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Life After Loss: A Prospective Analysis of Mortality Exposure and Unintended Fertility

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Abstract

The relationship between mortality and fertility is a key component of demographic transition theory, placing it at the center of extensive inquiry. Among other linkages, mortality in women's communities and social networks influences their subsequent fertility. Existing demographic research assumes this is principally due to volitional mechanisms, implying that exposure to mortality consolidates women's desire to become pregnant, leading to *intended* fertility. Yet, insights from other disciplines suggest that mortality exposure could also increase women's *unintended* fertility through psychological, relational, and behavioral mechanisms. This study examines the relationships between network mortality exposure and women's hazard of pregnancy, and of unintended pregnancy specifically. We analyze two years (2009–2011) of closely spaced panel data on young Malawian women ($N=1,272$) enrolled in the Tsogolo la Thanzi study. Our data include information on funeral attendance and fertility desires measured weeks before conception, which is confirmed through frequent pregnancy testing. Hazard models show that the number of funerals women attend corresponds with a higher hazard of pregnancy and of unintended pregnancy specifically. These findings make clear that mortality exposure can influence fertility not by shaping women's desires but by disrupting the realization of those desires.

Keywords

Mortality; Fertility; Unintended pregnancy; Demographic transition; Malawi

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Introduction

The relationship between mortality and fertility is central to demographic transition theory. Early formulations of demographic transition theory emphasized mortality decline as a key precursor for fertility decline (Freedman 1962; Heer 1966; Notestein 1945). For decades, demographic research has sought to identify the micro-level processes that could drive a link between mortality and fertility at the macro level. Most studies have focused on the influence of child mortality, including the death of one's own child and children in one's interpersonal network and community (Cleland 2001; Sandberg 2006).

As child mortality declined worldwide, demographers began to consider whether changes in broader mortality conditions could also elicit changes in women's fertility. Studies have leveraged sudden, pronounced mortality shocks caused by violence, natural disasters, and pandemics to demonstrate that an increase in mortality often corresponds with an initial decrease, but eventual increase, in fertility (Agadjanian and Prata 2002; Boberg-Fazlic et al. 2017; Heuveline and Poch 2007; Nobles et al. 2015; Rodgers et al. 2005). These findings raise questions about why this is the case: Does exposure to mortality increase women's fertility by driving their desire to become pregnant? Or does mortality exposure increase women's fertility primarily through nonvolitional mechanisms? Much of the demographic literature implicitly assumes the mortality–fertility link is borne out of volitional mechanisms. Even as demographers have recognized that the personal loss of an infant could elevate women's risk of an additional, and perhaps not intended, pregnancy owing to abbreviated lactational amenorrhea (Bongaarts and Delgado 1977; Delgado et al. 1982; Jones and Palloni 1990), studies have not parsed whether broader mortality conditions influence women's likelihood of having an intended or unintended pregnancy. Unintended fertility constitutes a sizable share of total fertility: globally, nearly one half of pregnancies are unintended, either unwanted or occurring sooner than desired (Bearak et al. 2018). Incorporating fertility desires into this literature will clarify if a widely studied determinant of fertility works by crystallizing women's desire for a child or by disrupting their plan to avoid pregnancy.

In this study, we examine the salience of short-term fluctuations in women's exposure to mortality for their likelihood of pregnancy, and specifically their likelihood of unintended pregnancy. To do so, we analyze two years (2009–2011) of closely spaced panel data from a cohort study of young women in Malawi. The data include time-varying indicators of recent mortality exposure as measured by women's funeral attendance in the prior month. The data also feature time-varying measures of women's fertility desires collected an average of eight weeks before conception, which is confirmed through frequent pregnancy testing. Our findings are consonant with evidence that mortality exposure can increase women's fertility but clarify that this influence does not necessarily align with women's desires.

Background

Mortality and Fertility

A key proposition of demographic transition theory is that a population's fertility rate will decline after its mortality rate declines (Notestein 1945). Even as demographers caution that

these associations result from complex mechanisms that are difficult to identify empirically (Billari 2015; Cleland 2001), there have still been concerted efforts to do so. Two micro-level, volitional mechanisms have enjoyed much of the limelight: replacement effects and insurance effects. Both mechanisms pertain to child mortality and are thought to be of relevance in contexts where couples are engaging in family-building strategies (Lloyd and Ivanov 1988).

The “replacement effect” centers on parents’ personal reactions to their own child dying. This perspective emphasizes that, in the wake of a child’s death, couples are more likely to have an additional birth to compensate for their loss (Grummer-Strawn et al. 1998; Knodel 1978; Preston 1978). Evidence suggests, however, that couples’ post-bereavement fertility has a relatively small influence on overall fertility levels (Grummer-Strawn et al. 1998; Hossain et al. 2007; Lindstrom and Kiros 2007; Palloni and Rafalimanana 1999).

The second mechanism, the “insurance effect,” emphasizes the salience of general child mortality conditions for couples’ fertility. This perspective contends that couples pursue a larger family size to offset the child deaths they anticipate based on what they observe among their neighbors, friends, and extended family (Preston 1978). High-mortality conditions heighten couples’ concern that their own children may die prematurely, motivating them to have more children to ensure that they do not end up with fewer than desired (Cain 1983; Hossain et al. 2007; Kalemli-Ozcan 2003; Kirk 1996; Mason 1997). Studies show that women’s exposure to child mortality in their communities and social networks informs their mortality perceptions and fertility outcomes, offering support for this perspective (Sandberg 2005, 2006; Sandberg et al. 2012; Shapiro and Tenikue 2017).

As child mortality declined worldwide and the relevance of these mechanisms for understanding fertility change diminished, research began to examine whether general mortality conditions could also influence women’s fertility. Although the genesis of this literature was evidence that a *decrease* in mortality ushers in lower fertility, demographers inverted the long-standing question to ask whether an *increase* in mortality could induce higher fertility—further testing the solidity of the mortality–fertility link. For instance, researchers have examined large-scale mortality shocks to see if they elicit fertility change (Agadjanian and Prata 2002; Finlay 2009; Heuveline and Poch 2007; Hosseini-Chavoshi and Abbasi-Shavazi 2013; Kraehnert et al. 2019; Lindstrom and Berhanu 1999; National Research Council et al. 2004; Nobles et al. 2015; Thiede et al. 2020; Urdal and Che 2013). Ongoing conflict tends to correspond with an initial decline in fertility, but a subsequent rebound after the violence ceases (Agadjanian and Prata 2002; Heuveline and Poch 2007; Lindstrom and Berhanu 1999; Thiede et al. 2020). For example, Heuveline and Poch (2007) document a dramatic rise in fertility following widespread mortality in Cambodia under the Pol Pot regime in the 1970s. Similarly, some studies of natural disasters involving high death tolls show a corresponding increase in fertility (Finlay 2009; Hosseini-Chavoshi and Abbasi-Shavazi 2013; Nobles et al. 2015), whereas others document that the displacement, economic disruption, and food scarcity associated with natural disasters can lower fertility (Lindstrom and Berhanu 1999; Seltzer and Nobles 2017).

Although this literature has established that mass mortality events can affect fertility, it is complicated by the fact that wars, natural disasters, and pandemics are not solely mortality events. Instead, they are multidimensional crises that feature other concerns, such as residential displacement, economic depression, and the fraying of social institutions (Aassve et al. 2020). These other dimensions could confound or delay the true effect of changes in mortality conditions on fertility, which likely explains the varied linkages between high-mortality events and fertility. Additionally, exposure to a contained, period-specific increase in mortality may be experientially distinct from the ordinary, day-to-day mortality in one's community and social network that is centered in demographic transition theory. Thus, in this study, we focus on mortality exposure that is not obscured by broader social disruptions but occurs instead amid the mundanity of everyday life. Specifically, we use within-person variation in women's exposure to social network mortality to assess its correspondence with women's short-term risk of pregnancy.

Further departing from past work, our study differentiates between intended and unintended pregnancies. Studies of the mortality–fertility link have not assessed whether women's fertility was intended. Nonetheless, much of the literature implies that observed links between mortality exposure and fertility are attributable to increases in women's intended fertility. For instance, studies have suggested that mortality shocks can lead to higher fertility as part of a collective community response to initiate a “return to normal” or to achieve “renewal” following tragedy (Nobles et al. 2015:19). Studies have also described higher fertility in the wake of a crisis as embodying the “proactive role of individuals, families, and communities” to confront an existential threat (Heuveline and Poch 2007:422). Aside from recognition that conflict could increase (unwanted) fertility through sexual violence (Thiede et al. 2020) and that women with more resources are better able to delay births until conflict ceases (Agadjanian and Prata 2002), demographic studies have yet to test if mortality exposure leaves women vulnerable to unintended pregnancy specifically. Thus, we draw on theoretical perspectives from other literatures to consider whether network mortality could produce a disjuncture between women's fertility desires and outcomes.

Theoretical Perspectives of Mortality Exposure and Unintended Fertility

Evolutionary psychology describes how exposure to death can lead women to engage in future discounting by instilling the perception that they too will die before reaping any delayed benefits of their immediate behaviors (Placek and Quinlan 2012). By obscuring individuals' visions of their future, reminders of death can prime people to behave in riskier ways as they focus on a shorter time horizon. From this perspective, mortality exposure may lead women to engage in sexual behavior that increases their risk of pregnancy, even if they have no plan or desire to become pregnant (Chisholm et al. 1993; Wilson and Daly 1997).

Psychological research suggests that exposure to mortality could also elevate women's likelihood of unintended pregnancy by encouraging them to value prenatalism and to adopt prenatal behaviors, even if these ideals and behaviors conflict with their personal plans. Terror management theory suggests that people work to reduce the conscious effect of mortality as an existential threat (Burke et al. 2010). When reminded of death, individuals control their natural anxiety by adhering to cultural values, providing a sort of symbolic

immortality (Greenberg et al. 1997). On the one hand, this could initiate a woman's conscious desire to become pregnant, increasing her likelihood of intended pregnancy. On the other hand, even if a woman invests in macro-cultural ideals, this does not necessarily mean she will consciously plan or desire a particular outcome for herself. This tension could result in a woman behaving in ways that directly conflict with her desire to postpone pregnancy, ultimately increasing her likelihood of unintended pregnancy.

Related to notions of pronatalism, mortality salience can also encourage individuals to invest their time in life domains that have intrinsic meaning and value. Psychologists have shown that reminders of death make people yearn for deep connection and emotional closeness, leading them to invest in intimate relationships (Fritsche et al. 2007; Nakonezny et al. 2004). This includes physical intimacy: mortality salience increases interest in sex (Goldenberg et al. 2000). Investment in a new or existing romantic relationship could sow desire for a child, resulting in an intended pregnancy. Or women could simply take solace in physical closeness and intimacy, and thus initiate or increase sexual activity even without desiring pregnancy, increasing their chance of becoming pregnant despite no intention to have a child.

Experiencing the loss of a family member or friend can also exact an emotional toll on women. Poor mental health is a well-studied risk factor for unintended pregnancy (Farr et al. 2010; Hall et al. 2016; Hall et al. 2014; Hall et al. 2013; Hall et al. 2015). By extension, this suggests that bereavement—and the decline in mental health it can provoke—could elevate women's likelihood of unintended pregnancy. At the same time, death is disruptive. Even when a death is expected, its precise timing is unknown. The need to change one's schedule to travel to a funeral or help host one on short notice could impede women from attending to day-to-day matters, such as their contraceptive routine. Women covered by long-acting contraceptives would not be vulnerable to brief, death-induced disruptions to their schedule, but the many women who rely on shorter-acting contraceptives may be prone to lapses in coverage. Thus, in line with evidence that high-mortality natural disasters can disrupt contraceptive use (Behrman and Weitzman 2016), more routine, social network mortality may also pose barriers, leaving women susceptible to unintended pregnancy.

Study Context: Mortality in Rural Malawi

To examine if periodic increases in women's exposure to mortality correspond with their likelihood of pregnancy, and unintended pregnancy specifically, we use longitudinal data from a study of young women living in Balaka, Malawi, a community comprising approximately 200 small villages surrounding a bustling town center. Critical to the current study is that women were interviewed every four months, during which they reported their recent funeral attendance and fertility timing desires and took a urine pregnancy test. Research from the United States suggests that unintended births, not necessarily pregnancies, carry distinct health consequences (Foster 2021); however, in a context of high maternal morbidity and mortality such as Malawi (Van den Broek et al. 2003), identifying the determinants of unintended pregnancy is critical given its high potential for health risks, regardless of whether it ends in miscarriage, abortion, or live birth.¹ It is estimated that over one half of all pregnancies are unintended in Malawi (Hall et al. 2016; Polis et al. 2017).

The commonality of unintended pregnancy allows us to examine if short-term fluctuations in women's exposure to social network mortality correspond with their immediate hazard of unintended pregnancy.

Our measurement of mortality exposure warrants clarification. As in most societies, funerals are communal events in Malawi. Village neighbors, including some who may not have known the deceased well, regularly join relatives, friends, and fellow church or mosque members to show their respect (Mtika 2001). It is customary for family and acquaintances to travel from other areas to attend, often by public transportation, and to spend several nights with the decedent's family.

Balaka is an ethnically and religiously diverse area, yielding differences in mourning and memorialization practices. Typically, however, burials occur on short notice, within 48 hours of death; when an individual of high social stature (e.g., village chief, head of family) passes away, the burial may be held a day later to prepare for a larger funeral. Funeral ceremonies commonly take place at the home of bereaved relatives (Peters et al. 2008). Villages often have burial committees that assist in digging the grave for the family. Some funerals last hours, others are briefer. Often the village headman or clergy will speak and will weave moral and spiritual lessons into their eulogy (Watkins 2004).

Studying the salience of funerals for pregnancy in a relatively short, two-year study is possible given how frequently women participate in funerals—owing not only to their communal nature but also to high mortality rates (Mwagomba et al. 2010). Life expectancy in Malawi was 55 years at the time of data collection (2009–2011)—ranking among the world's lowest. Malawi's high rates of child mortality and its severe HIV/AIDS epidemic among prime-aged adults combined to keep life expectancy low. HIV-related mortality has declined since the early 2000s (Floyd et al. 2010; Mwagomba et al. 2010), but data for this study were collected before widespread access to antiretroviral therapy. Noncommunicable diseases, such as cardiovascular diseases and neoplasms, are also leading causes of death in Malawi, as are accidents (Samuel et al. 2009; World Health Organization 2013). Limited access to specialty medical care means that even economically advantaged individuals in the country experience otherwise avoidable deaths.

Methods

Data and Sample

Tsogolo La Thanzi-1 (TLT-1) began in 2009 with the enrollment of a simple random sample of women between the ages of 15 and 25 living within a seven-kilometer radius of Balaka town ($N = 1,505$; 96% response rate) (Yeatman et al. 2019). Women were interviewed eight times (at four-month intervals) between 2009 and 2011. Female interviewers administered all interviews in Chichewa and did so in private rooms at a central research center. Women were first asked about their recent funeral attendance at Wave 2 (October–December 2009) and then at all subsequent waves; hence, baseline measures for our study are Wave 2 (with

¹As in most sub-Saharan African countries, abortion is illegal in Malawi except to save the life of the mother. Abortions still occur, but to a lesser extent than where it is legal. For example, an estimated 30% of unintended pregnancies in Malawi end in abortion (Polis et al. 2017), substantially lower than the 61% estimated worldwide (Bearak et al. 2020).

time-varying funeral attendance studied through Wave 7). Because we study pregnancy at the wave after women's prospective fertility desires and mortality exposures were recorded, we predict women's hazard of (unintended or intended) pregnancy at Waves 3 through 8 (February–April 2010 and October–December 2011, respectively).

We exclude all women who came into the study pregnant.² We also exclude the six women who reported that they or their sexual partner(s) were sterilized. In total, our analysis of pregnancy focuses on 1,272 women who contributed a total of 5,723 person-waves of data. Although study retention was relatively high in TLT-1 (81% of women were followed through Wave 8), 8% of women in our focal sample missed at least one wave. These women are in our main results—we addressed the minimal missing data with the carryforward command in Stata. Supplementary analyses confirm that the main study findings are robust to both the exclusion of the 156 person-waves of data missing (while retaining women's other available responses) and the full exclusion of the 104 women who missed at least one wave.

Key Measures

Pregnancy—Interviewers asked women to self-administer urine hCG (human chorionic gonadotropin) pregnancy tests at each interview.³ With these data, we create a time-varying indicator to model women's hazard of pregnancy over the two-year study period. Six percent of women in our analytic sample had two pregnancies (78 women); however, we adopt a single-failure approach and model only the first observed pregnancy. Thus, after a pregnancy, women no longer contribute person-waves to the analysis. Of the 1,272 women, 545 became pregnant during the study.

Even with pregnancy data collected every four months, it is possible that we still miss pregnancies that ended in miscarriage or abortion between interviews, and thus underestimate the total number of pregnancies. Also, because we do not know exactly when during the intersurvey period women conceived, we code women as pregnant at the first interview after conception. Because of the short and consistent intervals between surveys, and because almost one half of women learned of their pregnancy at the research center (45%), this interval censoring is not of concern.

Unintended Versus Intended Pregnancy—We combine information on women's prospective fertility desires (expressed at the wave prior to conception) and their fertility outcomes (at the next wave) to distinguish between intended and unintended pregnancies. Interviewers asked women, "How long would you like to wait before having your first/next child?" We classify a pregnancy as intended if, at the prior wave, the woman reported wanting her first/next birth within 2 years (versus more than two years later). We classify a

²Although we exclude all respondents who were pregnant at Wave 2, women who had a baby immediately before that wave could have been experiencing postpartum or lactation-induced amenorrhea, and thus may have had lower physiological risk of pregnancy toward the beginning of the study. In supplementary analyses, we exclude all women who gave birth in 2009 ($N=113$) and confirm that the findings are stable to the exclusion of these women.

³At each wave, some women opted out of taking a pregnancy test, most frequently citing their current menstruation. We use self-reported pregnancy status data to code 154 women's study outcomes. Supplementary analyses confirm the results are stable to exclusion of these cases.

pregnancy as unintended if, the wave before the conception, the woman reported not wanting a birth for at least two years.⁴ Note that in the first set of analyses of women's hazard of any pregnancy, we maintain the full categorical coding of this indicator as a predictor (Yeatman et al. 2020).

With prospective measures of women's fertility desire and frequent pregnancy testing, we can also identify women who had no pregnancy over the study period. This allows us to study the counterfactual to unintended pregnancy while addressing the competing risk of intended pregnancy. Thus, we classify women as having no pregnancy as desired (coded 0), an unintended pregnancy (1), or an intended pregnancy (2).⁵ Thirteen women consistently wanted to become pregnant but never conceived. The small size of this group prohibits us from meaningfully studying a fourth outcome of "no pregnancy despite desire";⁶ thus, we remove these women from analyses of unintended pregnancy, resulting in a sample of 1,259 women who contribute 5,649 observations to the hazard models.

Funeral Attendance—At Wave 2 and each subsequent interview, women reported how many funerals they had attended in the prior month, which we use as a proxy for the intensity of women's recent exposure to social network mortality. We treat this time-varying indicator continuously in our main models but explore different specifications in sensitivity analyses.

Controls—In all models, we control for covariates that could correlate with women's funeral attendance and their fertility desires and outcomes. We account for two time-invariant, psychosocial characteristics. The first is a measure of future orientation. Interviewers asked women whether and, if so, how often they think about the future. We classify women into four categories according to whether they think about the future never or only rarely (coded 1), sometimes (2), fairly often (3), or very often (4). Second, along with their beliefs about a range of other locally salient statements, interviewers asked women whether they consider the statement "You don't plan having children, they just happen" to be true (coded 1) or not true (0), allowing us to account for women's sense of reproductive agency.

⁴For 44 women who missed interviews, we measure their fertility desires two or more waves before the pregnancy was confirmed. In supplementary analyses, we remove these 44 cases; doing so does not change the findings. Three women are coded as having an unintended pregnancy after expressing "no preference/whenever." In supplementary analyses, we removed these three cases; doing so does not alter any of the findings. Finally, only 11 women in our young sample who had an unintended pregnancy reported not wanting a(nother) child at the prior wave, thus we cannot differentiate between "mistimed" versus "unwanted" births in this study.

⁵Women in this group could change their fertility desires over time, but this was relatively rare as confirmed by supplementary analyses. At each wave, more than 90% maintained their desire to postpone pregnancy. The same is true of women who had an unintended pregnancy. Women who had an intended pregnancy more commonly expressed variable fertility desires leading up to their pregnancy, with a tendency to shift toward wanting a child sooner. In supplementary models, we assess the sensitivity of our models to these small fluctuations by including a dummy variable of whether a woman was inconsistent in her desires (i.e., switched back and forth across interviews); doing so does not change the main results.

⁶It is possible that more women consistently wanted a child but never became pregnant, and thus either gave up or began concealing their desire (Gemmill 2019). Such cases would be included in the "no pregnancy as desired" outcome despite the women's latent desire to become pregnant. Other research, however, has shown that women in our analytic sample are less likely to perceive infertility than women in the United States (Polis et al. 2020). This research also finds that perceived infertility tends to be experienced by women who nonetheless report wanting more children, suggesting that difficulty conceiving does not lead many women to revise their reported fertility desires.

We also account for socioeconomic factors. We include a time-varying indicator of women's highest level of education (in years) and a household goods index, both of which we measure at the wave prior to the study outcome.⁷ We also include time-invariant indicators of women's number of siblings and children. Given evidence that one's own child dying may speed up women's time to their next pregnancy, we include a dummy variable for whether women experienced the death of a child during the study period.⁸ We also include time-varying indicators of women's age (in years) and marital status (never married, currently married, or formerly married).

Statistical Models

We begin by describing the contextual and sociodemographic characteristics of the sample at baseline, including a detailed description of funeral attendance, fertility desires, and study outcomes.

We present Cox proportional hazard models that estimate women's likelihood of becoming pregnant over the two-year study period while accounting for censoring. The Cox model is expressed as

$$h(t) = h_0(t)\exp(b_1x_1 + b_2x_2 + \dots + b_px_p).$$

$h(t)$ is the hazard of pregnancy determined by a set of covariates $(b_1x_1, b_2x_2, \dots, b_px_p)$, which is interpretable as the risk of becoming pregnant at time t , where t represents survival time. h_0 is the baseline hazard, which corresponds to the value of the hazard if all the independent variables are equal to zero.

To ensure that funeral attendance and other predictors preceded pregnancy, we measure all covariates at the wave prior to the study outcome. That is, because the data do not feature the precise dates of funeral attendance nor conceptions during the intersurvey period, this ensures covariates are measured prior to pregnancy. As a result, funeral attendance pertains to the period roughly two to three months before conception and roughly one month prior to the expression of fertility desires.

Figure 1 offers a visual representation of our measurement approach in the hazard models, presenting the example of a woman who became pregnant at Wave 6. In this example, the respondent had a positive pregnancy test at Wave 6, having conceived during the preceding intersurvey period. Using data from the prior wave (here, Wave 5), we can classify the pregnancy as intended or unintended. With information on recent funeral attendance, as well as demographics and socioeconomic factors at the wave prior, we can examine how the former correspond with women's likelihood of pregnancy.

⁷Previous research has validated this approach (Filmer and Pritchett 2001; Howe et al. 2008). The linear asset index comprises nine durable goods (a bed with a mattress, a television, a radio, a landline or mobile phone, a refrigerator, a bicycle, a motorcycle, an animal-drawn cart, and an automobile) and one household asset (electricity). The focus on durable goods better captures economic fluctuation across waves. A principal components analysis calculates weights to construct a wealth index. The resulting index places households on a continuous scale relative to the sample. To ensure factorial invariance, weights are consistent across waves.

⁸In additional analyses, we exclude the 19 women with a recent child death to ensure stability of the findings. The results confirm the findings are consistent regardless.

In our analysis of women's hazard of pregnancy, we estimate two Cox models. In model 1, we estimate the hazard of pregnancy as a function of women's funeral attendance. In model 2, we examine the association net of covariates.

After establishing the link between mortality exposure and women's likelihood of pregnancy, in a second set of models we estimate the hazard of unintended pregnancy. Not only can a woman become pregnant unintentionally (vs. no pregnancy), but she can also become pregnant intentionally, requiring that we estimate a series of competing risk models.

The competing risk approach is based on a proportional sub-hazards model (Fine and Gray 1999). Whereas the survivor function in Cox proportional hazard models indicates the probability of surviving beyond a given time, a competing risk model focuses on the cumulative incidence function, indicating the probability that the event of interest happened before a given time. Competing risk regression models are semi-parametric: the baseline sub-hazard of the focal event is left unspecified, and the effects of the covariates are assumed to be proportional while still accommodating time-varying covariates and coefficients. Thus, these models estimate the cumulative incidence of unintended pregnancy (vs. no pregnancy) in the presence of a competing risk (intended pregnancy).

We estimate two models of unintended pregnancy. In model 1, we estimate the hazard of unintended pregnancy as a function of women's funeral attendance. In model 2, we add covariates to examine the association net of controls.

Results

Descriptive Characteristics

Fertility Desires and Outcomes—As shown in Table 1, 43.4% of women became pregnant during the study period. Combining these outcomes with women's prospective fertility desires, 28.5% of women had an unintended pregnancy, 14.9% had an intended pregnancy, and 56.6% did not become pregnant.

To further characterize this cohort, the online Appendix A shows women's contraceptive behaviors and demographic characteristics by study outcome, focusing on the wave prior to the outcome. Women who became pregnant tended to be sexually active and were not using contraception (55.8%) at the preceding wave, although 11.7% of these women, and as many as 15.0% who had unintended pregnancies, reported using an injectable. Women who had an unintended pregnancy were often never married (43.5%), childless (40.7%), and younger (average age was 20.9). Among women who never became pregnant (as intended), 57.5% were never married, 54.3% had no children, and their average age was 20.9. Women who became pregnant had similar levels of future thinking and ideas about childbearing regardless of whether the pregnancy was intended; a higher proportion of women who had no pregnancy as desired reported thinking about the future "very often" and were less likely to agree that children "just happen."

Mortality Exposure—Table 1 shows that women attended one funeral, on average, in the month prior to the baseline interview. However, attendance ranged from 0 to 11 funerals in

the past month, highlighting sizable variation in women's exposure to death in their social networks. While demonstrating the ubiquity of funerals, this level of attendance reflects a substantial decline from the peak of the HIV/AIDS crisis less than a decade earlier, when adults in this area commonly attended four funerals per month (Watkins 2004). On average (either at baseline or at subsequent waves), however, women who never became pregnant attended fewer funerals (mean = 0.8; $p < .05$) than women who experienced intended (mean = 1.1) or unintended pregnancies (mean = 1.2).⁹ Overall, approximately 85% of women attended at least one funeral, and this does not differ by study outcome (not shown).

One concern of studying routine mortality in women's social networks rather than a mortality event resulting from an exogenous force is that the women who experienced more deaths in their networks, and thus attended more funerals, could be a distinct group. If women who attended more funerals were selected on observable or unobservable traits that also influence their disposition to become pregnant unintentionally, any associations between higher funeral attendance and unintended pregnancy could be spurious. Thus, we explore whether women's characteristics correlated with their intensity of recent funeral attendance.

As shown in the online Appendix B, women who agreed that children "just happen" attended more funerals at baseline than women who disagreed; however, we find no variation by women's future orientation. In line with past work (Doctor 2004), there are no large socioeconomic differences in women's funeral attendance; women with varying levels of school attended a similar number of funerals. There are small differences by women's household economic status: women living in households below the mean wealth score attended 1.2 funerals on average, whereas those living in households above the mean wealth score attended 1.0 funerals ($p < .05$). There are also demographic differences: older women, married women, and those with multiple children attend more funerals relative to those who are younger, unmarried, and have fewer children ($p < .05$).

Notably, the demographic profile of women who attended more funerals overlaps closely with the profile of women who had intended pregnancies (see online Appendix A). These results emphasize the need to control for socioeconomic and demographic differences when studying whether routine, short-term fluctuations in women's network mortality exposure influence their immediate likelihood of pregnancy, especially intended pregnancy.

Hazard Models

Funeral Attendance and Pregnancy—Table 2 presents results from the Cox proportional hazard models of pregnancy. As shown in model 1 of Table 2, having recently attended more funerals is associated with a higher hazard of pregnancy: each additional funeral corresponds with a 21.5-percentage-point increase in women's hazard of pregnancy.

⁹In supplementary analyses, we find evidence of minor seasonality of funeral attendance. In interviews that took place during the driest, hottest months in Balaka (October–December), 55% of women reported attending one or more funerals (mean = 0.99). In interviews during the peak of the rainy season (February–May), 53% of women reported attending one or more funerals (mean = 0.91). Finally, in interviews that occurred during the driest but coolest months (June–August), 47% of women reported attending one or more funerals (mean = 0.75). We do not find any seasonality to women's study outcomes—in each season, 9–10% of observations end in pregnancy (and 6–7% in unintended pregnancy).

The finding is robust, albeit smaller, with the inclusion of controls in model 2: net of women's socioeconomic, demographic, and psychosocial traits, each additional funeral women attended comes with an 11.9-percentage-point increase in the hazard of pregnancy. As expected, women's desire to become pregnant sooner increases their likelihood of pregnancy. Married women and those who agreed that pregnancy "just happens" were also more likely to become pregnant than their counterparts, whereas older women and those living in households with more resources were less likely.

Figure 2 plots the cumulative hazard of pregnancy by recent funeral attendance to convey the magnitude of the association. At the midpoint of the roughly two-year observation period, for instance, the cumulative hazard of pregnancy was 20% for women who had recently attended no funerals. Conversely, the cumulative hazard was 40–50% for women who had recently attended four or more.

In supplementary analyses, we tested the stability of these findings when considering any funeral attendance rather than the total number (results not shown; available upon request). The results show that attending at least one funeral recently (vs. no funerals) corresponds with a 20-percentage-point increase in the hazard of pregnancy ($p < .05$) net of controls.

Funeral Attendance and Unintended Pregnancy—Table 3 presents results from the competing risk models that examine women's hazard of unintended pregnancy versus no pregnancy while accounting for the competing risk of intended pregnancy. As shown in model 1 of Table 3, having recently attended more funerals is associated with an increase in the likelihood of unintended pregnancy: each funeral a woman attended corresponds with a 17.3-percentage-point increase in the hazard of unintended pregnancy. As shown in model 2, the association is attenuated with the inclusion of controls: net of covariates, each funeral a woman recently attended corresponds with a 14.9-percentage-point increase in her likelihood of unintended pregnancy.¹⁰ Furthermore, women with more children and those who expressed that pregnancy "just happens" have a higher likelihood of unintended pregnancy than their counterparts, whereas women who live in households with more resources have a lower likelihood.

To illustrate our main finding, Fig. 3 shows the cumulative incidence of having an unintended pregnancy by intensity of recent funeral attendance. The cumulative incidence of unintended pregnancy for women who did not attend any funerals recently was 20% relative to 40–50% for women who attended more than four.

In supplementary analyses, we estimated models to examine if recent funeral attendance corresponds with women's likelihood of *intended* pregnancy versus no pregnancy while accounting for the competing risk of *unintended* pregnancy. As shown in model 1 of the online Appendix C, there is a significant bivariate association between funeral attendance and women's likelihood of having an intended pregnancy. However, the inclusion of sociodemographic controls in model 2 explains the association: we find no evidence that

¹⁰We again tested the stability of this association to the coding of recent funeral attendance. Additional analyses showed that attending one or more funerals increases the hazard of unintended pregnancy by 26.5 percentage points ($p < .05$).

mortality exposure is independently associated with women's likelihood of having an intended pregnancy. Instead, women's likelihood of intended pregnancy is patterned by demographic factors, including their age, parity, and marital status.

Together, the findings make clear that the association between funeral attendance and women's hazard of pregnancy is driven by unintended pregnancies. This begs the question: Is a woman more likely to have an unintended pregnancy because mortality exposure reduces her desire for pregnancy in the near term, or because it interferes with her ability to avoid a pregnancy she does not want? In a final set of supplementary models (results not shown; available upon request), we examine whether our results are due, at least in part, to funeral attendance altering women's fertility desires. We find no evidence of a link between funeral attendance and desires at any wave net of the control variables, regardless of how we code fertility desires. Moreover, fixed-effects models examining within-person change in fertility desires as a function of funeral attendance also produced null results. These supplementary models, combined with the main results, suggest that mortality exposure increases women's likelihood of pregnancy by preventing them from achieving their desire to postpone pregnancy—not by changing the desire itself.

Discussion

Building on decades of research on the relationship between mortality and fertility, we examined whether short-term variation in women's exposure to death in their social networks increases their likelihood of pregnancy, and of unintended pregnancy specifically. We find that women's funeral attendance corresponds with a higher likelihood of becoming pregnant in the subsequent months, net of many psychosocial, socioeconomic, and demographic traits. Importantly, women's funeral attendance does not increase their likelihood of intended pregnancy net of demographic factors—only women's likelihood of unintended pregnancy increases with their funeral attendance.

Demonstrating that mortality can influence fertility through unintentional pathways attests to the need to draw on diverse fields to expand demography's repertoire of explanations for how mortality conditions influence women's fertility. Our findings align with perspectives from other disciplines that mortality exposure can affect women's behaviors and routines in ways that leave them vulnerable to unintended pregnancy.

Nonetheless, we cannot resolve precisely how network mortality leads to a higher likelihood of unintended pregnancy. As in studies of large-scale mortality events, we are unable to parse the individual and joint influence of the specific emotional, psychological, or logistical mechanisms that undergird this finding. Is it the sudden, disruptive nature of funerals? The psychology of mourning someone? Or the reminder of one's own mortality? Moreover, even as funerals offer a convenient proxy for individuals' recent exposure to deaths in their social network, they also represent social events. Given the large study effects that we document, we think it is implausible that the findings are driven by the effect of the funeral event alone, but instead reflect the network mortality it is measuring; however, without information on other, non-death-related events (e.g., weddings) against which to compare, nor other comprehensive measures of network mortality, we cannot prove this.

Though our results suggest mortality exposure can thwart women's desires to avoid pregnancy, this is but one manifestation of the link between mortality and fertility. In interpreting these results, it is imperative not to overlook the larger structural and cultural forces that inform population dynamics. Mortality conditions likely work through a constellation of forces to influence norms and expectations that ultimately shape individual women's ideas and behaviors surrounding fertility. Our study design—focused on a singular geographic area and mortality context—allows us to analyze only short-term fluctuations in women's exposure to death in their social networks. It is possible, however, that the broader mortality context that our study participants share has an equally large influence on their fertility—and could potentially operate through intentional mechanisms. Said differently, by holding constant background mortality, we measure only the influence of deaths that involve funeral attendance.

The view we offer of a singular expression of the mortality–fertility link is also temporally abbreviated. Our findings pertain only to the influence of exposure to death on women's likelihood of unintended pregnancy in the near term; yet, mortality conditions can influence fertility desires and outcomes variably across the short, medium, and longer terms (Heuveline and Poch 2007; Kraehnert et al. 2019; Weitzman et al. 2021). Thus, the higher risk of unintended pregnancies that we document may not replicate over longer time horizons. It is possible that the unintended pregnancies we document do not mean women will end up with more than their desired number of children in the long run.

Our study features prospective fertility desires measured just months before pregnancy testing, a rare design feature that allows us to capture short-term fluctuations in women's preferences—fluctuations that align with changes in women's life circumstances (Sennott and Yeatman 2012). Even so, we acknowledge that some women could have changed their desires between the time they reported them and becoming pregnant. Results from a journal study tracking weekly variation in women's fertility desires reinforce this possibility (Barber et al. 2011). However, we anticipate that such measurement error would be randomly dispersed and unlikely to drive the study results.

Notwithstanding these limitations, our study demonstrates the fertility implications of routine mortality fluctuations—experiences that are not obscured by other, large-scale social crises and thus are arguably more analogous to the routine mortality conditions centered in demographic transition theory. Even when comparing women who live in the same high-mortality community, contemporaneous differences in the salience of mortality in women's social networks patterns their immediate risk of pregnancy in ways that are often misaligned with their desires. When studying the mortality–fertility link, research should not assume that what women experience is indicative of what they desire (Johnson-Hanks 2007).

As demographers continue to contemplate what drives fertility change in sub-Saharan Africa, socioeconomic development, governance, and health services are seen as preeminent forces (Bongaarts 2017; Kebede et al. 2019; Tsui et al. 2017). Our study emphasizes the value in returning the spotlight to an age-old determinant—mortality conditions—and drawing from other disciplines to theorize their salience more broadly. Our findings further

support the continued expansion and evolution of research on the relevance of adolescent and adult mortality—not only child mortality—for understanding fertility.

This study further reminds us that high-mortality conditions are not only indicative of disadvantage but can also have a hand in producing it. Unintended pregnancy is a vital conjuncture—a pivotal life moment when one's anticipated future is upended (Johnson-Hanks 2002)—that can lead to health disadvantage (Herd et al. 2016; Yeatman and Smith-Greenaway 2018, 2021). That mortality exposure increases women's fertility not by shaping their desires but by weakening the link between their desires and outcomes is disconcerting from a health and reproductive justice perspective. Integrating women's desires into studies of their fertility is essential for understanding how social conditions shape these outcomes and their implications for women's lives.

Supplementary Material

Refer to Web version on PubMed Central for supplementary material.

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Wave 5: Pre-conception measures of:

- Funeral attendance in past month
- Desire to become pregnant
- Demographic & socioeconomic controls

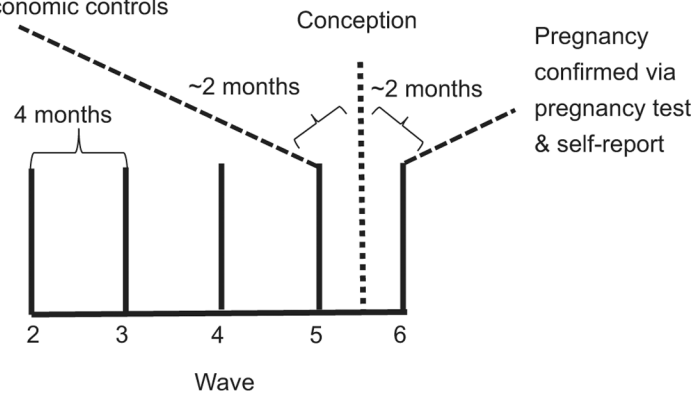


Fig. 1.

Design of TLT-1 panel study of mortality exposure, fertility desires, and pregnancy. This figure illustrates an example respondent who was identified as pregnant at Wave 6, at which time she exits the study. Data from Wave 5, collected approximately four months earlier, allow us to identify her recent mortality exposure and code the pregnancy as either intended or unintended on the basis of her expressed fertility desires.

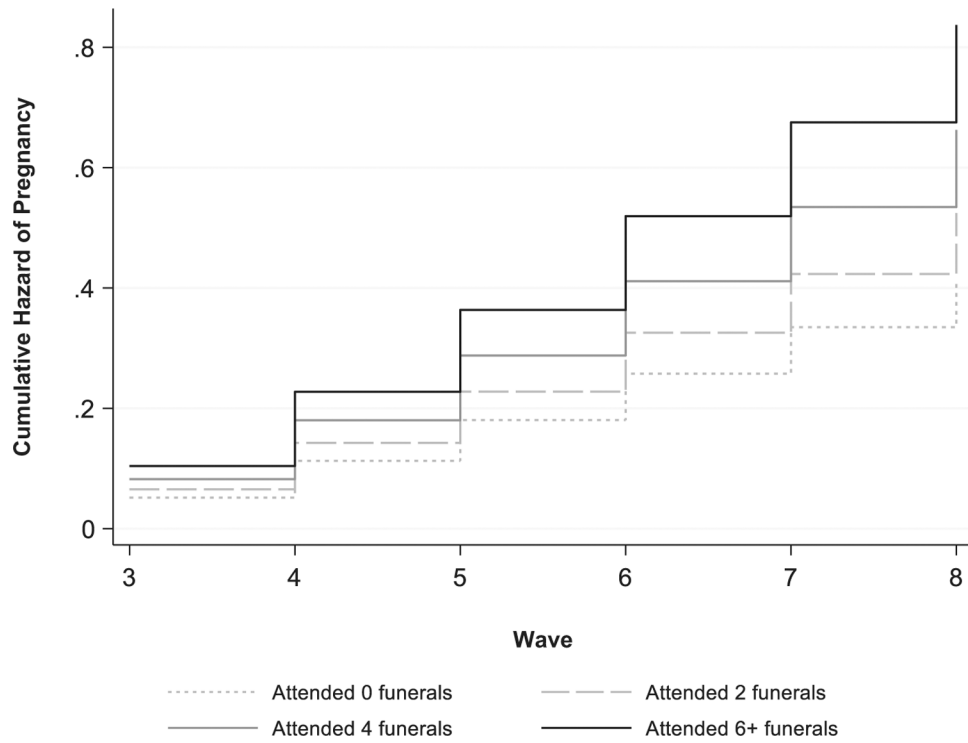


Fig. 2. Cumulative hazard of pregnancy over two-year study period, by intensity of mortality exposure. Funeral attendance was measured as the number of funerals attended within the previous month (measured at the prior interview). Estimates were adjusted for all covariates in Table 2 (held at mean value). *Source:* TLT-1 (Waves 3–8).

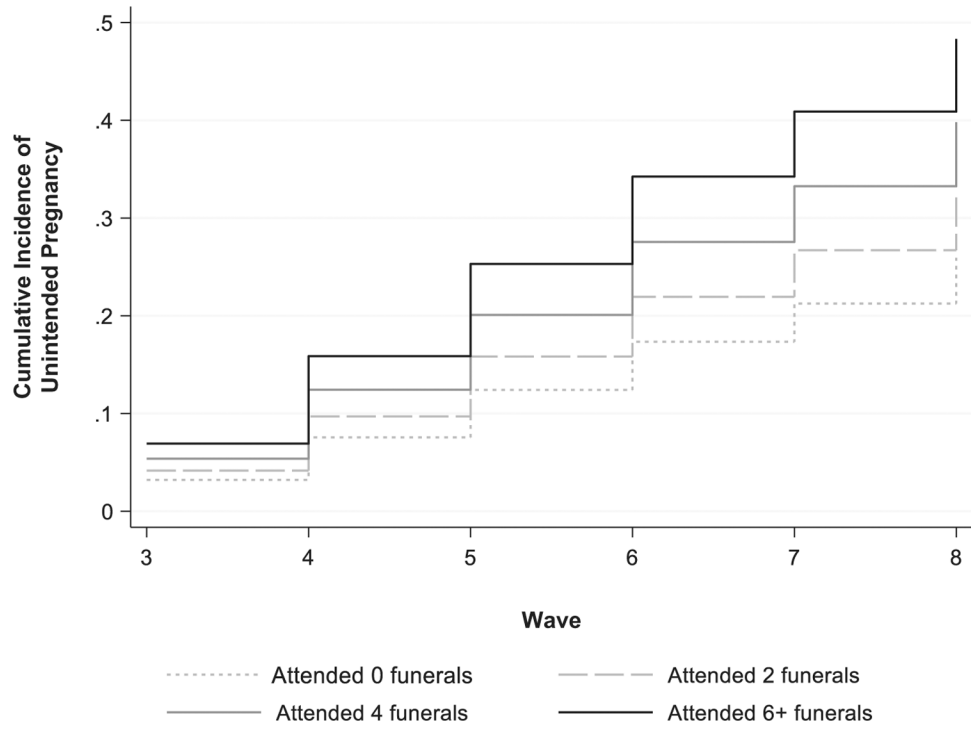


Fig. 3. Cumulative incidence of unintended pregnancy over two-year study period, by intensity of mortality exposure. The figure presents the cumulative incidence of unintended pregnancy versus no pregnancy (as intended) while accounting for the competing risk of intended pregnancy. Estimates were adjusted for all covariates in Table 3 (held at mean value). *Source:* TLT-1 (Waves 3–8).

Table 1

Descriptive statistics of key study variables of 15- to 25-year-old women at baseline of two-year study period (2009–2011), Balaka, Malawi

	%/Mean	SD
Ever Pregnant Over Study Period	43.4	
Study Outcomes ^a		
Unintended pregnancy	28.5	
Intended pregnancy	14.9	
No pregnancy as desired (ref.)	56.6	
Mortality Exposure		
Number of funerals attended (tv)	1.1	1.2
Psychosocial Controls		
Future orientation		
Rarely think about future	4.0	
Sometimes	11.2	
Fairly often	30.7	
Very often (ref.)	54.1	
Children “just happen”	45.8	
Socioeconomic Controls		
Highest year of school (tv)	7.6	2.8
Household wealth index (tv)	0.0	2.4
Demographic Controls		
Total number of siblings	5.2	2.6
Total number of children	0.9	1.0
Recently bereaved by child death	1.5	
Age (tv)	20.4	3.3
Marital status (tv)		
Never married (ref.)	50.7	
Formerly married	7.8	
Currently married	41.5	

Note: tv = time-varying controls measured at each wave.

Source: Tsogolo la Thanzi-1 ($N = 1,272$ women).

^a $N = 1,259$ women in analyses of unintended and intended pregnancy.

Table 2

Cox proportional hazard models of pregnancy (vs. no pregnancy) among 15- to 25-year-old women over two-year study period (2009–2011), Balaka, Malawi

	Model 1		Model 2	
	Hazard Ratio	SE	Hazard Ratio	SE
Mortality Exposure				
Number of funerals attended (tv)	1.215***	0.043	1.119**	0.042
Psychosocial Controls				
Fertility desires (tv)				
As soon as possible			4.353***	0.854
<2 years			4.598***	0.762
2–3 years			2.533**	0.413
3–4 years			2.118***	0.354
4–5 years			1.619**	0.282
5+ years (ref.)			—	—
Whenever			2.009	1.191
Never			0.834	0.265
Future orientation				
Rarely			1.187	0.219
Sometimes			0.995	0.135
Fairly often			0.950	0.096
Very often (ref.)			—	—
Children “just happen”			1.187 [†]	0.106
Socioeconomic Controls				
Highest year of school (tv)			0.987	0.019
Household wealth index (tv)			0.912***	0.023
Demographic Controls				
Total number of siblings			1.027	0.017
Total number of children			1.025	0.071
Recently bereaved by child death			1.160	0.358
Age (tv)			0.962 [†]	0.019
Marital status (tv)				
Never married (ref.)			—	—
Formerly married			1.222	0.219
Currently married			1.264 [†]	0.175
Model Fit (likelihood ratio chi-square)	27.530***		263.910***	

Note: tv = time-varying controls measured at each wave.

Source: Tsogolo la Thanzi-1 (N = 1,272 women; 5,723 person-waves).

[†] $p < .10$;

**
 $p < .01$;

 $p < .001$

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Table 3

Competing Cox proportional hazard models of unintended pregnancy versus no pregnancy (with competing risk of intended pregnancy) among 15- to 25-year-old women over two-year study period (2009–2011), Balaka, Malawi

	Model 1		Model 2	
	Hazard Ratio	SE	Hazard Ratio	SE
Mortality Exposure				
Number of funerals attended (tv)	1.173***	0.050	1.149**	0.052
Psychosocial Controls				
Future orientation				
Rarely			1.201	0.286
Sometimes			1.127	0.186
Fairly often			0.965	0.120
Very often (ref.)			—	—
Children “just happen”			1.250*	0.132
Socioeconomic Controls				
Highest year of school (tv)			0.986	0.024
Household wealth index (tv)			0.939*	0.027
Demographic Controls				
Total number of siblings			1.033	0.021
Total number of children			1.191*	0.093
Age (tv)			0.971	0.023
Recently bereaved by child death			0.457	0.264
Marital status (tv)				
Never married (ref.)			—	—
Formerly married			0.974	0.208
Currently married			0.799	0.131
Model Fit (likelihood ratio chi-square)	13.940***		53.210***	

Notes: Results represent the subdistribution hazard rate for unintended pregnancy while adjusting for competing risk of intended pregnancy. tv = time-varying controls measured at each wave.

Source: Tsogolo la Thanzi-1 ($N = 1,259$ women; 5,649 person-waves).

* $p < .05$;

** $p < .01$;

*** $p < .001$