The Demographic Foundations of the Lived Experience of Kin Death

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Abstract

The last two centuries have been marked by increases in life expectancy, reductions in family size and changes in the timing of fertility. We analyze how demographic change has altered individuals lived experience of death during life. Drawing upon historical and projected age-specific vital rates for Sweden, we use formal demographic analysis and microsimulation to measure trends in the extent and timing of child loss, in the average age at first experience of death of a maternal kin member, and in the type of kin death experienced. Our results indicate a considerable reduction in child loss across cohorts, an increase in the average age at first experience of maternal kin death, and a shift in the first death experience, from that of a sister, mother, or aunt to that of a grandmother. These transformations of the life course have profound implications for the health and well-being of individuals and families.

Our lifetime is defined by the timing of our own births and deaths, but our lived experience is defined by the lives and deaths of others. Considerable gains against mortality have been made over the course of the demographic transition; still, our family, friends, and neighbors die. While death has become more predictable, it has not become less inevitable. In this paper, we examine how demographic change observed in developed countries over the course of the last two centuries has altered individuals' lived experience of death during life.

Drawing upon nearly 360 years of historical and projected age-specific demographic rates for Sweden, we use formal demographic analysis and microsimulation to characterize changes across time in the experience of kin death. At the cohort level, we examine changes in the *average timing* and *variability in timing* of key experiences of kin death (e.g. the death of a mother), the *frequency* of certain experiences of death (e.g. loss of a child), and the *type* of kin death that characterizes an individual's first experience of death. Taken together, these findings illustrate *changes in the lived experience of death for the average individual* as well as characterize changes in demographic regimes by the *frequency or rarity of certain experiences of death among members of a birth cohort.*

Our results indicate that, beyond improvements in individual lifespan, the demographic transition has led to increased time spent with family members and a chronological "ordering" of deaths within families, with deaths of earlier generations generally preceding those of later generations. This transformation of the lived experience of death has important implications for the inequality of access to care and to family resources. Beyond a historical perspective, the evaluation of the relationship between demographic rates and experience of kin death is relevant to assess, in developing countries, the impact of improvements in child mortality on child loss, and reductions in adult mortality on prevalence of orphans.

Background

The grief caused by experiencing the death of a close family member, whether a grandparent, parent, sibling, child, or other kin, can have profound effects on an individual over the life course (Stroebe et al., 2007). The availability of nuclear and extended family members, especially grandmothers, has been linked with child survival across a variety of settings (Sear and Mace, 2008). The loss of a mother in infancy or childhood has been linked with higher mortality rates in both historical studies of maternal orphanhood (Campbell and Lee, 2009; Pavard et al., 2005; Reher and González-Quiñones, 2003; Willführ, 2009) and contemporary studies in developing countries (Ronsmans et al., 2010). Orphanhood has also been linked to reductions in growth across diverse settings (Beegle et al., 2006; Kadiyala et al., 2009; Reher and González-Quiñones, 2003) and to lower educational attainment (Beegle et al., 2006) and enrollment (Gertler et al., 2004). Beyond survival, nutrition, and educational attainment, loss of a parent in childhood and adolescence has been linked to depression, anxiety, higher rates of functional impairment, increased substance use, and participation in foster care (Cluver et al., 2012; Franzén and Vinnerljung, 2006; Kaplow et al., 2010).

Like orphanhood, the experience of child loss can also have detrimental effects on parents over their life course (Hendrickson, 2009). Comparisons between bereaved parents and similar non-bereaved parents in the Wisconsin Longitudinal Study suggests that bereaved parents are more likely to suffer from depression, depressive systems, more frequent health problems, and overall lower well-being (Rogers et al., 2008) as well as significantly worse health-related quality of life (Song et al., 2010). Results from a large follow-up study based on population registers in Sweden suggest that parents who suffer the loss of either minor children (10-17 years old) or adult children are at increased risk of mortality (Rostila et al., 2012), and a similar study in Denmark indicates that both bereaved mothers and fathers faced excess risk of death due to unnatural causes immediately following the death of their child (Li et al., 2003). A study on kin availability and mortality among the elderly, based on data from MATLAB, highlights the protective effect of the presence of sons as well as spouses and brothers

(Rahman, 1999). Taken together, these findings highlight the importance of kin as a resource for children and the elderly as well as provide evidence of the long-term negative impacts of grief on psychological well-being.

Because of the importance of kin for health, education, survival, and overall quality of life, the availability of kin has been a relevant subject of research since the early 1900s (Lotka, 1931). Demographic methods have been developed to estimate family structure and the availability of kin members analytically (Brass, 1983; Goodman et al., 1974; Keyfitz and Caswell, 2005) and through microsimulation techniques (Hammel et al., 1976; Ruggles, 1986; Wolf, 1988). A number of studies have utilized these techniques to study the impact of long term demographic trends such as declining fertility and mortality, postponement of marriage, and rise in divorce, on the availability of parents and grandparents across the life course (Uhlenberg, 1996) and on the availability of kin support for the elderly in old age (Wachter, 1997; Wolf, 1994).

Demographic forces shaping trends in kin death

As prior studies have demonstrated, the impact of the demographic transition on the availability of kin is not self evident as declines in fertility, postponement of fertility, and improvements in longevity interact in complex ways (Matthews and Sun, 2006; Murphy and Grundy, 2003; Puur et al., 2011; Uhlenberg, 1996). Below, we review the potential for these long-term demographic changes to alter experiences of death during life including child loss, timing of maternal death, and first experience of maternal kin death.

Child loss

We examine child loss from the perspective of a mother, and consider the *frequency* and the *timing* of a mother's experience of the death of a child. Improvements in mortality that increase the mother's chance of survival also increase the probability that she will experience child loss. The effect of improved maternal survival is typically offset by three countervailing demographic trends that characterize the demographic transition:

reductions in fertility, postponement of fertility, and improvements in child's survival. Reductions in fertility act to decrease the risk of child loss as parents who do have children typically have fewer offspring to lose than preceding generations. Moreover, a greater proportion of cohort members remain childless, thus never entering the risk pool. Postponement of fertility both reduces the likelihood of experiencing child loss and potentially delays the timing of child loss. Improvements in infant, child, and young adult mortality act to compress death at older ages (Kannisto, 2000) and reduce mother's risk of experiencing the death of her child, especially during her reproductive years when children are young.

Timing of Maternal Death

We consider the *average age* at which children in a particular birth cohort experience the death of their mothers, the *variability* around this average age as well as the age at which a particular fraction of a birth cohort has lost their mother. Improvements in mothers survival delay the timing of maternal deaths thus potentially leading to an increased amount of time a child spends with a living mother. However, postponement of fertility counteracts these trends in increased survivorship reducing the time parents and children spend together. Projections of kin networks for Italy suggest that the effect of postponement may overwhelm that of increased survivorship leading to less time spent with a living mother (Tomassini and Wolf, 2000).

First Experience of Kin Death

We examine the *average age* at which an individual first experiences the death of a maternal kin member (grandmother, mother, aunt, sister), the *variability* around that age, and the *type* of death experienced. The first experience of kin death an individual experiences depends upon the structure of his or her kin network upon birth. Increases in survival improve the chances that an individual will be born into a three- or four-generation family, but the postponement of fertility has the potential to counteract the effect of mortality improvement thus shrinking the number of multigenerational ties (Matthews and Sun, 2006; Puur et al., 2011).

While an individual is constrained to one set of biological parents and two sets of grandparents, the number of siblings, cousins, aunts, and uncles within the kin network is bounded by the fertility and mortality experience of the family. Declines in fertility decrease generation size effectively reducing the number of horizontal kin (i.e. siblings, cousins) as well as extended kin in older generations (i.e. aunts and uncles). Thus, fertility decline makes it more likely that the first experience of death will be that of a vertical ascendent (parent or grandparent) rather than a horizontal kin member or an aunt or uncle.

Data and Approach

Capturing cohort changes in the lived experience of death across the demographic transition requires multiple centuries of age-specific fertility and mortality rates. For this analysis, we have chosen to use data from Sweden, which is an excellent representative country, because of the unique availability of long series of historical data on vital rates. We combined data on historical fertility rates from the Human Fertility Database (HFD), historical mortality rates from the Human Mortality Database (HMD), and period vital rates projected through 2110 available from Statistics Sweden (HFD, 2010; HMD, 2010; Statistics Sweden, 2010). Sweden is the country for which the longest series of data is available in the HMD and HFD with mortality data extending back to the birth cohort of 1751 and complete cohort fertility histories from the birth cohort of 1878. Partial information on cohort fertility is available in the HFD for cohorts extending back to 1836.

The cohort fertility series available in the Human Fertility Database for Sweden does not fully encompass the fertility change observed over the entire course of the demographic transition. The earliest cohort for which full information is available, the cohort of 1879, has a TFR of around 3.3. Information on trends in period fertility, included in the classic demographic text *The Decline of Fertility in Europe*, suggests that prior to the demographic transition the TFR was closer to 4.5 in Sweden (Coale, 1986, Figure 1.4). Partial data on cohort fertility histories and the strong linear decline

in TFR across the earliest cohorts for which full information is available suggests that a linear extrapolation is appropriate to estimate full fertility schedules from partial schedules. That is the approach that we adopted to generate full fertility schedules from partial schedules.

We pursue two complementary strategies for quantifying changes in the lived experience of death across the demographic transition. First, we rely upon aggregate-level demographic analysis by building on existing methods for calculating frequencies of living kin (Goodman et al., 1974). Second, we use SOCSIM, a computer-based demographic microsimulation program, to investigate how the lived experience of death has changed across the demographic transition. SOCSIM was originally developed at UC Berkeley in the 1970s and has been widely used to address research questions in social sciences (Hammel et al., 1976; Wachter, 1997). It is particularly useful for our purposes because no analytical solution exists to evaluate quantities such as the first experience of kin death.

Methods for Estimating Trends in Kin Death

Using aggregate demographic rates, we calculate expected child loss by mother's age, average child loss by mother's cohort, probability of a living mother by child's age, and child's average age at mother's death. The demographic formulas that we propose to calculate these measures are described below.

Expected child loss

We refer to the expected number of children a woman born in cohort c loses, conditional on surviving to age a, as $ECLC_{(a,c)}$ (Expected Child Loss Conditional). It is computed as follows:

$$\underbrace{ECLC_{(a,c)}}_{\text{children lost}} = \underbrace{\sum_{x=15}^{x=a} {}_1F_{(x,c)}}_{\text{children born}} - \underbrace{\sum_{x=15}^{x=a} {}_1F_{(x,c)} l_{(a-x,c+x)}}_{\text{children surviving}} \quad (1)$$

${}_1F_{x,c}$ represents age-specific fertility rates for cohort c, at age x.

$l_{(a-x,c+x)}$ represents the survival probability until age $(a-x)$ for the cohort born in year $(c+x)$. It it the probability that children of mothers who gave birth at age x will survive until the mother potentially reaches age a.

$ECLC$ is a function of mother's fertility and child survival but not mother's survival because it is conditional on mother's survival to age a.

We use information on expected child loss by age to estimate, for each cohort of mothers, how many children they are expected to lose during their lifetime, $E[ECLC_{(-,c)}]$. This quantity is obtained by weighting $ECLC_{(a,c)}$ by the cohort life table death distribution, $d_{(-,c)}$, of women:

$$E[ECLC_{(-,c)}] = \frac{\sum_{a=0}^{120} d_{(a,c)} ECLC_{(a,c)}}{\sum_{a=0}^{120} d_{(a,c)}} \tag{2}$$

Average age at mother's death

Trends in average time spent with living parents are influenced by two key features of the demographic transition: mortality improvements and delays in childbearing. While mortality improvements tend to increase the amount of time that children can potentially spend with parents, delaying fertility into older ages tends to decrease the amount of time that children and parents will spend together.

Consider a child of age a in year t. The probability, $M_{a,t-a}$, that a child of age a born in the cohort year $(t-a)$, has a living mother, can be expressed in the following way:

$$M_{a,t-a} = \sum_{x=15}^{49} \left(\underbrace{\frac{f_{x,t-a-x} K_{x,t-a-x}}{\sum_{x=15}^{49} f_{x,t-a-x} K_{x,t-a-x}}}_{\text{distribution of mothers}} \times \underbrace{\frac{l_{x+a,t-a-x}}{l_{x,t-a-x}}}_{\text{mother's survival}} \right) \tag{3}$$

where

$f_{x,t-a-x}$ is the fertility rate for women of age x, born in the year $(t-a-x)$.

$K_{x,t-a-x}$ is the size of the female population of age x at time $(t-a)$. In other

words, women who were born in year $(t-a-x)$ and survived until age x.

$l_{x,t-a-x}$ is the probability of surviving to age x for the cohort born in the year $(t-a-x)$.

Consider $M_{a,t-a}$ to be like the survivorship column in the life table where survivorship is not based on one's own survival but rather on mother's survival. We can construct a pseudo-life table based upon the $M_{a,t-a}$. The life expectancy column of this pseudo life table will give us the average age at mother's death. Expressed in a formula, the average age at mother's death for the cohort born at time t, $AAMD_t$, is:

$$AAMD_t = \sum_{a=0}^{W} M_{a,t} + (M_{a,t} - M_{a+1,t})_1\alpha_a \tag{4}$$

where

W is the oldest age group.

${}_1\alpha_a$ is the average time lived by mothers dying when the child is between ages a and $a+1$.

Timing and type of first experience of kin death

So far we have developed analytical methods to estimate the quantities of interest for our purposes. When we expand our analysis to the evaluation of kin beyond mother and child relationships, the complexity of the model increases substantially. Analytical formulas either do not exist or are extremely cumbersome. In order to evaluate the type of first experience of maternal kin death (e.g., whether it's the mother, grandmother, sister or aunt), we use the classic kinship microsimulator SOCSIM.

In the simulation, each individual is an observation in a rectangular data file, with records of demographic characteristics for the individual, and identification numbers for key kinship members. Socsim is efficiently written in the programming language C and takes full advantage of arrays of linked lists to keep track of kinship relationships and to store information. The simulator takes as input population files and demographic rates. It returns updated population files as output. The demographic rates consist

of fertility, mortality, marriage, and group transition rates. They can vary with the age, sex, marital status and group affiliation of the individual. Overall, the simulator is quite flexible and can be used to address a number of research questions.

The individual is the unit of analysis of the simulator. Each person is subject to a set of rates, expressed as monthly probabilities of events, given certain demographic characteristics such as age, sex, marital status, etc. Every month, each individual faces the risk of a number of events including childbirth, death and marriage . The selection of the event and the waiting time until the event occurs are determined stochastically, using a competing risk model. Some other constraints are included in the simulation program in order to draw events only for individuals that are eligible for the events (e.g. to allow for a minimum interval of time between births from the same mother, to avoid social taboos such as incest, etc.). Each event for which the individual is at risk is modeled as a piecewise exponential distribution. The waiting time until each event occurs is randomly generated according to the associated demographic rates. The individual's next event is the one with the shortest waiting time.

At the end of the simulation, population files that contain a list of everyone who has ever lived in the population are created. From these data, it is possible to determine the main demographic characteristics of the population and the entire kin network of any individual at any time. For more details about SOCSIM, its history, computer routines and applications, see (Hammel et al., 1976; Wachter, 1997) and the online documentation available at lab.demog.berkeley.edu/socsim.

Results

Trends in Child Loss

We examine trends in child loss in two ways. First, we look at the expected number of child deaths occurring to cohorts of mothers. In addition to examining trends in the average number of children lost while the mother is still alive, we also examine trends in the variability around this expected number. Second, we use microsimulation to

evaluate trends in the proportion of mothers experiencing child loss.

Cohort trends in $ECLC_{(a,c)}$ are depicted in Figure 1(a). As expected, later birth cohorts of mothers experience less child loss at all ages. For the birth cohort of 1880, the trend in $ECLC$ across age indicates that mothers were losing children during their reproductive ages. Thus, their children were likely dying in infancy and childhood. For the most recent birth cohorts, for instance the birth cohort of 2000, the projected vital rates indicate that mothers are not likely to lose children before their 80th birthday; however, mothers who are long lived accumulate child loss at a steadily increasing rate above age 80.

Figure 1 about here

Figure 1(b) depicts similar results to Figure 1(a) but focuses on the number of children a birth cohort of mothers can expect to have surviving at a particular age rather than the number of children lost. Looking at the question of child loss from this perspective, we are interested in knowing if the number of surviving children at any age is similar across birth cohorts of mothers despite differences in child loss. The two earliest cohorts observed here, the birth cohort of 1880 and 1900, clearly demonstrate the differences in surviving children across birth cohorts of mothers. Those potential mothers born in 1880 could expect to have over 2.5 surviving children at the end of their childbearing years if they themselves survived. In contrast, potential mothers born in 1900 surviving to the end of their childbearing years could be expected to have only slightly over 1.5 surviving children.

In addition to thinking about the number of children a woman can expect to lose if she survives to a particular age, it is useful to summarize the experience of a particular cohort by calculating the average number of children a woman born into a particular cohort loses during her lifetime. Trends in expected child loss by birth cohort of prospective mothers are shown in Table 1 (column EECLC). For the earliest birth cohort of prospective mothers, born in 1880, $E[ECLC]$ was around .5 children. The average number of children lost rapidly declined roughly between the birth cohorts of 1880 and 1900 (likely mainly due to rapid reductions in fertility), stabilized across the

birth cohorts of 1900 to 1930 (as fertility rose and mortality fell), and then declined again across the birth cohorts from 1930 forward. $E[ECLC]$ as a proportion of TFR gives some insight into the significance of these losses even for the most recent cohorts. In the earliest cohorts, the number of child deaths that mothers experienced, on average, represented around 15% of the TFR. In contrast, for the birth cohort of 2000, the projected vital rates indicate that the number of child deaths mothers born into this cohort will experience represent around 3% of the anticipated TFR.

In addition to thinking about the average number of children a woman can expect to lose during her lifetime, we can also consider the frequency of the experience of child loss within a particular cohort of women. Looking at child loss from this perspective gives us insight into whether child loss was a universal phenomenon prior to the demographic transition and how rare of a phenomenon child loss is today when mortality declines should have produced a more predictable ordering of death within families. We focus on the proportion of mothers who experience child loss during their lifetime.

Figure 2 depicts the fraction of mothers of age 60 with at least one child dead by mother's birth cohort. This figure suggests that a mother's risk of losing a child before age 60 declined rapidly around the turn of the twentieth century. About half of the women born at the end of the 19th century who survived to age sixty experienced child loss. In contrast, for women born in the last quarter of the 20th century and the beginning of the 21st, the likelihood of losing a child before age 60 is negligible.

Figure 2 about here

Timing of Parental Death

For birth cohorts of children in Sweden, we calculated the probability of having a living mother by a particular age, a. These results are shown in Figure 3. For the earliest cohort of children depicted in this graph, the birth cohort of 1900, loss of a mother during infancy, childhood, and early adulthood was quite common. About 20% of this cohort had lost their mother by the time they reached 30 years old. In contrast, projected vital rates indicate that for the most recent cohort, born in 2000, loss of a

mother will be relatively rare before age 40. Similar to analyses of changes in cohort survivorship curves across the demographic transition, this analysis shows that the curves of probability of mother's survival at a particular child's age are becoming more rectangular over time. This means that the ages at which children experience the death of their mother become more concentrated across the demographic transition.

Figure 3 about here

Table 1 (column AAMD) shows trends in the average age at mother's death across birth cohorts of children. The earliest cohorts (around 1890) experienced the death of their mothers on average around age 40 while more recent cohorts can expect to lose their mothers around age 60. Surprisingly, average age at mother's death looks to have reached a peak for the birth cohort of 1974. Later birth cohorts experience the death of their mothers, on average, earlier in life, presumably because their mothers bear them later in life (i.e. delaying fertility reduces the amount of time a mother has to spend with her child). While delays in fertility likely explain some of the flattening of the trend, these results are also sensitive to the rates of decline in old age mortality anticipated in the projected vital rates from Statistics Sweden.

Table 1 about here

We can quantify the variability in the ages at which children experience the death of their mother by looking at the ages at which 10%, 25%, 50%, 75%, and 90% of the cohort have experienced the loss of their mother. These results are shown in Figure 4. Similar to the results for average age at mother's death, the results in this figure suggest that time spent with a living mother increased across the birth cohorts born in the late 1800s through the 1970s. For more recent birth cohorts, observed delays in fertility coupled with possible slowdowns in mortality improvement suggest a flattening of trends in time spent with a living mother. Measuring variability in child's age at death using the inter-quartile range (the difference between ages when 75% and 25% of the cohort have experienced the loss of a mother), we find that variability in age at mother's death is mainly decreasing over our period of analysis, even for the most

recent birth cohorts, suggesting continued compression in the typical ages at which children experience mother's death (see Table 1, column IQR).

Figure 4 about here

First Experience of Death

In this section, we use microsimulation to answer questions about changes in individual's first experience of death across the demographic transition. Using fertility and mortality data from Sweden, we examine the average age at which women experience the first death among selected maternal kin members (grandmother, mother, sister, or aunt). We also examine trends in the variability of age at first experience of kin death and the distribution of types of kin death that occur.

In Table 1 (column AAFKD), we show trends in the average age at the experience of first death of maternal kin across birth cohorts. For the earliest birth cohorts, women generally experienced the first death of maternal kin in childhood (the mean age being below 10). The mean age at experience of first death rises steadily across birth cohorts, although similar to trends for average age at mother's death, the trends seem to flatten somewhat for the most recent birth cohorts. For these recent cohorts, women on average experience the first death of a maternal kin member around age 30 suggesting that many women are transitioning into adulthood before experiencing the death of a grandmother, mother, sister, or aunt.

Trends in the standard deviation of ages at first experience of death of maternal kin show an inverse-U pattern, suggesting that the cohorts born in the first half of the 20th century experienced the most variability in the age at which they had their first experience of death (i.e., these birth cohorts have a higher standard deviation in age at experience of first death in comparison to cohorts born in the 19th century and the later half of the 21st century). This pattern might be explained by the major medical breakthroughs that took place over this time period. Some women born in these years might have been losing maternal kin early in their lives due to infectious diseases. However, the decline of infectious disease meant that women who had not yet

experienced a death might have not experienced it until later than they would have had under the earlier mortality regime. Fertility postponement might also explain this trend as the average age gap between generations would be expected to be larger for more recent birth cohorts and thus the time to the experience of a grandmother's death potentially shorter.

In addition to looking at the timing of the first experience of death, we also examined trends in the composition of the types of first death. We considered cohorts of women and whether they first experienced the death of a grandmother, mother, sister, or aunt. The results depicted in Figure 5 suggest that the earliest cohorts were more likely to have their first experience of death of maternal kin be that of a sister. With fertility decline and continued improvements in mortality, women became more likely to have their first experience of death be that of their grandmother. For cohorts born at the turn of the twentieth century, grandmothers represented around half of first experiences of death of maternal kin, the deaths of mothers and aunts each made up around 20%, and the remaining 10% of experiences of death were those of sisters. For recent cohorts, the likelihood of the first experience of death being that of a sister is extremely rare: well over 80% of first deaths experienced are those of a grandmother.

Figure 5 about here

Trends in the mean and standard deviation in age at first death of kin, and trends in type of kin death suggest that women born during the first half the 19th century generally experienced their first death in childhood and young adulthood (mean age of 10-15 years with a standard deviation of 10-11 years). The type of death experienced varied with women first experiencing the deaths of sisters, mothers, aunts, and grandmothers in similar proportions. For the most recent cohorts, the first experience of death of maternal kin is becoming concentrated in adulthood (mean of 30 with a standard deviation of 13-14 years). Overwhelmingly, this first experience of death is the loss of a grandmother.

Discussion

The results presented in the previous section show the long term transformations in the lived experience of death. Table 1 collates the results for birth cohorts born between 1880 and 2000. In terms of average child loss, the quantities presented in Table 1 suggest a decline in average child loss ($EECLC$) from 0.48 children to an anticipated 0.06 children across these birth cohorts, representing 15% and 3% of the TFR respectively. As a result of the demographic transition, child loss has become a rare phenomenon, especially during a mother's reproductive years (as shown in Figure 1(a)). Trends in the average age at mother's death ($AAMD$) suggest rapid gains in time spent with a living mother across cohorts born prior to 1960 and an anticipated flattening and even slight reversal in trends for cohorts born in the latter part of the 20th century. These trends in part are thought to be driven by postponement of fertility, which is reflected in the rising trends in mean age in childbearing (μ) observed across cohorts born after 1940. The overall trend in the mean age at first experience of maternal kin death has been an increase across birth cohorts, rising from 18 years for the cohort born in 1880 to an anticipated 31 years for the cohort born in 2000. The final column of Table 1 suggests that, for the most recent birth cohorts, the first experience of maternal kin death is typically that of a grandmother (85%), a stark contrast to the experience of the cohort of 1880 where less than half of first experiences of maternal kin death were those of a grandmother (42%).

Changes in family structure and the lived experience of death have happened against a backdrop of long-term demographic change. These dynamics can be understood in terms of changes occurring at both individual and societal levels. This paper seeks to unify the individual- and aggregate-level perspectives since the lived experience of death is important for individuals and has relevant population-level consequences. In particular, the literature on kin availability suggests a protective effect of living kin on the probability of survival. Therefore, demographic changes, which delay the timing of kin death, may induce positive externalities in survival probabilities at the population level. In other words, improvements in mortality at the population-level may be the

direct result of medical breakthrough, nutritional improvements, etc., as well as the indirect effect of having a bigger probability of having kin alive for a larger number of years

Although we have been able to provide evidence of a shift in the lived experience of death by examining cohort trends in a number of typical experiences of kin death, our analysis of trends in the lived experience of kin death has important limitations that we would like to acknowledge. Although divorce and remarriage can alter kin networks (Wachter, 1997) and therefore the experience of kin death, we did not incorporate trends in divorce and remarriage into our analysis. If the major effect of fertility decline is to reduce the overall size of kin networks and limit experiences of kin death, divorce and remarriage present a countervailing force that would lead to more frequent exposure to (step) kin death. Our current approach also does not take into account shared environment or genetic factors within households. However, we did some sensitivity analysis in which we accounted for potential correlation in fertility and mortality rates within households, and these results indicate that the potential impact of these correlations on the quantities under study is minor. Finally, our results are limited to the Swedish context. Studies of kin availability across European countries suggest that different demographic regimes can produce similar kin structures in terms of the number of multi-generational ties, because of the opposing effects of increases in survival and postponement of fertility (Puur et al., 2011). Future research should examine how trends in measures of the lived experience of death respond to various demographic trajectories observed across demographic transitions in different countries. The benefit of using the long series of historical and projected vital rates available for Sweden is that we are able to examine real long-term changes in the experience of loss across cohorts. In this sense, our work builds upon prior studies of kin availability, which often relied on period rates and made inferences about stable populations corresponding to those rates (Watkins et al., 1987; Uhlenberg, 1996). We also build on the work of our predecessors by using both microsimulation and classic analytic methods. This combination of techniques produces extremely rich results.

Conclusions

Taken together, our analysis of cohort trends in child loss, age at mother's death, and typical first experience of death suggests that the mortality transition has radically altered the lived experience of death. In an era of high fertility and mortality, death was more unpredictable. A woman was just as likely to have the first experience of death be that of her sister as that of her grandmother. In the context of low fertility and low mortality, women on average experience the death of a member of their close maternal kin in adulthood, rather than childhood, and this death is most likely to be that of her grandmother.

As a result of the mortality transition, the average number of years spent with a living mother has increased dramatically, and mothers themselves rarely experience child loss when the child is young. However, the century-long increase in the age at mother's death might have come to an end. The trend has become flat for cohorts born in the 1970s and has reversed since then. The effect of fertility postponement more than counteracted improvements in mortality anticipated in the projected vital rates.

The lives and deaths of parents, children and close kin have an important impact on individuals' life trajectories, health and well-being. This study documents the impact of demographic change on the lived experience of death and has relevant implications for life course analysis. We showed a transition from high to low levels of variability in the experience of kin death. This article opens relevant questions about the way in which societies cope with the lived experience of death. The fact that the experience of close kin death has shifted to later ages and has become a rare phenomenon at young ages has relevant consequences for the inequality of access to family resources. On the one hand, the inequality of the lived experience of death has decreased as deaths occur in a more orderly way. On the other hand, those who now experience the death of a family member early in the life course may face more dire consequences, partly because family sizes and the safety net of kinship are smaller, partly because of stigmatization. As a result, a higher level of support may be necessary to meet the needs of those who experience death of kin early in the life course.

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Table 1: Experience of kin death by birth cohort.

Birth Cohort	e_0	TFR	μ	$EECLC$	$\frac{EECLC}{TFR}$	$AAMD$	IQR_{AMD}	$AAFKD$	SD_{AAFKD}	Grandmother 1st death
1880	52.7	3.2	30.4	0.48	0.15	–	–	18.0	13.7	0.42
1900	61.1	1.9	29.0	0.23	0.12	41.2	27.3	17.3	14.4	0.48
1920	71.9	2.1	28.2	0.20	0.09	46.0	27.9	19.7	15.0	0.55
1940	79.7	2.0	26.4	0.17	0.08	52.1	23.6	24.0	15.2	0.67
1960	84.0	2.0	28.6	0.11	0.06	57.0	22.6	27.2	14.6	0.76
1980	86.5	2.0	31.0	0.08	0.04	59.0	20.4	30.6	13.9	0.82
2000	87.7	1.9	31.2	0.06	0.03	58.1	18.3	31.0	13.3	0.85

e_0: Life expectancy

TFR: Total fertility rate

μ: Mean age at childbearing

$EECLC$: Expected child loss for birth cohort

$\frac{EECLC}{TFR}$: Expected child loss as a proportion of TFR

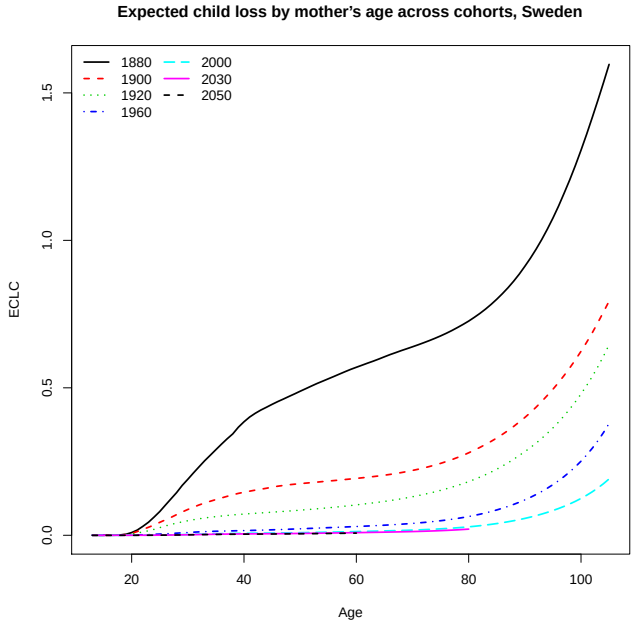
$AAMD$: Average age at maternal death

IQR_{AMD}: Inter-quartile range of the ages at maternal death

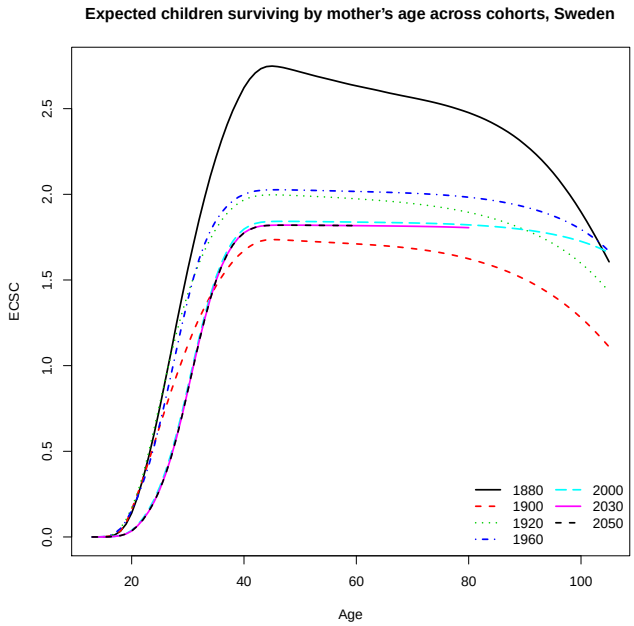
$AAFKD$: Average age at first maternal kin death

SD_{AAFKD}: Standard deviation of ages at first kin death

Grandmother 1st death: Proportion of birth cohort whose first experience of maternal kin death is their grandmother



(a) Child loss



(b) Child survival

Figure 1: Expected child loss and child survival by mother's age across cohorts, Sweden.

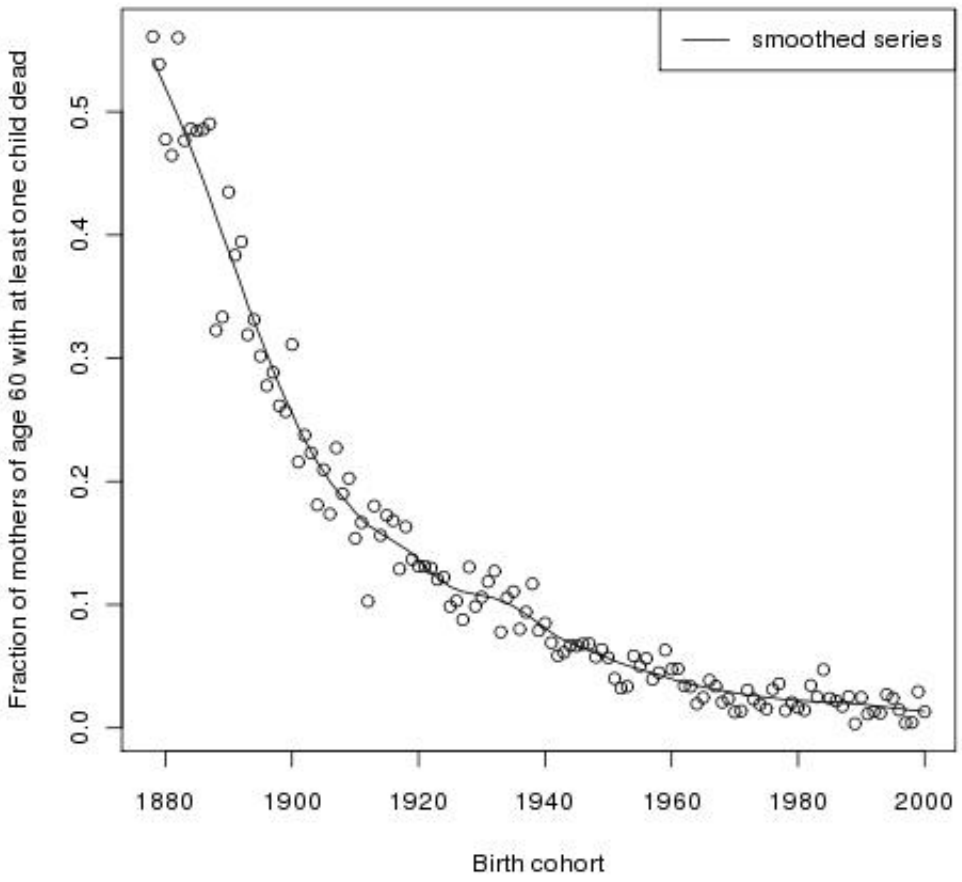


Figure 2: Fraction of mothers of age 60 with at least one child dead by birth cohort, Sweden (from SOCSIM).

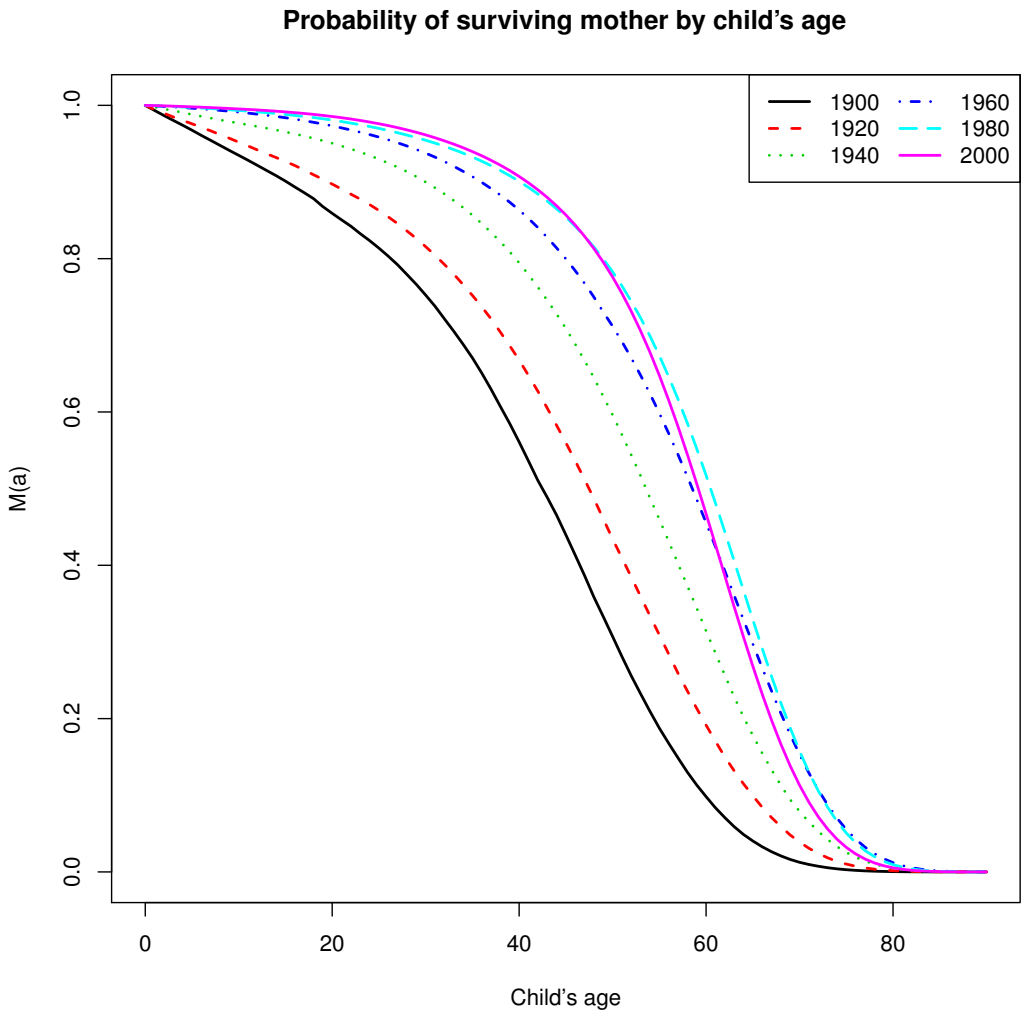


Figure 3: Probability of surviving mother by child's age across birth cohorts of children, Sweden.

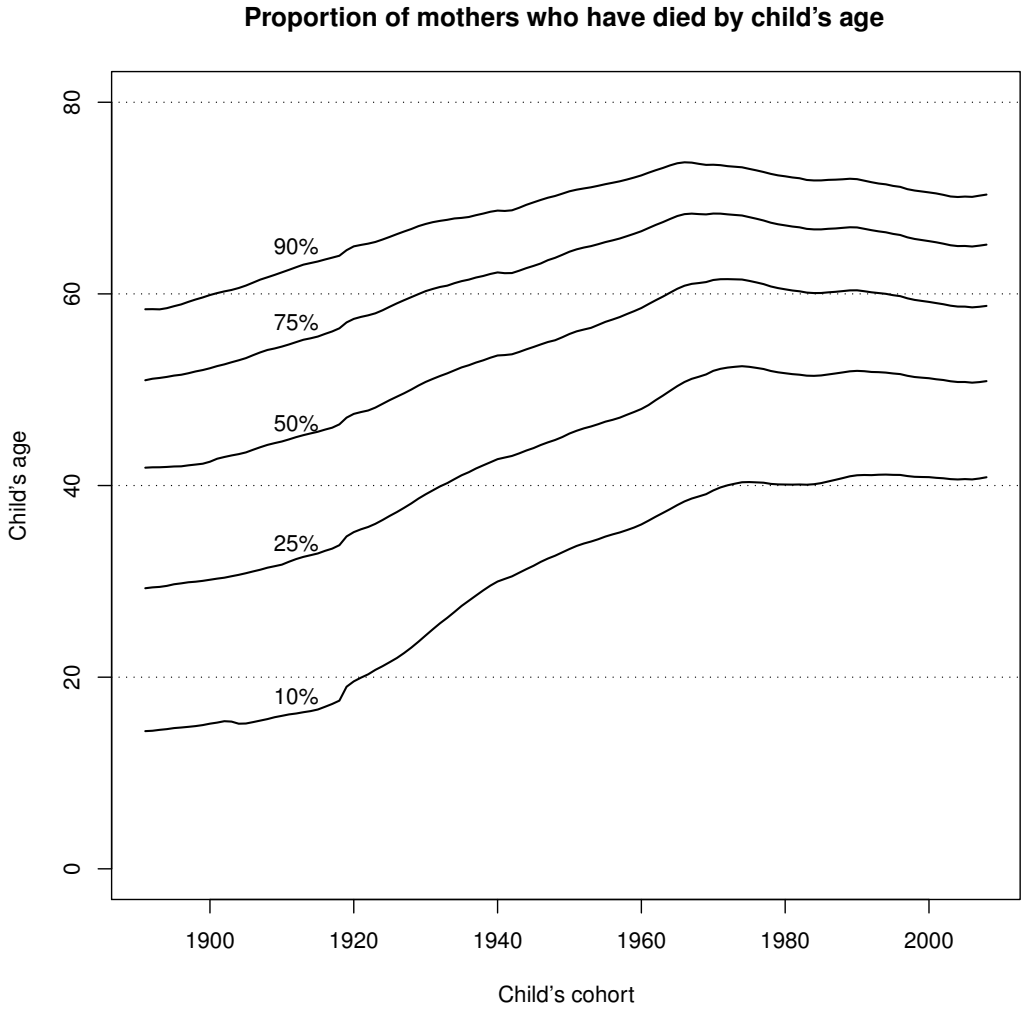


Figure 4: Age at which various percentiles of a birth cohort have experienced the loss of their mother, Sweden.

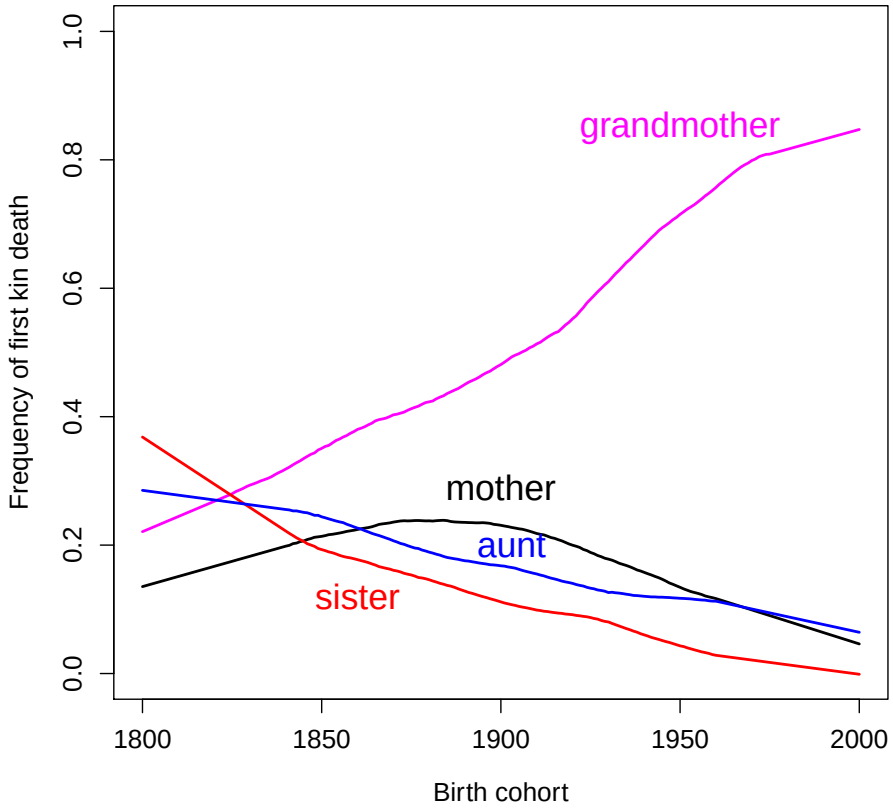


Figure 5: Frequency of different types of kin death, Sweden (from SOCSIM).