risk of mortality if the parents do not have tertiary education. Further, a similar pattern of association is found across regions with different levels of welfare provision, family forms and regimes of help and care. Although the analyses cannot determine the causal direction of the intergenerational exchange, we argue that the results suggest upward health transfers from adult children to their parents and thus support an intergenerational approach to health policy interventions.

KEYWORDS

Longevity; mortality; parents; adult children; education; health transfers; Europe.

EDITORIAL NOTE

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INTERGENERATIONAL EXCHANGES, CHILDREN'S EDUCATION AND PARENTS' LONGEVITY IN EUROPE

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1. INTRODUCTION

The education of parents has been shown to influence children's health in many parts of the world (Case et al 2002; Kravdal 2004), especially in the global South (Grossman 2006; Grossman and Kaestner 1997). However, far less is known about 'upward' health transfers, from children to their parents. While several earlier studies have demonstrated a relationship between an individual's mortality and the *quantity* of children he or she has, with childless individuals having higher mortality than those with children (Christiansen 2014; Grundy 2009), the relationship between an individual's mortality and the *quality* of children in terms of their educational attainment is still under-researched despite further educational expansion among the younger generations[1]. This paper therefore addresses an important knowledge gap by investigating the association between adult children's education and parents' health in Europe.

In traditional societies that feature close family ties, including co-residence between parents and children, but lack a reliable public support system, the old age security hypothesis (Nugent 1985) and the theory of intergenerational wealth transfers (Caldwell 2005) argue that parents invest in children's education so that future upward intergenerational transfers are more likely to occur. However, in Western societies where frequency of contact and geographical proximity between adult children and their parents have come to replace co-residence as indicators of family solidarity (Dykstra and Fokkema 2011; Silverstein and Bengtson 1997), intergenerational transfers are often assumed to be 'downwards' (i.e. from parents to children). This study hypothesises that a positive relationship between adult children's education and parents' longevity (indicative of upward intergenerational transfers) also occurs in Europe, with health benefits for older parents with well-educated adult children.

Although most research to date investigating the association between adult children's education and parents' health (Zimmer et al. 2002; Zimmer et al. 2007) focuses on societies (e.g. Taiwan) which tend to experience tighter familial integration than is typical in Western countries, the potential significance of young people's education as a family resource is also increasingly being acknowledged in Western

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[1] In the European Union, the share of persons aged 25 to 34 years with tertiary education has increased from 23% to 33% between 2000 and 2010 (Barslund 2012).

societies (Friedman and Mare 2014; Torssander 2013, 2014). Numerous studies have shown that contacts and exchanges of support between adult children and their parents are substantial in Western countries (Finch 1989; Grundy 2005; Shelton and Grundy 2000; Silverstein et al. 2002). For many older parents in Europe and North America, ties with adult children represent a major element of their social networks as well as a source of extra household support (Silverstein et al. 2006; Smith 1998). While it has long been recognised by social exchange theory that the rearing of children and intergenerational transfers are seen as major investments in virtually all societies (Astone et al. 1999), so far only a few studies have examined the importance of adult children's education for parents' longevity in Western contexts such as Sweden (Torssander 2013, 2014) and the USA (Friedman and Mare 2014). In order to extend our understanding of reciprocity in Western societies, this study examines whether adult children's education is associated with parents' longevity across 11 European countries.

2. EDUCATION AS A FAMILY-LEVEL RESOURCE

Resource pooling transforms an individual's education into a family-level resource (Smith and Zick 1994). As a result, social relationships within, and outside, the household have the potential to create synergistic effects, including the promotion of health among older adults (Marmot et al. 2003; Seeman 2000). To this end, an extensive literature has discussed how the education of significant others may affect an individual's mortality favourably via knowledge transmission, imitation of behaviour and economic support (Ross and Mirowsky 1999). The educational composition of the family clearly matters for the health of individual family members, with many studies suggesting a 'spillover effect' from the education of partners (Huijts et al. 2010; Monden et al. 2003). Further, the notion that the educational achievements of other family members may have an impact on an individual's mortality has been gradually gaining traction in recent years, with reports highlighting that not only spouse's education (Monden et al. 2003) but also parents' education (Davey Smith 2003), as well as average education in the community (Kravdal 2008), can have an impact on a person's mortality, net of the well-established influence of his or her own education.

Although it seems reasonable to assume that the individual education-based gradient in health will remain pivotal (Elo 2009; Huisman et al. 2005), it has also been accepted that a solely individualistic approach to the socioeconomic determinants of health among older adults ignores how families interact and influence one another in a multiplicity of ways (Ross et al. 1990). From this extended perspective, it follows that adult children may have important effects on their parents' health if the essential components of intergenerational solidarity are in place during the adult family life course, including affection, association, consensus, resource sharing, and the opportunity structure for interaction (Bengtson and Roberts 1991). Further, there is some evidence supporting the idea that the educational level of children can be an added influence on their parents' health status. For instance, in a non-Western context, Zimmer and colleagues found that, in Taiwan, the level of education of an adult child is positively associated with older parents' greater physical functioning (Zimmer et al. 2002), and negatively associated with the mortality of their elderly parents (Zimmer et al. 2007). Of course, contextual factors are important in stimulating, or hindering, specific forms of family behaviour (Dykstra 2010), with some environments characterised by high degrees of family integration and, therefore, much more likely to provide the opportunity structure for interaction (Roberts et al. 1991). While high rates of co-residency in the Taiwanese context imply additional influences from the education of children (Zimmer et al. 2002), recent work by Friedman and Mare (2014) in the US also points to an independent effect of adult children's educational attainment for parents' mortality even after controlling for parents' own socio-economic resources. Similarly, research in Sweden indicated that parents' mortality cannot be fully explained by their own socioeconomic resources or those of their partners (Torssander 2013) and identified net associations between children's various socioeconomic resources (education, occupation and income) and parent's mortality risk, with the clearest association for education (Torssander 2014). Therefore, children's education can act as a family-level resource even in the context of increased geographical separation between adult children and parents.

While intergenerational co-residence is among the strategies that can be adopted to organise support, there are several other possible channels of contact and communication between non-coresident adult children and their parents. Theories about the relationships between social networks and health suggest various pathways through

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which social contacts may influence health (Berkman and Glass 2000). According to Torssander (2013: 638) "three of these pathways are potentially relevant for child-to-parent transmission: provision of social support, social influence, and access to resources". Another way of thinking about potential upward health transfers is *via* direct and indirect effects (Friedman and Mare 2014). In other words, while children may directly affect parents' health by consciously providing better access to information and care, they may also affect parents' health through health "spillover" or "contagion" effects. In practical terms, the latter means that parents exposed to educated children's health behaviours and lifestyles may be influenced to adopt healthier behaviour themselves without explicit intervention from their children. In sum, although the advantages of having children with important resources extend beyond the health benefits to parents, explanations that are directly related to the value of education for health are possible and may constitute a core component of family support in the broader context of intergenerational exchanges. These potential mechanisms of upward intergenerational transfers underpin the main focus of our analysis, which is to test our hypothesis linking adult children's education and the longevity of their parents.

2.1. RESEARCH QUESTIONS

This study's aim is to investigate associations between adult children's education and parental mortality using data from 11 European countries. Although other studies have documented the importance of adult children's socio-economic resources for parents' health and longevity in Western contexts (Friedman and Mare 2014; Torssander 2013, 2014), none of this work has specifically examined whether educational differences between the younger and older generations affect the education-mortality relationship between adult children and their older parents. Indeed, structural and behavioural factors may suppress or accentuate the benefits of adult children's education depending on the level of education of their parents. For instance, if low education is particularly detrimental for the longevity of older parents, having highly educated adult children may be especially beneficial for this group.

Building on earlier seminal works (Friedman and Mare 2014; Torssander 2013, 2014; Zimmer et al. 2002; Zimmer et al. 2007), this study addresses the following research questions: (1) does the association between adult children's education and

parents' longevity have differential effects on the survival of mothers and fathers?; (2) does the educational attainment of adult children have a stronger influence on the longevity of older parents with lower education than their children?; and (3) does the association between adult children's educational attainment and parents' survival vary regionally across Europe? Using data from the Survey of Health and Ageing and Retirement in Europe (SHARE), the study contributes to critical debates about educational attainment as a family-level resource, and the potential extent of upward intergenerational transfers in Western societies. To our knowledge, this is the first study to examine the association between adult children's education and their parents' health in a pan-European context.

3.   DATA AND METHODS

3.1.   DATA

Data for the study are drawn from four waves (2004, 2006, 2010 and 2012/13) of the Survey of Health, Ageing and Retirement in Europe (SHARE). SHARE is a cross-national representative panel database of individuals in Europe aged 50 and above, along with their spouses or partners (if any). SHARE aims at understanding the process of individual ageing in Europe and includes detailed cross-national information on, among other things, the health and socioeconomic circumstances of the older non-institutionalised population (for a detailed description, including imputation for missing data see Börsch-Supan et al. 2008; Christelis 2011).

Critically, the availability of information on the respondent's own socio-economic status and the characteristics of their children, including educational attainment, makes SHARE a valuable dataset for examining the relationship between adult children's education and parents' longevity. We use data for Austria, Belgium, Denmark, France, Germany, Greece, Italy, Spain, Sweden, Switzerland and The Netherlands from the baseline study in 2004[2], with the initial population consisting of 28,488 individuals who were born between 1900 and 1954 and were alive and residing in one of the countries at the baseline in 2004. Parents whose children were aged under 25 years (N = 1,334; 4.9%) were then excluded from the study on the grounds that their

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[2] Although Israel is also in the SHARE baseline study (2004), it is not included in the current analysis due to later data collection (2005/06) and missing individual weights.

children may not yet have finished their education. While not all adults have completed their education by age 25, stability in educational attainment generally occurs from this age onwards[3]. A relatively small number of other cases were excluded due to inconsistent information for education across waves (N = 652; 2.3%). Since most studies report differential educational inequalities in mortality for older men and older women (Elo and Preston 1996; Huisman et al. 2005), separate analysis are conducted for each gender. The final study sample thus consists of 26,502 individuals (14,459 women and 12,043 men), with a total of 1,955,962 person-years and 1,871 deaths.

In order to examine geographical variations (research question 3), countries are grouped into three regions to maintain sufficiently large numbers of observations for the analysis: the North (Denmark, Sweden and The Netherlands), Central Europe (Austria, Belgium, France, Germany and Switzerland), and the South (Greece, Italy and Spain). These regional groups fit well with the different levels welfare provision and regimes of help and care identified by previous theoretical frameworks (Brandt et al. 2009; Esping-Andersen 1990; Hank and Jürges 2010; Kohli et al. 2009).

3.2. MEASURES

3.2.1. OUTCOME: PARENTAL DEATHS

All deaths in the second and subsequent waves (i.e. over a 9 year period) were registered by interviewers using personal identification numbers. Interviewers conduct an end-of-life interview with a proxy-respondent (e.g. family member, household member, neighbour or any other person in the closer social network), which collects information on the circumstances of death and includes exact age at death and cause of death. Small sample sizes present difficulties for the analysis of cause-specific hazards of mortality and thus all-cause mortality is chosen as the main outcome in this study.

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[3] For instance, data from the EU Labour Force Survey shows that only 3.6% of all adults gained medium-qualifications (up to upper secondary) during adulthood (i.e. aged 25 and above), thus indicating that the contribution of adult education and training to the stock of qualification in Europe is relatively small (European Commission 2015).

3.2.2. SOCIOECONOMIC STATUS OF RESPONDENTS AND SPOUSE

Several measures of socioeconomic status (SES) are used, including the educational attainment of respondents (fixed covariate), total household income and wealth (time-varying covariates) and spouse's educational attainment, which is also allowed to vary over time in cases of remarriage, re-partnering or taking up further education. We select education as our measure of socioeconomic status because, compared with occupation and income, it is a more stable measure and is available for men and women (Huisman et al. 2005; Mackenbach et al. 2008). Educational attainment is identified as the highest level of education reported by respondents, and classified into four categories: levels 0-1 (pre-primary and primary), 2 (lower secondary), 3-4 (upper secondary and post-secondary non-tertiary) and 5-6 (first and second stages of tertiary education) of the ISCED (international standard classification of education). We used a categorical specification of education for predicting mortality following previous research indicating a better model fit compared to a continuous specification (Backlund et al. 1999).

Household income and wealth are used as measures of financial resources. Household income is defined by annual earnings by all household members. Household wealth (total net worth) consists of the sum of all financial (net stock value, mutual funds, bonds and savings) and housing wealth (value of primary residence net of mortgage, other real estate value, own business share and owned cars) minus liabilities. Income and wealth data include corrections for differences in purchasing power parity (PPP) and conversions into Euros across countries, as well as imputation if respondents declined to answer or were unable to provide exact answers (Christelis 2011). To account for household size, we divide income and wealth by the square root of the number of household members.

3.2.3. ADULT CHILDREN'S EDUCATION

Information on adult children's educational attainment, as well as their age and sex, is also reported by SHARE respondents. For comparability, the measure of adult children's education, which is also allowed to vary over time, follows the same coding as for parents' education, with the highest level of educational attainment classified into four categories (primary, lower secondary, upper secondary and tertiary). As most

families have more than one child, preliminary analyses considered and compared several constructions of adult children's education, including (1) whether any child has tertiary education, (2) the average years of educational attainment of all children, and (3) the most educated of the children, aged at least 25. The initial model comparisons with all adult children suggest that the three constructions of education fit the data equally well. However, the last one facilitates the comparison of daughters and sons and we therefore use the most educated of the adult children in our analyses. Since some respondents have two or more children with the same level of education, we select the oldest child with the highest level of education[4]. Therefore, we assume that the health of an older adult is most strongly influenced by the oldest child with the highest educational attainment as she or he is likely to have the greatest availability of resources (Torssander 2013; Zimmer et al. 2007). This approach is also consistent with the notion that there is a larger benefit from the first daughter or son than the later children of the same sex (Christiansen 2014).

To evaluate whether the educational attainment of adult children has a stronger influence on the longevity of older parents with lower education than their children, we devised a measure of educational differences based on model fit tests[5]. For this purpose, two categories were used for mothers and fathers (primary/lower secondary, and upper secondary/tertiary) and three categories for adult children (primary/lower secondary, upper secondary, and tertiary). Separate models were run for daughters and sons as numerous studies have shown that daughters provide more contact and social support to parents than sons (Grundy and Shelton 2001; Suitor and Pillemer 2006).

3.2.4.   OTHER POTENTIAL CONFOUNDERS

All models also include time-varying control variables for marital status (with or without spouse) and economic status (working[6] or retired) of respondents, as well as co-residence between parents and their adult children. The latter information is of particular importance as the prevalence of intergenerational co-residence varies

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[4] A control variable was also included in the analyses to account for the number of children, including respondents with no children.

[5] We compared model fits using the Akaike and the Bayesian Information Criterion (AIC and BIC respectively) as well as the Log-Likelihood Value (LLV).

[6] The category 'working' also includes those actively seeking work.

markedly across countries in Europe - it is lowest in the Scandinavian countries and the Netherlands, and highest in the Mediterranean and South-East European countries, while intermediate levels are reported for Central Europe (Jappens and van Bavel 2012).

3.3. METHODS

We use Cox proportional hazard models to estimate the hazard ratios of mortality, with age in months as the time variable, death as the event and censoring resulting from nonresponse or the end of the study period (using information on dates of birth, death and interviews). Since respondents belong to several birth cohorts, countries of residence and countries of birth (i.e. some are natives and others foreign-born), different strata are allowed to have different baseline hazard functions, although they all have the same coefficient estimates for covariates. The stratified analysis prevents bias arising from non-proportionality of the survival curves. Birth cohorts are classified using a five-year grouping (due to small numbers, the oldest respondents are grouped into the pre-1915 cohort).

Cox proportional hazard models estimate the risks of death during the follow up period for mothers and fathers separately. Analyses are carried out sequentially. First, survival rates are modelled as a function of a respondent's education (Model 1) and their adult child's education (Model 2). Thereafter, model specifications include educational attainment for both respondents and their children (Model 3), and other potential confounders – household income and wealth, economic status, marital status, partner's education and co-residence between parents and their children (Model 4). Hazard ratios (HR) from Cox models predicting risk of death are reported in all tables. Since spouses of respondents were also interviewed, robust standard errors are estimated to adjust for clustering of respondents within households. In the final part of the analysis, we also estimate Cox proportional hazard models to test the relationship between adult children's education and parental health separately for three regions (Northern, Central and Southern Europe) in order to account for contextual heterogeneity in terms of socio-economic conditions, culture and welfare systems.

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4. RESULTS

4.1. DESCRIPTIVE STATISTICS

Table 1 provides the descriptive statistics for the analytical sample. It reports the characteristics of female and male respondents in the year of entry into the study, divided into those who remained alive or were censored between 2004 and 2013 and those who died during the study period. The distribution of individuals shows that there are more female than male respondents, reflecting the size of populations by gender born in 1954 or earlier in the 11 European countries that contributed to the 2004 SHARE baseline study. In addition, the sample shows that more male than female respondents died during the study period, which is consistent with gender differences in mortality typically found in all sample countries.

Respondent's characteristics		Female respondents			Male respondents		
		All (baseline) 2004 (n = 14,459)	Survived to 2013 (n =13,573)	Died by 2013 (n = 886)	All (baseline) 2004 (n = 12,043)	Survived to 2013 (n = 11,058)	Died by 2013 (n = 985)
Cohort	Born <1915	1.99	1.34	11.23	0.99	0.68	4.62
	Born 1915-1919	3.25	2.5	13.89	1.6	1.12	7.22
	Born 1920-1924	9.02	7.8	26.37	5.4	4.59	14.9
	Born 1925-1929	10.62	10.22	16.32	9.18	8.1	21.67
	Born 1930-1934	13.1	13.08	13.29	12.1	11.95	13.92
	Born 1935-1939	14.26	14.72	7.61	15.77	16.02	12.77
	Born 1940-1944	14.98	15.7	4.74	16.17	16.62	10.87
	Born 1945-1949	16.36	17.18	4.72	19.44	20.49	7.21
	Born 1950-1954	16.43	17.45	1.82	19.35	20.43	6.83
Foreign-born	No	89.92	89.62	94.14	90.19	89.89	93.69
	Yes	10.08	10.38	5.86	9.81	10.11	6.31
Education	Primary	39.28	37.39	66.3	30.76	28.77	53.99
	Lower secondary	19.56	19.93	14.23	14.13	14.39	11.05
	Higher secondary	28.31	29.32	13.86	34.57	35.47	24.08
	Tertiary	12.85	13.35	5.61	20.54	21.37	10.88
Economic status	Working	23.15	24.54	3.31	37.98	40.35	10.62
	Retired	76.85	75.46	96.69	62.02	59.65	89.38
Partner's characteristics	With spouse	56.54	58.38	30.56	77.79	78.46	69.93
	No spouse	43.46	41.62	69.44	22.21	21.54	30.07
Partner's education	Primary	35.14	33.65	56.43	30.51	29.08	47.16
	Lower secondary	14.12	14.32	11.22	13.38	13.31	14.22
	Higher secondary	36.55	37.4	24.37	39.9	40.86	28.84
	Tertiary	14.19	14.63	7.98	16.2	16.75	9.78
Income (median)	Household income - Euros	37,661 (40,210)	38,248 (40,286)	29,248 (38,146)	43,648 (43,720)	44,692 (44,593)	32,578 (31,003)
Wealth (median)	Household wealth - Euros	97,336 (530,000)	100,000 (550,000)	57,261 (210,000)	120,000 (680,000)	120,000 (680,000)	73,102 (630,000)
Child's characteristics	Any children aged 25+	94.9	94.57	99.24	86.09	85.41	93.8
	No. of children aged 25+	2.07 (1.08)	2.05 (1.08)	2.32 (1.04)	1.89 (1.13)	1.86 (1.12)	2.28 (1.12)
Child's education	Primary	9.9	9.04	22.25	7.05	6.57	12.67
	Lower secondary	11.79	11.5	15.97	10.46	9.85	17.62
	Higher secondary	56.63	57.47	44.67	59.55	60.24	51.49
	Tertiary	21.67	21.99	17.11	22.94	23.34	18.22
Parent-child co-residence	Yes	12.44	12.81	7.27	15.59	16.03	10.58
	No	87.56	87.19	92.73	84.41	83.97	89.42

Table 1: Analytical sample. Characteristics of female and male respondents in year of entry (2004). Percentages.

Notes: Weighted using SHARE sampling weight. Standard deviations are shown in parentheses.

In the selected sample, almost 40% of female respondents only have primary education, just under 50% have secondary education and 13% have tertiary education. For male respondents, around 30% have primary education, nearly 50% have secondary education, and just over 20% have tertiary education. On average, among female and male respondents who survived the study period, over a fifth of their children have tertiary education, in contrast to 17% and 18% respectively for the children of female and male respondents who died during the study period. This preliminary evidence

suggests that children's education may indeed be associated with parents' survival. However, other factors also appear to play a crucial role. For instance, female and male respondents who survived have higher median incomes than those who died during the study period. On average, female respondents - both those who survived and those who died - have fewer economic resources (household wealth and income) than comparable men.

Table 2 shows the cross-tabulation of adult children's educational attainment by parents' own educational attainment. While many children attain the same educational qualifications as their parents, the results indicate that there is a widespread distribution of respondents (mothers and fathers) with children who have different levels of education to their parents. For example, for mothers with lower secondary education, an average of 18.9% of their children have tertiary education, 65.9% have upper secondary, 11% lower secondary and 4.2% have primary education; and for fathers with upper secondary education, an average of 23.3% of their children have tertiary education, 66.7% have upper secondary, 57% have lower secondary and 4.3% have primary education. The results also indicate that the availability of daughters and sons with higher and lower levels of educational attainment clearly varies for mothers and fathers. For instance, mothers with upper secondary education have a larger proportion of daughters with tertiary education (28.8%) than do similarly educated fathers (22.9%), whereas fathers with lower secondary have a larger proportion of sons with the same level of education (19%) than do mothers (10.8%).

		Proportion of children with:				Proportion of daughters with:				Proportion of sons with:			
		Primary	Lower secondary	Upper secondary	Tertiary	Primary	Lower secondary	Upper secondary	Tertiary	Primary	Lower secondary	Upper secondary	Tertiary
Mother's Education	Primary	19.7	18.5	46.7	15.1	21.5	20.9	45.2	12.4	25.0	22.0	41.0	12.0
		(0.008)	(0.007)	(0.010)	(0.007)	(0.013)	(0.013)	(0.015)	(0.010)	(0.015)	(0.016)	(0.018)	(0.012)
	Lower secondary	4.2	11.0	65.9	18.9	2.3	9.6	71.4	16.7	2.3	10.8	66.3	20.6
		(0.006)	(0.010)	(0.016)	(0.012)	(0.005)	(0.015)	(0.022)	(0.017)	(0.009)	(0.021)	(0.032)	(0.025)
	Upper secondary	3.4	5.6	65.6	25.5	1.5	3.4	66.3	28.8	3.1	4.1	69.3	23.5
		(0.004)	(0.006)	(0.014)	(0.012)	(0.004)	(0.007)	(0.021)	(0.021)	(0.009)	(0.008)	(0.025)	(0.023)
	Tertiary	3.1	6.1	53.1	37.7	1.2	1.4	44.6	52.7	2.3	4.0	52.9	40.9
		(0.006)	(0.008)	(0.017)	(0.017)	(0.005)	(0.004)	(0.034)	(0.034)	(0.010)	(0.013)	(0.039)	(0.036)
Father's Education	Primary	13.6	17.2	53.0	16.3	17.2	19.6	51.9	11.4	17.6	23.7	47.6	11.2
		(0.008)	(0.010)	(0.011)	(0.009)	(0.015)	(0.017)	(0.020)	(0.012)	(0.019)	(0.021)	(0.024)	(0.013)
	Lower secondary	5.2	14.7	62.3	17.8	3.4	15.4	61.9	19.4	5.3	19.0	61.4	14.3
		(0.008)	(0.014)	(0.019)	(0.015)	(0.011)	(0.024)	(0.030)	(0.023)	(0.019)	(0.030)	(0.037)	(0.025)
	Upper secondary	4.3	5.7	66.7	23.3	2.0	4.6	70.5	22.9	3.4	4.6	70.8	21.1
		(0.005)	(0.005)	(0.014)	(0.013)	(0.005)	(0.008)	(0.021)	(0.020)	(0.011)	(0.009)	(0.025)	(0.021)
	Tertiary	3.2	5.4	55.5	35.9	2.0	3.1	54.9	40.0	0.7	6.0	50.3	43.0
		(0.005)	(0.007)	(0.017)	(0.016)	(0.007)	(0.008)	(0.029)	(0.027)	(0.004)	(0.018)	(0.034)	(0.033)

Table 2: Children's educational attainment (daughters and sons) by parent's own attainment. Percentages.

Notes: Weighted using SHARE sampling weight. Standard errors are shown in parentheses.

4.2. ADULT CHILDREN'S EDUCATIONAL ATTAINMENT AND PARENTS' MORTALITY

Our first research question asks whether the association between adult children's education and parents' longevity has differential effects on the survival of mothers and fathers. Tables 3 and 4 show the results from Cox models predicting the hazard of mortality for mothers and fathers separately. The first two models display the association between parental mortality and own and children's education before controls are added. Model 3 includes parents' and children's education together, while Model 4 adds controls for the economic status of the respondent, partners' educational attainment, household income and wealth, and co-residence between parents and adult children. Models 1 to 4 indicate a strong relationship between parents' own educational attainment and the mortality risk of mothers and fathers, thus supporting previous extensive evidence of an education-mortality gradient (Elo 2009; Huisman et al. 2005). For instance, a value of 0.505 for mothers with tertiary education in Model 4 means that the risk of death for mothers with the highest level of educational attainment is 100 (0.505-1) = 49.5% lower than the risk for mothers with primary education, the reference group. Similarly, a value of 0.754 for men with tertiary education indicates that the risk of death among highly educated fathers is 24.6% lower than the risk for fathers with primary education. Consistent with previous reports (Mackenbach et al. 1999; Montez et al. 2009), the education-mortality gradient suggests that the risk of death is greater

among men with higher levels of education (i.e. upper secondary or tertiary) than among women with the same educational attainment. While a large body of literature has established an evidence base on the inverse association between educational attainment and adult mortality, as well as on the differential educational gradients in mortality for men and women (Hummer and Lariscy 2011), the health-enhancing potential of the presence of highly educated adult children remains largely unknown.

		M1: Respondent Only	M2: Children Only	M3: Respondent + Children	M4: Final model
Respondent's Education[a]	Lower secondary	0.820		0.846	0.872
		(0.108)		(0.114)	(0.135)
	Upper secondary	0.766 *		0.814 *	0.762 *
		(0.101)		(0.110)	(0.120)
	Tertiary	0.582 **		0.615 **	0.505 **
		(0.108)		(0.119)	(0.115)
Children's Education[a]	Lower secondary		0.998	1.002	1.022
			(0.033)	(0.033)	(0.037)
	Upper secondary		0.951 *	0.960 *	0.958 *
			(0.028)	(0.028)	(0.033)
	Tertiary		0.918 **	0.941 *	0.929 *
			(0.031)	(0.032)	(0.037)
AIC		4,202	4,160	4,146	3,416
BIC		4,231	4,188	4,195	3,519
LLV		-2,097	-2,076	-2,066	-1,693

Table 3: Mothers. Hazard ratios from Cox survival model predicting risk of death.

Notes: [a]Reference group is primary education. Standard errors are shown in parentheses.
Final model includes controls for household income and wealth of respondents, their economic and marital status, partner's education and co-residence with adult children.
All models stratified by cohort, country of birth and country of residence.
*p<.05; **p<.01; ***p<.001

Model 2 in Tables 3 and 4 suggests that the educational attainment of adult children is associated with the mortality risk of both mothers and fathers. However, because children's educational attainment largely reflects parental resources, a model without controlling for possible confounders tells us little about the possible significance of children's education for parents' survival. After controlling for several plausible confounders (Model 4 in Tables 3 and 4), the relationship between children's education and mothers' and fathers' longevity persists, thus suggesting an independent association between adult children's educational attainment and parental risk of death.

Our analyses therefore indicate that parental mortality risks may be shaped by the combined educational attainment of parents' and their children. The final model (Model 4) in Table 3 shows that the risk of death among mothers with an adult child who has upper secondary, or tertiary, education decreases by 4.2% and 7.1% respectively compared to the reference group whose adult children only have primary education. A similar relationship is found for fathers, whose risk of death decreases by 3.5% if they have an adult child with upper secondary education, and by 7.7% if the child has tertiary education.

		M1: Respondent Only		M2: Children Only		M3: Respondent + Children		M4: Final model	
Respondent's Education[a]	Lower secondary	0.901	***			0.942	*	0.921	*
		(0.089)				(0.096)		(0.104)	
	Upper secondary	0.787	**			0.870	*	0.869	*
		(0.092)				(0.107)		(0.122)	
	Tertiary	0.644	***			0.736	*	0.754	*
		(0.087)				(0.109)		(0.127)	
Children's Education[a]	Lower secondary			1.026		1.038		1.045	
				(0.037)		(0.038)		(0.042)	
	Upper secondary			0.921	**	0.935	*	0.965	*
				(0.030)		(0.032)		(0.038)	
	Tertiary			0.891	**	0.916	*	0.923	*
				(0.034)		(0.037)		(0.042)	
AIC		4,450		4,304		4,295		3,503	
BIC		4,477		4,332		4,343		3,603	
LLV		-2,221		-2,148		-2,141		-1,737	

Table 4: Fathers. Hazard ratios from Cox survival model predicting risk of death.

Notes: [a]Reference group is primary education. Standard errors are shown in parentheses.
Final model includes controls for household income and wealth of respondents, their economic and marital status, partner's education and co-residence with adult children.
All models stratified by cohort, country of birth and country of residence.
*p<.05; **p<.01; ***p<.001.

These lower risks are sufficiently large enough to suggest that higher levels of education among the younger generation may indeed have an important influence on parents' longevity. Educational attainment may, of course, be acting here as a marker for other resources adult children bring to their family. As Torssander (2014) pointed out, children's multiple socioeconomic resources, such as their occupational class and income, might be associated with parental mortality. Adult children's education may

also affect parental mortality because educational attainment has been found to be closely associated with health behaviours (Cutler and Lleras-Muney 2010).

4.3. EDUCATIONAL DIFFERENCES BETWEEN ADULT CHILDREN AND THEIR PARENTS

If children's education impacts on parental mortality through its influence on the health behaviours of mothers and fathers, then we might expect the strongest influence in circumstances where children have higher educational attainment than their parents. In other words, we might expect the well-established educational gradient in mortality among parents to be modified by the higher educational achievement of their children. Our second research question therefore asks whether the educational attainment of adult children has a stronger influence on the longevity of older parents with lower education than their children, compared to circumstances where both parent and child have similar levels of education.

In order to investigate whether respondents with various levels of educational attainment may benefit differently from their children's education, we estimate the risk of death for mothers and fathers using a measure of educational difference between adult children and their parents. In line with the hypothesis that children influence their parents' health behaviours, we also recognise the possibility that sons and daughters may have different relationships with their parents and thus different levels of influence. We therefore extend the previous models by examining the influence of daughters and sons (as well as mothers and fathers) separately. Table 5 shows the results based on our model fit tests after controlling for possible confounders.

Overall, we find that having adult children with higher educational attainment (i.e. upper secondary or tertiary) is associated with lower mortality risks not only for both mothers and fathers who have lower educational attainment (i.e. primary or lower secondary) but also for parents with higher educational attainment (i.e. upper secondary or tertiary). The largest health gains are for mothers and fathers whose children have the highest level of education, with a 9.8% lower risk of death for mothers who have primary/lower secondary education, and a 14% lower risk for mothers who have upper

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secondary/tertiary education, compared to their counterparts whose adult children only have primary/lower secondary education.

		All	Daughters	Sons
Mother's education	Children's education			
Primary or lower secondary[a]	Primary or lower secondary	1.000	1.000	1.000
Primary or lower secondary	Upper secondary	0.947 *	0.972	0.906 *
		(0.027)	(0.035)	(0.045)
Primary or lower secondary	Tertiary	0.902 **	0.897 *	0.884 *
		(0.036)	(0.045)	(0.062)
Upper secondary or tertiary	Primary or lower secondary	0.990	0.959	1.030
		(0.080)	(0.133)	(0.122)
Upper secondary or tertiary	Upper secondary	0.878 **	0.890 *	0.854 *
		(0.038)	(0.052)	(0.058)
Upper secondary or tertiary	Tertiary	0.860 **	0.854 **	0.873 *
		(0.043)	(0.057)	(0.065)
AIC		3428	1874	941
BIC		3524	1964	1023
LLV		-1700	-923	-456
Father's education	Children's education			
Primary or lower secondary[a]	Primary or lower secondary	1.000	1.000	1.000
Primary or lower secondary	Upper secondary	0.927 *	0.904 *	0.960
		(0.030)	(0.038)	(0.048)
Primary or lower secondary	Tertiary	0.862 **	0.902 *	0.847 **
		(0.044)	(0.054)	(0.080)
Upper secondary or tertiary	Primary or lower secondary	0.944	0.954	0.980
		(0.062)	(0.081)	(0.099)
Upper secondary or tertiary	Upper secondary	0.922 *	0.925	0.941
		(0.035)	(0.044)	(0.062)
Upper secondary or tertiary	Tertiary	0.887 **	0.823 **	0.997
		(0.041)	(0.052)	(0.069)
AIC		3510	1798	1098
BIC		3604	1885	1177
LLV		-1741	-885	-535

Table 5: Mothers and fathers. Hazard ratios from Cox survival final model predicting risk of death by children's educational attainment, gender and parent's own attainment.

Notes: [a]Reference group is primary or lower education for parents and children.
Models include controls for household income and wealth of respondents, their economic and marital status, partner's education and co-residence with adult children.
All models stratified by cohort, country of birth and country of residence.
*p<.05; **p<.01; ***p<.001.

Similarly, fathers with tertiary-educated adult children have a 13.8% lower risk of death if they themselves have primary/lower secondary education and an 11.3% lower risk of death if they have upper secondary/tertiary education. All parents with

highly educated children thus appear to gain a substantial longevity benefit but, contrary to our initial expectations, this advantage is greatest for highly educated parents with highly educated children. In this sense, it may be that highly educated older parents are better equipped to take advantage of the resources offered by highly educated adult children not only because they understand better the possible benefits, but also because they have a greater incentive to protect their health compared to less educated parents (Zimmer et al. 2007).

As can be seen from the results in Table 5, the health benefits derived from the educational attainment of the younger generation are differentiated not only by the gender of the parent but also by the gender of the adult child. More specifically, mothers with primary/lower secondary education have a reduced mortality risk if either their daughter or son has tertiary education. However, only having adult sons – and not daughters – with upper secondary education is associated with a similar maternal benefit. For fathers with primary/lower secondary education, a lower mortality risk is associated with all tertiary-educated children but only with adult daughters – and not sons – with upper secondary education. Although the gender of the adult child appears to be immaterial to the effect of having a tertiary-educated child, it appears that having at least one daughter with tertiary education is particularly beneficial for parents, as the risk of death is significantly lowered for both mothers (by 10.3%) and fathers (by 9.8%) with primary/lower secondary education and, even more, for both mothers (by 14.6%) and fathers (by 17.7%) with tertiary education. These results are intriguing because they suggest that gendered relationships within families are important to the strength of impact of children's education on parental longevity, possibly through their influence on communication between parent and child.

4.4.   REGIONAL VARIATIONS IN EUROPE

The observation that family relationships may be implicated in upward health transfers from children to parents leads us to a further expectation; namely that the influence of adult children's education on parental longevity may vary across Europe as a reflection of differences in family systems. To investigate potential geographical differences, our final research question asks whether the association between children's educational attainment and parents' survival varies regionally across Europe.

To answer this question, we estimate Cox survival models separately for three regional clusters (Northern, Central and Southern Europe)[7] using the same derived measure of educational differentials between adult children and their parents employed in the previous section, but in this case without distinguishing parents or children by gender. Other studies have highlighted important differences in welfare regimes and family norms across Europe (Esping-Andersen 1990; Kohli et al. 2009) and these could play a major role in determining the extent to which family members provide help to parents in later life (Brandt et al. 2009; Hank and Jürges 2010). Although the grouping of study countries into three broad regions is a pragmatic response to sample sizes, it nevertheless captures essential differences in family arrangements and relationships. In particular, it distinguishes the family-based welfare regimes of Southern Europe from the State-based regimes of Northern Europe. Since the frequency of co-residence between parents and adult children is also likely to vary between these country groups, we control for co-residence in the survival models.

Table 6 reports results with and without co-residence as a control variable. Examining the role of co-residence is important as it could be associated with both positive and negative impacts on longevity. For example, co-residence between parents and adult children may enhance communication and strengthen the children's influence on parental health. On the other hand, older parents and their adult children may co-reside because the parents (already) have health problems and are therefore at increased risk of death. The results are indicative of positive impacts of co-residence on parental longevity and thus tend to support the first scenario. Comparing the top (with co-residence) and bottom (without co-residence) panels of Table 6, we see that the addition of co-residence as a control variable reduces the magnitude of the coefficients for each category of educational difference between parents and adult children. Therefore, the effect of accounting for co-residence is to further increase, rather than diminish, the influence of children's education on parental mortality. Moreover, a similar result is apparent in all three regions, although the net effect is smallest in Northern Europe, where changes in the risk of death are minimal, and greatest in Central Europe.

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[7] To avoid non-significant effects due to a lack of statistical power, analyses are presented with mothers and fathers combined.

		All	Northern	Central Europe	Southern
With co-residence as a control variable					
Parents' education	Children's education				
Primary or lower secondary[a]	Primary or lower secondary	1.000	1.000	1.000	1.000
Primary or lower secondary	Upper secondary	0.938 **	0.930 *	0.885 **	0.960
		(0.020)	(0.032)	(0.044)	(0.031)
Primary or lower secondary	Tertiary	0.890 ***	0.901 *	0.828 **	0.894 *
		(0.028)	(0.043)	(0.055)	(0.051)
Upper secondary or tertiary	Primary or lower secondary	0.924	0.973	0.927	0.977
		(0.048)	(0.063)	(0.100)	(0.136)
Upper secondary or tertiary	Upper secondary	0.903 ***	0.916 *	0.847 **	0.872
		(0.025)	(0.038)	(0.047)	(0.068)
Upper secondary or tertiary	Tertiary	0.874 ***	0.901 *	0.772 ***	0.936
		(0.029)	(0.043)	(0.051)	(0.065)
AIC		6932	3067	1563	2331
BIC		7036	3157	1651	2419
LLV		-3452	-1520	-767	-1151
Without co-residence as a control variable					
Parents' education	Children's education				
Primary or lower secondary[a]	Primary or lower secondary	1.000	1.000	1.000	1.000
Primary or lower secondary	Upper secondary	0.943 **	0.932 *	0.901 *	0.966
		(0.020)	(0.032)	(0.043)	(0.031)
Primary or lower secondary	Tertiary	0.897 ***	0.902 *	0.871 *	0.991 *
		(0.028)	(0.043)	(0.056)	(0.051)
Upper secondary or tertiary	Primary or lower secondary	0.933	0.967	0.950	1.010
		(0.048)	(0.062)	(0.107)	(0.130)
Upper secondary or tertiary	Upper secondary	0.921 **	0.919 *	0.895 *	0.881
		(0.026)	(0.038)	(0.049)	(0.070)
Upper secondary or tertiary	Tertiary	0.888 ***	0.901 *	0.816 **	0.957
		(0.029)	(0.042)	(0.052)	(0.067)
AIC		8231	3626	1879	2752
BIC		8328	3709	1962	2834
LLV		-4102	-1800	-927	-1363

Table 6: Hazard ratios from Cox survival final model predicting risk of death by children's educational attainment and parent's own attainment. Regional variations.

Notes: [a]Reference group is primary or lower secondary education for parents and children.
Models include controls for household income and wealth of respondents, their economic and marital status, partner's education and co-residence with adult children, unless specified.
All models stratified by cohort, country of birth and country of residence.
*p<.05; **p<.01; ***p<.001.

Table 6 also indicates that having adult children with tertiary education is significantly associated with a greater chance of survival for parents with primary or lower secondary education in all regional contexts, although there are also some notable differences

between the three regions. For instance, having adult children with upper secondary education is associated with a reduced mortality risk for parents with primary/lower secondary education in Northern and Central Europe of 7% and 11.5% respectively, whereas there is no significant relationship in Southern Europe. Moreover, having adult children with upper secondary education is also associated with a lower risk of mortality for parents with upper secondary/tertiary education in Northern and Central Europe of 8.4% and 15.3% respectively, whereas this is not the case for Southern Europe. Therefore, contrary to the common assumption that transfers between the generations are more intense in the 'strong family' countries of the European South than they are in the rest of Europe (for a review and challenge, see Albertini and Kohli 2012), the results reveal that the benefits of having highly educated children are more likely in Central and Northern Europe.

5. DISCUSSION

The results from this study provide new insights into the association between children's education and parental health in the pan-European context. Intergenerational health transfers from children to parents in Western societies is an under-researched topic, with only a few studies to date having investigated the significance of children's education for parental survival (Friedman and Mare 2014; Torssander 2013, 2014; Zimmer et al. 2002; Zimmer et al. 2007). This is the first study to examine evidence from a range of European countries. Its findings are both consistent with previous research and support the hypothesis that highly-educated children have a positive impact on their parent's health. More specifically, the results suggest that both mothers and, especially, fathers in the 11 European study countries derive a longevity benefit from having highly-educated adult children (i.e. with tertiary education) that is additional to any health benefit or disadvantage associated with their own educational attainment. This leads us to conclude that the phenomenon of upward health transfers is likely to be common, not only in the USA and Sweden, but in many Western countries. Further, the findings extend previous understandings of this association by examining parent-child gender differences, the relative educational attainment of parent and adult child, and difference between European regions.

In relation to parent-child gender differences, the results highlight that the health benefits derived from the educational attainment of the younger generation appear to be differentiated not only by the gender of the parent but also by the gender of the adult child. In line with previous studies on intergenerational solidarity (Grundy and Shelton 2001; Suitor and Pillemer 2006), our results suggest that having daughters with tertiary education is particularly beneficial for both mothers and fathers, whereas well-educated fathers appear to derive no health benefit from having tertiary educated sons. These gender differences are likely to reflect complex family relationships and deserve greater attention in future research to establish in more detail whose education matters for families (Kravdal 2008), and for society more generally (Esping-Andersen 2002). To advance this agenda, we devised a test to determine which combination of parental and child education is associated with lower mortality risks for older mothers and fathers.

The results from these analyses show that the education of the younger generation has a differential influence on the longevity of older parents depending on the relative educational attainment of parent and adult child. We found that having adult children with either tertiary, or upper secondary, education significantly reduces the risk of mortality for both mothers and fathers with primary or lower secondary education. This accords with our initial expectations and is consistent with a causal pathway that links the (greater) health knowledge of adult children with the provision of health advice to their parents. However, the same advantage is evident for parents who themselves have upper secondary or tertiary education, thus signalling that, even in the absence of significant educational differences between adult children and parents, upward health transfers may also occur. Moreover, the parental group with the lowest risk of death consists of well-educated parents – either mothers or fathers - with tertiary educated children. Arguably, this could be because well-educated parents have a lower perceived extrinsic mortality risk and thus a greater incentive to take steps to protect their own health compared to less educated parents (Pepper and Nettle 2014). This unexpected finding also draws attention to possible generational differences in health understanding and behaviour as younger cohorts may have better access to up-to-date health knowledge via the media and the Internet (Friedman and Mare 2014).

In the final part of the study, we examined whether the association between parental risk of death and adult children's education varies across different European

regions, perhaps in response to different family systems and welfare regimes. We accounted for co-residence with adult children in one model in recognition of known differences in living arrangements between Northern, Central and Southern Europe so that we could compare results with and without this control. The findings demonstrate that the association between children's education and parental mortality is evident in all three European regions, albeit with some interesting differences. In Northern Europe, we see the longevity advantage of having well-educated children for both well-educated and less well-educated parents, which is consistent with Torssander's (2014) findings for Sweden. Unsurprisingly given that the majority of adult children do not live with their parents, results change little whether or not co-residence is taken into account, whereas the results for Southern Europe are more sensitive to the inclusion of co-residence. Yet Southern Europe, despite the traditional emphasis on multi-generational families, is the region where adult children's education is least associated with parental longevity since only parents with primary or lower secondary education and whose children have tertiary education appear to derive a significant benefit. Most importantly, however, our study finds that the strength of the relationship between children's education and parents' mortality is strongest in Central Europe. The explanation of this finding is less clear but one possibility is that generational differences in health knowledge are more pronounced in Central Europe, leading to the younger generation having greater influence on parental health-related behaviours and treatment than in other regions of Europe. Additionally, the presence of larger cohorts of parents with upper secondary/tertiary education in both Central and Northern Europe compared with Southern Europe might exert an effect on the relationship under consideration (Appendix 1). Sample size precluded the analysis of data for individual countries but these regional differences are sufficiently pronounced to warrant further investigation.

It appears from the findings that adult children's education matters, to a greater or lesser degree, with regard to parental mortality across different geographical settings in Europe. This highlights the likely significance of family interactions for the health and longevity of older parents at a time when debates about the erosion of family solidary in Western societies have come to the fore (Antonucci et al. 2011; Dykstra 2010; Hank 2007).

Further work is needed, however, to address some of the limitations of the study. Although the analyses considered many aspects of parent's socioeconomic status as well as factors related to partners and the household, the current study is not able to disentangle the causal relation between adult children's education and parents' longevity. Rather, it documents statistically significant associations between adult children's education and parental survival in Europe. Identifying causal effects is a challenging endeavour for several reasons, including the threat of omitted variable bias and the multiple (often reciprocal) causal effects that may underpin the observed relationships. While the longitudinal perspective of SHARE allowed us to investigate the relationship between parents' longevity and adult children's education dynamically by including a range of controls in our models, it has to be stressed that the causal direction of this relationship cannot be determined using these data; we are only able to identify associations that might indicate potential causalities. Nor can we rule out the possibility that the results are, at least partly, a statistical artefact. Indeed, children's resources are likely to be correlated with family characteristics, and parents and children may also share many environmental and genetic circumstances (Lawlor and Mishra 2009). While family fixed-effects models adjusting for the characteristics that parents share with their children might be one way of overcoming this problem (Torssander 2013), the details of generational differences *per se* cannot be investigated using SHARE data. Therefore, while this study sheds further light on the association between adult children's education and parents' health, more work remains to be done on the causal direction of this critical relationship.

6. CONCLUDING REMARKS

To date, although much research has examined the impact of different sources and types of social support on health, few studies have systematically examined the potential impact of children's education as a family-level resource. While social support from others, including emotional, instrumental, and financial support, may exert a positive influence on older adult's health through increased immune functioning, ability to cope with stress, and healthy behaviours (House et al. 1988), the role of children's education in improving parental health is an overlooked aspect in the informal support system.

The results from this study could have important policy implications, especially if the hypothesised direction of causation –upwards from children to their parents - is confirmed by future research. The potential importance of children's socioeconomic resources for parents broadens current health policy debates, which emphasise individual interventions, by adding a multigenerational family perspective. Individuals themselves rarely make choices in isolation from one and other. Rather, their lives are linked to the lives of others who may influence their health in various ways. There are many aspects of "linked lives" that could be expected to have repercussions. For instance, further investments in education in one generation may contribute to improved health for others in both previous and subsequent generations. Despite the unprecedented low number of children born in most European countries in recent decades, different generations still enjoy longer years of shared lives than ever before (Bengtson and Lowenstein 2003; Hank and Buber 2009), with studies suggesting the increasing relevance of multigenerational bonds even in Western contexts (Bengtson 2001). Maintaining strong intergenerational exchanges, combined with further educational expansion, could offer the opportunity to reduce the public health burden of ageing populations, as well as health inequalities, in Europe. The education of children could thus have significant and far-reaching effects, not only within the broader family unit but also across the societies in which families live.

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