Was Cinderella Just a Fairy Tale? Survival Differences between Step and Biological Children.

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Abstract

Parents must make decisions about how to allocate finite resources to their children. Because time and energy are limited, some offspring may garner more resources than their siblings. To better understand how parents make allocation decisions, as well as their consequences, the presence of step-children in a household provides an opportunity to compare how their well-being compares to non-stepchildren. Stepchildren face a number of stressors through parental marital dissolution, parental remarriage, and changes in parenting due to the arrival of step-parents and step/half-siblings in a newly reconstituted family. This analysis targets whether step-children have poorer survival in relation to offspring of intact parental marriages. We first assess the effect of parental death on child survival in the Utah Population Database (UPDB) for individuals born between 1847-1940. Cox proportional hazard models for mortality between 28 days and 18 years of age were used on a sample of 211,349 boys and 202,545 girls in the UPDB. Our models show that maternal, but not paternal, death is significantly associated with excess mortality for both sons and daughters. Next, we restrict the comparison to individuals who became stepchildren and those who did not. We find that it is stepchildren who have lower rates of mortality. When we specifically look at which parent died, we find that regardless of the gender of the remarrying parent, stepchildren have lower mortality risks than non-stepchildren. Lastly, we further elaborate on this model and compare half-siblings to each other using fixed effects models. With this more aggressive control for unobserved heterogeneity, where we require early survival experiences to cover the same ages, we continue to observe a benefit of the stepchild, but primarily when the deceased parent is the mother. In summary, the loss of a parent, the arrival of stepparents, and the birth of half-siblings all affect stepchild survival: we see pernicious effects of parental death yet beneficial effects of parental remarriage and the production of half-siblings.

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Introduction

Children that experience parental loss also experience a suite of well-documented negative outcomes. These include lower educational attainment, greater involvement in criminal or delinquent activities, and elevated levels of poverty in both childhood and adulthood. There are a number of reasons behind these adverse outcomes, however economic instability coupled with reduced levels of parental care in parental loss households seem to be key drivers. While remarriage by the remaining parent is one way to mediate the negative effects of parental loss, these gains may be overshadowed by the potential costs due to the introduction of a stepparent into the household. This new family also often includes additional children (stepsiblings) who too require resources and attention from parents. Thus, because not all new family members are related, conflict within the household over resource allocation is likely, resulting in mortality differentials possibly emerging in step-structured households.

To understand why child outcomes might be sensitive to levels of relatedness within the household, evolutionary-oriented research targets patterning in parental expenditure in ways predicted to maximize inclusive fitness. In particular, parents are expected to prioritize investments in their biological children. In support of this, stepchildren have been shown to experience higher rates of abuse, neglect, and mortality than children in households with two biological parents (dubbed the "Cinderella Effect"; Daly & Wilson 1998). However, these results are not robust across place and have not been found to consistently replicate. For example, a seminal study on stepchild outcomes found that stepchildren received investment from their stepfathers proportional to their half-siblings. The researchers highlighted that investments in non-biological children can also be fitness enhancing and serve to signal relationship commitment to a partner in order to help maintain a second marriage (which are often more fragile than first marriages).

Here we seek to answer this open question in the literature. Specifically, do stepchildren experience more adverse outcomes compared to others that never lost a parent or instead does remarriage and the presence of a stepparent serve a protective effect?

Analyses are divided into three distinct approaches to answer very specific aspects of stepchild survival. First, and in order to compare our results to analyses of historic Canadian and German families (Willführ & Gagnon 2013), we identify all children in the UPDB who experience a parental death in childhood and compare them to children who did not, while controlling for potential confounders. This initial analysis is important because the death of a parent is the dominant reason for an individual to become a stepchild for the period under study here: a parent dies, the surviving parent remarries with his or her children, these existing children are now stepchildren to the new parent, and then half-siblings may be produced. This sequence of events, as observed in the UPDB, provide several opportunities to understand the survival of stepchildren. For this first set of analyses, the question is simply whether children who experienced the death of a parent in childhood face worse survival in relation to children who did not net of other confounding factors.

The second phase of the analysis focuses exclusively on the subset of egos whose parents died when these egos were children. Our attention here is on the role of remarriage and its influence on the survival of these two sets of bereaved children. Put simply, egos with a widowed parent may see that parent remarry or not. Our question is whether remarriage affects the survival of these children.

In the third portion of the analysis we make survival comparisons between sibling types. This requires that we identify all egos who became stepchildren, half-siblings who were born to parents from a second marriage but where one parent is common to the stepchild (half-sibling), as well as step-siblings who accompanied the new parent and who have no genetic relationship to the original stepchild. These models are performed in two distinct ways. The first is where we compare all stepchildren to all other children in the household. The second is where we focus explicitly on pairs of half-siblings.

Methods

In this study, we use the Utah Population Database (UPDB) to examine the relationship between the status of being a stepchild or a full biological child in its relationship to survival. This analysis is performed in three stages as described: a parental loss analysis, a remarriage analysis, and a within-family sibling comparison analysis. The UPDB is housed at the Huntsman Cancer Institute at the University of Utah and is a unique and comprehensive source of in-depth information on individuals and families that supports research on genetics, epidemiology, demography, and public health. The central component of the UPDB is an extensive set of Utah genealogies, in which family members are linked to demographic and medical information. The genealogies are based on a combination of original genealogical data of the founders and descendants of the state of Utah derived from the Genealogical Society of Utah and extensive use of birth certificates derived from the Utah state vital record system. In this study, we use data from individuals who were born between 1847 and 1940 and assess their survival probabilities across the three types of analyses.

Results

Parental loss models.

The broader question posed in this study deals with the well-being and survival of stepchildren. The precipitating event which creates the circumstances for step-childhood for the era in which we are investigating is the death of a parent while the ego is still a child. Accordingly we examine here the effect of parental death on child survival. Table 1 provides descriptive statistics for the sample comprising N(females) = 202,545 and N(males) = 211,349. Approximately 9% of these children experienced the death of their father prior to age 18 while the comparable figure for mothers is roughly 6%.

Table 2 summarizes sex-specific Cox regression models for childhood mortality between the ages of 28 days and 18 years of age. We did not include the first month of life as part of the follow up. In order to focus on mortality that was not the immediate consequence of maternal mortality. Parental mortality for these models are treated as time varying covariates. In general these models indicate that for both sons and daughters the death of a mother is associated with excess mortality before age 18 in relation to offspring whose mother was still alive over this interval. No similar significant effects were found for paternal mortality.

Parental remarriage models

The next phase of the analysis includes only those children who lost a parent to death prior to age 18. In **Tables 3 and 4** we show sex-specific results (of the offspring) for father death/mother remarriage and mother death/father remarriage models, respectively. Again these Cox regression results treat a remarriage event is a time varying covariates. We find no evidence that a child's gender or the gender of the remarrying parent affects child survival.

Models comparing stepchild and biological children within families

A useful model for comparing the survival chances of stepchildren versus biological offspring of parents is the use of fixed effects models where the step and biological children are contrasted within a family. This specification is attractive because it allows us to isolate the survival differences between these two types of children while simultaneously controlling for common characteristics shared between them such as parental and family traits. In general, the sample for these models require that children experienced the death of one parent and the remarriage of the surviving parent. Once the stepparent joins the newly constituted family, the existing children accompanying the widowed parent become the stepchildren. It is indeed possible for both parents in the new marriage to bring existing children but certainly it may be only one parent who does so. It is also commonplace for the new marriage to lead to newly born children. The distribution of these various types of family transitions are summarized in **Table 5.** Since we adopt fixed-effects models the number of potential confounders that we introduce into the analysis is quite minimal since the number of stable characteristics are potentially very large but need to be explicitly considered with a fixed-effects specification. **Table 6** provides basic descriptive statistics for the samples used for the within-family analyses.

The first set of results are again Cox regression models where there are both stepchildren and biological children within the family. Here we structure the file so that we can group all sibships that contain both step and biological children within a given family and then use stratified Cox regressions (survival models with fixed-effects). In **Table 7** we show results that indicate that, within the same family, stepchildren have lower rates of mortality than their half-siblings and the protective effects of being a stepchild are comparable whether it was the mother or the father who was the surviving parent. One of the artifactual aspects of this specification is that the sequence of first marriage, offspring birth, parental death, remarriage, and new offspring birth means that the children from the first marriage are going to be older, by definition, then the children born from the newly formed (second) marriage. As we constructed the file we required that the children born from the first marriage who later become the stepchildren had to survive long enough to be present when children from a second marriage were born so that parents are faced with resource allocation questions between the two types of children. This requirement means that the children from the first marriage have a mortality hazard rate of zero since they must live to the time when their half-siblings are born.

To improve the within-family model specification, we imposed a more stringent criteria where we compare the last-born child from the first/original marriage to the first-born child from the newly constituted marriage; the former being the stepchild (to the new parent) and the latter being the "biological" child (of the newly formed, second marriage). We further required that the comparison of mortality would be restricted to those years where both had to have live to a minimum age. For example, if the stepchild live to five years of age when the biological child was born, then we would compare the mortality experience between these two individuals within the family from age five onward were both would be equally exposed to the risk of mortality. This "exposure alignment" is the basis of the sample used to conduct the final set of analyses. Descriptive statistics for this refined sample is shown in **Table 8.**

Table 9a shows that stepchildren have better survival than the biological children (after exposure alignment) irrespective of which parent is the common parent linking the stepchildren to the biological children (See **Figure 1**). In **Table 9b**, we find that stepchildren with a new stepmother (the shared parent is the father) have better survival in relation to their half-siblings; this advantage is larger than those cases where stepchildren have a new stepfather (the shared parent is the mother). In other words, the new stepmother affords a survival advantage rather than a disadvantage to the stepchildren, an association not consistent with the Cinderella-Effect (Daly & Wilson 1988). Note that for these data we have more instances where it is the mother who initially dies which then leads to the new stepmother, and fewer cases where it is the father who initially dies. The differential sample sizes reflect the hazards of maternal mortality for certain decades examined here in which affect the power of the analyses examining survival prospects of stepchildren where it was the father who died initially.

Summary

We posed three related and fundamental questions in this study regarding the survival of offspring. First, we asked whether parental death experience in childhood altered the survival prospects of children under age 18. From our analyses we would answer that exposure to this particular stressor is indeed associated with elevated mortality risk in childhood. Second, we examined whether remarriage among the surviving parent was associated with altered offspring mortality schedules. We concluded that remarriage by the surviving parent was not significantly associated with mortality rest of the offspring. And finally, we posed our central question which was whether mortality risks differed between half-siblings (a stepchild and a full biological child of a couple) within a given family. Our conclusion here is that stepchildren enjoy higher survival probabilities than their half-siblings within the same family, particularly if the parent that connects the two siblings is a common father (i.e., it was initially the mother's death that led to the blended family).

We initially discussed possible mechanism and predictions about which type of child would benefit more: the stepchild or the biological child. Our preliminary findings are consistent with the idea that investments in stepchildren can promote fitness and may be a demonstration by the stepparent that they are committed to the new union, especially following their partner's travails associated with the death of their first spouse.

In our final paired fixed-effects survival models, it is important to note that the sample constructed required invoking several constraints to maximize the rigor in the comparisons made. In particular, for a stepchild and a half-siblings to be compared within a family it requires that following the death of the first parent, the surviving parent must live long enough to remarry and reproduce with a new partner and that the original offspring from the first marriage also had to survive. It is possible therefore, that the survival advantage that we detect among stepchildren is a reflection of their robust nature as well as their parents' that is implied by their endurance and capacity to move on to the formation of a second family. At this point it is not yet possible to differentiate this mortality survival selection mechanism from positive behaviors by the stepparent which demonstrate crucial levels of commitment and resources that serve to benefit differentially the stepchild over the newly arrived offspring from the parents in the newly constituted second marriage.

Table 1: Descriptive statistics by gender

	Female (N = 202,545)	Male (N = 211,349)
Died before age 18	21432 (10.6%)	23646 (11.2%)
Follow up time to age 18 (months)	200.0 ± 51.6	198.1 ± 54.7
Birth year	1905.4 ± 22.6	1905.6 ± 22.7
Birth order	4.3 ± 2.9	4.3 ± 2.9
Birth order (categories)		
- 1	35117 (17.3%)	36948 (17.5%)
- 2	33203 (16.4%)	34304 (16.2%)
- 3-5	73911 (36.5%)	77562 (36.7%)
- 6-8	40217 (19.9%)	42085 (19.9%)
- 9-11	16504 (8.1%)	16834 (8.0%)
- 12+	3593 (1.8%)	3616 (1.7%)
Father's LDS status		
- Active	129132 (63.8%)	134837 (63.8%)
- Inactive	50545 (25.0%)	52670 (24.9%)
- Unknown	22868 (11.3%)	23842 (11.3%)
Mother LDS status		
- Active	133678 (66.0%)	139525 (66.0%)
- Inactive	53169 (26.3%)	54960 (26.0%)
- Unknown	15698 (7.8%)	16864 (8.0%)
Number of full siblings	7.8 ± 3.2	7.8 ± 3.1
Father died before age 18	17881 (8.8%)	18660 (8.8%)
Mother remarried before age 18	1294 (0.6%)	1254 (0.6%)
Half-brother born before age 18	666 (0.3%)	641 (0.3%)
Half-sister born before age 18	655 (0.3%)	661 (0.3%)
Number of mother's stepsons alive*	0.0 ± 0.2	0.0 ± 0.2
Number of mother's stepsons died*	0.0 ± 0.1	0.0 ± 0.1
Number of mother's stepdaughters alive*	0.0 ± 0.2	0.0 ± 0.2
Number of mother's stepdaughters died*	0.0 ± 0.0	0.0 ± 0.1
Mother died after father's death before age 18	826 (0.4%)	755 (0.4%)
Mother died before age 18	11961 (5.9%)	12034 (5.7%)
Father remarried before age 18	3610 (1.8%)	3746 (1.8%)
Half-brother born before age 18	2593 (1.3%)	2703 (1.3%)
Half-sister born before age 18	2609 (1.3%)	2719 (1.3%)
Number of father's stepsons alive*	0.0 ± 0.2	0.0 ± 0.2
Number of father's stepsons died*	0.0 ± 0.1	0.0 ± 0.1
Number of father's stepdaughters alive*	0.0 ± 0.2	0.0 ± 0.2
Number of father's stepdaughters died*	0.0 ± 0.0	0.0 ± 0.1
Have an older brother at least 7 when pa/ma died	7818 (3.9%)	7832 (3.7%)
Have an older sister at least 7 when pa/ma died	7726 (3.8%)	7946 (3.8%)
Father died after mother's death before age 18	1003 (0.5%)	1041 (0.5%)

*At the time when father/mother remarried

Table 2: Cox models of mortality from 28 days to 18 years (parental loss models) using time-varying dataset

	Daughters							Sons						
N individuals	202545							211349						
N failures	21432							23646						
N episodes	239440							248733						
Model characteristics														
LR chi2	3752							3866						
Prob > chi	< 0.001							< 0.001						
	Coef	SE	Z	P	HZ	LL	UL	Coef	SE	Z	P	HZ	LL	UL
Birth cohort (centered)	-0.36	0.01	-52.65	0.000	0.69	0.68	0.70	-0.35	0.01	-53.95	0.000	0.70	0.69	0.71
- Interaction with age	0.00	0.00	5.46	0.000	1.00	1.00	1.00	0.00	0.00	3.80	0.000	1.00	1.00	1.00
Birth order (centered)	0.13	0.01	19.18	0.000	1.14	1.12	1.15	0.13	0.01	20.36	0.000	1.14	1.13	1.16
- Interaction with age	0.00	0.00	1.45	0.146	1.00	1.00	1.00	0.00	0.00	-1.43	0.154	1.00	1.00	1.00
Father LDS status: Inactive vs Active	0.05	0.03	1.59	0.112	1.05	0.99	1.11	0.04	0.03	1.38	0.169	1.04	0.98	1.10
Father LDS status: Unknown vs Active	0.11	0.03	3.39	0.001	1.12	1.05	1.20	-0.01	0.03	-0.22	0.828	0.99	0.93	1.06
Mother LDS status: Inactive vs Active	0.03	0.03	0.88	0.377	1.03	0.97	1.09	0.03	0.03	1.21	0.225	1.03	0.98	1.09
Mother LDS status: Unknown vs Active	-0.03	0.03	-0.94	0.348	0.97	0.90	1.04	-0.04	0.03	-1.10	0.270	0.96	0.90	1.03
Mother dies	**0.45**	**0.08**	**5.21**	**0.000**	**1.57**	**1.32**	**1.86**	**0.69**	**0.08**	**7.91**	**0.000**	**1.99**	**1.68**	**2.35**
- Interaction with age	**0.00**	**0.00**	**-1.72**	**0.085**	**1.00**	**1.00**	**1.00**	**0.00**	**0.00**	**-3.70**	**0.000**	**1.00**	**0.99**	**1.00**
Father remarries	0.01	0.16	0.05	0.963	1.01	0.73	1.39	-0.43	0.25	-1.58	0.115	0.65	0.38	1.11
- Interaction with age	-	-	-	-	-	-	-	0.00	0.00	1.71	0.087	1.00	1.00	1.01
Birth of male half sibling[1]	-0.17	0.19	-0.90	0.368	0.85	0.59	1.22	-0.04	0.19	-0.23	0.817	0.96	0.66	1.39
Birth of female half sibling[1]	-0.07	0.19	-0.37	0.708	0.93	0.64	1.35	-0.13	0.19	-0.67	0.503	0.88	0.61	1.27
Stepmother's sons alive	-0.01	0.05	-0.17	0.865	0.99	0.89	1.10	-0.04	0.05	-0.88	0.379	0.96	0.87	1.05
- Interaction with age	0.00	0.00	-1.34	0.180	1.00	1.00	1.00	-	-	-	-	-	-	-
Stepmother's daughters alive	0.03	0.05	0.48	0.629	1.03	0.92	1.14	-0.01	0.04	-0.17	0.866	0.99	0.90	1.09
Father dies	**0.08**	**0.05**	**1.61**	**0.107**	**1.09**	**0.98**	**1.20**	**0.02**	**0.05**	**0.35**	**0.723**	**1.02**	**0.92**	**1.13**
Mother remarries	0.02	0.29	0.06	0.955	1.02	0.55	1.87	-0.06	0.30	-0.21	0.836	0.94	0.51	1.73
Birth of male half sibling[2]	0.23	0.35	0.59	0.555	1.26	0.58	2.75	0.39	0.36	1.15	0.251	1.47	0.76	2.86
Birth of female half sibling[2]	-0.15	0.36	-0.39	0.700	0.86	0.40	1.86	-0.29	0.36	-0.85	0.394	0.75	0.38	1.46
Stepfather's sons alive	-0.01	0.05	-0.25	0.803	0.99	0.88	1.10	0.05	0.04	1.12	0.261	1.05	0.97	1.13
- Interaction with age	0.00	0.00	-1.90	0.058	1.00	0.99	1.00	-	-	-	-	-	-	-
Stepfather's daughters alive	-0.03	0.05	-0.57	0.571	0.97	0.89	1.07	0.06	0.05	1.39	0.165	1.06	0.98	1.15

Note: If the proportional hazards assumption is not fulfilled for a predictor, the interaction of this predictor with time (age) is given in an extra line. [2]From the same mother; [1]from the same father.

Table 3: Cox models of mortality from 28 days to 18 years (mother's remarriage models) using time-varying dataset

	Daughters							Sons						
N individuals	16230							16811						
N failures	552							446						
N episodes	19340							19756						
Model characteristics														
LR chi2	73.71							41.95						
Prob > chi	< 0.001							0.003						
	B	SE	Z	P	HRR	LL	UL	B	SE	Z	P	HRR	LL	UL
Birth cohort (centered)	-0.32	0.09	-3.80	0.000	0.72	0.61	0.85	-0.27	0.09	-3.52	0.000	0.76	0.65	0.89
- Interaction with age	0.00	0.00	3.85	0.000	1.00	1.00	1.00	0.00	0.00	1.40	0.163	1.00	1.00	1.00
Birth order (centered)	-0.12	0.08	-1.50	0.134	0.89	0.77	1.04	-0.16	0.09	-1.70	0.090	0.85	0.71	1.03
Father LDS status: Inactive vs Active	0.08	0.14	0.56	0.578	1.08	0.82	1.44	0.15	0.15	1.06	0.290	1.16	0.88	1.53
Father LDS status: Unknown vs Active	0.24	0.16	1.46	0.144	1.27	0.92	1.74	0.06	0.17	0.34	0.732	1.06	0.77	1.46
Mother LDS status: Inactive vs Active	0.03	0.15	0.22	0.828	1.03	0.77	1.38	0.09	0.15	0.65	0.519	1.10	0.83	1.46
Mother LDS status: Unknown vs Active	0.34	0.17	1.96	0.050	1.41	1.00	1.99	-0.02	0.20	-0.08	0.938	0.98	0.67	1.44
Mother remarries	**-0.03**	**0.30**	**-0.08**	**0.934**	**0.97**	**0.52**	**1.81**	**-0.03**	**0.31**	**-0.10**	**0.919**	**0.97**	**0.52**	**1.80**
Birth of male half sibling[1]	**0.31**	**0.35**	**0.76**	**0.446**	**1.36**	**0.62**	**2.98**	**0.44**	**0.36**	**1.29**	**0.195**	**1.55**	**0.80**	**2.99**
Birth of female half sibling[1]	**-0.06**	**0.36**	**-0.14**	**0.887**	**0.95**	**0.44**	**2.03**	**-0.22**	**0.36**	**-0.62**	**0.535**	**0.81**	**0.41**	**1.60**
Stepfather's sons alive	-0.12	0.11	-0.90	0.366	0.89	0.68	1.15	0.02	0.10	0.23	0.817	1.02	0.87	1.19
Stepfather's daughters alive	0.08	0.10	0.71	0.480	1.08	0.87	1.36	0.07	0.10	0.76	0.447	1.07	0.89	1.29
Elder brother	0.34	0.29	1.05	0.294	1.40	0.75	2.63	0.17	0.32	0.51	0.612	1.18	0.62	2.24
Elder sister	-0.22	0.30	-0.71	0.478	0.80	0.43	1.48	-0.06	0.32	-0.21	0.837	0.94	0.51	1.73
Family size when father dies (centered)	0.38	0.09	4.31	0.000	1.47	1.23	1.75	0.30	0.10	2.74	0.006	1.35	1.09	1.68
Mother dies after the father	0.04	0.27	0.14	0.889	1.04	0.60	1.79	0.12	0.33	0.35	0.726	1.12	0.58	2.17

Note: If the proportional hazards assumption is not fulfilled for a predictor, the interaction of this predictor with time (age) is given in an extra line. [1]from the same mother.

Table 4: Cox models of mortality from 28 days to 18 years (father's remarriage models) using time-varying dataset

	Daughters							Sons						
N individuals	10864							10782						
N failures	469							464						
N episodes	19534							19560						
Model characteristics														
LR chi2	70.42							55.81						
Prob > chi	< 0.001							< 0.001						
	B	SE	Z	P	HRR	LL	UL	B	SE	Z	P	HRR	LL	UL
Birth cohort (centered)	-0.42	0.08	-5.56	0.000	0.65	0.56	0.76	-0.32	0.08	-4.55	0.000	0.73	0.64	0.83
- Interaction with age	0.00	0.00	3.02	0.003	1.00	1.00	1.00	0.00	0.00	2.16	0.031	1.00	1.00	1.00
Birth order (centered)	-0.02	0.09	-0.23	0.821	0.98	0.82	1.17	-0.09	0.10	-0.92	0.360	0.91	0.75	1.11
Father LDS status: Inactive vs Active	-0.02	0.16	-0.11	0.909	0.98	0.73	1.33	-0.17	0.16	-1.02	0.307	0.84	0.60	1.17
Father LDS status: Unknown vs Active	-0.06	0.18	-0.35	0.726	0.94	0.65	1.35	-0.30	0.18	-1.56	0.119	0.74	0.51	1.08
Mother LDS status: Inactive vs Active	0.21	0.16	1.41	0.158	1.24	0.92	1.67	0.18	0.16	1.02	0.308	1.19	0.85	1.68
Mother LDS status: Unknown vs Active	0.32	0.17	1.86	0.063	1.38	0.98	1.94	0.42	0.16	2.35	0.019	1.52	1.07	2.14
Father remarries	**0.10**	**0.17**	**0.59**	**0.552**	**1.11**	**0.79**	**1.54**	**-0.02**	**0.17**	**-0.11**	**0.916**	**0.98**	**0.70**	**1.38**
Birth of male half sibling[1]	**-0.16**	**0.19**	**-0.85**	**0.397**	**0.85**	**0.59**	**1.24**	**0.05**	**0.19**	**0.25**	**0.804**	**1.05**	**0.72**	**1.53**
Birth of female half sibling[1]	**-0.05**	**0.19**	**-0.27**	**0.784**	**0.95**	**0.65**	**1.39**	**-0.02**	**0.19**	**-0.10**	**0.921**	**0.98**	**0.68**	**1.42**
Stepmother's sons alive	-0.35	0.16	-3.02	0.003	0.71	0.56	0.89	0.06	0.10	0.53	0.598	1.06	0.86	1.30
Stepmother's daughters alive	0.05	0.11	0.51	0.609	1.05	0.86	1.29	-0.02	0.10	-0.21	0.833	0.98	0.78	1.22
Elder brother	0.12	0.13	0.86	0.392	1.12	0.86	1.46	0.07	0.13	0.54	0.588	1.07	0.83	1.38
Elder sister	-0.13	0.13	-0.98	0.328	0.88	0.68	1.14	-0.12	0.13	-0.90	0.368	0.89	0.69	1.15
Family size when mother dies (centered)	0.22	0.09	2.29	0.022	1.25	1.03	1.51	0.27	0.11	2.66	0.008	1.31	1.07	1.61
Father dies after the mother	-0.07	0.23	-0.31	0.757	0.93	0.60	1.46	-0.04	0.25	-0.17	0.861	0.96	0.60	1.53

Note: If the proportional hazards assumption is not fulfilled for a predictor, the interaction of this predictor with time (age) is given in an extra line. [1]from the same father.

Table 5: Family and Child Counts by Marriage History and Parent Gender (N = 23,610)

Father	Mother	No. Families	No. of Children From any Parent (Total)	No. Shared Children from New Union	No. Children of the Mother Only	No. Children of the Father Only
Had Child from 1^{st} marriage	Had Child from 1^{st} marriage	255	3023	775	716	1155
Had Child from 1^{st} marriage	No Child from 1^{st} marriage	10	80	44	0	36
Had Child from 1^{st} marriage	No prior marriage	1981	16411	10006	0	6405
No prior marriage	Had Child from 1^{st} marriage	389	2484	1546	938	0

Table 6: Descriptive statistics

	No. Shared Children from New Union (N = 12,371)	No. Children of the Father Only (N = 7,596)	No. Children of the Mother Only (N = 1,654)
Gender			
- Female	6127 (49.5%)	3785 (49.8%)	827 (50.0%)
- Male	6244 (50.5%)	3811 (50.2%)	827 (50.0%)
Birth year	1903.0 ± 22.3	1891.7 ± 22.4	1894.9 ± 23.6
Father LDS status			
- Active LDS	8397 (67.9%)	5539 (72.9%)	1029 (62.2%)
- Inactive LDS	2857 (23.1%)	1578 (20.8%)	358 (21.6%)
- Unknown	1117 (9.0%)	479 (6.3%)	267 (16.1%)
Mother LDS status			
- Active LDS	9161 (74.1%)	5576 (73.4%)	1096 (66.3%)
- Inactive LDS	2398 (19.4%)	1354 (17.8%)	425 (25.7%)
- Unknown	812 (6.6%)	666 (8.8%)	133 (8.0%)

Table 7: Cox models stratified by family ID

	Follow up to death							Follow up to age 18						
Covariate	Est	SE	Z	Pval	RR	ll.ci	ul.ci	Est	SE	Z	Pval	RR	ll.ci	ul.ci
male	0.30	0.02	16.56	0.000	1.35	1.30	1.39	0.14	0.05	3.06	0.002	1.15	1.05	1.26
byr	0.00	0.00	-0.43	0.667	1.00	1.00	1.00	0.01	0.00	2.91	0.004	1.01	1.00	1.02
Pa LDS: Inactive	0.09	0.08	1.13	0.259	1.10	0.93	1.29	-0.10	0.32	-0.30	0.764	0.91	0.49	1.70
Pa LDS: Unknown	0.08	0.09	0.90	0.369	1.08	0.91	1.29	-0.49	0.40	-1.20	0.229	0.62	0.28	1.36
Ma LDS: Inactive	0.04	0.05	0.92	0.355	1.05	0.95	1.15	-0.07	0.17	-0.43	0.670	0.93	0.66	1.31
Ma LDS: Unknown	-0.04	0.06	-0.71	0.478	0.96	0.85	1.08	0.04	0.20	0.18	0.853	1.04	0.70	1.55
Stepkid: Ma died (vs. no)	**-0.04**	**0.03**	**-1.11**	**0.266**	**0.96**	**0.90**	**1.03**	**-1.25**	**0.10**	**-12.23**	**0.000**	**0.29**	**0.24**	**0.35**
Stepkid: Pa died (vs. no)	**-0.09**	**0.05**	**-1.79**	**0.073**	**0.92**	**0.84**	**1.01**	**-1.38**	**0.18**	**-7.52**	**0.000**	**0.25**	**0.18**	**0.36**

Table 8: Descriptive statistics. Dataset includes pairs of half sibs, with the youngest pakid/makid and the oldest shared child (step child) were chosen in each family. When both parents were previously married and had children from the first marriage, the oldest step child was duplicated to compare to pakid and makid individually.

	Shared father		Shared mother	
	SharedKid (N = 2024)	PaKid (N = 2024)	SharedKid (N = 558)	MaKid (N = 558)
Gender				
- Female	969 (47.8%)	1028 (50.8%)	270 (48.4%)	271 (48.6%)
- Male	1056 (52.2%)	996 (49.2%)	288 (51.6%)	287 (51.4%)
Birth year	1904.6 ± 23.5	1897.1 ± 22.8	1905.8 ± 24.3	1898.4 ± 23.6
Father LDS status				
- Active LDS	1476 (72.9%)	1476 (72.9%)	261 (46.8%)	351 (62.9%)
- Inactive LDS	411 (20.3%)	411 (20.3%)	194 (34.8%)	111 (19.9%)
- Unknown	137 (6.8%)	137 (6.8%)	103 (18.5%)	96 (17.2%)
Mother LDS status				
- Active LDS	1550 (76.6%)	1452 (71.7%)	383 (68.6%)	383 (68.6%)
- Inactive LDS	345 (17.0%)	350 (17.3%)	132 (23.7%)	132 (23.7%)
- Unknown	129 (6.4%)	222 (11.0%)	43 (7.7%)	43 (7.7%)
# full sibs alive and < 18	0.0 ± 0.0	3.5 ± 2.2	0.0 ± 0.0	3.1 ± 1.8
# half sibs alive and < 18	4.9 ± 3.4	1.0 ± 0.0	5.7 ± 4.3	1.0 ± 0.0
# step sibs alive	0.0 ± 0.0	0.4 ± 1.2	0.0 ± 0.0	1.6 ± 2.4

Table 9A: Cox models stratified by family ID for paired half-sibs. All Children were followed until age 18.

	Full Sample						
Covariate	Est	SE	Z	Pval	RR	ll.ci	ul.ci
male	0.15	0.16	1.00	0.319	1.17	0.86	1.58
byr	0.11	0.04	2.99	0.003	1.12	1.04	1.20
Pa LDS: Inactive	0.45	0.47	0.96	0.339	1.57	0.62	3.97
Pa LDS: Unknown	0.05	0.61	0.08	0.939	1.05	0.32	3.46
Ma LDS: Inactive	0.13	0.27	0.50	0.615	1.14	0.68	1.92
Ma LDS: Unknown	0.06	0.30	0.19	0.853	1.06	0.59	1.90
Stepkid (vs. never-stepkid)	**-1.02**	**0.36**	**-2.84**	**0.004**	**0.36**	**0.18**	**0.73**
# full sibs alive and < 18	0.14	0.11	1.27	0.204	1.15	0.93	1.42
# half sibs alive and < 18	0.00	0.08	-0.02	0.981	1.00	0.85	1.17
# step sibs alive	-0.04	0.12	-0.36	0.718	0.96	0.75	1.22

Table 9B: Cox models stratified by family ID for paired half-sibs by which was the shared parent. All Children were followed until age 18.

	Shared father Half-sibs are related through the common father							Shared mother Half-sibs are related through the common mother						
Covariate	Est	SE	Z	Pval	RR	ll.ci	ul.ci	Est	SE	Z	Pval	RR	ll.ci	ul.ci
male	0.13	0.17	0.77	0.439	1.14	0.82	1.59	0.31	0.39	0.79	0.429	1.37	0.63	2.96
byr	0.11	0.04	2.84	0.005	1.12	1.04	1.21	0.07	0.10	0.75	0.454	1.07	0.89	1.30
Pa LDS: Inactive	-	-	-	-	-	-	-	0.39	0.51	0.76	0.449	1.47	0.54	3.99
Pa LDS: Unknown	-	-	-	-	-	-	-	0.11	0.64	0.17	0.865	1.11	0.32	3.88
Ma LDS: Inactive	0.14	0.27	0.53	0.599	1.15	0.68	1.94	-	-	-	-	-	-	-
Ma LDS: Unknown	0.05	0.30	0.16	0.877	1.05	0.58	1.89	-	-	-	-	-	-	-
Stepkid (vs. never-stepkid)	**-0.99**	**0.38**	**-2.58**	**0.010**	**0.37**	**0.18**	**0.79**	**-1.31**	**1.02**	**-1.28**	**0.199**	**0.27**	**0.04**	**2.00**
# full sibs alive and < 18	0.16	0.12	1.33	0.183	1.17	0.93	1.48	0.04	0.28	0.15	0.879	1.04	0.60	1.82
# half sibs alive and < 18	0.02	0.09	0.21	0.831	1.02	0.85	1.23	-0.09	0.19	-0.50	0.618	0.91	0.63	1.31
# step sibs alive	-0.02	0.16	-0.12	0.907	0.98	0.72	1.34	-0.13	0.24	-0.55	0.579	0.88	0.55	1.40

Figure 1. Survival probabilities of stepchildren and half-siblings from 28 days to 18 years of age.