Women's experience of child death over the life course: a global demographic perspective

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Abstract

Recent population change has seen increases in life expectancy, reductions in family size, and postponement of fertility to older ages. We analyze the effect of these dynamics on the experience of child death over the life course for the 1950-1999 annual birth cohorts of women around the world. The paper draws on age-specific fertility and mortality rates (UN WPP estimates and projections) to assess trends in the *frequency* and *timing* of child death using formal demographic methods. We discuss the variation in women's exposure to child death according to the demographic regimes prevailing in different world regions. Our analyses predict a global reduction in the overall frequency of child death over a woman's life course. We expect the largest improvements in regions of the Global South where child death is still common for women. In spite of persisting regional inequalities, we show evidence of a global convergence towards a future where the death of a child will become ever more infrequent for women. We show that global population aging will be accompanied by an aging of generational relationships where life events such as the death of a child are experienced at older ages. Given these results, it seems likely that 'child death' will increasingly come to mean the death of an adult child for younger generations of women.

Significance

Losing a child is an especially devastating experience for mothers. Existing studies consider period measures of infant and young child mortality, but little is known about the experience of child death over a woman's life course. Using methods from mathematical demography, we project that child death will be more infrequent for younger generations of women around the world, who will increasingly experience the death of adult children. We expect the gap between the Global South and North to narrow over time but persisting international inequalities are troubling in a rapidly aging population where the loss of support from children can affect parental well-being. This is especially worrying for populations without access to effective institutional support for the elderly.

The adage that *no parent should have to bury a child* reflects an old societal aspiration: deaths over the life course should follow an orderly sequence, with deaths of earlier generations preceding those of later generations. In reality, young child mortality rates have been extremely high for most of human history and continue to be high in many contemporary populations [33]. This is the result of a long-standing demographic regime which has been changing rapidly as the average levels of mortality and fertility continue to decline around the world.

The death of a child affects parental well-being [7, 12] and has been linked to higher mortality for parents and for mothers in particular [27, 5, 15]. Child death also affects the availability of social, emotional, and financial support in the family [32, 30], something especially detrimental for parents who planned their lives with the expectation that their children would survive to provide them with social support at old ages [21, 3]. This has important implications for the inequality of access to care and to family support in the context of an aging global population [13, 20]. Parents in low-income countries, which are expected to experience a radical demographic transformation in the coming years, but often lack access to effective pension systems and welfare regimes, are likely to be the most vulnerable [25].

The Demographic Transition (DT) - understood as a historical regularity [3] and a framework for conceptualizing global population change [1, 14, 25] - is often represented as a movement from 'disorder' to 'order'. An influential view portrays the DT as a transition towards a 'natural chronological hierarchy' of death [16]. However, the impact of the DT on the experience of child death over a woman's life course is not self-evident considering that improvements in longevity, declines in fertility, and postponement of fertility affect kinship dynamics in complex ways [19, 32]. On the one hand, higher mean ages at childbirth and lower total fertility decrease the exposure to the death of young children. On the other hand, global population aging seems inevitable in the long-term [13, 20] and, with it, an 'aging of generational relationships' [19] where life events such as the death of a child are postponed to older ages.

In this paper, we explore the effect of past and future global demographic changes on the experience of child death from the perspective of women living through them in different world regions. We ask how a sustained fertility decline and rising life expectancy, driven by radical reductions in young child mortality, affect the experience of child death over the life course. The analysis centers on the *frequency* and the *timing* of the experience of child death to determine how common the experience of losing a child will be in the future and at which stage of the life course it will occur. Our calculations refer to male and female chil-

dren born from women given that child death is more detrimental for mothers [15, 7] and we lack quality international data on male fertility [28]. We estimate the current and future dimensions of the problem by applying methods from formal demography to data from the UN World Population Prospects (UN WPP). Our analyses use reported and projected demographic rates to explore the experience of women born in all years between 1950 and 1999 around the world (see *Materials and Methods*), offering a truly global overview of the phenomenon while emphasizing regional differences connected to the prevailing demographic regimes. This novel analytical approach is more parsimonious and less computationally intensive than the demographic microsimulations used in previous studies of kinship availability, none of which have focused on child death [32, 30, 19, 36].

Life course effects of parental bereavement

Parental bereavement impacts the psychological, physical, and material well-being of parents. The death of a young child is associated with increased risk of mortality for parents [15, 27, 5], depressive symptoms [18, 35, 12], lower self-rated health [7], and lower overall quality of life [26, 29]. This traumatic event can influence health-related behaviors, such as diet, smoking, or alcohol consumption [7]. It can also affect the couple dynamics between parents [2] and increase the risk of intimate partner violence [34]. Parental bereavement generally affects mothers more than fathers, perhaps as a result of gendered coping mechanisms or because mothers develop stronger emotional ties with their children [12, 27, 15, 35]. It is still unclear how family size and the gender of the deceased child affect parental bereavement [17, 24, 35] but some studies have found stronger effects following the death of an only child [15, 5]. The few existing studies on adult child death have also shown increased mortality risks for elderly mothers [27] as well as depressive symptoms and lower self-rated health [12]. The death of an adult child can interrupt the transfer of essential emotional and instrumental support to elderly parents [37] but no study has looked at this phenomenon in depth. Overall, very little research exists on the consequences of child death for parents in the Global South.

Demographic forces affecting child death

The DT theory predicts sustained declines in mortality and fertility for subsequent birth cohorts, following the assumption of an eventual convergence towards an older stationary population [14, 25]. This transition is not necessarily smooth since local idiosyncrasies and disruptive events such as wars and epidemics affect demographic rates in unexpected ways (Fig. 1). The HIV/AIDS epidemic in sub-Saharan Africa, for example, brought life expectancy improvements to a halt and increased exposure to kin death [36]. The demographic stability projected for high-income regions like Europe, which underwent the transition decades or centuries ago, is a reminder of the dramatic demographic disparities around the world [1]. Future cohort changes in mortality and fertility are expected to affect the experience of child death during a woman's life.

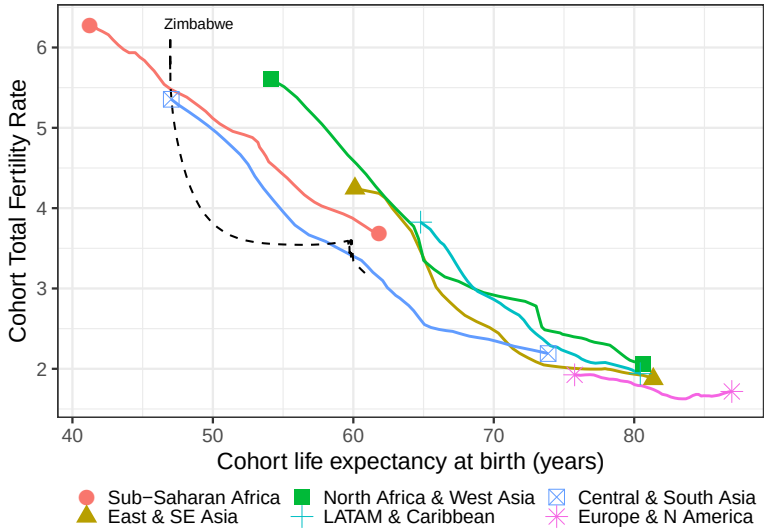

Figure 1: Cohort fertility and cohort life expectancy for UN SDG regions (solid lines, median values) and selected countries (dashed) for the 1950-1999 annual birth cohorts (cohorts approximated using UN WPP period data). The DT theory predicts a progression from the top-left of the figure (high fertility and mortality) to the bottom-right (low fertility and mortality) for younger generations. Country estimates for Zimbabwe (dashed line) show how a mortality crisis can affect this transition. Omitted estimates for Oceania, Australia and New Zealand included in the *Supporting Information*.

Mortality

The last 50 years have seen considerable improvements in mortality. Under-5 mortality has fallen from 213 per 1,000 live births in 1950-1954 to 46 in 2010-2015. The UN Sustainable Development Goals (UN SDG) aim to reduce it to 25 by 2030. At the same time, excluding large demographic shocks like the recent HIV/AIDS epidemic [36], period life expectancy has increased at a constant rate of around 2.5 years per decade all over the world. This is one of the most robust regularities in contemporary population dynamics [31]. In the future, large gains in life expectancy are expected in low-income countries, where mortality is still concentrated at young ages. In high-income countries, slow but sustained increases in life expectancy have re-energized the debate of whether we will approach an inflection point for trends in human lifespan [22].

Lower mortality rates can increase or decrease the frequency of women's experience of child death in a population. Higher life expectancy for mothers increases the exposure to risk by expanding the overlap between the lives of mothers and their children. Lower infant, child, and young adult mortality reduce the mother's risk of experiencing the death of a child during her reproductive years, when children are young, at the expense of compressing death at older ages for women [8]. As a population undergoes the DT, the effect of improved survival on child death also depends on changes in the distribution of fertility over age.

Fertility

Post-transition populations are characterized by lower and later fertility. Global period Total Fertility Rate (TFR) is projected to fall from 4.97 in 1950-1954 to 1.94 by 2095-2100, just below replacement level [4]. Nearly half of the world population currently lives in a region with below-replacement period fertility and this share is projected to increase [13, 25]. The largest fertility declines are expected in some parts of the Global South, where fertility is currently still high. Important changes are also expected in the timing of fertility, another key component of the DT. The Global Mean Age at Childbirth (MACB) in Europe and N America is projected to increase steadily over the projection horizon, reflecting a historical tendency for women in high-income and low-fertility countries to postpone the start of their childbearing years. MACB values for sub-Saharan Africa, the world's most impoverished region, will remain virtually unchanged over the same period.

Reductions in fertility decrease the risk of child death as parents have, on av-

erage, fewer offspring to lose compared to parents in previous generations. Similarly, postponement of fertility both reduces the likelihood of experiencing child death and potentially delays the timing of child death. Levels of childlessness also matter because only parents with children are at risk of losing them [11]. Furthermore, women in low-fertility settings are more likely to become childless after the death of a child, all else constant.

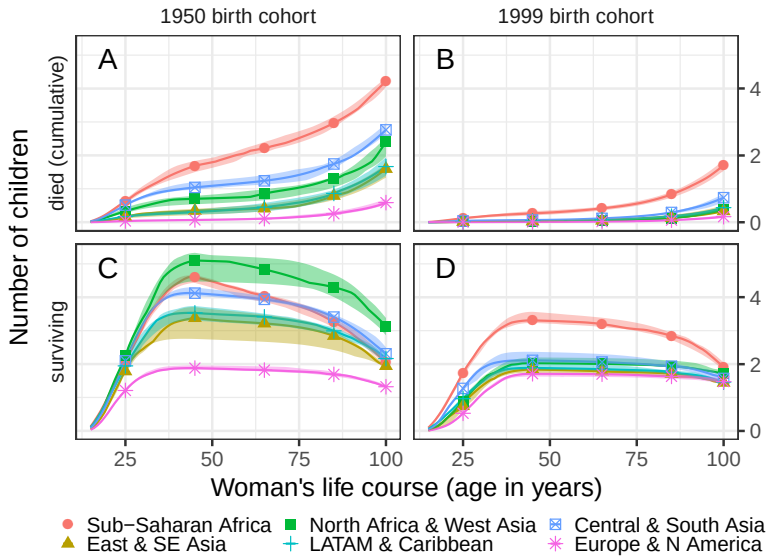

Figure 2: Frequency of child death and child survival over the life course of two selected birth cohorts of women. (A and B) Cumulative number of child deaths experienced by a hypothetical woman surviving to age a. (C and D) Total number of children surviving (currently alive) for a woman aged a. The solid lines represent regional median values and the bands the variability among countries in each region (40^{th} and 60^{th} percentiles). Results for all country-cohort combinations are included in the *Supporting Information*.

Results

Child death

We start by examining global trends in the cumulative frequency of child death $CD_{(a,c,r)}$ for an average woman born in cohort c and region r surviving to age a

(Fig. 2, A and B). We project a sustained decline in the overall frequency of child death for younger generations of women, leading to a convergence towards lower values across all world regions. This will shrink the large disparities between the Global North and South observed for the 1950 cohort of women. Even so, the experience of child death will continue to be relatively frequent in regions of the Global South such as sub-Saharan Africa and Central and South Asia in the foreseeable future, especially for women surviving to older ages.

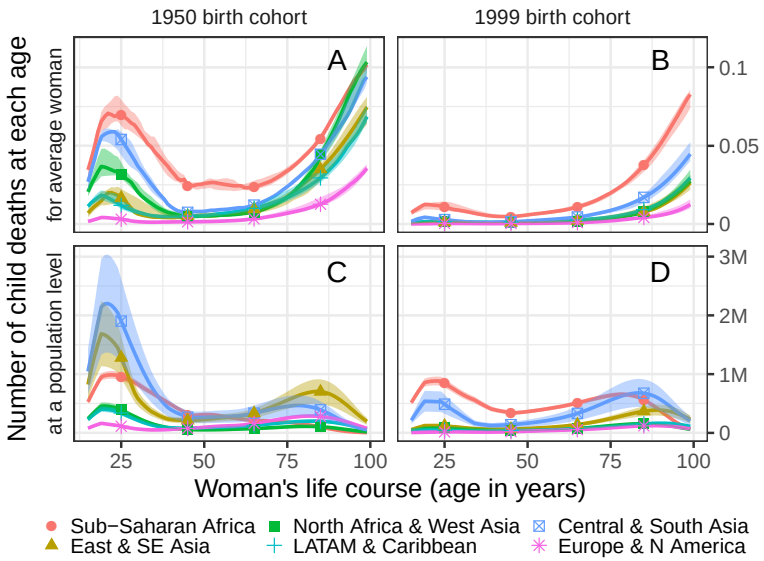

Figure 3: Timing of child death in two female birth cohorts. (A and B) First difference of child death, ΔCD: number of child deaths experienced at each age a by a woman surviving to that age (median, 40^{th}, and 60^{th} percentiles). (C and D) Burden of child death: total number of child deaths experienced by all women in a region at each age a (point estimate and standard deviation in millions).

We now consider the distribution of child deaths over a woman's life course (ΔCD) to evaluate changes in the timing of child death conditional on women surviving to a given age. The experience of losing a young child was common for a woman born in 1950 outside Europe and N America. This will no longer be the case for a woman born 50 year later, who will be more likely to lose an adult child in her old age than a young child during her reproductive years (Fig. 3, A-B). We find further evidence of this postponement of the experience of child death to older ages in the fact that the age at which an older woman will experience the

same values of ΔCD as a young woman is expected to fall for more recent birth cohorts.

We computed a population-level overview of the phenomenon by weighting our estimates of ΔCD by the number of women actually exposed to these levels of child death. The 'burden of child death' (Fig. 3, C and D) shows the total number of child deaths experienced by all women in region r at each age a. We obtained it by multiply ΔCD by the l_x column of a cohort life table with a radix equal to the initial size of each female birth cohort (see *Supporting Information*). As expected, the curves tail off at older ages reflecting the declining number of women surviving to older ages.

Our population-level analyses find evidence of the two trends discussed so far: a reduction in the overall frequency of child death and a postponement of the experience of child death to older ages. The expected decline in the global burden of child death is remarkable considering that a third more women were born in 1999 than in 1950. Yet, regional differences will endure, especially between Africa, Asia, and the rest of the world. The burden of child death in the Global North, Latin America, and North Africa and West Asia is expected to be comparatively low at all ages as these regions go on to represent an increasingly lower share of the total world population. The extremely high levels of young child death in Central and South Asia and East and SE Asia are predicted to decline by a factor of ten for women born in 1999. They will remain unchanged in sub-Saharan Africa, reflecting the interaction between high mortality and rapid population growth in a region projected to represent 35% of the world population by 2100. The burden of adult death is also expected to decline worldwide even as the age at which women can expect to experience child death increases for younger generations. This is not true for Central and South Asia and sub-Saharan Africa, where persisting high levels of adult child death will result from a combination of improved women's survival, relatively high mortality rates for children, and large population growth.

Child survival

We now focus on the number of surviving children for a woman reaching age a, $CS_{(a,c,r)}$. The expected reduction in CS between the 1950 and 1999 cohorts (Fig. 2, C and D) reflects the anticipated decline in global TFR and, to some extent, the assumption of convergence to replacement fertility levels built into the UN projections [13]. The expected change will be concentrated in the Global South, as the projected demographic stability in Europe and N America will bring about little change in CS between the 1950 and 1999 cohorts. Period TFR in North Africa

and West Asia is expected to fall sharply over the projection horizon, explaining the noticeable decline in the levels of CS between the two birth cohorts. The high levels of child survival for women in sub-Saharan Africa in both cohorts result from enduring high fertility in the region coupled with significant improvements in mortality (Fig. 1).

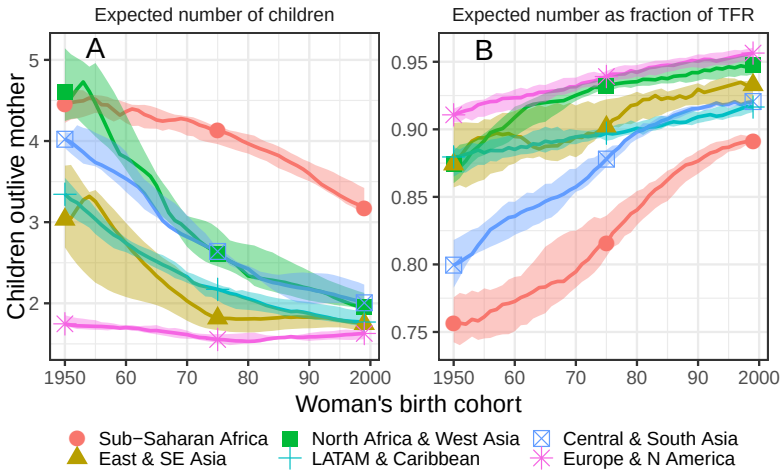

Figure 4: Absolute and relative number of children expected to live longer than their mothers (median values, 40^{th} and 60^{th} percentiles). (A) Number of children expected to outlive an average woman. (B) Children expected to outlive a woman as a fraction of her cohort's TFR.

Child survival is important if women draw on resources provided by their living children at older ages. The number of children expected to outlive their mothers, $E[CS]$, is an intuitive measure of child availability for elder women (details of estimation in *Supporting Information*). The $E[CS]$ (Fig. 4, A) is predicted to fall around the world, with the largest change expected in North Africa and West Asia. This global decline is partially explained by the projected fall in TFR but is also influenced by the changing mortality regimes affecting women and children. Plateaus or slight bumps in $E[CS]$ can result either from increased fertility (e.g. Europe after 1980), considerable improvement in the life expectancy of children (e.g. East and SE Asia), or a combination of both.

We use $E[CS]$ as a proportion of cohort TFR to evaluate improvements in reducing the accumulated experience of child death over a woman's life course (Fig. 4, B). The general picture is one of progress as an ever-larger share of a cohort's TFR can be expected to outlive their mothers. Furthermore, we can

expect the gap between the Global North and South to narrow for more recent birth cohorts of women. Women in sub-Saharan Africa and Central and South Asia will go from losing almost a fourth of all their children to losing only one in ten.

Discussion

Overall, we find a general decrease in the *frequency* of child death over the life course for more recent birth cohorts of women. This is partly because lower cohort fertility implies a lower number of children at risk of dying. We showed that in spite of a remarkable reduction in the North-South divide, international inequalities in the experience of child death will continue to affect women born at the turn of the 20^{th} century. Globally, most young child deaths will be experienced by women in Central and South Asia and sub-Saharan Africa, as a result of a growing population coupled with persistently high levels of mortality and fertility. The death of a young child, a rare event for East Asian or North American women, will continue to be a distressing reality for many in sub-Saharan Africa.

The expected global population dynamics will also affect the *timing* of child death over a woman's life course. Given equivalent levels of fertility, more rectangular survival curves, with deaths compressed around the mean age at death, will contribute to the aging of generational relationships, where the experience of child death is shifted to older ages. For women in more recent birth cohorts, child death will increasingly come to mean the death of an adult child. This phenomenon is expected if young child mortality continues to decline over the course of the century even as fertility converges towards replacement level.

Globally, we expect most adult child deaths to happen to women in sub-Saharan Africa, Central and South Asia, and, to a lesser extent, East and SE Asia. These expected developments should be accompanied by the establishment of robust systems of social care and support for the old. The death of an adult child can result in the loss of crucial social and material support for elderly women [7]. The consequences can be more severe following the death of an only child, a growing risk for parents in regions with very low fertility [15, 5]. An 'old-age security' motive, where fertility decisions follow the expectation of future support, may not be compatible with an aging population without adequate pension and retirement schemes, social care, or alternative safety nets for bereaved parents [25].

We identify three main limitations of the study. Initially, the formal approaches that inspired this work (see Materials and Methods) ignore inter-generational cor-

relations. Positive correlations between the fertility of mothers and the mortality of children, for example, could imply that women who give birth to many children also have children who are at higher risk of dying [10]. However, we do not expect these second-order effects to affect our estimates substantially. Future work can study the nature of these correlations in countries with quality register data. Second, our analyses focus on the experience of an average woman, not an average mother. They do not factor in childlessness, for which no comprehensive global data exists, nor consider a woman's parity [11]. Future studies can use register data or demographic microsimulations to address this. Third, the results of any regional analysis depend on how countries are aggregated. We developed a web application to easily generate alternative regional estimates.[1]

Losing a child is a traumatic event linked to negative outcomes for women in particular [27, 7, 12]. In this paper we unpacked the complex interactions between global demographic change - reductions in young child mortality, increases in life expectancy, reductions in total fertility, and postponement of births - and the experience of child death over a woman's life course. The exposure to child death is a pervasive, yet often unnoticed, form of international inequality which varies predictably according to the demographic regime prevailing in a population [30]. Nevertheless, we showed an opportunity for this historical gap between the Global North and South to narrow in the future. We are edging towards a world where the death of a child, particularly of a young child, will be an extremely uncommon experience. Some women are already living in this world - many others will have to wait to benefit from it.

Materials and methods

We extend existing formal methods [6, 9] to analyze changes in *child death* using country-level demographic rates. We calculate $CD_{(a,c,r)}$, the expected number of child deaths experienced by a woman born in cohort c and UN SDG region r (defined using the M49 standard for area codes), conditional on surviving to age a:

$$\underbrace{CD_{(a,c,r)}}_{\text{child deaths}} = \underbrace{\sum_{x=15}^{x=a} {}_1F_{(x,c,r)}}_{\text{children born}} - \underbrace{\sum_{x=15}^{x=a} {}_1F_{(x,c,r)} l_{(a-x,c+x,r)}}_{\text{child survival or } CS_{(a,c,r)}} \quad (1)$$

[1] Link to interactive shiny web application here.

where ${}_1F_{(x,c,r)}$ represents age-specific fertility rates for the women's cohort c at age x and $l_{(a-x,c+x)}$ represents the survival probability until age $(a-x)$ for the cohort of children born in year $(c+x)$.

Child survival was estimated from the right hand-side of Eq. 1, which is a function of woman's fertility and child survival but not of woman's survival because it is conditional on her survival to age a. We estimate the number of surviving children for a women at the end of her life, $E[CS_{(-,c,r)}]$, by weighting $CS_{(a,c,r)}$ by the cohort life table death distribution of women $d_{(a,c,r)}$ up to age e, the life expectancy for women in cohort c and region r:

$$E[CS_{(-,c,r)}] = \frac{\sum_{a=15}^{e} d_{(a,c,r)} CS_{(a,c,r)}}{\sum_{a=15}^{e} d_{(a,c,r)}}. \tag{2}$$

We approximated cohort rates from period age-specific mortality and fertility rates from the 2019 Revision of the UN World Population Prospects [4]. Period data for 1950-2018 come from primary sources, where available, and for 2019-2100 from deterministic cohort-component projections (*medium* scenario) [1]. We expanded the UN abridged life tables by interpolating single-age values on the ${}_nm_x$ column, modelling values for the very young and very old ages separately [23]. We then obtained single-calendar-year rates through linear interpolation. The code to reproduce the results and the complete country estimates are available online[2], as is the data used for the analysis[3].

References

[1] Selected Results of the 2019 UN World Population Projections. *Population and Development Review*, 45(3):689–694, Sept. 2019.

[2] S. Albuquerque, M. Pereira, and I. Narciso. Couple's Relationship After the Death of a Child: A Systematic Review. *Journal of Child and Family Studies*, 25(1):30–53, Jan. 2016.

[3] J. C. Caldwell. A Theory of Fertility: From High Plateau to Destabilization. *Population and Development Review*, 4(4):553–577.

[4] U. DESA. World Population Prospect 2019: Dataset. 2019. itemType: dataset.

[2] https://osf.io/ptj7f/?vie_only=4a5400964dfa496eaa7ea3366a4cdad4

[3] https://population.un.org/wpp/

[5] J. Espinosa and W. N. Evans. Maternal bereavement: The heightened mortality of mothers after the death of a child. *Economics & Human Biology*, 11(3):371–381, July 2013.

[6] L. A. Goodman, N. Keyfitz, and T. W. Pullum. Family formation and the frequency of various kinship relationships. *Theor Popul Biol*, 5(1):1–27, Feb 1974.

[7] K. C. Hendrickson. Morbidity, mortality, and parental grief: a review of the literature on the relationship between the death of a child and the subsequent health of parents. *Palliat Support Care*, 7(1):109–19, Mar 2009.

[8] V. Kannisto. Measuring the compression of mortality. *Demographic Research*, 3, Sept. 2000.

[9] N. Keyfitz and H. Caswell. *Applied Mathematical Demography*. Springer, New York, 2005.

[10] M. Kolk, D. Cownden, and M. Enquist. Correlations in fertility across generations: can low fertility persist? *Proceedings of the Royal Society B: Biological Sciences*, 281(1779):20132561, Mar. 2014.

[11] M. Kreyenfeld and D. Konietzka, editors. *Childlessness in Europe: Contexts, Causes, and Consequences*. Demographic Research Monographs. Springer International Publishing, Cham, 2017.

[12] C. Lee, D. A. Glei, M. Weinstein, and N. Goldman. Death of a child and parental wellbeing in old age: Evidence from Taiwan. *Social Science & Medicine*, 101:166–173, Jan. 2014.

[13] R. Lee. The Outlook for Population Growth. *Science*, 333(6042):569–573, July 2011.

[14] R. Lesthaeghe. The second demographic transition: A concise overview of its development: Table 1. *Proceedings of the National Academy of Sciences*, 111(51):18112–18115, Dec. 2014.

[15] J. Li, D. H. Precht, P. B. Mortensen, and J. Olsen. Mortality in parents after death of a child in Denmark: a nationwide follow-up study. *Lancet*, 361(9355):363–7, Feb 1 2003.

[16] M. Livi Bacci. *A concise history of world population*. Blackwell, 2nd ed edition.

[17] K. L. Meert, A. E. Donaldson, C. J. L. Newth, R. Harrison, J. Berger, J. Zimmerman, K. J. S. Anand, J. Carcillo, J. M. Dean, D. F. Willson, C. Nicholson, and K. Shear. Complicated Grief and Associated Risk Factors Among Parents Following a Child's Death in the Pediatric Intensive Care Unit. *Archives of Pediatrics & Adolescent Medicine*, 164(11):1045–1051, Nov. 2010.

[18] T. A. Mills, C. Ricklesford, A. Cooke, A. E. P. Heazell, M. Whitworth, and T. Lavender. Parents' experiences and expectations of care in pregnancy after stillbirth or neonatal death: a metasynthesis. *BJOG: An International Journal of Obstetrics & Gynaecology*, 121(8):943–950, 2014.

[19] M. Murphy. Long-Term Effects of the Demographic Transition on Family and Kinship Networks in Britain. *Population and Development Review*, 37:55–80, Jan. 2011.

[20] M. Myrskylä, H.-P. Kohler, and F. C. Billari. Advances in development reverse fertility declines. *Nature*, 460(7256):741–743, Aug. 2009.

[21] P. A. Neher. Peasants, procreation, and pensions. *The American Economic Review*, 61(3):380–389, 1971.

[22] J. Oeppen. Enhanced: Broken Limits to Life Expectancy. *Science*, 296(5570):1029–1031, May 2002.

[23] S. H. Preston, P. Heuveline, and M. Guillot. *Demography: measuring and modeling population processes*. Blackwell Publishers, Malden, MA, 2001.

[24] M. O. Rahman. Family matters: The impact of kin on the mortality of the elderly in rural Bangladesh. *Population Studies*, 53(2):227–235, 1999/01/01 1999.

[25] D. S. Reher. The Aftermath of the Demographic Transition in the Developed World: Interpreting Enduring Disparities in Reproductive Behavior. *Population and Development Review*, June 2019.

[26] C. H. Rogers, F. J. Floyd, M. M. Seltzer, J. Greenberg, and J. Hong. Long-term effects of the death of a child on parents' adjustment in midlife. *J Fam Psychol*, 22(2):203–211, Apr 2008.

[27] M. Rostila, J. Saarela, and I. Kawachi. Mortality in parents following the death of a child: a nationwide follow-up study from Sweden. *Journal of Epidemiology and Community Health*, 66(10):927–933, Oct. 2012.

[28] B. Schoumaker. Male Fertility Around the World and Over Time: How Different is it from Female Fertility? *Population and Development Review*, 45(3):459–487, Sept. 2019.

[29] J. Song, F. J. Floyd, M. M. Seltzer, J. S. Greenberg, and J. Hong. Long-term effects of child death on parents' health related quality of life: A dyadic analysis. *Fam Relat*, 59(3):269–282, Jul 1 2010.

[30] D. Umberson, J. S. Olson, R. Crosnoe, H. Liu, T. Pudrovska, and R. Donnelly. Death of family members as an overlooked source of racial disadvantage in the United States. *Proceedings of the National Academy of Sciences*, 114(5):915–920, Jan. 2017.

[31] J. W. Vaupel. Biodemography of human ageing. *Nature*, 464(7288):536–542, Mar. 2010.

[32] A. M. Verdery and R. Margolis. Projections of white and black older adults without living kin in the United States, 2015 to 2060. *Proceedings of the National Academy of Sciences*, 114(42):11109–11114, Oct. 2017.

[33] A. A. Volk and J. A. Atkinson. Infant and child death in the human environment of evolutionary adaptation. *Evolution and Human Behavior*, 34(3):182–192, May 2013.

[34] A. Weitzman and E. Smith-Greenaway. The Marital Implications of Bereavement: Child Death and Intimate Partner Violence in West and Central Africa. *Demography*, page 44, Feb. 2020.

[35] L. Wijngaards-de Meij, M. Stroebe, H. Schut, W. Stroebe, J. van den Bout, P. van der Heijden, and I. Dijkstra. Couples at Risk Following the Death of Their Child: Predictors of Grief Versus Depression. *Journal of Consulting and Clinical Psychology*, 73(4):617.

[36] E. Zagheni. The Impact of the HIV/AIDS Epidemic on Kinship Resources for Orphans in Zimbabwe. *Population and Development Review*, 37(4):761–783, Dec. 2011.

[37] E. Zagheni and B. Wagner. The impact of demographic change on intergenerational transfers via bequests. *Demographic Research*, 33:525–534, Sept. 2015.