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Life expectancy and parental education

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ABSTRACT

This study analyses the relationship between life expectancy and parental education. Based on data from the German Socio-Economic Panel Study and survival analysis models, we show that maternal education is related to children's life expectancy – even after controlling for children's own level of education. This applies equally to daughters and sons as well as to children's further life expectancies examined at age 35 to age 65. This pattern is more pronounced for younger cohorts. In most cases, the education of the father is not significantly related to children's life expectancy. Neither the vocational training nor the occupational position of the parents in childhood, which both correlate with household income, can explain the connection. The health behaviour of the children and the health accumulated over the life course appear as important channels. This study extends the previous literature that focused mostly on the relationship between individuals' own education and their life expectancy. It implies that the link between education and life expectancy is substantially stronger and that returns to education are higher if the intergenerational component is considered.

1. Introduction

Numerous studies document a strong correlation between individuals' education and their life expectancy (Cutler et al., 2011; Grossman, 2015; Galama et al., 2018). Little research, however, studies the extent to which life expectancy is related to parental education. Studies increasingly point out that parents play a central role in the health, education, and labour market success of their children: Even before children enter school, their language skills, socio-emotional stability, and school readiness show strong correlations with parental education (e.g. Huebener et al., 2018). In the further course of a child's life, significant correlations between parental education and their child's educational and labour market success solidify. Despite this important role of parental background on child outcomes throughout life, little is known about the link between parental education and children's life expectancy. This paper analyses this relationship.

Based on data from the German Socio-Economic Panel Study and Cox survival analysis models, we present evidence for a strong correlation between children's mortality after age 65 and maternal education, which exists for both sons and daughters. This correlation proves to be very robust, taking into account general cohort effects and regional differences. The link with paternal education is smaller and, in most cases, not statistically significant. Children whose mothers have completed middle or upper secondary school live an average of about two years longer after the age of 65 than children whose mothers have no school leaving certificate or only attended the basic school track.

Parental education may influence children's life expectancy through various channels. Better educated parents may influence the health and important health-related behaviours of children early in their lives (e.g. Aizer and Currie, 2014; Carneiro et al., 2013). For example, better educated parents could already behave more health-consciously during pregnancy and, for example, attend pre-natal check-ups more frequently. Studies show that better educated mothers are less likely to experience premature birth or deliver underweight children (e.g. Chou et al., 2010; Currie and Moretti, 2003; McCrary and Royer, 2011). In early childhood, better educated parents may provide healthier diets and encourage healthier lifestyles (e.g. Case et al., 2002; A. Currie, Shields and Price, 2007; J. Currie and Stabile, 2003; Soteriades and DiFranza, 2003) or act as health-oriented role models themselves (e.g. Göhlmann et al., 2010; Powell and Chaloupka, 2005). Better educated parents could send their children to better schools in which their classmates behave healthier – during the phase of life in which health-related behaviours such as smoking, physical activity, and diet are influenced (e.g. Richter, 2010). A higher school degree can, in turn, improve children's labour market success, leading to less physically demanding jobs. Moreover, parents with more education usually have a higher income with which they can afford better medical care. A further channel could be that better educated parents attain professions that are less demanding for their health and that parents' professions affect the children's professional choices (e.g. Constant and Zimmermann, 2003; Minello and Blossfeld, 2014).

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This study also explores the relevance of possible channels of the relationship. These analyses indicate that family income and the professional position of parents during childhood cannot explain the connection, as maternal education is still highly correlated with children's life expectancy after controlling for these characteristics in the regressions. Instead, children's health behaviours and the resulting actual health at the age of 65 prove to be important channels through which maternal education is related to life expectancy: Controlling for health and health-related behaviours significantly reduces the overall relationship. One explanation may be that higher parental education is related to better development and health in early childhood, which further accumulates over the life course. Better health of children can also lead to higher educational attainment. These factors can promote children's labour market success and health-related lifestyles, which ultimately translate into higher life expectancy. An important explanation for the fact that in particular the education of the mother and not so much that of the father is related to the life expectancy of the child could be that in the cohorts considered in the analysis the mother was usually the primary caregiver in early childhood and throughout schooling (Gauthier and DeGusti, 2012; Sayer et al., 2004).

The study shows that the overall relationship between education and life expectancy is much stronger than previously assumed due to the intergenerational component. The study documents important socio-economic differences in life expectancy and mortality. It shows a strong inequality in life expectancy, already due to differences in early childhood, namely the education of parents. While the literature usually documents a strong correlation between life expectancy and one's own socio-economic characteristics,[1] other studies have often shown that one's own income position or educational level is essentially related to one's parents' socio-economic background (e.g. Björklund and Jäntti, 2009; Black et al., 2005; Oreopoulos et al., 2006).

Only few studies combine these two strands of the literature. Based on administrative data, either the highest educational level of parents is considered (Elo et al., 2014; Kröger et al., 2018), or only the education of the father (Tarkiainen et al., 2015). Some studies include parental education in mortality analyses, but do not report their coefficients (Bijwaard et al., 2017; Bijwaard et al., 2018). If parents' education is not considered separately, the relationship between parental education and life expectancy may be described insufficiently. Some studies suggest that the effect of mothers' and fathers' education on children varies (e.g. Holmlund et al., 2011; Huebener, 2018). Especially in older cohorts, men often earned higher educational degrees than women. Information on parents' highest educational attainment is therefore often based on fathers' educational attainment. Only two studies from Norway (Kravdal, 2008; Strand and Kunst, 2006) and one from the USA (Lawrence et al., 2016) consider the education of mother and father separately. While both mothers' and fathers' education correlate significantly with the life expectancy of the children in Norway, only mothers' education correlates with children's life expectancy in the US.[2]

The present study expands the existing literature in different dimensions: (a) it examines the relationship separately for the education of mothers and fathers; (b) it examines the relationship of further life expectancy after age 65, i.e. at a comparatively high age; (c) in the consideration of control variables, we distinguish between variables that were determined before parents completed their education and variables that could be impacted by parental education (possible channels). It is also the first study to examine the relationship for Germany.

2. Data and methodology

2.1. The German Socio-Economic Panel Study

The analysis is based on data from the German Socio-Economic Panel Study (SOEP, see Goebel et al., 2018). This household-based panel survey started in 1984 and is conducted annually. The SOEP contains rich information on living conditions, socio-economic and socio-demographic characteristics of households, as well as the biographical background of individuals, including parents' year of birth and their school-leaving qualifications. In addition, the questionnaire collects information on parents' vocational training and occupational status when the child was 15 years old.

A concern in the analysis of mortality differences with survey data is the dropout of study participants, since it is unclear whether individuals left the survey due to their (impending) death or for other reasons. The SOEP has collected the vital status of dropped out participants through repeated, time-consuming follow-up surveys (see e.g. Rosenbladt et al., 2002). It is thus better able to determine deaths than many other surveys.[3] The SOEP is therefore regularly used to carry out analyses of social differences in life expectancy that are as representative as possible for Germany.[4]

The main analysis studies the link between parental education and further life expectancy after age 65.[5] This age limit marks the typical statutory retirement age and is also used in other life expectancy studies (Haan et al., 2017; Kröger et al., 2017). It requires individuals to have participated in the survey at age 65. This excludes individuals who die before the age of 65 or who only enter the survey after the age of 65. The exclusion of individuals who only enter the survey at an older age avoids a positive selection bias that would occur if only those individuals who survived to an older age were included in the sample.[6] In order to also investigate the relationship between parental education and children's life expectancy[7] in earlier life phases, further analyses also draw samples from individuals who participated in the SOEP survey at ages 35, 45 and 55.

This study is based on all available SOEP information on life expectancy of individuals in West Germany. It includes the survey waves 1984–2016 (SOEP v33). To the best of our knowledge, this is the longest period of time over which mortality differences according to socio-economic characteristics are studied in panel data. The sample in the main analysis includes children with parents born after 1880.[8] It includes 6003 observed individuals, of whom 1086 are identified as deceased.

[1] For Germany, for example, Haan et al. (2017), Kröger et al. (2017) and Breyer and Marcus (2011) investigate the relationship between income and life expectancy. Günther and Huebener (2018) provide an overview of the literature on the relationship between education and life expectancy.

[2] A related literature examines how parental education is related to infant mortality (e.g. Currie and Moretti, 2003; Chou et al., 2010; McCrary and Royer, 2011). These studies cannot, however, make a statement about the long-term influence of parents on the entire life course and life expectancy. Other studies consider the relationship between parental socio-economic characteristics and life expectancy, but do not include parental education in the analysis (e.g. Kuh, 2002; Naess et al., 2007; Juárez et al., 2016).

[3] Nevertheless, the average mortality rate is still somewhat underestimated using SOEP data (see e.g. Schnell & Trappmann 2006; Kroll & Lampert 2009). There is no information on the effects of this general underestimation on differential mortality (e.g. by educational background).

[4] For example, Kröger et al. (2017) analyse mortality differences by income. This processed information on sample failures and the results of follow-up surveys are summarised in the SOEP data set LIFESPELL, on which the analysis is based (for details, see Kroh and Kröger, 2017).

[5] In Germany, more than 80% of men and more than 90% of women reach the age of 65 (Kröger et al., 2017).

[6] To increase the sample size and the precision of the estimates, individuals who participated in the household survey at the age of 64 or 66, respectively, are also included in the analysis if no survey participation took place at the age of 65. We draw the sample for the ages 35, 45 and 55 analogously.

[7] The term "children" clarifies the difference between children's and parents' generation. In the main analysis, the "children" are at least 65 years old.

[8] Individuals for whom the year of birth of the parents is unknown are excluded from the analysis.

Parental education is defined as the highest school leaving certificate. Due to the small number of cases in certain values of the variable, parental education is classified in two categories: We distinguish between parents who have a basic school degree (*Volksschulabschluss*) or no school degree, and parents with a middle or upper secondary school degree (i.e. *Realschulabschluss/Abitur*).[9]

Table B.1 shows descriptive statistics for the main sample. Accordingly, 81% of mothers (75% of fathers) have a basic school leaving certificate or no school leaving certificate, 13% (19% of fathers) have a middle or upper secondary school leaving certificate. For 6% of mothers (7% of fathers), education information is missing. For the oldest parental cohorts, there is hardly any variation in the educational attainment, as most parents have only completed basic schooling. The proportion of middle and upper secondary school leavers was very low (Figure A.1) and was then gradually increased across federal states (Figure A.2).

2.2. Survival analysis with cox regression models

For descriptive purposes, we present non-parametric Kaplan-Meier survival graphs first. The regression models are based on the flexible Cox proportional hazard model (Cox, 1972), a standard model in the analysis of factors determining the mortality of individuals (see e.g. Strand and Kunst, 2006).

In the following we estimate variants of the Cox model of the form

$$h(t|x) = h_0(\mathrm{t})\exp(E^{p\prime}\beta_1 + X'\beta_2 + M'\beta_3) \tag{1}$$

Here $h(t|x)$ represents the hazard function as a function of time t (measured in years), which depends on various factors $x = \{E^p, X, M\}$. The hazard function represents the probability to die in a certain time period, if one has survived up to the beginning of this time period. As the baseline hazard function $h_0(\mathrm{t})$ is not estimated in Cox models, we do not need to impose assumptions about its distribution. The only weak assumption is that the baseline hazard has the same shape for all individuals.

We include a vector of parental education E^p consisting of either the mother's education, the father's education or both parents' education simultaneously. Typically, in previous analyses (see e.g. Kroh and Kröger, 2017) the highest parental education is included in mortality analyses. In the cohorts considered, this results in the educational information of the mother being often overwritten by that of the father.[10] Now, if the relationship between paternal or maternal education and the life expectancy of the child varies, differentiated relationships with parental education cannot be discovered and the resulting estimates are biased.

The vector $X = \{C, P, F\}$ comprises predetermined control variables that can control for possible confounding factors. These include a set of indicator variables C for the child's birth cohort, a set of indicators P for parents' birth cohort (depending on the subject of analysis, we control for mother's or father's cohort; if both parents are included, we control for both their birth cohorts). The birth cohorts are included with 5-year-bin indicators. Further control variables (F) are dummy variables for the state in which the person was most frequently observed, for the child's gender and the sample membership in the SOEP. If indicators for each federal state and for each cohort are included in the analysis, general time trends and state differences can no longer explain the relationship between parental education and the life expectancy of children. Thus, the model identifies differences in life expectancy between children of higher and lower educated parents who lived in the same state while removing cohort differences in life expectancy that occur across states. Most of the remaining variation in parental education should then be attributable to an expansion of the regional school infrastructure with the expansion of secondary schools.

In a next step, we include variables that may constitute possible mechanisms through which parental education could affect children's further life expectancy. This vector M refers first to other characteristics of the parental background, namely parents' vocational training and occupational status when the child was 15 years old. The vector M then accommodates child characteristics, namely children's school degree, their career entry position, income at age 65, health behaviours and health at age 65 as well as proxies for their social inclusion and social activities.

The distinction between predetermined control variables (X) and possible mechanisms (M) is necessary to describe the overall relationship between parental education and children's life expectancy. While predetermined control variables control the influence of external, independent factors, such as time trends, including variables that are themselves determined by parental education could absorb parts of the overall relationship that we are interested in ("bad control variables" according to Angrist and Pischke, 2009). However, it can still be useful to include them in the model if one wants to learn about possible underlying channels.

The Cox model assumes that covariates increase or decrease the underlying hazard by the same proportion across time. We discuss the plausibility of this assumption in Section III together with our main result. Inference is based on Huber-White standard errors, which account for possible heteroskedasticity of the error term. The conclusions of this study are also robust to clustering standard errors at the parental birth cohort - federal state level.

3. Results

3.1. Graphical results

Fig. 1 presents Kaplan-Meier survival functions for children according to their parental education background from age 35, 45, 55 and 65 onward. They describe the proportion of survivors compared to the remaining population (net of sample dropouts).

First, the probability of dying in the following twenty years increases expectedly with age. Across all ages, the survival probability of children with mothers who have completed middle and upper secondary schooling is higher than that of children whose mothers have completed basic schooling or who have no degree. The same pattern appears for fathers' education, but it is less pronounced. After age 80, the socio-economic differences converge again, proposing that biological factors may then dominate any social differences. This figure represents only the mean differences and does not account for any cohort or regional differences, or other potentially confounding factors. These are considered in the regression-based Cox models below.

3.2. Regression results

Table 1 presents the main results. The coefficients denote hazard ratios: values greater than one indicate an increase in mortality risk, values below one indicate a reduction. First, without the inclusion of control variables, there is a highly significant correlation between further life expectancy after age 65 and maternal education. Children of mothers with a higher secondary school degree have a hazard ratio of 0.59 compared to children whose mothers have a basic track or no school degree. This means that children with better educated mothers have a probability of dying in a given year that is about 59% of the baseline mortality risk.

This strong correlation could be partly determined by cohort effects and general time trends. For example, later-born children have access to better health care that can improve life expectancy. We therefore include our set of predetermined control variables (vector X). The

[9] In a robustness check, we consider the different education categories separately, which leads to the same conclusions. In addition, we convert the parental education variable into years of education, with the typical number of years required to obtain the educational degree.

[10] About 12.4% of men achieve a higher educational qualification than their partners, 84.2% the same, 3.5% a lower qualification.

Table 1
Relationship between mortality after age 65 and parental education.

	Maternal education		Paternal education		Both parents
	(1)	(2)	(3)	(4)	(5)
Panel A: All children					
(*Reference: Mother with basic track or no school degree*)					
Mother with middle/upper secondary schooling	0.585***	0.728***			0.704**
	(0.070)	(0.087)			(0.098)
(*Reference: Father from basic track or no school degree*)					
Father with middle/upper secondary schooling			0.774***	0.866	1.016
			(0.071)	(0.081)	(0.111)
Number of observed individuals	6003	6003	6003	6003	6003
Number of deceased individuals	1086	1086	1086	1086	1086
Panel B: Daughters					
Mother with middle/upper secondary schooling	0.621***	0.753			0.676*
	(0.113)	(0.143)			(0.148)
Father with middle/upper secondary schooling			0.773*	0.902	1.108
			(0.117)	(0.143)	(0.204)
Number of observed individuals	3120	3120	3120	3120	3120
Number of deceased individuals	466	466	466	466	466
Panel C: Sons					
Mother with middle/upper secondary schooling	0.560***	0.692**			0.707*
	(0.087)	(0.109)			(0.132)
Father with middle/upper secondary schooling			0.733***	0.850	0.978
			(0.084)	(0.099)	(0.137)
Number of observed individuals	2883	2883	2883	2883	2883
Number of deceased individuals	620	620	620	620	620
Child cohort fixed effects		✓		✓	✓
Parental cohort fixed effects		✓		✓	✓
Control variables		✓		✓	✓

Notes: The table reports hazard ratios from Cox regression models on the conditional mortality of children after age 65. If indicated, models include dummy variables for the birth year of the child (child cohort fixed effects), and the mother or the father (parental cohort fixed effects). Models with control variables include dummy variables for the gender, as well as the federal state and the survey sample in the SOEP data. All models include indicators for variables with missing information on maternal and paternal education. Robust standard errors are reported in parentheses.
* $p < 0.1$, ** $p < 0.05$, *** $p < 0.01$.
Source: Own calculations based on SOEP v33.

relationship remains highly statistically significant and substantial in size (column 2 of Table 1). Children of better educated mothers have a hazard ratio of 0.73 compared to baseline. This means that children of higher educated mothers live almost two years longer after the age of 65 than children of mothers with less schooling.[11] In columns 3 and 4 of Table 1, the relationship with fathers' education is analysed separately. Only the specification without control variables shows a statistically significant correlation.

Paternal education often coincides with maternal education (assortative mating). Parts of the relationship between life expectancy and paternal education may be due to maternal education - or *vice versa*. Therefore, we include both mothers' and fathers' education in the regression (column 5). Maternal education shows an economically and statistically significant correlation with the life expectancy of the child – keeping fathers' education constant. The hazard ratio of 0.7 means that children of higher educated mothers have a 2.2 years longer life expectancy after age 65 than children of less educated mothers. In terms of fathers' education, however, the hazard ratio is close to 1, which means that the mortality rate between children of higher and lower educated fathers is similar if mothers' education is kept constant.[12]

In Panels B and C of Table 1, we study the relationship separately by the sex of the child, as previous studies have documented gender-specific differences in the relationship between parental education and children's health (e.g. Kemptner and Marcus, 2013). For both daughters and sons, there is a statistically significant relationship between maternal education and the life expectancy of the children, although this relationship is somewhat more pronounced for sons in the separate analysis of mothers and fathers. For paternal education, we cannot find a significant relationship for both daughters and sons if control variables are taken into account.

The regression results are based on the assumption that parental education increases or decreases the underlying hazard by the same proportion over time (proportional hazard assumption). Whether the proportional hazard assumption is satisfied depends on the inclusion of other covariates and control variables. We test the proportional hazard assumption for parental education using Schoenfeld residuals (see, e.g., Cleves et al., 2016, for details). The unconditional Kaplan Meier graphs (Fig. 1) suggest that the role of parental education reduces as children reach age 80. Expectedly, we reject the proportional hazard assumption if we only include maternal or paternal education (Appendix Table B.3, columns 1 and 3). When we add cohort effects and further controls to

[11] The calculation of the differences in further life expectancy requires a parametric assumption about the underlying survival hazard function. Following the literature, we assume that the hazard function follows a Gompertz distribution (see Panel A of Appendix Table B.2). With simple OLS regressions, Panel B of Appendix Table B.2 also shows that children of mothers with a secondary school leaving certificate have an 8.3 percentage point lower probability of dying before age 80 (3.6 percentage points with *X*-control variables). This is a substantial difference, especially in view of the fact that the proportion of deaths up to the age of 80 in the sample examined is 15 percent (note that only observed deaths are reported due to sample dropouts).

[12] The role of parental education could vary with the level of education of the partner. When we include interaction terms for higher maternal and paternal education, the interaction term is not significant. The role of maternal education increases, with a coefficient of 0.563 (s.e. 0.159). The coefficient on paternal education does not change much.

Table 2
Relationship between parental education and mortality after different ages.

	Maternal education	Paternal education	Both parents
	(1)	(2)	(3)
Panel A: Mortality after age 35			
(*Reference: Mother with basic track or no school degree*)			
Mother with middle/upper secondary schooling	0.643 (0.183)		0.589* (0.185)
(*Reference: Father with basic track or no school degree*)			
Father with middle/upper secondary schooling		0.907 (0.206)	1.135 (0.282)
Number of observed individuals	9911	9911	9911
Number of deceased individuals	157	157	157
Panel B: Mortality after age 45			
Mother with middle/upper secondary schooling	0.646** (0.120)		0.735 (0.168)
Father with middle/upper secondary schooling		0.707** (0.112)	0.798 (0.156)
Number of observed individuals	10507	10507	10507
Number of deceased individuals	345	345	345
Panel C: Mortality after age 55			
Mother with middle/upper secondary schooling	0.679*** (0.100)		0.746* (0.125)
Father with middle/upper secondary schooling		0.756** (0.089)	0.872 (0.117)
Number of observed individuals	7418	7418	7418
Number of deceased individuals	690	690	690
Panel D: Mortality after age 65 (main results)			
Mother with middle/upper secondary schooling	0.728*** (0.087)		0.704** (0.098)
Father with middle/upper secondary schooling		0.866 (0.081)	1.016 (0.111)
Number of observed individuals	6003	6003	6003
Number of deceased individuals	1086	1086	1086
Child cohort fixed effects	✓	✓	✓
Parental cohort fixed effects	✓	✓	✓
Control variables	✓	✓	✓

Notes: The table reports hazard ratios from Cox regression models on the conditional mortality of children after age 35, 45, 55 and 65. All models include dummy variables for the birth year of the child (child cohort fixed effects), and the mother or the father (parental cohort fixed effects). Control variables are dummy variables for the gender, as well as the federal state and the survey sample in the SOEP data. All models include indicators for variables with missing information on maternal and paternal education. Robust standard errors are reported in parentheses.
* $p < 0.1$, ** $p < 0.05$, *** $p < 0.01$.
Source: Own calculations based on SOEP v33.

the model (columns 2 and 4), we weakly reject the proportional hazard assumption for maternal education (p-value of 0.05), and we fail to reject it for paternal education. When we include maternal and paternal education together (column 5), we also fail to reject it for both maternal and paternal education. We estimate two alternative models that account for time varying relationships (see Appendix Table B.4): First, we allow the relationship to change with every time period. Second, the relationship can change after age 80. We draw the same conclusions.

4. Sensitivity checks

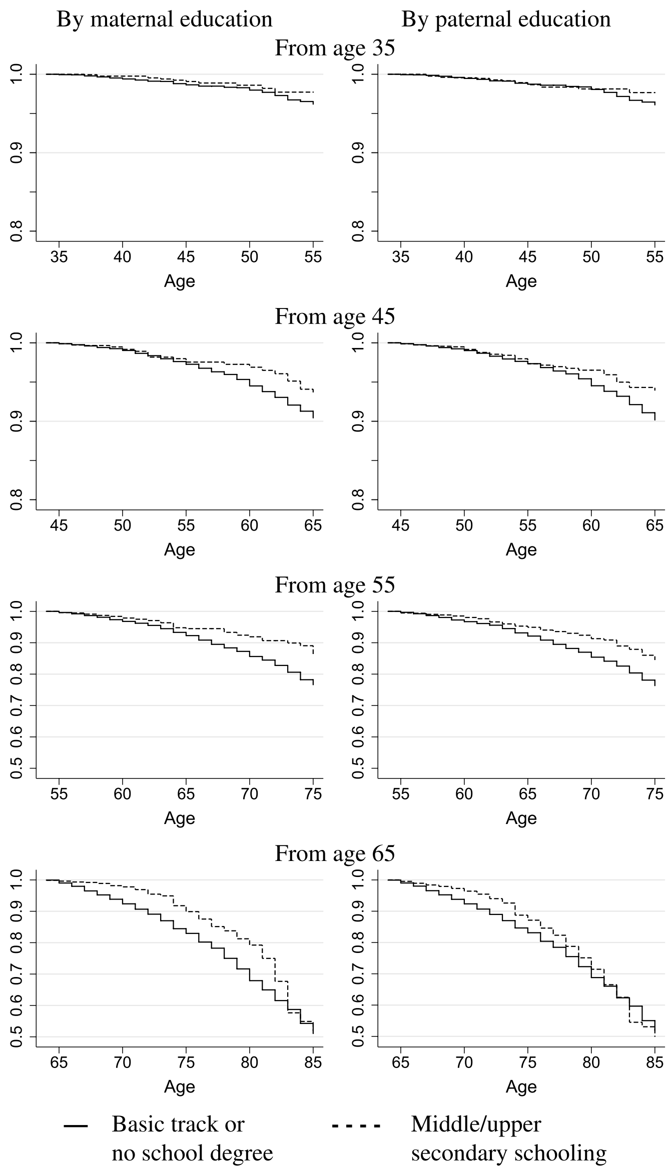
4.1. Considering different age thresholds

In the main analysis, we consider further life expectancy after age 65. A disadvantage of this age limit, however, is that deaths before the age of 65 are not taken into account. Therefore, we analyse other age limits (35, 45 and 55) in the following. The disadvantage of these other age limits, however, is that only a certain number of years after this age can be observed in the SOEP, and that there are naturally much fewer deaths at younger ages. However, studying these earlier age thresholds still allows learning something about the link between parental education and mortality before age 65. Table 2 reports the results of Cox regressions applied to samples in which individuals that were interviewed at age 35 (Panel A), 45 (Panel B), 55 (Panel C) or 65 (Panel D, repeating the main results for comparison). All regressions include control variables.

For further life expectancy after age 35 (Panel A), the picture resembles the main results: There is a stronger correlation with maternal education than with paternal education. As expected, only comparatively few deaths occur in this age group. Therefore, statistical precision is much lower and the educational coefficient is statistically significant only in the model where maternal and paternal education are included at the same time. For further life expectancy from age 45 onwards and from age 55 onwards, the link with maternal education is also stronger than with paternal education. Here, the coefficients for the education of the mother are statistically significant not only when the parents are considered separately, but also mostly when parents' education is considered together. The connection with the education of the father is not statistically significant in any of these joint models. This also suggests that the sample selection resulting from conditioning on age 65 does not explain the smaller role of fathers' education (e.g. it could have been that deaths related to paternal education already occur before age 65).

While children of higher educated mothers live about two years longer after the age of 65, this relationship could be larger when we also consider deaths occurring before age 65. However, as Fig. 1 shows, economically significant differences related to parental education emerge around age 55, and the number of deaths occurring before age 65 is comparably small. Accordingly, we also estimate differences in further life expectancy after age 45 and age 55 of about 2.2 years of children of higher educated mothers compared to children of mothers with less schooling.[13]

[13] Based on the assumption of a Gompertz distribution of the underlying hazard function, we estimate differences in further life expectancy of 2.3 after age 45, of 2.25 after age 55 and 2.22 after age 65 of children with higher educated mothers. For children with higher educated fathers, the estimates are 1.67 at age 45, 0.834 at age 55 and -0.175 at age 65.



Notes: The figure shows Kaplan-Meier survival functions for children from age 35, 45, 55 and 65 years onward by the educational attainment of the parents.
Source: Own illustration based on SOEP v33.

Fig. 1. Kaplan-Meier survival function by parental education.

4.2. Inclusion of alternative measures of parental socio-economic position

In the previous analyses, the school education of parents was considered. However, this may only represent the role of other family factors, such as family income or parents' occupational status. Therefore, Table 3 examines the extent to which parents' vocational education and occupation when the child was 15 years old are related to the life expectancy of the child after age 65, and whether the link with parental education persists after controlling for these additional measures of parental socio-economic status. Columns 1 and 3 of Table 3 repeat the main results for immediate comparability.

If the analysis includes the vocational education of the mother and her occupational status when the child was 15 years old, column 2 shows that children with mothers who have completed a vocational or apprenticeship training have a statistically significantly lower mortality risk than children whose mothers have no professional training. A similar picture emerges for children whose mothers have a master craftsmen degree or a university degree. However, in the cohorts considered, only a very small number of mothers has this level of qualification, which may explain the low statistical power. With regard to the occupational status, children of mothers who worked in positions that require professional training, or positions with higher-qualified tasks have a significantly reduced mortality rate compared to children whose mothers worked in unskilled positions. Children whose mothers were not working do not show a statistically significant difference in mortality risk compared to children with mothers in unskilled positions. The strong correlation between maternal schooling and the life expectancy of the child also persists when the vocational training of the mother and her professional position are included. This means that the labour market success of the mother is not a direct mediator for the relationship between maternal education and the life expectancy of the child.

For the father, similar to school education, there is no evidence of a relationship between vocational training and the further life expectancy of children after age 65 (column 4). There is a connection only for the professional position of the father. Accordingly, children whose fathers

Table 3
Controlling for other parental background characteristics.

	Mothers		Fathers		Both parents
	(1)	(2)	(3)	(4)	(5).
Schooling of the mother, reference: Basic track or no school degree					
Middle/upper secondary schooling	0.728*** (0.087)	0.776** (0.098)			0.742** (0.108)
Vocational training of the mother, reference: no vocational training					
Apprenticeship training		0.872* (0.066)			0.836** (0.067)
Master craftsmen/university		0.933 (0.306)			0.863 (0.283)
Professional position of the mother when child was 15 years old, reference: tasks do not require professional training					
Not employed		0.715 (0.149)			0.696* (0.146)
Professional training tasks		0.607* (0.168)			0.600* (0.166)
Highly qualified tasks		0.443** (0.158)			0.450** (0.161)
Schooling of the father, reference: Basic track or no school degree					
Middle/upper secondary schooling			0.866 (0.081)	0.893 (0.094)	1.044 (0.123)
Vocational training of the father, reference: no vocational training					
Apprenticeship training				1.077 (0.088)	1.130 (0.098)
Master craftsmen/university				1.190 (0.138)	1.305** (0.159)
Professional position of the father when child was 15 years old, reference: tasks do not require professional training					
Not employed				1.062 (0.305)	1.095 (0.311)
Professional training tasks				0.970 (0.117)	0.967 (0.117)
Highly qualified tasks				0.767** (0.097)	0.797* (0.101)
Number of observed individuals	6003	6003	6003	6003	6003
Number of deceased individuals	1086	1086	1086	1086	1086
Child cohort fixed effects	✓	✓	✓	✓	✓
Parental cohort fixed effects	✓	✓	✓	✓	✓
Control variables	✓	✓	✓	✓	✓

Notes: The table reports hazard ratios from Cox regression models on the conditional mortality of children after age 65. All models include dummy variables for the birth year of the child (child cohort fixed effects), and the mother or the father (parental cohort fixed effects). Control variables are dummy variables for the gender, as well as the federal state and the survey sample in the SOEP data. All models also include indicators for variables with missing information on maternal and paternal education. Robust standard errors are reported in parentheses.
* $p < 0.1$, ** $p < 0.05$, *** $p < 0.01$.
Source: Own calculations based on SOEP v33.

have pursued a higher-qualified activity have a lower mortality risk than children with fathers who have pursued an unskilled activity.

In column 5, the characteristics of school education, vocational training, and the professional positions of mothers and fathers are considered jointly. It confirms the overall picture: The education of the mother has an economically and statistically strong correlation with the further life expectancy of the children. It cannot be explained by the family income (approximated by the occupational characteristics in the family).[14]

5. Possible underlying channels

This section examines channels through which maternal education may be related to children's life expectancy. In a first step, we correlate possible channels with parental education. In a second step, we include these potential channels in our survival analysis one after the other (and finally combined). In particular, we consider the following potential channels: children's educational and professional career, their health behaviours and health at the age of 65 as well as their social integration and activities.[15]

Table 4 includes these possible channels in the analysis as control variables. This exercise will first show whether the respective factor can explain the mortality risk of children themselves. Second, changes in the coefficient on parental education show whether the included channel can explain parts of the statistical relationship between mortality and parental education.

First, children's school degree is included in the model. Numerous studies have shown that the life expectancy of individuals correlates strongly with their education. This result can be confirmed. What is more, it shows that the education of the mother can explain differences in mortality between individuals independent of children's own level of education. The inclusion of children's education reduces the coefficient on maternal education by about 16%.[16] It also shows that children's occupational position at the start of a career is related to their life expectancy, although the coefficient on maternal education hardly changes. This suggests that children's career does not primarily mediate the relationship between life expectancy and mothers' education.

Other studies show that individual income is strongly linked to life expectancy (e.g. Haan et al. 2017 for Germany). This relationship can be confirmed. In addition, however, the education of the mother has explanatory power that is independent of income. According to the point estimates, children with better educated mothers have a reduced mortality risk that corresponds to the difference between children with income below 60% of the median income and children with income between 100% and 150% of the median income.

Children's health behaviours can also be an important channel for the link between parental education and children's life expectancy. Important health-related behaviours are shaped early in life. For

[14] See Appendix B for further sensitivity checks.

[15] Appendix Table B.5 shows that parental education is strongly related to these potential channels. Note that children's smoking behaviour is not correlated with parental education in the cohorts we study. This may be related to the fact that smoking habits were developed before the harmful effects of tobacco on health were generally communicated in the Surgeon General's Report of 1964 (see also de Walque, 2010; Jürges and Meyer, 2017). There is also no connection between parental education and cancer, which squares with the conclusion that there is no connection between smoking behaviour and parental education in the cohorts considered.

[16] The percentage change in the relationship is calculated as follows: $1-[(1-0.752)/(1-0.704)] = 0.162$, i.e. the change in the difference to a hazard ratio of 1 (no mortality difference) after inclusion of control variables compared to a model without control variables.

Table 4
Potential mediators of the relationship between parental education and mortality.

	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)
Education of the parents								
Mother with middle/upper secondary schooling	0.704**	0.752**	0.718**	0.748**	0.780*	0.843	0.762*	0.933
	(0.098)	(0.107)	(0.102)	(0.105)	(0.108)	(0.116)	(0.110)	(0.133)
Father with middle/upper secondary schooling	1.016	1.149	1.085	1.072	1.057	0.976	1.090	1.098
	(0.111)	(0.130)	(0.122)	(0.118)	(0.119)	(0.105)	(0.122)	(0.128)
Education of the child								
Middle secondary schooling		0.826**						1.004
Upper secondary schooling		0.684***						0.937
Professional position of the child at labour market entry (ref.: blue collar tasks)								
Self-employed			0.878					1.020
White collar tasks			0.814***					1.063
Working in public sector			0.674**					1.061
Income of the child at age 65 (reference: income below 60% of the median)								
60–80% of the median				0.987				1.145
80–100% of the median				0.819*				0.937
100–150% of the median				0.734***				0.899
≥150% of the median				0.545***				0.762*
Health behaviour around age 65								
Smoking					1.718***			1.611***
BMI > 30					1.159*			1.112
Never sports					1.811***			1.437***
Health status around age 65 (reference: No respective illness)								
Chronical disease						1.310***		1.358***
Depression						0.874		0.823
High blood pressure						0.826		0.807*
Ever cancer						1.636***		1.693***
Ever cardiovascular disease						1.374***		1.312**
Diabetes						1.765***		1.597***
Societal engagement/activities (reference: Never)								
Meeting friends/relatives							0.648***	0.736*
Volunteering							0.778***	0.908
Visiting cinemas, concerts, etc.							0.926	0.999
Visiting operas, theatres, exhibitions, etc.							0.642***	0.792***
Engagement in neighbourhood initiatives, etc.							0.983	1.053
Child cohort fixed effects	✓	✓	✓	✓	✓	✓	✓	✓
Parental cohort fixed effects	✓	✓	✓	✓	✓	✓	✓	✓
Control variables	✓	✓	✓	✓	✓	✓	✓	✓

Notes: The table reports hazard ratios from Cox regression models on the conditional mortality of children after age 65. All models include dummy variables for the birth year of the child (child cohort fixed effects), and the mother or the father (parental cohort fixed effects). Control variables are dummy variables for the gender, as well as the federal state and the survey sample in the SOEP data. All models also include indicators for variables with missing information on maternal and paternal education. The sample includes 6003 observations, with 1086 deceased individuals. Robust standard errors are reported in parentheses.
* $p < 0.1$, ** $p < 0.05$, *** $p < 0.01$.
Source: Own calculations based on SOEP v33.

example, most smokers initiate smoking while they are still in school (Jürges and Meyer, 2017). If better educated parents prevent their children from developing unhealthy lifestyles early in their lives, this could have a positive effect on their life expectancy. The analysis shows that children who smoke at the age of 65, who are overweight or who never exercise have a higher mortality risk. The coefficient on maternal education coefficient decreases by about 25%, suggesting that higher educated mothers have a positive impact on health behaviours, which can explain a substantial part of the link with life expectancy.

Various indicators of the health of children aged 65 are also related to their previous health behaviour and further life expectancy. In particular, chronic diseases, cancer, experiencing a heart attack or suffering from diabetes are all associated with higher mortality risks. If these factors are included in the regression model, the relationship between life expectancy and maternal education is reduced by almost 50%. This suggests that better educated mothers contribute significantly to increased life expectancy through their influence on children's health.

Finally, an active life and social integration as well as the avoidance of loneliness can also contribute to longer lives (Kröger et al., 2017). Children who spend time with friends and relatives, volunteer or attend cultural events at the age of 65 have a lower mortality risk. The coefficient on maternal education decreases by about 20% when these variables are included.

Column 8 controls for all channels jointly. Taken together, these channels can explain most of the connection with maternal education and children's mortality risks. In sum, the result indicate that maternal education is related to children's life expectancy through various channels, and that health behaviours and health play an important role for this link.

6. Conclusion

This study provides novel evidence for a strong correlation between life expectancy and maternal schooling. Children of better educated mothers live about two years longer after age 65 than children of less educated mothers. For paternal education, the correlation is smaller and in most analyses not statistically significant.

Previous studies have almost exclusively studied the relationship between one's own level of education and life expectancy. The available results show that the relationship between education and life expectancy is much stronger if the intergenerational perspective is also taken into account. The results thus indicate that education plays an important role for one's own life course, but also for the life course of one's children. The study documents a strong socio-economic inequality in life expectancy, which can already be attributed to differences in early childhood with respect to the education of parents.

As the study is based on cohorts born around 1940, one may wonder whether the link is also relevant for later-born cohorts. Studies of current cohorts also show a continuing strong correlation between the education of the parents and the children: Better educated mothers behave more health-oriented during pregnancy (e.g. Currie and Moretti, 2003; Kost and Lindberg, 2015), children show better linguistic and socio-emotional development in school entrance examinations (e.g. Huebener et al., 2018), they are more likely to attend an upper secondary school or to study (e.g. Peter et al., 2018), and they smoke less frequently (e.g. Huebener, 2018). In addition, this study has shown that parental education also plays a role in mortality for younger cohorts after age 35. These findings suggest that the relationship between the education of parents and children also persists for future cohorts.

The study cannot claim a causal interpretation of the relationship. Note, however, that our results complement findings that an increase in maternal compulsory schooling after World War II improved children's health-related behaviours and health in adolescence and adulthood (Huebener, 2018). As unhealthy lifestyles are leading health risk factors for premature deaths, these findings suggest that maternal education may impact children's life expectancy also causally. We are not aware of any suitable setting allowing answering this question with quasi-experimental variation, but we encourage future research to follow up on this question.

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Declaration of conflict of interest

I, Mathias Huebener, declare that I have no conflict of interest.

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Appendix A

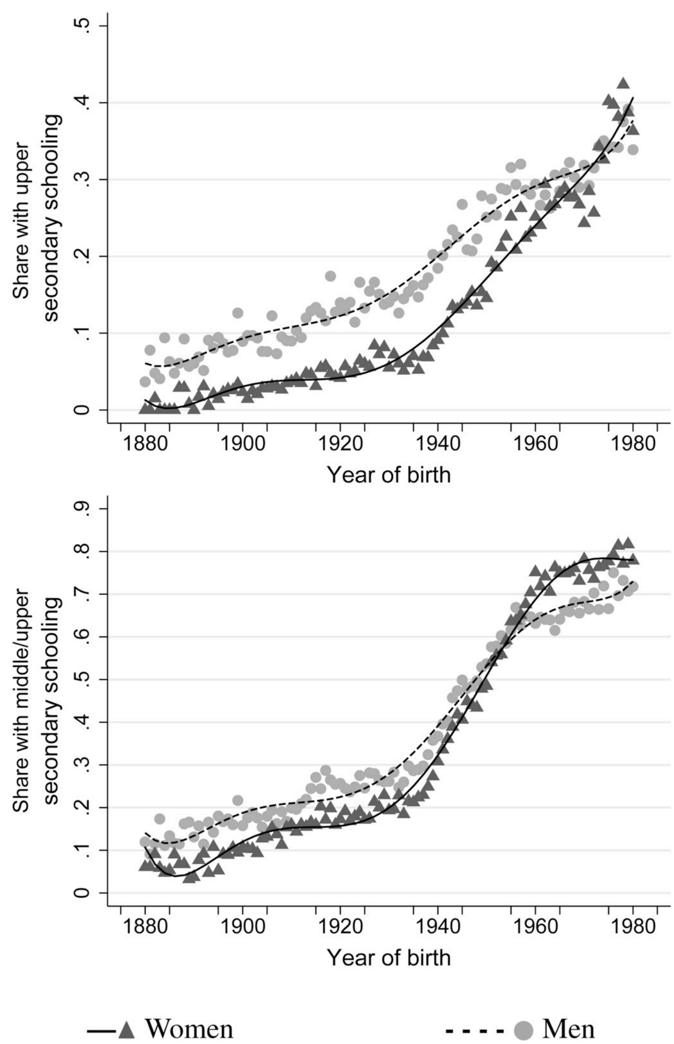

Fig. A.1. Educational degrees of men and women 1880–1980
Notes: The figure plots the share of men and women with middle and upper secondary school degrees in West Germany between 1880 and 1980.
Source: Own illustration based on SOEP v33.

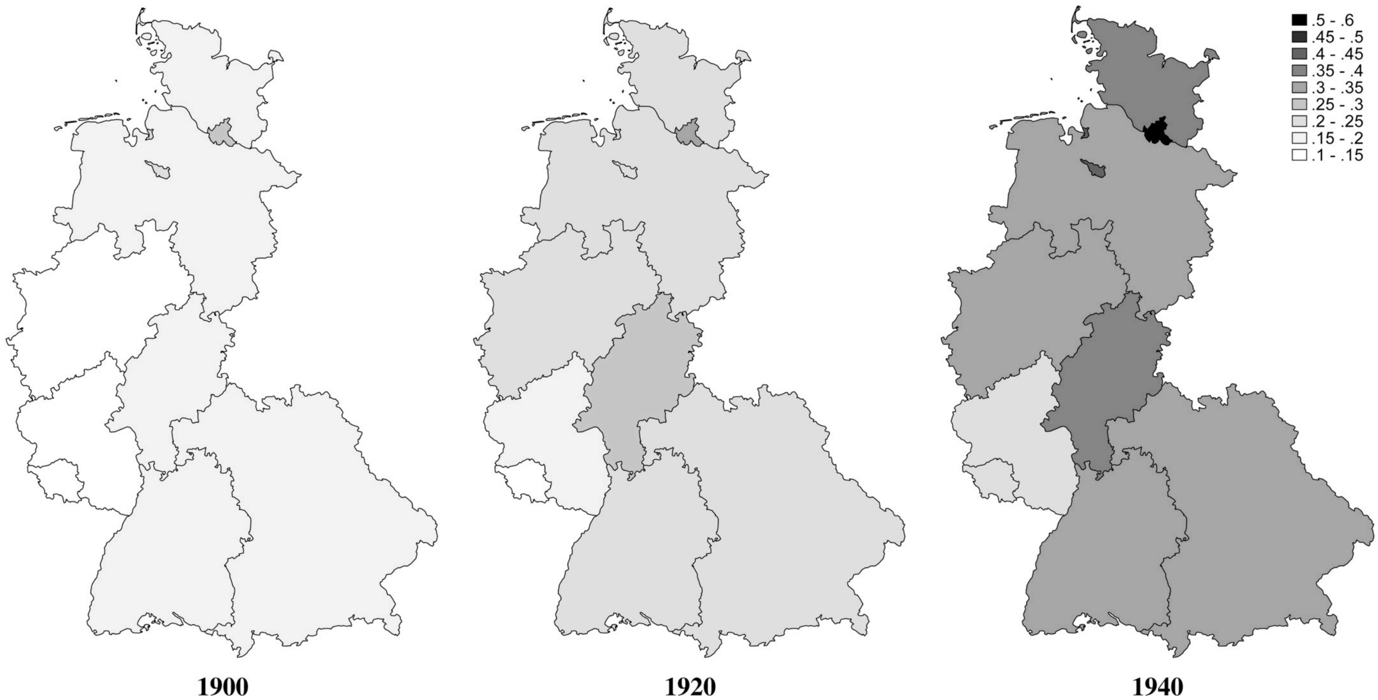

Fig. A.2. Share of the population with middle and upper secondary school degrees by cohort across federal states
Notes: The figure shows the share of the population with middle and upper secondary school degrees for the cohorts born 1900, 1920 und 1940 across federal states (only West Germany).
Source: Own illustration based on SOEP v33.

Table B.1
Descriptive statistics

Variable	Mean	Standard deviation	Min.	Max.
Characteristics of the mother				
Basic track/no school degree	0.81	0.40	0	1
Middle/upper secondary school degree	0.13	0.34	0	1
School degree unknown	0.06	0.24	0	1
Year of birth	1910.92	10.26	1881	1938
Characteristics of the father				
Basic track/no school degree	0.75	0.43	0	1
Middle/upper secondary school degree	0.19	0.39	0	1
School degree unknown	0.07	0.25	0	1
Year of birth	1907.62	10.53	1881	1935
Characteristics of the child				
Year of birth	1939.50	8.59	1918	1959
Female	0.52	0.50	0	1
Education of the child				
Basic track degree	0.57	0.49	0	1
Middle secondary school degree	0.18	0.39	0	1
Upper secondary school degree	0.18	0.38	0	1
Other school degree	0.07	0.25	0	1
Income of the child at age 65				
<60% of the median	0.07	0.25	0	1
60–80% of the median	0.12	0.33	0	1
80–100% of the median	0.16	0.36	0	1
100–150% of the median	0.30	0.46	0	1
≥150% of the median	0.27	0.44	0	1
Income unknown	0.08	0.27	0	1
Health behaviour of the child at age 65				
Smoking *(ref.: no)*	0.24	0.42	0	1
Smoking status unknown	0.09	0.29	0	1
BMI <30 *(ref.: BMI ≤ 30)*	0.19	0.39	0	1
BMI unknown	0.14	0.34	0	1
Sports activities *(ref.: no)*	0.51	0.50	0	1
Sports activities unknown	0.02	0.12	0	1
Health status of the child at age 65				
Chronic illness *(ref.: none)*	0.47	0.50	0	1
Chronic illness unknown	0.12	0.33	0	1
Depression *(ref.: none)*	0.05	0.21	0	1

(*continued on next page*)

Table B.1 (*continued*)

Variable	Mean	Standard deviation	Min.	Max.
Depression unknown	0.31	0.46	0	1
High blood pressure *(ref.: none)*	0.30	0.46	0	1
High blood pressure unknown	0.31	0.46	0	1
Ever cancer *(ref.: none)*	0.06	0.24	0	1
Ever cancer unknown	0.31	0.46	0	1
Ever cardiovascular disease *(ref.: none)*	0.13	0.33	0	1
Ever cardiovascular disease unknown	0.31	0.46	0	1
Diabetes *(ref.: none)*	0.09	0.29	0	1
Diabetes unknown	0.31	0.46	0	1
Societal engagement/activities of the child				
Meeting friends/relatives *(ref.: never)*	0.95	0.21	0	1
Meeting friends/relatives unknown	0.02	0.12	0	1
Volunteering *(ref.: never)*	0.35	0.48	0	1
Volunteering unknown	0.02	0.13	0	1
Visiting cinema/theater, etc. *(ref.: never)*	0.48	0.50	0	1
Visiting cinema/theater, etc. unknown	0.02	0.12	0	1
Visiting theatre, opera, etc. *(ref.: never)*	0.71	0.45	0	1
visiting theatre, opera, etc. unknown	0.02	0.12	0	1
Engagement in neighbourhood initiatives, etc. *(ref.: never)*	0.12	0.33	0	1
Engagement in neighbourhood initiatives, etc. unknown	0.02	0.13	0	1
Number of observations	6003			

Notes: The table reports descriptive statistics for the sample of children aged 65 and older used in the main analysis.
Source: Own calculations based on SOEP v33.

Table B.2
Alternative model specifications

Independent variable:	Maternal education		Paternal education		Both parents
	(1)	(2)	(3)	(4)	(5)
Panel A: Gompertz model to estimate differences in life expectancy after age 65					
(Reference: Mother with basic track or no school degree)					
Mother with middle/upper secondary schooling	2.760***	1.957**			2.221**
	(0.761)	(0.819)			(0.952)
(Reference: Father with basic track or no school degree)					
Father with middle/upper secondary schooling			1.229**	0.875	−0.175
			(0.601)	(0.663)	(0.756)
Number of observed individuals	6003	6003	6003	6003	6003
Number of deceased individuals	1086	1086	1086	1086	1086
Panel B: OLS regression with dep. variable: Deceased before age 80					
(Reference: Mother with basic track or no school degree)					
Mother with middle/upper secondary schooling	−0.083***	−0.036***			−0.044***
	(0.010)	(0.010)			(0.012)
(Reference: Father with basic track or no school degree)					
Father with middle/upper secondary schooling			−0.056***	−0.012	0.009
			(0.010)	(0.010)	(0.012)
Mean	0.14	0.14	0.14	0.14	0.14
Number of observed individuals	6003	6003	6003	6003	6003
Child cohort fixed effects		✓		✓	✓
Parental cohort fixed effects		✓		✓	✓
Control variables		✓		✓	✓

Notes: Panel A reports marginal effect estimates of Gompertz survival analyses models, denoting the estimated differences in further life expectancy after age 65. Panel B reports marginal effect estimates of OLS regression models with the dependent variable whether an individual deceased before age 80 (and after age 65). If indicated, models include dummy variables for the birth year of the child (child cohort fixed effects), and the mother or the father (parental cohort fixed effects). Control variables are dummy variables for the gender, as well as the federal state and the survey sample in the SOEP data. All models include indicators for missing information on maternal and paternal education. Robust standard errors are reported in parentheses.
* $p < 0.1$, ** $p < 0.05$, *** $p < 0.01$.
Source: Own calculations based on SOEP v33.

Table B.3
Testing the proportional hazard assumption

Independent variable:	Maternal education		Paternal education		Both parents
	(1)	(2)	(3)	(4)	(5)
	p-values				
Mother with middle/upper secondary schooling	0.013	0.050			0.145
Father with middle/upper secondary schooling			0.025	0.161	0.597
Child cohort fixed effects		✓		✓	✓
Parental cohort fixed effects		✓		✓	✓
Control variables		✓		✓	✓

Notes: The table reports *p*-values of tests of the proportional hazard assumption on single covariates based on Schoenfeld residuals. If indicated, the underlying Cox models include dummy variables for the birth year of the child (child cohort fixed effects), and the mother or the father (parental cohort fixed effects). Control variables are dummy variables for the gender, as well as the federal state and the survey sample in the SOEP data. All models also include indicators for missing information on maternal and paternal education. Robust standard errors are reported in parentheses.
* $p < 0.1$, ** $p < 0.05$, *** $p < 0.01$.
Source: Own calculations based on SOEP v33.

Table B.4
Survival models with time-varying covariates

Independent variable:	Maternal education		Paternal education		Both parents	
	(1)	(2)	(3)	(4)	(5)	(6)
Mother with middle/upper secondary schooling						
Main	0.040**	0.540**			0.049*	0.492**
	(0.059)	(0.148)			(0.084)	(0.155)
Time-varying (each *t*)	1.040**				1.037	
	(0.020)				(0.024)	
Time-varying ($T > 80$)		1.245				1.305
		(0.221)				(0.275)
Father with middle/upper secondary schooling						
Main			0.240	0.834	0.789	1.113
			(0.249)	(0.172)	(1.004)	(0.267)
Time-varying (each *t*)			1.017		1.003	
			(0.014)		(0.017)	
Time-varying ($T > 80$)				1.028		0.932
				(0.141)		(0.152)
Number of observations	6003	6003	6003	6003	6003	6003
Child cohort fixed effects	✓	✓	✓	✓	✓	✓
Parental cohort fixed effects	✓	✓	✓	✓	✓	✓
Control variables	✓	✓	✓	✓	✓	✓

Notes: All Cox regression models include dummy variables for the birth year of the child (child cohort fixed effects), and the mother or the father (parental cohort fixed effects). Control variables are dummy variables for the gender, as well as the federal state and the survey sample in the SOEP data. All models also include indicators for missing information on maternal and paternal education. Robust standard errors are reported in parentheses.
* $p < 0.1$, ** $p < 0.05$, *** $p < 0.01$.
Source: Own calculations based on SOEP v33.

Table B.5
Correlations between parental education and potential channels

Dependent variable: Child outcome	Mean	Independent variable:	
		Mother with middle/upper sec. schooling	Father with middle/upper sec. schooling
Educational and professional attainment			
Middle/upper secondary schooling *(ref.: basic or no school degree)*	0.36	0.40***	0.41***
First prof. activity: white collar *(ref.: blue collar, self-empl.)*	0.46	0.20***	0.22***
Income above the median income	0.62	0.16***	0.17***
Health behaviour around age 65			
Smoking	0.26	0.00	0.02
BMI > 30	0.22	−0.07***	−0.06***
No sports	0.51	−0.14***	−0.15***
Health status around age 65 *(reference: No respective illness)*			
Chronical disease	0.53	−0.05**	−0.05***
Depression	0.07	−0.01	−0.02*
High blood pressure	0.43	−0.07***	−0.03

(*continued on next page*)

Table B.5 (*continued*)

Dependent variable: Child outcome	Mean	Independent variable:	
		Mother with middle/upper sec. schooling	Father with middle/upper sec. schooling
Ever cancer	0.09	−0.01	0.01
Ever cardiovascular disease	0.19	−0.04***	−0.05***
Diabetes	0.14	−0.04***	−0.04***
Societal engagement/activities *(reference:Never)*			
Meeting friends/relatives	0.97	0.02***	0.01*
Volunteering	0.35	0.06***	0.04***
Visiting cinemas, concerts, etc.	0.49	0.12***	0.10***
Visiting operas, theatres, exhibitions, etc.	0.72	0.14***	0.12***
Engagement in political parties, neighbourhood initiatives, etc.	0.13	0.07***	0.04***

Notes: The table reports OLS regression coefficients. All models include dummy variables for the birth year of the child (child cohort fixed effects), and the mother or the father (parental cohort fixed effects). Control variables are dummy variables for the gender, as well as the federal state and the survey sample in the SOEP data. All models include indicators for variables with missing information on maternal and paternal education. All models also include indicators for missing information on maternal and paternal education. Robust standard errors are reported in parentheses.
* $p < 0.1$, ** $p < 0.05$, *** $p < 0.01$.
Source: Own calculations based on SOEP v33.

Appendix B

Further robustness checks

In the main analysis, we grouped parental education into two categories, i.e. parents with a basic track degree or no school degree, and parents with a middle and upper secondary school degree. If each of these categories is analysed separately (see column 2 of Table B.6), it can be seen that the mortality hazard ratio of children of mothers without a degree does not differ significantly from those of mothers with a basic school degree. Children of mothers with a middle and upper secondary school degree have significantly lower mortality rates. However, only about 4% of the mothers in the sample have an upper secondary school degree, which may explain why the statistical precision of this estimate is low. This shows that combining these education levels in joint categories does not conceal any heterogeneities. For the education of the father, there are no differences that would allow drawing a different conclusion, even in the more differentiated analysis. If the educational level of the parents is expressed as years of schooling (see Chapter 2 for details), the conclusions remain (Table B.6, column 3).

A fundamental concern with regard to the interpretation of our results is that the relationship between maternal education and children's life expectancy is spuriously related via unaccounted time trends in life expectancy and maternal education. We perform two robustness checks to rule out this possibility: We include linear state specific time trends according to the birth year of the children in the analysis (Table B.6, column 4). Alternatively, we include dummies for each combination of federal state and birth cohort of the child to account flexibly for any cohort-state specific differences (Table B.6, column 5). In both alternative models, the results are almost identical to the main result, despite the latter specification placing very high demands on the data.

Another threat to our findings is that the relationship between children's life expectancy and parental education varies with unobserved factors that are not included in the analysis (*unobserved heterogeneity*). If these factors are related to parental education, our estimates would capture a spurious relationship. To account for individual level unobserved heterogeneity, we require a parametric assumption on the baseline hazard. We assume a Gompertz distribution and first confirm our main findings based on Cox models (Appendix Table B.6, column 6). Next, we account for individual level unobserved heterogeneity assuming it to be Gamma distributed (Appendix Table B.6, column 7). Both mothers' and fathers' hazard ratios get even larger, strengthening the evidence for an important role of parental education in children's life expectancy. We conclude that our findings are robust to accounting for unobserved heterogeneity.

The last robustness check assumes an alternative correlation structure of the error term. If we cluster standard errors at the level of the year of birth of the parents and the federal state, inference is identical to the main result (Table B.6, column 8).

Table B.6
Sensitivity checks

Independent variable:		Alternative definition of the education variable		Region-specific trends		Gompertz distribution:Unobserved heterogeneity		Inference
	Main results(1)	All education Categories (2)	Years of schooling(3)	Region-time trends(4)	Region-cohort fixed effects(5)	No(6)	Yes(7)	Clustered standard errors(8)
Panel A: Maternal education								
(Reference: Basic track/no school degree)								
Mother with middle/upper secondary schooling	0.728***			0.727***	0.714***	0.736**	0.590***	0.728***
	(0.087)			(0.087)	(0.087)	(0.094)	(0.106)	(0.087)
(Reference: Basic track degree)								
Mother without school degree		1.038						
		(0.358)						
Mother with middle secondary school degree		0.703**						
		(0.097)						
		0.825						

(*continued on next page*)

Table B.6 (*continued*)

Independent variable:		Alternative definition of the education variable		Region-specific trends		Gompertz distribution:Unobserved heterogeneity		Inference
	Main results(1)	All education Categories (2)	Years of schooling(3)	Region-time trends(4)	Region-cohort fixed effects(5)	No(6)	Yes(7)	Clustered standard errors(8)
Mother with upper secondary school degree		(0.176)						
Maternal years of schooling			0.915** (0.037)					
Panel B: Paternal education								
(Reference: Basic track/no school degree)								
Father with middle/upper secondary schooling	0.866 (0.081)			0.858 (0.081)	0.845* (0.080)	0.872 (0.090)	0.673** (0.127)	0.866* (0.071)
(Reference: Basic track degree)								
Father without school degree		0.891 (0.439)						
Father with middle secondary school degree		0.864 (0.105)						
Father with upper secondary school degree		0.868 (0.118)						
Paternal years of schooling			0.967 (0.025)					
Number of observed individuals	6003	6003	6003	6003	6003	6003	6003	6003
Number of deceased individuals	1086	1086	1086	1086	1086	1086	1086	1086

Notes: The table reports hazard ratios from Cox regression models on the conditional mortality of children after age 65. All models include dummy variables for the birth year of the child (child cohort fixed effects), and the mother or the father (parental cohort fixed effects). Control variables are dummy variables for the gender, as well as the federal state and the survey sample in the SOEP data. All models include indicators for variables with missing information on maternal and paternal education. Huber-White robust standard errors are reported in parentheses. Column 6 reports cluster-robust standard errors clustered at the level of the parental year of birth cohort × federal state (108 clusters).

* $p < 0.1$, ** $p < 0.05$, *** $p < 0.01$

Source: Own calculations based on SOEP v33.

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