



Cause of parental death and child's health and education: The role of parental resources

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ABSTRACT

Early parental death has been linked to problems in health and educational path. We added to the literature by examining disability pension and various educational outcomes after external (accident, violence, suicide) or natural parental death during childhood or adolescence, taking into account possible heterogeneous associations by parental resources. Using Finnish register data and linear random-effects models, we analysed outcomes of 90,620 and 88,859 children (paternal and maternal death samples, respectively) born between 1982 and 1990. Results indicated lower educational performance and attainment, and a higher probability of disability pension in the bereaved offspring, especially after external parental death. Half of these connections were explained after adjusting for childhood family characteristics. Having a highly educated surviving parent might protect from negative educational and health outcomes. The findings were partly similar for father's and mother's deaths. We demonstrated that the negative associations between parental death and child wellbeing differ by cause of death and parental resources. Cause of death and overall family circumstances should both be considered when analysing child outcomes after parental loss.

Introduction

Parental death in childhood is a traumatic life event that has been linked to various negative short-term and longer-term wellbeing outcomes, including increased mental health and adjustment problems (e.g., Cerel et al., 2006; Feigelman et al., 2017; Keyes et al., 2014), and lower educational performance and attainment (e.g., Amato & Anthony, 2014; Berg et al., 2014; Fronstin et al., 2001; Kailaheimo-Lönnqvist & Erola, 2020; Prix & Erola, 2017). Studies analysing the psychological consequences of early parental loss have shown that the strength of these links is stronger for the external causes of death, such as parental suicide and accident (Appel et al., 2016; Cerel et al., 2006; Lin et al., 2004; Pfeffer et al., 2000; Rostila & Saarela, 2011).

Evidence on the cause of parental death and educational outcomes is based on a few studies, in which external deaths that are sudden or otherwise more traumatic, had the strongest associations with lower grades and a higher drop-out at compulsory school in Sweden (Berg et al., 2014), and with impeded college or university enrolment in Taiwan (Chen et al., 2009; Gimenez et al., 2013) and Norway (Burrell et al., 2020). According to our knowledge, there are no studies that have

examined the role of cause of parental death on early disability pension, which is an indicator of severely poor health and functioning. In the two previous studies, which did not address causes of death, early parental death did not increase the risk of disability pension during early adulthood after controlling for family background (Salonen et al., 2019; Salonsalmi et al., 2019). In Finland, most of the disability pensions at younger ages are mental health related, which suggests that the risk of early disability pension after a potentially more traumatic parental loss (with higher mental health effects) should be examined separately from the natural deaths.

We add to the prior literature by examining multiple outcomes and causes of parental death on offspring's wellbeing after early maternal or paternal death. The first objective is to examine whether parental death is linked to (1) disability pension during early adulthood, (2) the grade point average (GPA) in compulsory education, (3) completion of secondary education, and (4) university education enrolment, comparing deaths by external causes (accident, violence, suicide) versus natural causes (diseases). The second objective is to assess whether the associations between cause of parental death and above-mentioned wellbeing outcomes differ by parental resources. Children in families with higher

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resources might cope better, because they have more protective factors, such as social support and knowledge on seeking help that buffer against adverse developments related to parental death (Mirowsky & Ross, 2005; Prix & Erola, 2017). Therefore, further elaboration is required on whether experiencing a “double-hit”, i.e. early parental loss by external, potentially more adverse cause combined with having less advantaged background, is shown in child’s educational attainment and health later in life – and in the intergenerational transmission of inequalities. Analysing the heterogeneous associations of parental death across social strata is important especially from the social security point-of-view: how and for whom to target the help?

Our research adds to the current knowledge of whether losing a parent during childhood or youth is negatively related to children’s educational path or health, using high-quality Finnish registry data with detailed information on individual life courses. About 4 percent of children lose a parent before the age of 17 in Finland, of which 3 percent lose a father and 1 percent a mother (own calculations). The Finnish universal social security system, free-of-charge education and financially supported non-compulsory education should minimise at least the negative educational outcomes after parental loss. If we find that this is not the case, the institutional non-financial support, such as basic life support and aid in parenting and seeking trauma care, should be increased and targeted especially to the most vulnerable bereaved families – if this study shows those to exist.

Background

According to life course approach, negative experiences especially during childhood and youth might threaten wellbeing, as they occur during sensitive developmental periods, and because they are often followed by or related to other negative exposures, increasing the number and/or duration of adverse experiences over the life course (cumulative processes, chains or pathways of risk) (Adler & Stewart, 2010; Ben-Shlomo & Kuh, 2002; O’Rand, 2009). The evidence on whether early parental loss is related to adverse educational and health outcomes (e.g., Amato & Anthony, 2014; Cerel et al., 2006; Fronstin et al., 2001; Keyes et al., 2014) or not (Biblarz & Gottainer, 2000; Francesconi et al., 2010; Salonsalmi et al., 2019) is partly inconclusive, depending on the outcome. The earlier during childhood the parental loss is experienced the more adverse consequences it might have (Berg et al., 2016; Kailaheimo-Lönnqvist & Erola, 2020), perhaps because older children are better equipped to deal with the death.

Potential pathways through which bereavement is related to health and education are various. Parental death tends to lead to a number of negative effects on mental and physical wellbeing, which appears to be more common in men (Marks et al., 2007). Grief, distress, and dysphoria, and non-specific emotional and behavioural difficulties are common after parental death, some children being more vulnerable for more severe psychological and psychosomatic outcomes (Dowdney, 2000). Parental bereavement is associated with an elevated risk for the onset of psychiatric disorders across the life course (Keyes et al., 2014). Mental health, warmth and discipline of the surviving parent seem important mediating or protective factors in this (Akerman & Statham, 2014; Dowdney, 2000). Prolonged and accumulated early life stress, in particular, appears to interfere with cognitive and affective functions through over-activation of the stress system, which can impair mental health as well as educational performance (Amato, 2000; Cerel et al., 2006; Lupien et al., 2009; Pechtel & Pizzagalli, 2011; Shonkoff et al., 2012). Premature school dropout and diminished interest in later education can lead, in turn, to lower academic attainment (Feigelman et al., 2017).

Losing a parent also leads to losing various economic, human, and social resources, such as a role model and parental support, which are useful during the educational path and for emotional development (e.g., Biblarz & Gottainer, 2000; Maier & Lachman, 2000). Prior studies find fairly similar negative associations between mother’s or father’s death

and child’s educational outcomes (Berg et al., 2014; Kailaheimo-Lönnqvist & Erola, 2020) and psychological well-being (Dowdney, 2000). In turn, some studies report that maternal loss might increase mortality risk (Rostila & Saarela, 2011), and have a stronger influence on cognitive skills (Adda et al., 2011) and on daughters rather than sons, compared with father’s death (Marks et al., 2007). Further, losing a same-sex parent might have larger negative consequences on the mental and physical wellbeing (Marks et al., 2007; Rostila & Saarela, 2011).

External and natural parental death and child wellbeing

Both cause of parental death and family’s resources are potential sources of variation in health and educational performance after bereavement, but there is much less evidence on this (e.g., Appel et al., 2016; Berg et al., 2014; Burrell et al., 2020; Chen et al., 2009; Gimenez et al., 2013). External or unnatural causes of death due to accident, violence, or suicide are generally linked to more adverse child outcomes, such as higher risk of depression, lower education, and self-inflicted injuries, compared with natural deaths by diseases (Berg et al., 2016; Burrell et al., 2020; Chen et al., 2009; Rostila et al., 2016; Rostila & Saarela, 2011). There is also some evidence that losing a mother unexpectedly is more adverse than a father’s sudden death (Chen et al., 2009).

One explanation for why external causes of death are more adverse is that they are linked to the most prominent mental health effects of children. The psychological problems related to mourning are mainly associated with a traumatic or sudden parental death (accident, suicide), rather than natural deaths (Merlevede et al., 2004). There is also evidence on post-traumatic stress and long-term problems in mental health, because children bereaved by parental suicide showed higher levels of depression and higher risk of initiating antidepressant use even after 2 years from the loss, compared with other causes of death (Appel et al., 2016; Cerel et al., 1999; Pfeffer et al., 2000). As depression is associated with school performance (e.g. Fröjd et al., 2008), external parental death might have more pronounced consequences on the educational performance and attainment.

Furthermore, the more severe negative consequences of external causes of parental death, such as accidents, have been explained by the lack of time for adaptation and missing parental support before sudden deaths, whereas the (natural) deaths by illnesses are usually expected and enable a longer period for adaptation (Gimenez et al., 2013). The seriously ill parent is also able to prepare the child for the death and for life thereafter.

Moreover, deaths due to external causes are more common in high-risk families with more household dysfunction, different forms of child maltreatment (Anda et al., 2002; Dube et al., 2001; Shepherd & Barraclough, 1976), and parental problems and distress, which compromise the health, wellbeing and adjustment of a child (Conger et al., 2010; Masarik & Conger, 2017). Therefore, some of the psychosocial problems might exist already before the parental loss (Kaplou et al., 2010), which questions the causal effect of the death per se.

Heterogeneous effects of causes of death by parental resources

Experiences, events and resources or the lack of them tend to accumulate over the life course and across different life domains, which may lead to more negative outcomes after early adverse events (Ben-Shlomo & Kuh, 2002; O’Rand, 2009). The current empirical literature does not cover sufficiently the heterogeneous effects of causes of parental death on children in different parts of social strata, even though most previous studies control for the family background (e.g., Berg et al., 2014). Some studies find that after adjusting for family characteristics, such as socioeconomic disadvantage and psychosocial problems, no difference between external and natural parental deaths remained (Berg et al., 2014).

A child from less advantaged background may be more vulnerable

for adverse family events (Biblarz & Gottainer, 2000; Grätz, 2015) and have difficulties to cope with further strains in life than a child with higher (compensatory) resources (Erola & Kilpi-Jakonen, 2017; Prix & Erola, 2017), higher social capital (e.g., external support from relatives, friends and school), and fewer experiences of negative life events prior to parental death, which all promote positive adaptation. Highly educated parents are likely to have less economic strain that causes stress as well as higher “learned effectiveness” to help children in coping with stress and strains after the death and navigate in the educational pathway (Masarik & Conger, 2017; Mirowsky & Ross, 2005). On the other hand, the advantages related to higher educational resources of the deceased parent are no longer (directly) available after the death, proposing that the surviving parent may become a stronger role model for the educational choice-making (Prix & Erola, 2017).

Moreover, a family’s economic situation is positively associated with children’s education (Acemoglu & Pischke, 2001; Duncan et al., 1998) and health outcomes (Devenish et al., 2017), but in parental death, one source of regular income is lost. In Finland, the survivor’s pension covers part of the economic loss for the remaining spouse and children under the age of 18 (Hietaniemi & Ritola, 2007), and in general, the role of parental income at least in the socioeconomic achievement is limited (Erola et al., 2016; Mayer, 1997). Compared with parental education, a family’s economic situation is likely to matter less for the health and educational performance of the bereaved child.

Finally, unobserved family characteristics, such as inherited genetic dispositions, might influence the cause of parental death, parental resources, and child’s health and achievement – and thus partially or fully confound the links between them. Due to this potential uncontrolled endogeneity (see e.g., Dahl & Lochner, 2012), the findings based on statistical models that require strong assumptions should be interpreted as statistical associations. As the cause of parental death and parental resources are not independent of unobserved family-level attributes, the findings presented in this paper are interpreted as associations rather than causal effects.

Hypotheses

The previous evidence indicates poorer health and educational performance after parental death by external causes, compared with natural causes. We contribute to this literature by examining the heterogeneous

associations of cause of parental death by parental resources (education and income) on GPA in compulsory school, completion of secondary education, university education enrolment, and severe health problems, that is, early disability pension. We propose three hypotheses:

H1. Losing a parent due to an external cause is associated with lower education than parental death by a natural cause (education hypothesis).

H2. Losing a parent due to an external cause increases the probability of being on a disability pension more than parental death by a natural cause (health hypothesis).

H3. Children with higher parental resources are less negatively affected by parental death than are children with low parental resources (parental resources hypothesis).

Data and methods

For our analyses, we used a longitudinal Finnish Growth Environment Panel (FinGEP), which is based on a 10% sample of the Finnish population drawn in 1980 and which was compiled by the Statistics Finland. All the sample persons were linked to their biological children and other family members, and we focused on the children of the sample persons, born between 1982 and 1990 and followed from their birth until 2014. The paternal death sample included 90,620 children in 56,586 families (Table 1) and the maternal death sample included 88,859 children in 55,523 families (Table 2). We excluded 60 individuals who had lost both parents by the age of 16, as we were unable to analyse the role of the surviving parents.

Outcome variables: educational performance and attainment, and disability pension

Our four outcome variables are: grade point average in compulsory education, completing secondary education, university education enrolment and receipt of disability pension (Tables 1 and 2). *Grade point average (GPA)* is a continuous variable measuring the mean grade for all school subjects, calculated at the end of compulsory (primary) education. The GPA scale varies between 4 and 10 (theoretical range). *Secondary education* is a binary variable indicating whether the child has completed (coded as 1) or has not completed (coded as 0) secondary

Table 1
Descriptive statistics of children by father’s cause of death.

	Alive	External	Natural	χ^2 -test
University education %	21	12	13	$p < 0.001$
Secondary education %	68	54	57	$p < 0.001$
Disability pension %	2	3	3	$p < 0.001$
Parental education ^a %				$p < 0.001$
primary	7	15	14	
secondary	73	74	74	
tertiary	20	10	12	
Female %	51	46	50	$p = 0.051$
Single parent ^b %	26	46	26	$p < 0.001$
Stepparent ^c %	9	42	28	$p < 0.001$
	<i>Mean (SD)</i>			<i>ANOVA</i>
GPA (mean)	8 (5)	8 (0.9)	8 (0.9)	$p < 0.001$
Family income ^d , €	577 (203)	509 (216)	522 (203)	$p < 0.001$
Family income ^d , € (1000 centiles)	547 (260)	468 (266)	478 (256)	$p < 0.001$
Father’s age at birth	31 (5)	32 (6)	36 (7)	$p < 0.001$
N	88,024	1365	1231	
%	97	1.6	1.4	

Notes.

^a The highest parental education when child is 0–18 years.

^b Child has ever lived (before possible parental death) in a single-parent household at the age of 0–18.

^c Child has ever lived with a stepparent at the age of 0–18.

^d Median household income at the age of 5–18. GPA = Grade point average from compulsory education.

Table 2
Descriptive statistics of children by mother's cause of death.

	Alive	External	Natural	χ^2 -test
University education %	21	12	17	$p < 0.001$
Secondary education %	68	53	59	$p < 0.001$
Disability pension %	2	4	2	$p = 0.018$
Parental education ^a %				$p < 0.001$
Primary	7	20	13	
Secondary	73	71	71	
Tertiary	20	9	16	
Female %	49	47	49	$p = 0.770$
Single parent ^b %	26	48	19	$p < 0.001$
Stepparent ^c %	3	40	39	$p < 0.001$
	<i>Mean (SD)</i>			<i>ANOVA</i>
GPA (mean)	8 (0.8)	8 (0.9)	8 (0.9)	$p < 0.001$
Family income ^d , €	577 (203)	487 (242)	521 (212)	$p < 0.001$
Family income ^d , € (1000 centiles)	547 (260)	445 (284)	481 (262)	$p < 0.001$
Father's age at birth	31 (5)	31 (6)	33 (6)	$p < 0.001$
N	88,025	265	569	
%	99	0.04	0.06	

Notes.

^a The highest parental education when child is 0–18 years.

^b Child has ever lived (before possible parental death) in a single-parent household at the age of 0–18.

^c Child has ever lived with a stepparent at the age of 0–18.

^d Median household income at the age of 5–18. GPA = Grade point average from compulsory education.

education or more by the age of 19. *University education* is a binary variable coded as 1 if the child has enrolled in or completed university education by the age of 24 and coded as 0 if a child has not.

Disability pension is a binary variable taking a value of 1 if a child received disability pension between ages 18 and 24, and a value of 0 if the child did not. Disability pension is a financial compensation for the loss of income (salary or benefit) due to long-term health problems, which prevent from participating in work or studies. It can be granted either part or full time or fixed-term or permanently from the age of 16, and a medical statement with medical diagnosis is required. Most young individuals receive disability pension as a fixed term (e.g., rehabilitation subsidy). We excluded 299 individuals who had received disability pension continuously from the age of 16 or 17, because most of these individuals are typically diagnosed with malformations or chromosomal abnormalities. We did not differentiate between different types of disability pension.

Measures of cause of parental death

The main independent variables are *cause of father's death* (N = 2599) and *cause of mother's death* (N = 838), which were observed between ages 0 and 16 (Tables 1 and 2). Causes of death were classified according to the International Classification of Diseases (ICD-10) as (1) natural deaths (diseases) or deaths by external causes (accident, violence, or suicide [ICD-10 code: V01–Y89]). A similar classification was used in many other Nordic studies (e.g., Burrell et al., 2020; Berg et al., 2014; Rostila and Saarela, 2011). The parental death variables consisted of the following values: 0 alive (no parental death), 1 external death, 2 natural death, based on the primary causes of death, since the secondary causes were not available in the data.

Measures of parental resources and control variables

The role of parental resources was investigated using two measures of parental education, and family income (Tables 1 and 2). *Parental education* was measured using the dominance principle, i.e., the highest level of parental education when the child was 0–18 years old (primary, secondary, or tertiary). The measure of *parental tertiary education* distinguished whether none, only father, only mother, or both parents had tertiary education. Family income was measured as total median

household income (adjusted for the cost-of-living index in 2014), including all taxable income between a child's age 5 and 18, further divided into 1000 categories to balance the effect of the highest and the lowest income.

The models were adjusted for the following variables (further information in Tables 1 and 2): child's gender, child's year of birth (cohort effects), father's age at birth, stepparent (ever lived in a stepfamily between ages 0–18), and single parent (ever lived in a single parent household before parental death).

To describe the analytical sample, external and natural parental deaths were distributed differently by parental resources, sociodemographic factors, and family circumstances (Tables 1 and 2). Bereaved children had lower education, more disability pension, lower family income, less educated parents, and generally a bit older parents; in addition, they have lived more often in step- and single-parent families than non-bereaved children. In sum, the bereaved children appeared to come from less advantaged family backgrounds.

Methods

Analyses were conducted using random-effects linear multilevel modelling, which takes into account the clustering by families in the data. In order to investigate the role of parental resources in the relationship between the cause of parental death and child's health and education (hypothesis 3), we added separate interaction terms for the

Table 3
Parental death and child's education and health. Predicted probabilities from linear random-effects models.

	Father's death	Mother's death
GPA	−0.278*** (0.020)	−0.210*** (0.033)
Secondary	−0.127*** (0.010)	−0.106*** (0.017)
University	−0.088*** (0.009)	−0.056*** (0.015)
DP	0.012*** (0.003)	0.008 [†] (0.004)

GPA = Grade point average in compulsory education. DP = disability pension. Models control for child's sex and year of birth. Standard errors in parentheses. [†] $p < 0.1$; * $p < 0.05$, ** $p < 0.01$, *** $p < 0.001$.

Table 4
Cause of father's death and child's education and health. Predicted probabilities from linear random-effects models.

	GPA		Secondary		University		DP	
	M1	M2	M1	M2	M1	M2	M1	M2
Cause of death (ref: alive)								
External	-0.306*** (0.026)	-0.146*** (0.025)	-0.143*** (0.014)	-0.083*** (0.013)	-0.092*** (0.012)	-0.034** (0.011)	0.014*** (0.004)	0.011** (0.004)
Natural	-0.250*** (0.027)	-0.197*** (0.026)	-0.111*** (0.014)	-0.099*** (0.014)	-0.083*** (0.013)	-0.060*** (0.012)	0.010** (0.004)	0.008* (0.004)
Female	0.579*** (0.005)	0.583*** (0.005)	0.041*** (0.003)	0.043*** (0.003)	0.046*** (0.003)	0.047*** (0.002)	-0.001 (0.001)	-0.001 (0.001)
Year of birth	-0.007*** (0.001)	-0.012*** (0.001)	0.004*** (0.001)	0.003*** (0.001)	-0.003*** (0.000)	-0.006*** (0.000)	0.001*** (0.000)	0.001*** (0.000)
Father's age at birth		0.007*** (0.001)		0.003*** (0.000)		0.003*** (0.000)		0.000*** (0.000)
Single parent ^a		-0.239*** (0.008)		-0.133*** (0.004)		-0.062*** (0.004)		0.010*** (0.001)
Stepparent ^b		-0.129*** (0.011)		-0.052*** (0.006)		-0.034*** (0.005)		-0.000 (0.002)
Parental education ^c								
Secondary		0.372*** (0.012)		0.134*** (0.006)		0.103*** (0.005)		-0.007*** (0.002)
Tertiary		0.939*** (0.013)		0.204*** (0.007)		0.410*** (0.006)		-0.009*** (0.002)
Family income ^d		0.000* (0.000)		0.000*** (0.000)		0.000* (0.000)		-0.000 (0.000)
Constant	21.685*** (2.018)	30.236*** (1.994)	-6.701*** (1.164)	-5.716*** (1.165)	6.960*** (0.992)	12.267*** (0.968)	-1.369*** (0.320)	-1.240*** (0.323)
N	87,676	87,676	89,428	89,428	89,467	89,467	90,554	90,554

GPA = Grade point average in compulsory education. DP = disability pension. Standard errors in parentheses.

* $p < 0.05$, ** $p < 0.01$, *** $p < 0.001$.

Notes.

^a Child has ever lived (before possible parental death) in a single-parent household at the age of 0–18.

^b Child has ever lived with a stepparent at the age of 0–18.

^c The highest parental education at the age of 0–18.

^d Household income with 1000 percentiles when child was 5–18 years old.

cause of death and parental education and family income.

Results

Cause of parental death and child's education and disability pension

The analysis showed after the father's or mother's death, respectively, 0.28 or 0.21 points lower grade point average (GPA), 12.7 or 10.6 percentage points lower probability to finish secondary education, 8.8 or 5.6 percentage points lower probability for university enrolment, and 1.2 or 0.8 percentage points higher probability for disability pension (DP) than non-bereaved children, when controlling for child's gender and year of birth (Table 3). The estimates for DP were small, especially for the mother's death, whereas the strongest negative associations were between parental death and secondary education.

Table 4 for paternal cause of death and Table 5 for maternal cause of death show that the external causes of death seemed much more adverse than natural causes of death (M1), when comparing their coefficient sizes with the main "effects" of death (Table 3) and the sample means of each outcome variable (Tables 1 and 2). For example, the estimates on GPA for father's external causes of death was -0.306 and for natural deaths -0.250, whereas the main "effect" for paternal death on GPA was -0.278. It is also notable that most of the variation in GPA is in a rather

narrow area in the scale. Estimates in Table 3 and M1 models in Tables 4 and 5 are comparable, as they include the same controls.

Parental death had the strongest associations with lower GPA and completing secondary education, and the weakest with university education and DP (Tables 4 and 5). The adjusted models (M2) showed that various childhood family characteristics explained most of the negative association between cause of parental death and child's education, after which the estimates between causes of death did not differ from each other significantly (comparisons not reported).

The estimates for DP were small and non-substantial both in M1 and M2, indicating only 1–2 percentage points higher probability of DP in the bereaved children. The associations between parental death and child's educational performance and disability pension did not vary much between maternal and paternal deaths (M2).

These analyses did not provide support for the hypotheses 1 and 2 which stated that the external causes of parental death are stronger related to negative educational outcomes and increased probability of being on a disability pension in early adulthood than the natural causes of death.

Heterogeneous associations by parental resources

We conducted interaction models to analyse whether the

Table 5
Cause of mother’s death and child’s education and health. Predicted probabilities from linear random-effects models.

	GPA		Secondary		University		DP	
	M1	M2	M1	M2	M1	M2	M1	M2
Cause of death (ref: alive)								
External	-0.274*** (0.061)	-0.119* (0.057)	-0.153*** (0.031)	-0.090** (0.030)	-0.089** (0.028)	-0.028 (0.026)	0.021** (0.008)	0.015 (0.008)
Natural	-0.179*** (0.039)	-0.174*** (0.037)	-0.086*** (0.021)	-0.091*** (0.021)	-0.044* (0.019)	-0.037* (0.018)	0.001 (0.005)	0.001 (0.005)
Female	0.579*** (0.005)	0.583*** (0.005)	0.041*** (0.003)	0.043*** (0.003)	0.045*** (0.003)	0.046*** (0.003)	-0.000 (0.001)	-0.001 (0.001)
Year of birth	-0.007*** (0.001)	-0.012*** (0.001)	0.004*** (0.001)	0.003*** (0.001)	-0.003*** (0.001)	-0.006*** (0.000)	0.001*** (0.000)	0.001*** (0.000)
Father’s age at birth		0.007*** (0.001)		0.003*** (0.000)		0.003*** (0.000)		0.000*** (0.000)
Single parent ^a		-0.244*** (0.008)		-0.134*** (0.004)		-0.063*** (0.004)		0.010*** (0.001)
Stepparent ^b		-0.120*** (0.011)		-0.051*** (0.006)		-0.032*** (0.005)		-0.000 (0.002)
Parental education ^c								
Secondary		0.370*** (0.012)		0.131*** (0.007)		0.103*** (0.006)		-0.006*** (0.002)
Tertiary		0.935*** (0.014)		0.201*** (0.007)		0.412*** (0.006)		-0.009*** (0.002)
Family income ^d		0.000* (0.000)		0.000*** (0.000)		0.000* (0.000)		-0.000 (0.000)
Constant	21.819*** (2.035)	30.168*** (2.013)	-6.759*** (1.174)	-5.809*** (1.174)	7.049*** (1.005)	12.370*** (0.981)	-1.259*** (0.320)	-1.130*** (0.323)
N	85,974	85,974	87,668	87,668	87,706	87,706	88,768	88,768

GPA = Grade point average in compulsory education. DP = disability pension. Standard errors in parentheses.

* $p < 0.05$, ** $p < 0.01$, *** $p < 0.001$. Notes: ^a Child has ever lived (before possible parental death) in a single-parent household at the age of 0–18; ^b Child has ever lived with a stepparent at the age of 0–18; ^c The highest parental education at the age of 0–18; ^d Household income with 1000 percentiles when child was 5–18 years old.

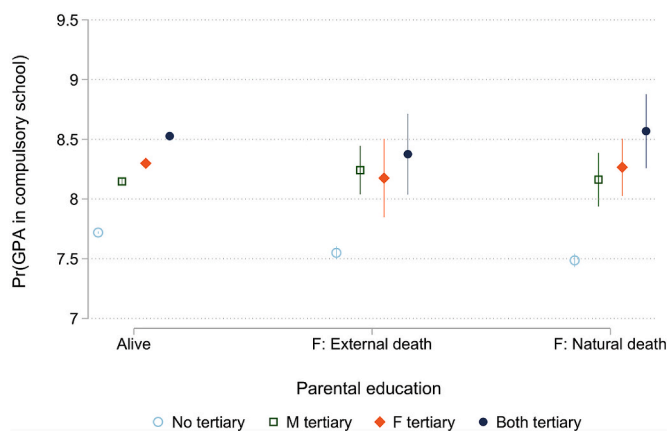


Fig. 1. Linear prediction of GPA in compulsory education by *father's death* and parental education.

associations between cause of parental death and child outcomes vary by parental resources, i.e., income and education. We did not find significant interactions between family income and cause of parental death (Appendix, Tables A5 & A6), indicating that the association does not vary by family income. Next we will show interactions between parental education and cause of death. It should be noted that early parental bereavement was less common in the more educated families (c.f.

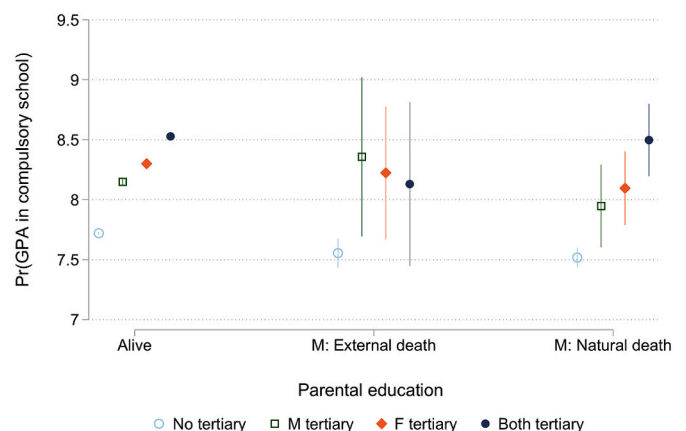


Fig. 2. Linear prediction of GPA in compulsory education by *mother's death* and parental education.

Tables 1 and 2), which widened the confidence intervals in that educational group. The confidence intervals were larger also in maternal deaths due to low number of deaths (N = 838), suggesting that the results on maternal death should be interpreted with caution.

GPA in compulsory education

Interaction analysis between cause of parental death and parental

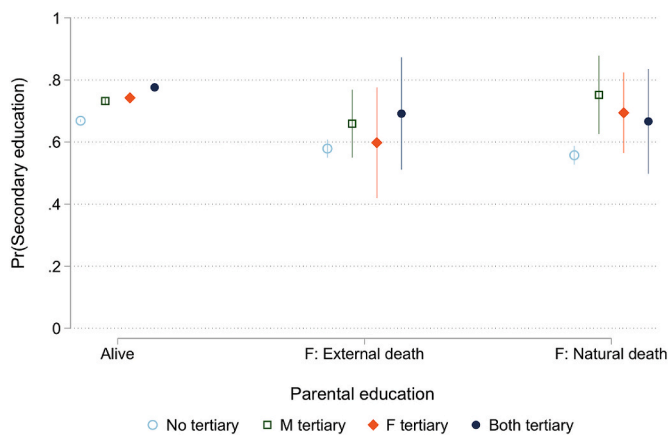


Fig. 3. Predicted probability of secondary education by father's death and parental education.

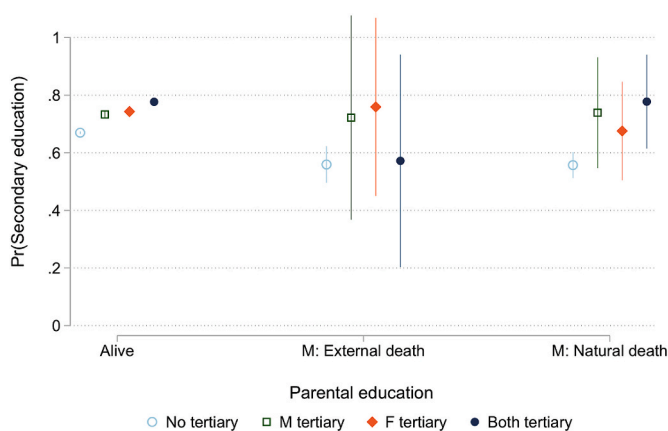


Fig. 4. Predicted probability of secondary education by mother's death and parental education.

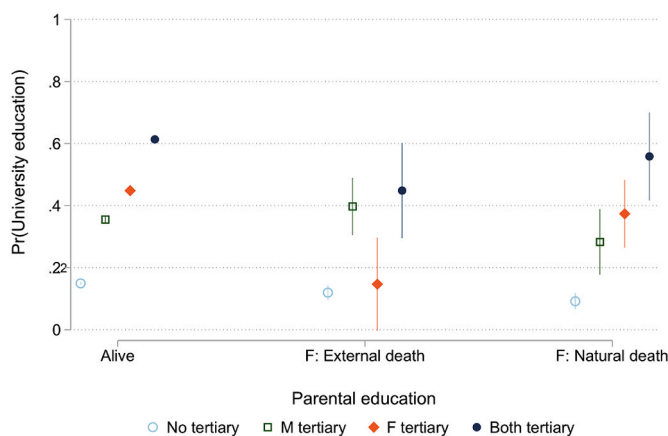


Fig. 5. Predicted probability of university education enrolment by father's death and parental education.

education showed higher GPA from compulsory school (Figs. 1 and 2; estimates in Appendix Tables A7 & A8) after father's and mother's death (external or natural), if one parent or both parents had tertiary education. Parental loss was related to lower GPA if the parents were not tertiary educated. In particular, having two highly educated parents seemed to protect from decreases in GPA after mother's natural death.

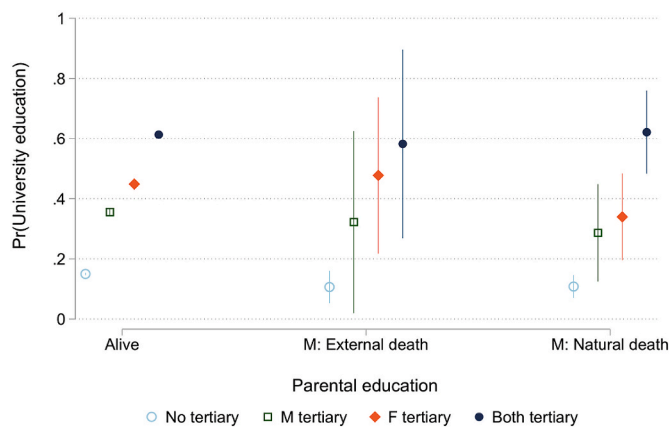


Fig. 6. Predicted probability of university education enrolment by mother's death and parental education.

Secondary education

Similar interaction analysis was performed for the probability to complete secondary education (Figs. 3 and 4; estimates in Appendix Tables A7 & A8). Bereaved children with no tertiary educated parents had a couple of percentage points lower likelihood to have secondary education than the non-bereaved children with no tertiary educated parents, whereas the bereaved children with highly educated parents did not. Moreover, the estimates for external parental death suggested lower education among individuals having tertiary educated parent(s), but the confidence intervals were wide, indicating high uncertainty in the prediction. Thus, the association differed by parental education, but its role did not significantly differ between natural and external causes of death.

University education

Analyses on the interaction between father's death and parental education (Fig. 5; estimates in Appendix Table A7) showed lower probability to attend university after external paternal death compared with a non-bereaved child. Having highly educated surviving mother seemed to protect from some of the negative educational consequences, but not completely in case the both parents had higher education and the father died due to external cause. After maternal death, the results did not show lower university enrolment by cause of death, and the confidence intervals were much overlapping (Fig. 6; estimates in Appendix Table A8). In part, the patterns looked quite similar to those of paternal death.

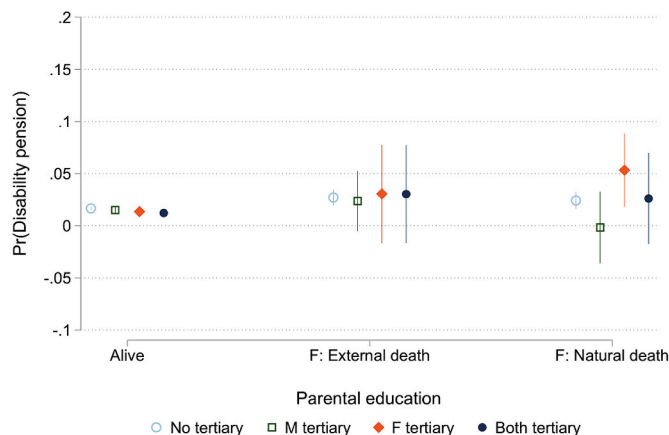


Fig. 7. Predicted probability of disability pension by father's death and parental education.

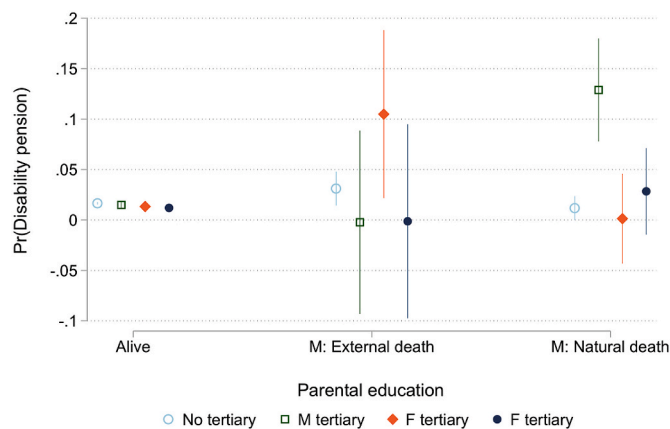


Fig. 8. Predicted probability of disability pension by mother's death and parental education.

Disability pension

According to the interaction analysis between cause of parental death and parental education on disability pension in early adulthood (Figs. 7 and 8; estimates in Appendix Tables A7 & A8), when father died from natural cause, the child was less often on disability pension if the surviving mother had tertiary education, compared to if the mother had lower education. In the case of maternal death, the pattern was similar: if only the mother who died due to natural cause had tertiary education (and the father did not), the child had a higher probability of being on disability pension. Moreover, if the mother died of external cause and the remaining father had tertiary education, the child was more often on disability pension.

To conclude, the *hypothesis 3* on the role of parental resources was partly supported, as children with higher parental resources had better educational outcomes and health than children with lower parental resources, but only if the both parents or at least the surviving parent was highly educated. We also found partial support for *hypothesis 1* and *2*, as in some cases, external causes of death were related to worse child outcomes than natural deaths, when the associations were examined by parental resources.

Additional analyses

We performed several robustness checks and extra analyses. We studied whether a child's age at parental death moderates the link between cause of death and child's education and disability pension, but we did not observe any moderation by age (Appendix Tables A1 & A2). We also found some differences in the outcomes between women and men after maternal but not paternal death (Appendix Tables A3 & A4). Daughters who lost their mother for external causes had less often completed secondary education than sons (Appendix Figure A1). We also found that daughters who lost their mother for external causes were more often on disability pension than sons (Appendix Figure A2). This supports the previous findings proposing that losing a same-sex parent might be more harmful (Buchmann & DiPrete, 2006; Marks et al., 2007).

Discussion

Previous studies have not sufficiently addressed the coexistent role of cause of death and parental resources in an offspring's health and long-term educational performance after early parental loss. This study filled this gap and examined the role of parental education and income in the grade point average (GPA) in compulsory school, in finishing secondary education, in university enrolment, and in receiving disability pension in early adulthood, after parental bereavement by external or natural causes of death.

Parental death had the strongest links with lower GPA and

completing secondary education, and the weakest with university education and DP, which is not surprising, as the bereaved children are older when admitted to the university and have had time to recover from bereavement. The weak associations with DP could be because it measures not only poor mental health but also physical health, which has been, in general, less deteriorated in the bereaved (Maier & Lachman, 2000). Approximately half of the connection between parental death and child's health and educational performance and attainment was explained after adjusting for childhood family characteristics, after which external and natural causes were quite equally adverse.

However, when the results were stratified by parental resources, we often observed less negative child outcomes in families with higher resources. In particular, higher education of the surviving parent seemed to protect from the adversities related to parental death in many cases, which has been reported previously as well (Prix & Erola, 2017). The resources of the remaining parent could also begin to matter more, as it might occur after parental separations (Erola & Jalovaara, 2017). We did not observe any variation in child outcomes by family income, which is consistent with the prior evidence questioning its independent role in child outcomes (Erola et al., 2016; Mayer, 1997).

Our main findings concerning parental resources were the following. *First*, having two highly educated parents was related to smaller decrease in GPA after natural parental death. *Second*, in the case of secondary education, we did not find any variation by parental resources, perhaps because most individuals attain a secondary degree in Finland (Statistics Finland, 2014) and early adverse events thus are less decisive in the first place. However, there was an interesting interaction with gender: daughters who lost their mother by external cause less often completed secondary education than sons. *Third*, we observed lower university enrolment after losing a parent due to external causes, compared with natural causes. This could be explained by a larger quantity of lost or no longer directly available resources in the better off families, such as human capital and support, possibly leading to a steeper decline in educational aspirations and capacities, and health (Maier & Lachman, 2000). However, the surviving parent with higher education appeared to better protect the child from the negative consequences of parental death (including external causes) for university education.

Fourth, we found that if the father died from disease and the mother was highly educated, the child less often ended up on disability pension. In the case of maternal death, the pattern was similar. If the mother who died by natural cause was highly educated but the surviving father was not, the child was more often on disability pension. However, losing a mother for an external cause when the remaining father was highly educated, increased the probability of disability pension. Disability pension can be also a desired outcome, as it might lead to better well-being than before the pension (e.g., Salonen et al., 2019). Disability pension is often a form of rehabilitation for young people, so maybe highly educated parents are more able to seek help for their children in order to recover from the health problems following parental death? We also found that daughters who lost their mother for external causes were more often on disability pension than sons, suggesting that losing a same-sex parent is more harmful for women (Buchmann & DiPrete, 2006; Marks et al., 2007).

The associations between parental death and child's health and education were moderate for both mother's and father's death, even for the external causes of death that are often sudden and traumatic, which is in line with previous findings (on school performance) (Berg et al., 2014). This suggests that safety nets of different kinds are working in Finland and that parental death has a quite limited role in the intergenerational transmission of disadvantages. These findings would more probably replicate in other Nordic countries and welfare states (e.g., Burrell et al., 2020) than in countries where parents and their resources matter more in education and access to health services. However, the results on maternal death should be interpreted with caution due to a lower number of maternal deaths and higher uncertainty in estimation.

On the other hand, the previous overall evidence is inconclusive on how much the parental loss per se matters. For example, the risk for early (and traumatic) death is higher among disadvantaged parents (Berg et al., 2014), while low parental resources also predict poorer health (Reiss, 2013) and lower achievement in the offspring (Erola et al., 2016). Social selection may thus explain some negative outcomes after parental death, which we observed after controlling for parental resources. Unmeasured confounding, such as inherited genetic dispositions, presumably accounts for part of the negative consequences as well. Some studies have made an effort to study (and have found) causal bereavement effects on health (Rostila et al., 2015), controlling also for the existing risk factors prior to death (Kaplou et al., 2010).

A strength of this study is our rich dataset, allowing the analysis of causes of parental death, and a wide range of socio-demographic background characteristics, without problems with non-response or self-selection into the study. However, our data did not allow for measuring biologically inherited characteristics, the quality of parenting or the psychological health of the child, both of which are potential correlates and mechanisms of the (cause of) parental death. In particular, unmeasured confounders, such as inherited abilities or vulnerability to a disease, may influence the cause of parental death, parental resources as well as child outcomes – and thus partly or fully explain their associations. In future, for example the availability of information on inherited genetic dispositions might reduce this potential bias in the estimates. We also look forward to methodological developments in controlling for unobserved family heterogeneity, such as fixed effects estimation (Amato & Anthony, 2014). Unobserved protective factors can also moderate the stress caused by adverse life events, such as high resilience which supports successful coping (Rutter, 1985; Schoon et al., 2004), and the social support from friends and the extended family. In future, further research on how these factors are related to wellbeing after a parental loss is highly encouraged.

Appendix

Table A1

Interaction between cause of *paternal* death and child's age at death on child's education and health. Predicted probabilities from linear random-effects models.

	University	Secondary	GPA	DP
Cause of death (ref. alive)				
External	1.675 (4.518)	-8.755 (5.435)	-9.780 (9.211)	0.430 (1.518)
Natural	1.666 (4.518)	-8.729 (5.435)	-9.768 (9.211)	0.414 (1.518)
Child's age at death	0.103 (0.266)	-0.507 (0.320)	-0.560 (0.542)	0.024 (0.089)
Cause of death (ref. alive) # Child's age at death				
External # Child's age at death	-0.099 (0.266)	0.512 (0.320)	0.572 (0.542)	-0.025 (0.089)
Natural # Child's age at death	-0.101 (0.266)	0.508 (0.320)	0.565 (0.542)	-0.024 (0.089)
Female	0.047*** (0.002)	0.043*** (0.003)	0.583*** (0.005)	-0.001 (0.001)
Year of birth ¹	x	x	x	x
Father's age at birth	0.003*** (0.000)	0.003*** (0.000)	0.007*** (0.001)	0.000*** (0.000)
Single parent ²	-0.062*** (0.004)	-0.134*** (0.004)	-0.240*** (0.008)	0.010*** (0.001)
Stepparent ³	-0.033*** (0.005)	-0.051*** (0.006)	-0.127*** (0.011)	-0.000 (0.002)
Parental education ⁴				
Secondary	0.102*** (0.005)	0.134*** (0.006)	0.371*** (0.012)	-0.007*** (0.002)
Tertiary	0.410*** (0.006)	0.204*** (0.007)	0.938*** (0.013)	-0.009*** (0.002)

(continued on next page)

Conclusions

According to our results, we conclude that the associations between cause of parental death and children's health and education differ by parental resources, and that the higher educated surviving parent may protect from some of the negative consequences after death. The heterogeneous associations of natural and external deaths and the overall family circumstances should be considered when studying children's health and wellbeing after parental loss. The support and help should be targeted to children of parents with low education, and especially to those who lost a parent due to external cause of death.

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Declaration of competing interest

None.

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Table A1 (continued)

	University	Secondary	GPA	DP
Family income ⁵	0.000* (0.000)	0.000*** (0.000)	0.000* (0.000)	-0.000 (0.000)
Constant	10.511* (4.617)	2.884 (5.553)	39.700*** (9.418)	-1.644 (1.551)
N	89,467	89,428	87,676	90,554

Standard errors in parentheses, * $p < 0.05$, ** $p < 0.01$, *** $p < 0.001$.

Notes.

¹ Cohorts born 1982–1990.

² Child has ever lived (before possible parental death) in a single-parent household when 0–18 years old.

³ Child has ever lived with a stepparent when 0–18 years old.

⁴ Dominance i.e. the highest parental education when child was 0–18 years old.

⁵ Household income with 1000 percentiles when child was 5–18 years old. DP = disability pension. GPA = grade point average in compulsory education.

Table A2

Interaction between cause of *maternal* death and child's age at death on child's education and health. Predicted probabilities from linear random-effects models.

	University	Secondary	GPA	DP
Cause of death (ref. alive)				
External	-0.822 (0.549)	-0.445 (0.651)	0.144 (1.149)	0.112 (0.118)
Natural	-0.837 (0.546)	-0.468 (0.648)	-0.120 (1.143)	0.017 (0.117)
Child's age at death	-0.044 (0.032)	-0.016 (0.038)	0.011 (0.067)	0.002 (0.007)
Cause of death (ref. alive) # Child's age at death				
External # Child's age at death	0.048 (0.033)	0.024 (0.039)	-0.018 (0.068)	-0.008 (0.007)
Natural # Child's age at death	0.049 (0.032)	0.025 (0.038)	0.001 (0.068)	-0.001 (0.007)
Female	0.046*** (0.003)	0.043*** (0.003)	0.583*** (0.005)	-0.001 (0.001)
Year of birth ¹	x	x	x	x
Father's age at birth	0.003*** (0.000)	0.003*** (0.000)	0.007*** (0.001)	0.000*** (0.000)
Single parent ²	-0.063*** (0.004)	-0.135*** (0.004)	-0.245*** (0.008)	0.010*** (0.001)
Stepparent ³	-0.032*** (0.005)	-0.051*** (0.006)	-0.120*** (0.011)	-0.000 (0.002)
Parental education ⁴				
Secondary	0.103*** (0.006)	0.131*** (0.007)	0.370*** (0.012)	-0.006*** (0.002)
Tertiary	0.412*** (0.006)	0.201*** (0.007)	0.935*** (0.014)	-0.009*** (0.002)
Family income ⁵	0.000* (0.000)	0.000*** (0.000)	0.000* (0.000)	-0.000 (0.000)
Constant	13.116*** (1.125)	-5.561*** (1.343)	29.953*** (2.318)	-1.156*** (0.344)
N	87,706	87,668	85,974	88,768

Standard errors in parentheses, * $p < 0.05$, ** $p < 0.01$, *** $p < 0.001$.

Notes.

¹ Cohorts born 1982–1990.

² Child has ever lived (before possible parental death) in a single-parent household when 0–18 years old.

³ Child has ever lived with a stepparent when 0–18 years old.

⁴ Dominance i.e. the highest parental education when child was 0–18 years old.

⁵ Household income with 1000 percentiles when child was 5–18 years old. DP = disability pension. GPA = grade point average in compulsory education.

Table A3Interaction between *paternal* death and child's gender on child's education and health. Predicted probabilities from linear random-effects models.

	University	Secondary	GPA	DP
Cause of death (ref. alive)				
External	−0.031* (0.015)	−0.085*** (0.018)	−0.115*** (0.032)	0.016** (0.005)
Natural	−0.068*** (0.016)	−0.111*** (0.019)	−0.239*** (0.035)	0.010 (0.005)
Female	0.046*** (0.003)	0.043*** (0.003)	0.583*** (0.005)	−0.001 (0.001)
Cause of death # Gender				
External #Female	−0.008 (0.021)	−0.010 (0.025)	−0.082 (0.042)	−0.011 (0.007)
Natural # Female	0.017 (0.022)	0.017 (0.026)	0.069 (0.044)	−0.004 (0.007)
Family income ¹	0.000* (0.000)	0.000*** (0.000)	0.000** (0.000)	−0.000 (0.000)
Year of birth ²	x	x	x	x
Father's age at birth	0.002*** (0.000)	0.002*** (0.000)	0.005*** (0.001)	0.000*** (0.000)
Single parent ³	−0.064*** (0.003)	−0.136*** (0.004)	−0.246*** (0.008)	0.010*** (0.001)
Stepparent ⁴	−0.032*** (0.005)	−0.053*** (0.006)	−0.128*** (0.011)	0.000 (0.002)
Parental education (ref: no tertiary)				
Mother tertiary	0.206*** (0.005)	0.065*** (0.007)	0.434*** (0.012)	−0.002 (0.002)
Father tertiary	0.297*** (0.006)	0.074*** (0.007)	0.582*** (0.013)	−0.003 (0.002)
Both tertiary	0.463*** (0.006)	0.108*** (0.007)	0.810*** (0.013)	−0.004* (0.002)
Constant	10.208*** (0.963)	−7.620*** (1.165)	24.336*** (1.995)	−1.143*** (0.323)
N	89,366	89,329	87,586	90,423

Standard errors in parentheses, * $p < 0.05$, ** $p < 0.01$, *** $p < 0.001$.

Notes.

¹ Household income with 1000 percentiles when child was 5–18 years old.² Cohorts born 1982–1990.³ Child has ever lived (before possible parental death) in a single-parent household when 0–18 years old.⁴ Child has ever lived with a stepparent when 0–18 years old. DP = disability pension. GPA = grade point average in compulsory education.**Table A4**

Interaction between cause of maternal death and child's gender on child's education and health. Predicted probabilities from linear random-effects models.

	University	Secondary	GPA	DP
Cause of death (ref. alive)				
External	−0.005 (0.034)	−0.039 (0.041)	−0.092 (0.073)	−0.004 (0.011)
Natural	−0.032 (0.023)	−0.108*** (0.028)	−0.201*** (0.049)	0.008 (0.008)
Female	0.046*** (0.003)	0.043*** (0.003)	0.583*** (0.005)	−0.001 (0.001)
Cause of death # Gender				
External #Female	−0.073 (0.047)	−0.141* (0.057)	−0.144 (0.098)	0.042** (0.016)
Natural # Female	−0.024	0.021	0.018	−0.014

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Table A4 (continued)

	University	Secondary	GPA	DP
	(0.032)	(0.039)	(0.064)	(0.011)
Family income ¹	0.000* (0.000)	0.000*** (0.000)	0.000** (0.000)	-0.000* (0.000)
Year of birth ²	x	x	x	x
Father's age at birth	0.002*** (0.000)	0.002*** (0.000)	0.005*** (0.001)	0.000*** (0.000)
Single parent ³	-0.065*** (0.004)	-0.137*** (0.004)	-0.251*** (0.008)	0.010*** (0.001)
Stepparent ⁴	-0.030*** (0.005)	-0.052*** (0.006)	-0.120*** (0.011)	-0.000 (0.002)
Parental education (ref: no tertiary)				
Mother tertiary	0.206*** (0.006)	0.064*** (0.007)	0.428*** (0.012)	-0.001 (0.002)
Father tertiary	0.298*** (0.006)	0.074*** (0.007)	0.580*** (0.013)	-0.003 (0.002)
Both tertiary	0.464*** (0.006)	0.108*** (0.007)	0.808*** (0.013)	-0.004* (0.002)
Constant	10.269*** (0.975)	-7.664*** (1.174)	24.283*** (2.012)	-1.037** (0.323)
N	87,678	87,642	88,708	85,955

Standard errors in parentheses, * $p < 0.05$, ** $p < 0.01$, *** $p < 0.001$.

Notes.

¹ Household income with 1000 percentiles when child was 5–18 years old.

² Cohorts born 1982–1990.

³ Child has ever lived (before possible parental death) in a single-parent household when 0–18 years old.

⁴ Child has ever lived with a stepparent when 0–18 years old. DP = disability pension. GPA = grade point average in compulsory education.

Table A5

Interaction between *paternal* death and family income on child's education and health. Predicted probabilities from linear random-effects models.

	University	Secondary	GPA	DP
Cause of death (ref: alive)				
External	-0.012 (0.023)	-0.077** (0.028)	-0.085 (0.051)	0.012 (0.007)
Natural	-0.079** (0.025)	-0.102*** (0.030)	-0.193*** (0.056)	-0.005 (0.008)
Family income ^a	0.000* (0.000)	0.000*** (0.000)	0.000** (0.000)	-0.000 (0.000)
Cause of death (ref: alive) # Family income ^a				
External # Family income	-0.000 (0.000)	-0.000 (0.000)	-0.000 (0.000)	-0.000 (0.000)
Natural # Family income	0.000 (0.000)	-0.000 (0.000)	-0.000 (0.000)	0.000 (0.000)
Female	0.046*** (0.002)	0.043*** (0.003)	0.583*** (0.005)	-0.001 (0.001)
Year of birth ²	x	x	x	x
Father's age at birth	0.002*** (0.000)	0.002*** (0.000)	0.005*** (0.001)	0.000*** (0.000)
Single parent ³	-0.064*** (0.003)	-0.136*** (0.004)	-0.246*** (0.008)	0.010*** (0.001)
Stepparent ⁴	-0.032*** (0.005)	-0.053*** (0.006)	-0.128*** (0.011)	0.000 (0.002)
Parental education (ref: no tertiary)				
Mother tertiary	0.206*** (0.005)	0.065*** (0.007)	0.434*** (0.012)	-0.002 (0.002)

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Table A5 (continued)

	University	Secondary	GPA	DP
Father tertiary	0.297*** (0.006)	0.074*** (0.007)	0.582*** (0.013)	-0.003 (0.002)
Both tertiary	0.463*** (0.006)	0.108*** (0.007)	0.810*** (0.013)	-0.004* (0.002)
Constant	10.211*** (0.963)	-7.622*** (1.165)	24.319*** (1.995)	-1.141*** (0.323)
N	89,366	89,329	87,586	90,423

Standard errors in parentheses, * $p < 0.05$, ** $p < 0.01$, *** $p < 0.001$.

Notes.

^a Household income with 1000 percentiles when child was 5–18 years old.

^b Cohorts born 1982–1990.

^c Child has ever lived (before possible parental death) in a single-parent household when 0–18 years old.

^d Child has ever lived with a stepparent when 0–18 years old. DP = disability pension. GPA = grade point average in compulsory education.

Table A6

Interaction between *maternal* death and family income on child's education and health. Predicted probabilities from linear random-effects models.

	University	Secondary	GPA	DP
Cause of death (ref: alive)				
External	-0.037 (0.048)	-0.124* (0.057)	-0.102 (0.107)	0.017 (0.015)
Natural	-0.057 (0.037)	-0.151*** (0.044)	-0.194* (0.079)	0.029* (0.011)
Family income ¹	0.000* (0.000)	0.000*** (0.000)	0.000** (0.000)	-0.000 (0.000)
Cause of death (ref: alive) # Family income ¹				
External # Family income	-0.000 (0.000)	0.000 (0.000)	-0.000 (0.000)	-0.000 (0.000)
Natural # Family income	0.000 (0.000)	0.000 (0.000)	0.000 (0.000)	-0.000 (0.000)
Female	0.046*** (0.003)	0.043*** (0.003)	0.583*** (0.005)	-0.001 (0.001)
Year of birth ²	x	x	x	x
Father's age at birth	0.002*** (0.000)	0.002*** (0.000)	0.005*** (0.001)	0.000*** (0.000)
Single parent ³	-0.065*** (0.004)	-0.137*** (0.004)	-0.251*** (0.008)	0.010*** (0.001)
Stepparent ⁴	-0.030*** (0.005)	-0.052*** (0.006)	-0.120*** (0.011)	-0.000 (0.002)
Parental education (ref: no tertiary)				
Mother tertiary	0.206*** (0.006)	0.064*** (0.007)	0.428*** (0.012)	-0.001 (0.002)
Father tertiary	0.298*** (0.006)	0.074*** (0.007)	0.580*** (0.013)	-0.003 (0.002)
Both tertiary	0.464*** (0.006)	0.108*** (0.007)	0.808*** (0.013)	-0.004* (0.002)
Constant	10.275*** (0.975)	-7.666*** (1.174)	24.293*** (2.012)	-1.036** (0.323)
N	87,678	87,642	85,955	88,708

Standard errors in parentheses, * $p < 0.05$, ** $p < 0.01$, *** $p < 0.001$.

Notes.

¹ Household income with 1000 percentiles when child was 5–18 years old.

² Cohorts born 1982–1990.

³ Child has ever lived (before possible parental death) in a single-parent household when 0–18 years old.

⁴ Child has ever lived with a stepparent when 0–18 years old. DP = disability pension. GPA = grade point average in compulsory education.

Table A7Interaction between cause of *paternal* death and parental education on child's education and health. Predicted probabilities from linear random-effects models.

	University	Secondary	GPA	DP
Cause of death (ref: alive)				
External	-0.030* (0.012)	-0.090*** (0.014)	-0.170*** (0.027)	0.010** (0.004)
Natural	-0.058*** (0.013)	-0.111*** (0.015)	-0.233*** (0.028)	0.008 (0.004)
Parental education (ref: no tertiary)				
Mother tertiary	0.206*** (0.006)	0.064*** (0.007)	0.428*** (0.012)	-0.002 (0.002)
Father tertiary	0.299*** (0.006)	0.074*** (0.007)	0.580*** (0.013)	-0.003 (0.002)
Both tertiary	0.464*** (0.006)	0.108*** (0.007)	0.808*** (0.013)	-0.004* (0.002)
Cause of death (ref: alive) # parental education (ref: no tertiary)				
External # Mother tertiary	0.072 (0.048)	0.017 (0.057)	0.265* (0.106)	-0.002 (0.015)
External # Father tertiary	-0.272*** (0.077)	-0.055 (0.092)	0.046 (0.169)	0.007 (0.024)
External # Both tertiary	-0.135 (0.079)	0.006 (0.093)	0.019 (0.174)	0.008 (0.024)
Natural # Mother tertiary	-0.015 (0.055)	0.131* (0.066)	0.248* (0.117)	-0.024 (0.018)
Natural # Father tertiary	-0.017 (0.057)	0.063 (0.068)	0.200 (0.125)	0.032 (0.018)
Natural # Both tertiary	0.003 (0.073)	0.002 (0.087)	0.275 (0.160)	0.006 (0.023)
Female	0.046*** (0.002)	0.043*** (0.003)	0.583*** (0.005)	-0.001 (0.001)
Year of birth ¹	x	x	x	x
Father's age at birth	0.002*** (0.000)	0.002*** (0.000)	0.005*** (0.001)	0.000*** (0.000)
Single parent ²	-0.064*** (0.003)	-0.136*** (0.004)	-0.246*** (0.008)	0.010*** (0.001)
Stepfather ³	-0.032*** (0.005)	-0.053*** (0.006)	-0.128*** (0.011)	0.000 (0.002)
Family income ⁴	0.000* (0.000)	0.000*** (0.000)	0.000** (0.000)	-0.000 (0.000)
Constant	10.230*** (0.963)	-7.620*** (1.165)	24.309*** (1.995)	-1.148*** (0.323)
N	89,366	89,329	87,586	90,423

Standard errors in parentheses, *p < 0.05, **p < 0.01, ***p < 0.001.

Notes.

¹ Cohorts born 1982–1990.² Child has ever lived (before possible parental death) in a single-parent household when 0–18 years old.³ Child has ever lived with a stepparent when 0–18 years old.⁴ Household income with 1000 percentiles when child was 5–18 years old. DP = disability pension. GPA = grade point average in compulsory education.**Table A8**Interaction between cause of *maternal* death and parental education on child's education and health. Predicted probabilities from linear random-effects models.

	University	Secondary	GPA	DP
Cause of death (ref: alive)				
External	-0.043 (0.027)	-0.110*** (0.032)	-0.167** (0.060)	0.015 (0.008)

(continued on next page)

Table A8 (continued)

	University	Secondary	GPA	DP
Natural	-0.042* (0.019)	-0.112*** (0.023)	-0.203*** (0.041)	-0.005 (0.006)
Parental education (ref. no tertiary)				
Mother tertiary	0.206*** (0.006)	0.063*** (0.007)	0.428*** (0.012)	-0.002 (0.002)
Father tertiary	0.299*** (0.006)	0.074*** (0.007)	0.579*** (0.013)	-0.003 (0.002)
Both tertiary	0.464*** (0.006)	0.107*** (0.007)	0.807*** (0.013)	-0.005* (0.002)
Cause of death (ref. alive) # parental education (ref. no tertiary)				
External # Mother tertiary	0.010 (0.156)	0.099 (0.183)	0.375 (0.343)	-0.032 (0.047)
External # Father tertiary	0.072 (0.135)	0.126 (0.160)	0.090 (0.286)	0.077 (0.043)
External # Both tertiary	0.012 (0.162)	-0.094 (0.191)	-0.231 (0.353)	-0.028 (0.050)
Natural # Mother tertiary	-0.027 (0.084)	0.119 (0.100)	0.001 (0.180)	0.119*** (0.027)
Natural # Father tertiary	-0.067 (0.076)	0.045 (0.090)	-0.002 (0.161)	-0.007 (0.023)
Natural # Both tertiary	0.050 (0.073)	0.113 (0.086)	0.172 (0.158)	0.021 (0.023)
Female	0.046*** (0.003)	0.042*** (0.003)	0.583*** (0.005)	-0.001 (0.001)
Year of birth ¹	x	x	x	x
Father's age at birth	0.002*** (0.000)	0.002*** (0.000)	0.005*** (0.001)	0.000*** (0.000)
Single parent ²	-0.065*** (0.004)	-0.137*** (0.004)	-0.251*** (0.008)	0.010*** (0.001)
Stepfather ³	-0.030*** (0.005)	-0.052*** (0.006)	-0.120*** (0.011)	-0.000 (0.002)
Family income ⁴	0.000* (0.000)	0.000*** (0.000)	0.000** (0.000)	-0.000* (0.000)
Constant	10.275*** (0.975)	-7.665*** (1.174)	24.279*** (2.012)	-1.034** (0.323)
N	87,678	87,642	85,955	88,708

Standard errors in parentheses, * $p < 0.05$, ** $p < 0.01$, *** $p < 0.001$.

Notes.

¹ Cohorts born 1982–1990.

² Child has ever lived (before possible parental death) in a single-parent household when 0–18 years old.

³ Child has ever lived with a stepparent when 0–18 years old.

⁴ Household income with 1000 percentiles when child was 5–18 years old. DP = disability pension. GPA = Grade point average from compulsory education.

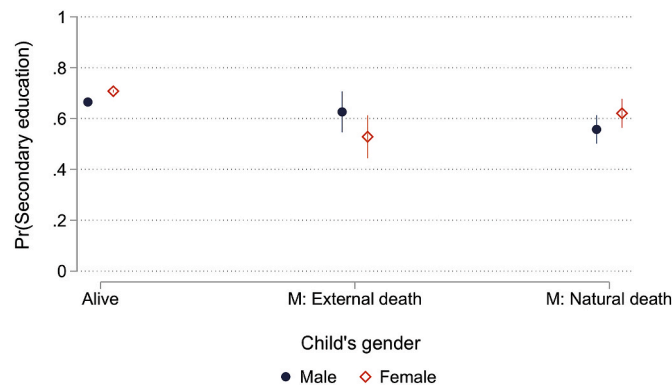


Fig. A1. Interaction between cause of maternal death and child's gender on child's secondary education. Predicted probabilities from linear random-effects models.

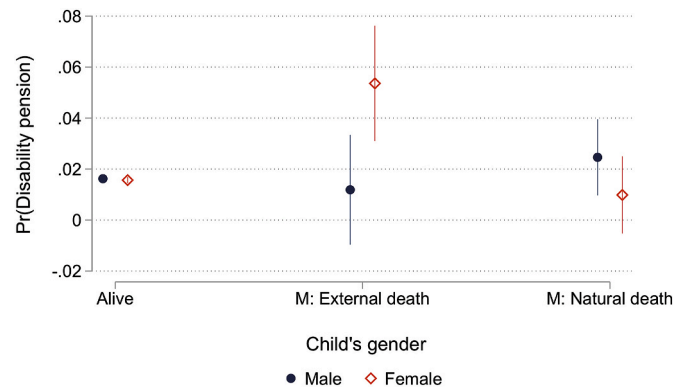


Fig. A2. Interaction between cause of maternal death and child's gender on child's disability pension. Predicted probabilities from linear random-effects models.

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