American Journal of Public Health

Global Burden of Maternal Bereavement: New Indicators of the Cumulative Prevalence of Child Loss

--Manuscript Draft--

Manuscript Number:	AJPH-202033758
Article Type:	Research Article
Keywords:	Child Death; Bereavement; Global Inequality
Corresponding Author:	Emily Smith-Greenaway, Ph.D. University of Southern California Los Angeles, California UNITED STATES
First Author:	Emily Smith-Greenaway, Ph.D.
Order of Authors:	Emily Smith-Greenaway, Ph.D.
	Diego Alburez-Gutierrez
	Jenny Trinitapoli
	Emilio Zagheni
Abstract:	Objectives. We provide estimates of the prevalence of mothers bereaved by a child's death in 170 countries and territories. Methods. We generate indicators of the cumulative prevalence of mothers who have had an infant, under-five-year-old, or any-age child ever die by using survey data, and an indirect approach that combines formal kinship models and life table methods. We label these measures the maternal cumulative prevalence of infant mortality (mIM), under-five mortality (mU5M), and offspring mortality (mOM). Results. In several Asian and European countries, the mIM and mU5M are below 10 per 1000 mothers yet exceed 200 per 1000 mothers in many Middle Eastern and African countries. Global inequality in mothers' experience of child loss is enormous: mothers in select high-mortality-burden countries are more than 100 times more likely to have had a child die than mothers in low-mortality-burden countries. In more than 20 African countries, the mOM exceeds 500 per 1000 mothers. Conclusions. The enormous global disparities in mothers' experience of child loss underscores the implications for the downstream mental and physical health risks associated with bereavement.
Full Title:	Global Burden of Maternal Bereavement: New Indicators of the Cumulative Prevalence of Child Loss
Manuscript Classifications:	20: Family Health; 25: Global Health; 47: Maternal and Infant Health
Author Comments:	
Suggested Reviewers:	Jessica Gipson Associate Professor, UCLA jgipson@ucla.edu Expert in maternal and child health.
	Chris Wildeman Full Professor, Duke University christopher.wildeman@duke.edu Expert in family inequality and child health.
	Mark Hayward Full Professor, University of Texas at Austin mhayward@prc.utexas.edu Demographer who specializes in health disparities.
	Deborah Umberson Full Professor, University of Texas at Austin umberson@prc.utexas.edu Leading scholar in cumulative experiences of family bereavement.

Additional Information:	
Question	**Response**
What is the public health importance of the paper?	Public health scholars lack formalized estimates of the cumulative prevalence of parents that have experienced a child death even as extensive work recognizes the relevance of bereavement for public health. We offer cumulative indicators of child loss and demonstrate enormous inequality in the burden of child loss across the globe. The maternal cumulative prevalence of infant, under-five, and all offspring mortality estimates are valuable metrics that show the extent to which epidemiological inequalities accumulate in mothers' lives, shedding new light on a vital dimension of a population's mortality regime that merits the attention and resources of public health scholars and practitioners.
Provide a description of what the paper adds to current knowledge base, particularly with respect to material previously published in AJPH, and if systematic reviews exist on the topic.	Health scholars have established the negative health consequences of family bereavement and parental bereavement specifically; yet we lack a standardized approach for estimating the prevalence of bereaved parents. We generate population estimates of the cumulative prevalence of mothers who have had an infant, under-five-year-old, or any-age child ever die. Our study offers the first estimates of the population prevalence of maternal bereavement and clarifies its global patterning. The enormous global disparities in mothers' experience of child loss and underscores the implications for the downstream mental and physical health risks associated with parental bereavement.
Provide one sentence summarizing the main message(s) of the paper. This is important as it may be used on social media (e.g., AJPH Twitter, etc) to highlight the findings of the paper.	Even as infant and mortality conditions improve worldwide, mothers in some countries in the global south are more than 10 times as likely to have had a child die than those in high-income countries; across much of sub-Saharan Africa, mothers are more than 100 times more likely to have experienced a child die than are mothers who inhabit the world's low-mortality-burden enclaves.
Please list the Abstract word count for this document. This count is forwarded to the Editors and Reviewers as part of the evaluation process.	177
Please list the main text word count for this document. This count excludes the abstract, figures and tables, and references and is forwarded to the Editors and Reviewers as part of the evaluation process.	3430
Please list the number of references in this document. This count is forwarded to the Editors and Reviewers as part of the evaluation process.	35
Please list the number of Tables and Figures and Supplemental Tables and Figures in this document. This count is forwarded to the Editors and Reviewers as part of the evaluation process. Please report counts as follows: Figures: #; Tables: #; Supplemental Tables: #; Supplemental Figures: # (where # represents the actual count of submitted Tables and Figures).	4

Please indicate the total number of authors for this submission. This number must match the number of listed authors included in the "Authors" tab located in the "Manuscript Data" section of the submission process. Please ensure the number and names are accurate, as authors cannot be added once a paper is submitted.	4
For individual or group randomized trials, provide the date of trial registration and the NCT number from Clinicaltrials.gov or other approved registry.	No
Affiliations Statement	Emily Smith-Greenaway1, Diego Alburez-Gutierrez2, Jenny Trinitapoli3, Emilio Zagheni2 1.Department of Sociology, University of Southern California, Los Angeles, US 2.Max Planck Institute for Demographic Research, Rostock, Germany 3.Department of Sociology, University of Chicago, Chicago, US
Acknowledgments and Funding Disclosure	No disclosures.
Disclosures of Potential and Actual Conflicts of Interest	None.
Human Participant Protection statement	Approved by USC IRB; UP-20-00015

Global Estimates of Maternal Bereavement: New Indicators of the Cumulative Prevalence of Child Loss

Emily Smith-Greenaway[1], Diego Alburez-Gutierrez[2], Jenny Trinitapoli[3], Emilio Zagheni[2]

1. Department of Sociology, University of Southern California, Los Angeles, US
2. Max Planck Institute for Demographic Research, Rostock, Germany
3. Department of Sociology, University of Chicago, Chicago, US

Abstract

Objectives. We provide estimates of the prevalence of mothers bereaved by a child's death in 170 countries and territories.

Methods. We generate indicators of the cumulative prevalence of mothers who have had an infant, under-five-year-old, or any-age child ever die by using survey data, and an indirect approach that combines formal kinship models and life table methods. We label these measures the maternal cumulative prevalence of infant mortality (mIM), under-five mortality (mU5M), and offspring mortality (mOM).

Results. In several Asian and European countries, the mIM and mU5M are below 10 per 1000 mothers yet exceed 200 per 1000 mothers in many Middle Eastern and African countries. Global inequality in mothers' experience of child loss is enormous: mothers in select high-mortality-burden countries are more than 100 times more likely to have had a child die than mothers in low-mortality-burden countries. In more than 20 African countries, the mOM exceeds 500 per 1000 mothers.

Conclusions. The enormous global disparities in mothers' experience of child loss underscores the implications for the downstream mental and physical health risks associated with bereavement.

USC Dornsife
Dana and David Dornsife
College of Letters, Arts and Sciences

SOCIOLOGY

14 November 2020

Dear Dr. Morabia,

My co-authors and I are pleased to submit our study of the global burden of maternal bereavement. Health scholars have established the negative health consequences of family bereavement and parental bereavement specifically; yet we lack global estimates of the prevalence of bereaved parents. This study offers a novel perspective of the global mortality landscape by quantifying the burden of maternal bereavement.

We generate population estimates of the cumulative prevalence of mothers who have had an infant, under-five-year-old, or any-age child ever die for 170 countries and territories. Our study reveals enormous global disparities in mothers' experience of child loss. Global inequality in mothers' experience of child loss is enormous: mothers in high-mortality-burden African countries are more than 100 times more likely to have had a child die than mothers in low-mortality-burden Asian and European countries. The findings underscore the implications for the downstream mental and physical health risks associated with parental bereavement.

Thank you for considering our manuscript for the *American Journal of Public Health.* Thanks, too, for your editorial work and for your service.

Sincerely,

Emily Smith-Greenaway
Associate Professor
Department of Sociology
University of Southern California
851 Hazel & Stanley Hall, Office 309
Los Angeles, California 90089

The Global Burden of Maternal Bereavement: New Indicators of the Cumulative Prevalence of Child Loss

Abstract

Objectives. We provide estimates of the prevalence of mothers bereaved by a child's death in 170 countries and territories.

Methods. We generate indicators of the cumulative prevalence of mothers who have had an infant, under-five-year-old, or any-age child ever die by using publicly available survey data, and an indirect approach that combines formal kinship models and life table methods. We label these measures the maternal cumulative prevalence of infant mortality (mIM), under-five mortality (mU5M), and offspring mortality (mOM) and generate prevalence estimates for 170 countries and territories.

Results. In several Asian and European countries, the mIM and mU5M are below 10 per 1000 mothers yet exceed 200 per 1000 mothers in many Middle Eastern and African countries. Global inequality in mothers' experience of child loss is enormous: mothers in high-mortality-burden African countries are more than 100 times more likely to have had a child die than mothers in low-mortality-burden Asian and European countries. In more than 20 African countries, the mOM exceeds 500 per 1000 mothers, meaning it is typical for a surviving mother to be a bereaved mother.

Conclusions. The study results reveal enormous global disparities in mothers' experience of child loss and underscores the implications for the downstream mental and physical health risks associated with bereavement.

Infant and child mortality rates have declined steadily worldwide over the last fifty years[1], including marked declines in the United States.[2] Even with periods of stagnant improvement, and persistent between- and within-country inequality, the global trends represent notable progress for children and their parents. The improvements in annualized rates of infant and child mortality, however, do not speak to parents' cumulative experience of child loss. A child's death has serious consequences for parents, but estimates of the population prevalence of bereaved parents are available only for select sub-Saharan African countries.[3] In multiple sub-Saharan African countries as recently as 2015, upwards of one-third of mothers have had at least one child die.[3] It is unclear whether such high levels of maternal bereavement characterize other low- and middle-income countries, and how they compare to levels in high-income countries.

In this article, we offer a global perspective on maternal bereavement by providing the first population-level estimates of the prevalence of bereaved mothers in the United States and in 169 additional countries. We generate three indicators of the cumulative prevalence of mothers who have had an infant, under-five year old, or any-age child ever die. We label these indicators: the maternal cumulative prevalence of infant mortality (mIM), under-five mortality (mU5M), and offspring mortality (mOM).[3] We calculate these measures separately for two groups of mothers: those in the peak of their reproductive years (ages 20-44) and those nearing the end of their reproductive careers (ages 45-49). To achieve global coverage, we generate these indicators using survey data and an indirect estimation strategy using widely available age-specific fertility and mortality schedules.[4]

These country-level measures of maternal bereavement demonstrate how infant, child, and adolescent mortality conditions accumulate and form a corresponding shadow population of bereaved parents—a population of parents that deserves public health attention. Social inequalities in the burden of family bereavement both reflect disparate health environments and also create inequalities by generating the poor health outcomes associated with bereavement.[5–9] A child's death, in particular, has profound and lasting influence on parents' wellbeing, including their mental health and physical health and longevity.[10–20] The consequences are especially severe for mothers, and the adverse effects of grief can persist for years—even decades.[17] Beyond the health implications of losing a

child, bereavement influences other aspects of parents' lives, including their relationship with one another. That bereavement corresponds with not only mothers' negative physical and mental health, but also the safety, health, and stability of their marriages, not only merits understanding its prevalence for women's health, but also for the health of surviving siblings.[5,21–28] By clearly demonstrating the size and distribution of child loss as its own health burden, these metrics render visible an epidemiological disparity that has been overlooked in the global mortality literature.

This study also clarifies that the prevalence of bereaved parents is a unique aspect of a population's public health profile that results from a combination of its past and present mortality conditions and its fertility levels and thus cannot be gleaned from current indicators. Adult mortality conditions dictate how many bereaved mothers survive to share their experience versus how many also die prematurely, thereby erasing their account of child loss. Moreover, the legacy of higher child mortality years earlier, when older mothers had their first child, will linger as an earlier maternal experience, further contributing to higher cumulative estimates of maternal bereavement than recent annualized mortality rates imply. Additionally, a mother's cumulative risk of ever experiencing a child die is determined by the number of children she bears and the number of years she spends as a parent. The degree to which child deaths are dispersed across a population in a country, versus concentrated among a small, disadvantaged subgroup of mothers, also plays a role. The confounding influence of these population dynamics and epidemiological conditions mandate that we explicitly estimate the prevalence of bereaved mothers.

METHODS

We first generate indicators of the maternal cumulative prevalence of child death directly using microdata from nationally representative surveys that collect full reproductive histories from female respondents. Then, to expand the global perspective further, we introduce a formal demographic approach that indirectly estimates the prevalence of bereaved mothers in a population.

Our direct estimation strategy makes use of three data sources. For the United States, we make use of the National Survey of Family Growth (NSFG) (2013-17). NSFG collects reproductive history calendars from women ages 15-44 years old

(https://www.cdc.gov/nchs/nsfg/index.htm). Because the NSFG included women 45 years and older in only one survey round, and because of the small sample for this age group, we rely on the indirect estimates of the mIM, mU5M, and mOM for older mothers. For 56 countries across Africa, Asia, Europe, Latin America and the Caribbean, and Oceania, we leverage data from the Demographic and Health Surveys (DHS) program. DHS data come from household surveys that collect detailed information from various household members, including women ages 15-49, and were collected between 2010 and 2018 (accessible at https://dhsprogram.com/). Finally, for 32 additional countries in Africa, Asia, Europe, and Latin America and the Caribbean that lack recent DHS data, we make use of Multiple Indicator Cluster Surveys (MICS), which come from household surveys collected between 2010-2018 (accessible at https://mics.unicef.org/). Supplementary Table S1 lists all countries, data sources, survey years, and sample sizes.

In each survey, we restrict the analytic sample to women who have had at least one live birth (i.e., the women exposed to the risk of child death) and use women's reproductive histories, specifically the vital status of each child and, for those deceased, the age at death, to calculate the mIM, mU5M, and mOM. Given data constraints, we cannot include bereavement associated with pregnancy loss. To estimate the mIM, we sum the number of mothers who had a child die before age one among those who ever had a live birth and express this per 1000 mothers. To estimate the mU5M, we do the same for mothers who ever had a child die before reaching age five. The mOM indexes the collective experience of a child death, regardless of that child's age. More than 95% of women in our survey estimates had their first child at age 14 or older; because our oldest respondents are 49 years old, children on which women were reporting could be no more than 35 years old. Thus, these estimates pertain specifically to children who died between infancy and early adulthood. Due to censoring, we calculate the mOM for 45- to 49-year-old mothers only.

Not all countries regularly collect publicly-available surveys with detailed reproductive histories; our indirect kin-cohort approach allows us to estimate the prevalence of bereaved mothers from publicly-available demographic data from the United Nations World Population Prospects (UNWPP, estimates from the 1950-2020 period and projections, medium scenario, for 2020-2100) (https://population.un.org/wpp/). This

approach extends the Goodman-Keyfitz-Pullum kinship equations from mathematical demography[29,30] to non-stable populations with changing demographic rates and combines them with standard life table methods.

Specifically, we use discrete kinship equations to determine the age-specific probability that an average woman will experience the death of an infant, child under age five, or older child. With these probabilities, we construct life tables to estimate the age- and cohort-specific fractions of women who ever experienced the death of a child. To do so, we account for the mortality of women using estimated country-specific life tables from the UNWPP data. Note that in select countries, mostly in Africa, the UNWPP data relies on model life tables given the lack of vital statistics; fortunately, our survey coverage is exceptionally high in sub-Saharan Africa. We then solve for the proportion of women (per 1000 mothers) who have ever lost a child. Next, we use a different set of life table equations to estimate the proportion of mothers, rather than all women, who have experienced the death of an offspring. We consider fertility as a "hazard rate" to approximate the number of women that have had at least one child at specific ages after experiencing a set of age-specific fertility rates. We then define, for a given cohort, the proportion of mothers (per 1000 mothers) who have ever lost a child of a specific age. We convert our cohort estimate to period estimates so that they are interpreted exactly as the direct survey estimates and refer to a child's death before age one (mIM), age five (mU5M), or any age (mOM). Note that for countries with no survey estimates, our kin-cohort estimates refer to calendar year 2016—the modal year of survey coverage. We generated indicators for all countries and territories with populations over one million, resulting in total coverage of 170 countries and territories.

In presenting results of maternal bereavement, we prioritize the survey-based estimates and only rely on the indirectly generated kin-cohort estimates for populations where survey data were unavailable (kin-cohort estimates are italicized in Table S1). Although we have almost complete survey coverage in Africa, we rely more heavily on the indirect estimates for all other world regions. Thus, for the 45 countries and territories with survey data in these other world regions, we also generated estimates using the kin-cohort method for comparison. As shown in Supplementary Figure S1, we found high

correspondence: the two estimation strategies produced values that were, on average, less than a fraction of a one % different for 20-44 year old mothers (mIM and mU5M) and between 3-5% for older mothers (mIM, mU5M, mOM). When the measures diverge, the indirect approach tends to yield slightly higher estimates of bereavement than the survey estimates, possibly because the indirect approach cannot account for the clustering of deaths to specific mothers. Thus, a limitation of the study is that, because we rely on the kin-cohort method for several countries in Asia and Europe, our estimates of the child loss burden in these low-mortality-burden regions may be elevated; as a result, any comparison drawn between these contexts and Africa—a high-mortality-burden region where we have almost complete survey coverage—may be conservative. Moreover, in select cases, the kin-cohort method produces estimates that are lower than the survey-based estimates (see Figure S1). This could be because child deaths are underestimated in the survey data; even though the survey estimates are derived from nationally representative samples, mothers may underreport the deaths of children or there may be hard-to-reach populations—including those affected by conflict and thus more burdened by child loss—that are underrepresented in national surveys.

RESULTS

Maternal burden of infant mortality

Figure 1 (top panel) maps the mIM for young mothers (20-44 years old), offering a worldwide portrait of the prevalence of mothers who have experienced an infant death. In 13 countries and territories, fewer than 5 per 1000 of mothers 20-44 have ever lost an infant (Hong Kong, Japan, Singapore, South Korea, Czech Republic, Slovenia, Finland, Iceland, Italy, Norway, Portugal, Spain, Sweden; see Table S1). The mIM is slightly higher in the United States, where NSFG survey data shows that 7.2 per 1000 mothers have lost a child.

In more than 30 countries, the mIM exceeds 150 per 1000 mothers ages 20-44 years old, meaning that ten or more times as many mothers have experienced an infant death than in the United States. And in as many as 16 of these countries, all located in sub-Saharan Africa and the Middle East, more than 200 per 1000 younger mothers have lost an infant (Afghanistan, Burkina Faso, Central African Republic, Chad, Democratic Republic of

the Congo, Ethiopia, Equatorial Guinea, Guinea, Guinea-Bissau, Liberia, Mozambique, Niger, Nigeria, Sierra Leone, Somalia, and South Sudan; see Table S1).

The mIM indexes a profound inequality that mothers in different countries endure and shows this inequality to be even more pronounced than differences in annualized child-centered mortality metrics imply. For example, in Sierra Leone, the country with the highest mIM (303 per 1,000 mothers), young mothers are 46 times more likely to have experienced a child die than mothers in the United States. This enormous difference far exceeds the still large discrepancy in the countries' infant mortality rates: infants born in Sierra Leone are 16 times more likely to die (95.5 infant deaths per 1,000 live births) than those born in the United States (6 infant deaths per 1,000 live births). Overall, the global range of mIM values for mothers ages 20-44 stretches from the low of 2.2 per 1000 mothers in Hong Kong to 303.3 per 1000 mothers in Sierra Leone. This means that infants born in Sierra Leone are 67 times more likely to die than those born in Hong Kong (95.5 versus 1.4 infant deaths per 1000 live births), but young mothers in Sierra Leone are 138 times more likely to have experienced a child die than their counterparts in Hong Kong.

Figure (bottom panel) presents the mIM estimates for older mothers (45-49 years old), which of course are higher than results for mothers 20-44 years old. In Hong Kong, Finland, Iceland, Japan, Singapore, Spain, and Sweden, fewer than 10 per 1000 of older mothers have lost an infant. In more than 50 countries across the Middle East and sub-Saharan Africa, however, over 200 per 1000 mothers ages 45-49 have. The United States ranks 30th in terms of the mIM for older mothers: 20 per 1,000 mothers ages 45-49 are estimated to have lost an infant—a prevalence of maternal bereavement also documented in Cuba, Cyprus, and Israel. Older mothers in Liberia (mIM of 465.3 per 1000 mothers) are 78 times more likely to have experienced an infant die than older mothers in Hong Kong, the country with the lowest recorded mIM for older mothers (6.0 per 1000 mothers). Global inequality in infant loss for older mothers is smaller than that for younger mothers, possibly due to the legacy of higher mortality worldwide, or because a disproportionate number of bereaved mothers in the highest mortality contexts have also died prematurely, resulting in their erasure from the population estimates of bereavement.

Maternal burden of under-five mortality

Figure 2 maps the mU5M for younger mothers, summarizing the prevalence of mothers (20-44 years old) (top panel) who have experienced a child die between birth and age five. The list of very low-mortality-burden countries and territories is similar to that for the mIM; in Hong Kong, Finland, Iceland, Japan, Singapore, Slovenia, Spain, and Sweden, fewer than 5 per 1000 young mothers have experienced a child die before age five. In the United States, nearly 15 per 1000 younger mothers have lost a young child; a prevalence of bereaved mothers comparable to the levels observed in Latvia, Malaysia, Puerto Rico, and Serbia. In more than a dozen countries across the Middle East and West and Central Africa, however, more than 300 per 1000 mothers have lost a child (Afghanistan, Burkina Faso, Cameroon, Central African Republic, Chad, Equatorial Guinea, Guinea, Guinea-Bissau, Liberia, Niger, Nigeria, Sierra Leone, Somalia, and South Sudan; see Table S1). Globally, the mU5M for mothers 20-44 years old ranges from 3.2 per 1000 mothers in Hong Kong to 437.2 per 1000 in Niger. As with the mIM, the inequality in mothers' experiences of under-five mortality far exceeds both current and historical differences in the under-five mortality rates themselves: the mU5M in Niger is 137 times that of Hong Kong, though the under-five mortality rate in the former is only 49 times higher than the latter (2.2 child deaths per 1000 in Hong Kong versus 108.7 per 1000 in Niger).

As expected, the mU5M levels are even higher for older mothers who entered motherhood during higher mortality conditions, have been mothers for several years, and typically have more children—all factors that increase their exposure and risk of child loss. Figure 2 (bottom panel) shows a picture that is consistent with the previous three: in very-low-mU5M countries, fewer than 30 per 1000 mothers have ever lost a child, and in Hong Kong, Japan, and Singapore, the estimates are less than 10 per 1000. Yet nearly 50 countries have levels of maternal loss of children under age five that are ten times higher—this means that in one-third of countries, nearly one-third of older mothers have experienced a young child die. In total, the estimates range from 8.2 (Hong Kong) to 705.7 per 1000 mothers (Niger). An estimated 24 per 1,000 mothers ages 45-49 have experienced a child die before age 5 in the United States, with similar levels of maternal

loss in Croatia, Cyprus, Cuba, and Israel. The US ranks 30th in the mU5M values, with a lower prevalence of bereaved mothers in this age group in 29 countries.

Maternal burden of offspring mortality

Despite the global emphasis on measuring and monitoring mortality among children under age five, parents' risk of losing a child persists beyond a child's fifth birthday. Thus, to understand the total burden of child loss, regardless of the child's age at the time of death, Figure 3 depicts the mOM, capturing the burden of all offspring mortality among mothers 45-49 years old. As expected, the global patterning of mOM values closely aligns with those of the mIM and mU5M: where many surviving mothers have had an infant or under-five year old die, many have lost adolescent and young adult children, too. The prevailing pattern across high-income Asian and European countries is that fewer than 30 per 1000 mothers have ever lost a child. The level in the United States is slightly higher: 33 per 1,000 mothers ages 45-49 have lost a child—a prevalence comparable to Ukraine, Israel, and Hungary. Even as 31 countries have lower mOM values than the United States, nearly 50 countries have mOM levels that are ten times as high as those observed in the United States. In more than 50 countries in Africa, Latin America, the Middle East, and Southeast Asia, however, the mOM levels are at least 10 times higher: in these countries, more than 30% of mothers have ever lost a child. In 22 countries—all within sub-Saharan Africa—more than 50% of older mothers have had a child die.

DISCUSSION

We formalized an accurate and systematic way to measure maternal bereavement to inform health systems and reveal global disparities. Our cumulative indicators of child loss identify enormous inequality in the burden of child loss across the globe—inequality that cannot be gleaned from child-centered measures of mortality. Even as infant and mortality conditions improve worldwide, mothers in some countries in the global south are more than 10 times as likely to have had a child die than those in high-income countries; across much of sub-Saharan Africa, mothers are more than 100 times more likely to have experienced a child die than are mothers who inhabit the world's low-mortality-burden enclaves.

Additional comparisons of the mIM and mU5M versus the infant and under-five mortality rates underscore that our explicitly maternal perspective reveals global patterns of bereavement that are not captured by annualized infant and child mortality indicators. Among the 20 countries with the lowest infant or child mortality rates, nine do not feature among the 20 countries with the lowest mIMs and mU5Ms. Similarly, 10 of the top 20 countries with the highest mIMs and mU5Ms do not feature the highest infant and under-five mortality rates. Along these same lines, even as mIM and mU5M values are, on average, lower in the countries and territories that have achieved the levels of infant and under-five mortality stated in Goal 3.2 of the Sustainable Development Goals (SDG)[31] than those that have not, there is far from perfect correspondence. Several countries and territories that have achieved the SDG goals for infant and child mortality have higher levels of maternal bereavement than countries that have yet to achieve these goals, while a handful of countries that have not met the SDG goals have relatively low levels of maternal bereavement. These comparisons attest to the importance of an explicitly maternal perspective to avoid overlooking countries with a higher than realized maternal burden of child loss despite recent child health success.

Public Health Implications

Overlaying these findings with the sheer absence of research on parental bereavement in low-income countries highlights yet another meta-inequality: the world regions in which child loss is concentrated have only rarely been the focus of empirical research dedicated to quantifying and assessing the health consequences of this experience.[32–35] Public health research is needed to understand the implications of bereavement in diverse global contexts. The maternal cumulative prevalence of infant, under-five, and all offspring mortality estimates are valuable metrics that show the extent to which epidemiological inequalities accumulate in mothers' lives, shedding new light on a vital dimension of a population's mortality regime that merits the attention and resources of public health scholars and practitioners.

REFERENCES

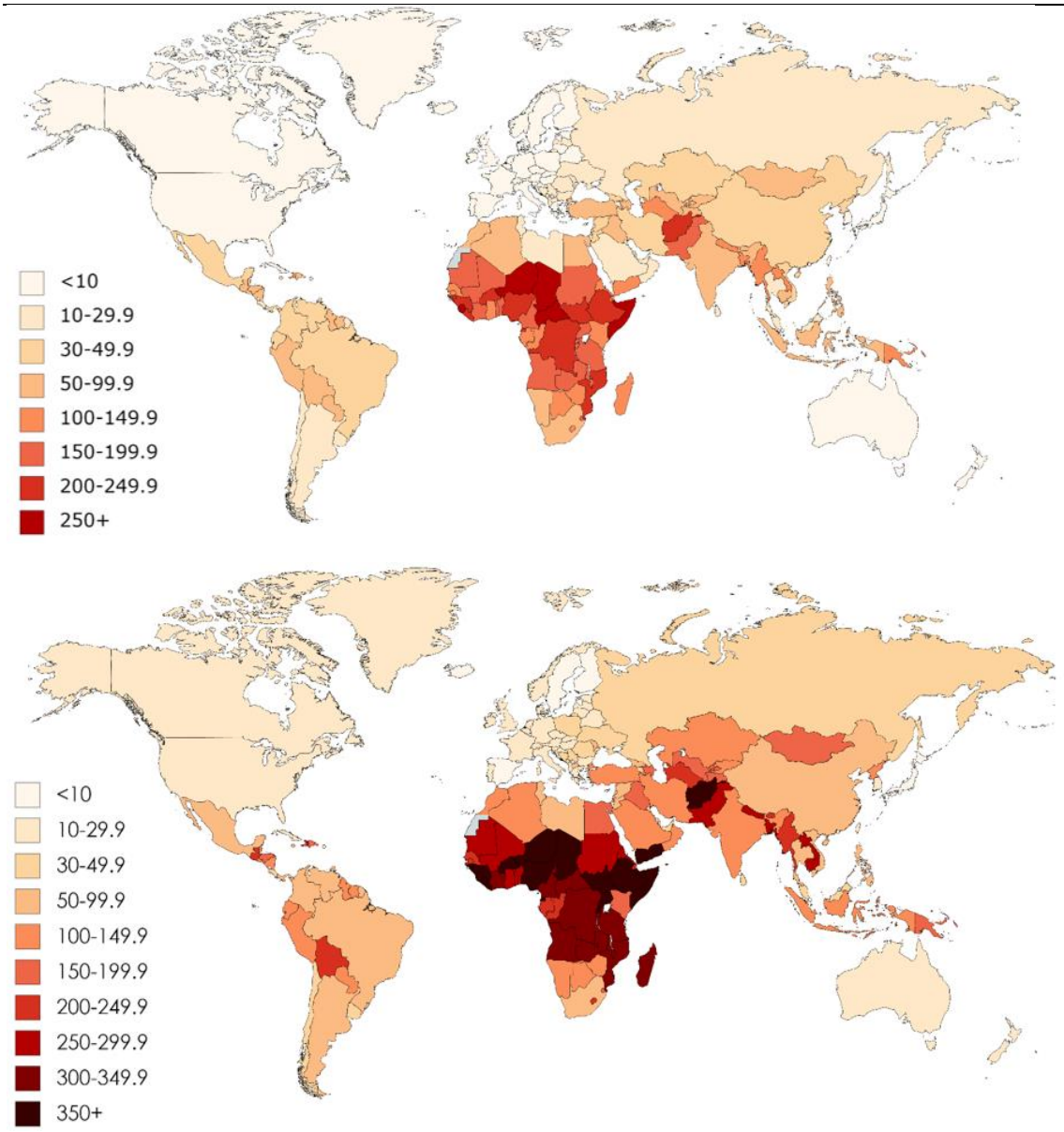
1. Wang, H. *et al.* Global, regional, and national levels of neonatal, infant, and under-5 mortality during 1990–2013: a systematic analysis for the Global Burden of Disease Study 2013. *The Lancet* **384**, 957–979 (2014).
2. Ely, D. M. & Driscoll, A. K. Infant mortality in the United States, 2017: Data from the period linked birth/infant death file. (2019).
3. Smith-Greenaway, E. & Trinitapoli, J. Maternal cumulative prevalence measures of child mortality show heavy burden in sub-Saharan Africa. *Proceedings of the National Academy of Sciences* **117**, 4027–4033 (2020).
4. Alburez-Gutierrez, D., Kolk, M. & Zagheni, E. Women's experience of child death over the life course: A global demographic perspective. (2019).
5. Fletcher, J., Mailick, M., Song, J. & Wolfe, B. A sibling death in the family: Common and consequential. *Demography* **50**, 803–826 (2013).
6. Umberson, D. Black deaths matter: Race, relationship loss, and effects on survivors. *Journal of health and social behavior* **58**, 405–420 (2017).
7. Umberson, D. *et al.* Death of family members as an overlooked source of racial disadvantage in the United States. *Proceedings of the National Academy of Sciences* **114**, 915–920 (2017).
8. Martikainen, P. & Valkonen, T. Mortality after the death of a spouse: rates and causes of death in a large Finnish cohort. *American journal of public health* **86**, 1087–1093 (1996).

9. Elwert, F. & Christakis, N. A. The effect of widowhood on mortality by the causes of death of both spouses. *American journal of public health* **98**, 2092–2098 (2008).
10. Li, J., Precht, D. H., Mortensen, P. B. & Olsen, J. Mortality in parents after death of a child in Denmark: a nationwide follow-up study. *The lancet* **361**, 363–367 (2003).
11. Rogers, C. H., Floyd, F. J., Seltzer, M. M., Greenberg, J. & Hong, J. Long-term effects of the death of a child on parents' adjustment in midlife. *Journal of family psychology* **22**, 203 (2008).
12. Song, J., Floyd, F. J., Seltzer, M. M., Greenberg, J. S. & Hong, J. Long-Term Effects of Child Death on Parents' Health-Related Quality of Life: A Dyadic Analysis. *Family relations* **59**, 269–282 (2010).
13. Li, J., Laursen, T. M., Precht, D. H., Olsen, J. & Mortensen, P. B. Hospitalization for mental illness among parents after the death of a child. *New England Journal of Medicine* **352**, 1190–1196 (2005).
14. Stroebe, M. & Schut, H. To continue or relinquish bonds: A review of consequences for the bereaved. *Death studies* **29**, 477–494 (2005).
15. Stroebe, M., Stroebe, W. & Abakoumkin, G. The broken heart: Suicidal ideation in bereavement. *American Journal of Psychiatry* **162**, 2178–2180 (2005).
16. Stroebe, M. S., Schut, H. A. W. & Stroebe, W. Health consequences of bereavement: A review. *The Lancet Infectious Diseases* **370**, 1960–1973 (2007).
17. Rostila, M., Saarela, J. & Kawachi, I. Mortality in parents following the death of a child: a nationwide follow-up study from Sweden. *J Epidemiol Community Health* **66**, 927–933 (2012).

18. Rostila, M., Mäki, N. & Martikainen, P. Does the death of a child influence parental use of psychotropic medication? A follow-up register study from Finland. *PloS one* **13**, e0195500 (2018).
19. Finnäs, F., Rostila, M. & Saarela, J. Divorce and parity progression following the death of a child: A register-based study from Finland. *Population studies* **72**, 41–51 (2018).
20. Levav, I. *et al.* Cancer incidence and survival following bereavement. *American Journal of Public Health* **90**, 1601 (2000).
21. Rostila, M., Berg, L., Saarela, J., Kawachi, I. & Hjern, A. Experience of sibling death in childhood and risk of psychiatric care in adulthood: a national cohort study from Sweden. *European child & adolescent psychiatry* **28**, 1581–1588 (2019).
22. Rostila, M., Saarela, J. & Kawachi, I. Suicide following the death of a sibling: a nationwide follow-up study from Sweden. *BMJ open* **3**, e002618 (2013).
23. Rostila, M., Saarela, J. & Kawachi, I. Mortality From Myocardial Infarction After the Death of a Sibling: A Nationwide Follow-up Study From S weden. *Journal of the American Heart Association* **2**, e000046 (2013).
24. Rostila, M., Saarela, J. & Kawachi, I. The forgotten griever: a nationwide follow-up study of mortality subsequent to the death of a sibling. *American journal of epidemiology* **176**, 338–346 (2012).
25. Rostila, M., Saarela, J. & Kawachi, I. "The psychological skeleton in the closet": Mortality after a sibling's suicide. *Social psychiatry and psychiatric epidemiology* **49**, 919–927 (2014).
26. Yu, Y. *et al.* Association of mortality with the death of a sibling in childhood. *JAMA pediatrics* **171**, 538–545 (2017).

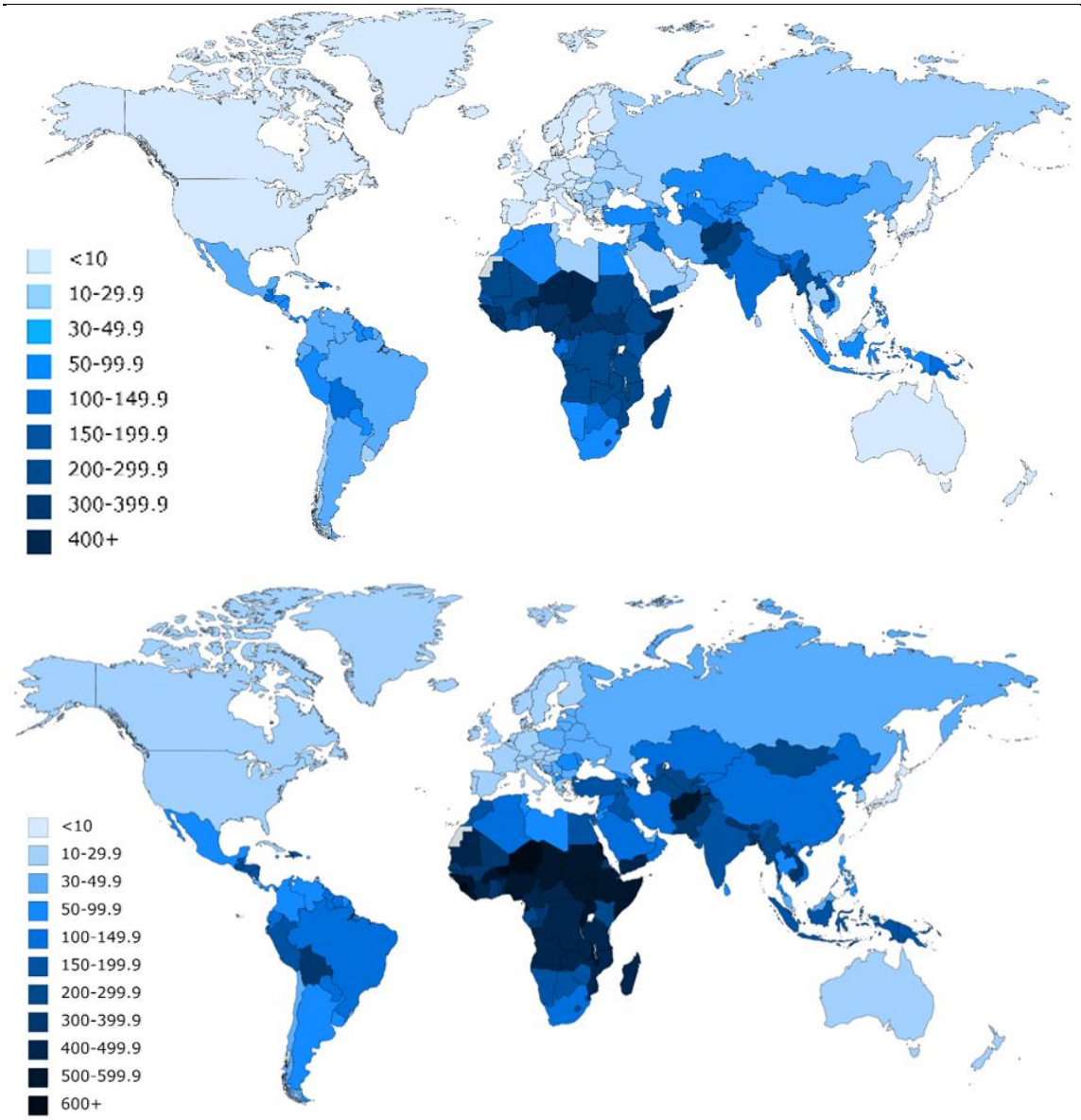
27. Yu, Y. *et al.* Prenatal maternal bereavement and mortality in the first decades of life: a nationwide cohort study from Denmark and Sweden. *Psychological medicine* **47**, 389–400 (2017).
28. László, K. D. *et al.* Maternal Bereavement the Year Before or During Pregnancy and Total and Cause-Specific Infant Mortality: A Cohort Study From Denmark and Sweden. *Psychosomatic Medicine* **82**, 577–585 (2020).
29. Keyfitz, N. *Applied mathematical demography*. (Springer, 1985).
30. Goodman, L. A., Keyfitz, N. & Pullum, T. W. Family formation and the frequency of various kinship relationships. *Theoretical Population Biology* **5**, 1–27 (1974).
31. GA, U. Transforming our world: the 2030 Agenda for Sustainable Development. *Division for Sustainable Development Goals: New York, NY, USA* (2015).
32. Weitzman, A. & Smith-Greenaway, E. The marital implications of bereavement: Child death and intimate partner violence in West and Central Africa. *Demography* 1–25 (2020).
33. Castle, S. E. The (re) negotiation of illness diagnoses and responsibility for child death in rural Mali. *Medical Anthropology Quarterly* **8**, 314–335 (1994).
34. Haws, R. A. *et al.* "These are not good things for other people to know": how rural Tanzanian women's experiences of pregnancy loss and early neonatal death may impact survey data quality. *Social science & medicine* **71**, 1764–1772 (2010).
35. McNeil, M. J., Namisango, E., Hunt, J., Powell, R. A. & Baker, J. N. Grief and Bereavement in Parents After the Death of a Child in Low-and Middle-Income Countries. *Children* **7**, 39 (2020).

Fig. 1. Maternal cumulative prevalence of infant mortality (mIM) for mothers age 20 to 44 (top panel) and mothers age 45-49 (bottom panel)



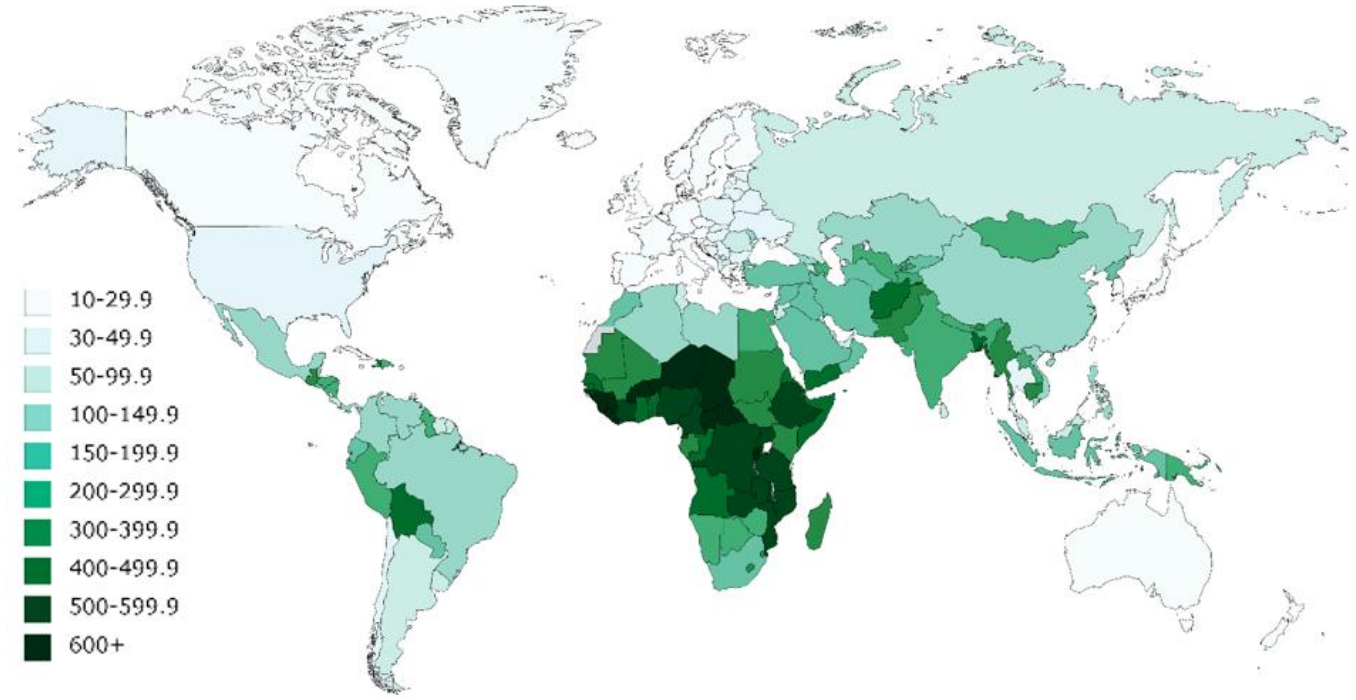
Note: See supplementary Table S1 for list of estimates and data sources

Fig. 2. Maternal cumulative prevalence of under 5 mortality (mU5M) for mothers age 20 to 44 (top panel) and mothers age 45-49 (bottom panel)



Note: See supplementary Table S1 for list of estimates and data sources

Fig. 3. Maternal cumulative prevalence of offspring mortality (mOM) for mothers age 45 to 49



Note: See supplementary Table S1 for list of estimates and data sources

Supplementary Table S1. List of countries, surveys, years, sample size, and estimates of maternal cumulative prevalence of infant mortality (mIM), maternal cumulative prevalence of under-five mortality (mU5M), and maternal cumulative prevalence of offspring mortality (mOM) for mothers age 20-44 and 45-49 (italicized estimates computed using indirect kin-cohort method)

				mIM		**mU5M**		**mOM**
	Source	Year	Sample	20-44	45-49	20-44	45-49	45-49
Africa								
Algeria	MICS	2012	17 540	*51.0*	*121.7*	*57.4*	*146.1*	150.5
Angola	DHS	2015	10 054	168.5	310.5	224.7	441.8	484.1
Benin	DHS	2017	11 247	177.1	276.7	258.9	411.8	476.9
Botswana		2016		*237.8*	*395.1*	*351.3*	*587.4*	*636.4*
Burkina Faso	DHS	2010	12 654	242.9	414.5	372.0	599.2	665.7
Burundi	DHS	2017	10 845	188.3	349.3	258.5	529.7	608.2
Cameroon	DHS	2011	10 225	197.7	311.8	305.6	446.5	530.4
Central African Republic	MICS	2010	8403	*263.7*	*322.7*	*373.6*	*443.4*	688.9
Chad	DHS	2015	13 012	274.0	382.6	402.6	563.8	632.5
Comoros	DHS	2012	2807	110.5	203.4	135.5	254.5	297.9
Côte d'Ivoire	DHS	2012	7050	198.9	313.7	272.3	424.3	516.0
Democratic Republic of the Congo	DHS	2013	13 258	208.5	340.3	294.4	484.5	557.8
Congo, Republic of	DHS	2011	8058	132.4	220.9	198.4	350.7	428.7
Djibouti		2016		*108.5*	*249.9*	*151.7*	*355.0*	*421.8*
Egypt	DHS	2014	19 447	70.0	162.5	80.8	195.9	220.0
Ethiopia	DHS	2016	9915	214.2	385.0	264.1	520.3	593.6
Eritrea		2016		*139.6*	*288.5*	*172.5*	*376.8*	*431.1*
Equatorial Guinea		2016		*244.1*	*375.6*	*330.0*	*502.2*	*551.9*
Eswatini	MICS	2014	3140	*152.6*	*151.0*	*207.1*	*210.3*	365.7
Gabon	DHS	2012	5851	110.3	201.4	149.9	292.4	383.7
Gambia (Republic of The)	DHS	2013	6471	127.6	246.2	183.5	373.8	420.6
Ghana	DHS	2014	6327	134.7	250.7	189.1	364.3	419.5
Guinea	DHS	2012	6394	237.0	379.7	335.9	540.1	612.2
Guinea-Bissau		2016		*227.8*	*404.4*	*309.4*	*539.5*	*591.8*
Kenya	DHS	2014	22 347	118.6	188.8	155.5	264.6	338.5
Lesotho	DHS	2014	4312	135.4	218.8	167.5	270.5	368.2
Liberia	DHS	2013	6966	224.0	465.3	318.4	597.3	653.5
Libya		2016		*23.9*	*81.7*	*27.6*	*96.1*	*122.0*
Madagascar	MICS	2018	11 889	*139.7*	*308.5*	*191.3*	*416.1*	339.8
Malawi	DHS	2015	17 834	151.2	340.7	222.6	502.1	564.4
Mali	DHS	2012	7858	191.4	253.2	263.0	348.3	377.2
Mauritania	MICS	2015	8811	*172.1*	*297.4*	*250.4*	*435.0*	363.4
Mauritius		2016		*22.5*	*44.1*	*26.1*	*50.3*	*66.2*
Morocco		2016		*51.8*	*130.1*	*60.4*	*159.7*	*176.9*
Mozambique	DHS	2011	9745	228.5	338.6	295.4	476.0	550.5
Namibia	DHS	2013	6167	90.0	137.1	118.1	191.3	243.3
Niger	DHS	2012	8656	260.3	435.0	437.2	705.7	792.6
Nigeria	DHS	2013	26 174	227.1	378.8	334.0	524.6	579.9

(continued) Table S1. List of countries, surveys, years, sample size, and estimates

				mIM		mU5M		mOM
	Source	Year	Sample	20-44	45-49	20-44	45-49	45-49
Rwanda	DHS	2015	8587	150.9	370.0	214.9	553.3	623.1
São Tomé and Príncipe	MICS	2014	2075	*128.7*	*292.6*	*154.7*	*365.8*	373.6
Senegal	DHS	2017	10 531	142.5	236.3	193.3	365.9	429.1
Sierra Leone	DHS	2013	11 468	303.3	460.7	398.6	614.5	670.3
Somalia	MICS	2011	3204	*291.3*	*421.5*	*414.5*	*572.3*	443.4
South Africa	DHS	2016	5919	74.1	98.6	86.9	131.8	172.0
South Sudan	MICS	2014	7709	*236.4*	*396.0*	*327.6*	*533.6*	398.2
Sudan	MICS	2014	11 250	*158.0*	*281.6*	*221.4*	*401.8*	403.5
Togo	DHS	2014	6702	150.6	253.2	225.1	387.5	483.7
Tunisia	MICS	2011	5316	*27.4*	*80.6*	*28.8*	*89.9*	63.6
Uganda	DHS	2016	12 908	185.1	368.8	254.1	522.0	595.0
United Republic of Tanzania	DHS	2015	9168	167.6	333.7	226.7	455.4	509.2
Zambia	DHS	2014	11 562	178.0	330.8	259.2	487.1	555.1
Zimbabwe	DHS	2015	6893	130.3	136.5	170.4	193.3	259.0
Asia and the Pacific								
Afghanistan	MICS	2011	12 956	*238.2*	*433.4*	*303.2*	*541.9*	440.4
Bangladesh	DHS	2014	15 018	133.8	292.8	158.0	363.2	414.1
Bahrain		2016		*14.4*	*38.8*	*17.9*	*47.5*	*61.6*
Bhutan	MICS	2010	10 168	*83.7*	*217.0*	*100.9*	*310.7*	390.1
Cambodia	DHS	2014	11 492	99.6	260.0	117.9	322.9	371.1
China		2016		*31.9*	*84.4*	*36.1*	*102.7*	*112.3*
Cyprus		2016		*6.9*	*20.3*	*8.0*	*24.0*	*27.7*
Hong Kong		2016		*2.3*	*6.1*	*3.3*	*8.2*	*10.8*
India	DHS	2016	470 695	96.8	145.4	114.5	182.6	224.6
Indonesia	DHS	2017	33 781	65.7	135.3	78.1	163.1	194.5
Israel		2016		*8.2*	*22.5*	*9.8*	*27.3*	*34.3*
Iran (Islamic Republic of)		2016		*32.9*	*103.7*	*37.5*	*126.4*	*152.6*
Iraq	MICS	2011	17 914	*86.2*	*160.6*	*101.7*	*197.4*	186.4
Japan		2016		*3.4*	*7.0*	*4.4*	*9.6*	*13.5*
Jordan	DHS	2017	12 719	41.7	54.1	46.1	69.9	83.2
Kazakhstan	MICS	2015	9226	*45.4*	*114.1*	*52.0*	*135.5*	121.6
Kuwait		2016		*17.7*	*36.5*	*20.1*	*42.0*	*53.2*
Kyrgyzstan	DHS	2012	5528	67.3	115.4	78.1	138.3	153.5
Lao People's Democratic Republic	MICS	2017	17 433	*135.3*	*297.6*	*170.3*	*387.1*	290.0
Lebanon		2016		*19.3*	*60.0*	*21.8*	*69.7*	*79.6*
Malaysia		2016		*11.9*	*32.3*	*14.0*	*39.3*	*56.2*
Maldives	DHS	2017	5393	39.9	111.8	46.4	128.9	152.6
Mongolia	MICS	2014	9776	*60.9*	*166.6*	*71.7*	*211.3*	238.6
Myanmar	DHS	2016	7700	138.9	222.6	159.0	271.5	321.7
Nepal	MICS	2015	9701	*103.7*	*257.5*	*126.8*	*333.3*	265.3

(continued) Table S1. List of countries, surveys, years, sample size, and estimates

				mIM		mU5M		mOM
	Source	Year	Sample	20-44	45-49	20-44	45-49	45-49
North Korea		2016		*40.9*	*108.1*	*49.8*	*142.5*	*166.2*
Oman		2016		*21.5*	*107.6*	*24.6*	*132.0*	*165.3*
Pakistan	DHS	2018	12 801	180.4	293.6	205.1	335.4	379.0
Philippines	DHS	2017	15 473	53.5	67.8	63.3	97.8	126.4
Qatar		2016		*14.7*	*51.0*	*16.8*	*58.7*	*74.9*
Saudi Arabia		2016		*22.0*	*100.6*	*24.5*	*117.7*	*155.0*
Singapore		2016		*2.9*	*7.2*	*3.5*	*9.2*	*13.3*
South Korea		2016		*4.3*	*17.0*	*5.1*	*21.7*	*28.4*
Sri Lanka		2016		*19.0*	*41.9*	*21.1*	*51.0*	*67.3*
Palestine (State of)		2016		*64.9*	*153.5*	*74.5*	*180.9*	*206.2*
Syrian Arab Republic		2016		*41.0*	*94.1*	*46.6*	*110.2*	*162.3*
Taiwan		2016		*6.7*	*13.3*	*8.0*	*18.3*	*26.5*
Tajikistan	DHS	2017	7380	81.3	175.1	93.5	205.6	226.2
Thailand	MICS	2015	17 533	*21.4*	*50.1*	*24.0*	*58.5*	51.7
Timor-Leste	DHS	2016	7322	100.1	169.7	123.3	201.6	274.7
Turkmenistan	MICS	2015	4901	*124.6*	*216.0*	*144.6*	*260.5*	160.9
United Arab Emirates		2016		*13.7*	*36.3*	*15.6*	*41.6*	*59.9*
Uzbekistan		2016		*85.8*	*185.3*	*99.7*	*225.5*	*238.5*
Viet Nam	MICS	2013	6999	*38.2*	*78.1*	*46.4*	*100.3*	119.1
Yemen	DHS	2013	17 647	140.7	351.9	162.9	415.4	456.5
Eastern Europe								
Albania	DHS	2017	7188	13.9	29.9	15.6	31.6	40.4
Armenia	DHS	2016	4064	24.7	43.6	27.9	45.4	57.0
Azerbaijan		2016		*79.5*	*181.6*	*90.7*	*218.2*	*226.6*
Belarus		2016		*10.0*	*28.8*	*12.2*	*34.9*	*48.3*
Bosnia & Herzegovina		2016		*13.3*	*30.7*	*15.0*	*35.7*	*42.2*
Bulgaria		2016		*16.5*	*29.9*	*19.2*	*37.3*	*47.7*
Croatia		2016		*8.3*	*19.5*	*9.5*	*22.4*	*28.9*
Czech Republic		2016		*4.5*	*16.8*	*5.3*	*19.9*	*28.1*
Estonia		2016		*7.3*	*28.7*	*9.0*	*34.7*	*47.6*
Georgia		2016		*34.8*	*85.1*	*38.6*	*93.6*	*103.9*
Hungary		2016		*8.4*	*25.4*	*9.5*	*29.1*	*35.8*
Latvia		2016		*11.0*	*30.0*	*13.4*	*36.7*	*49.5*
Lithuania		2016		*9.2*	*27.2*	*10.8*	*32.9*	*47.2*
Montenegro	MICS	2013	2166	*13.9*	*35.5*	*15.3*	*39.2*	43.8
North Macedonia		2016		*18.3*	*58.8*	*20.0*	*63.5*	*68.9*
Poland		2016		*8.2*	*30.4*	*9.3*	*34.1*	*43.8*
Moldova, Republic of	MICS	2012	4083	*26.0*	*60.0*	*30.5*	*72.1*	108.3
Romania		2016		*19.2*	*44.3*	*22.0*	*54.1*	*65.3*
Russian Federation		2016		*18.4*	*40.4*	*21.7*	*48.1*	*68.3*

(continued) Table S1. List of countries, surveys, years, sample size, and estimates

				mIM		mU5M		mOM
	Source	Year	Sample	20-44	45-49	20-44	45-49	45-49
Serbia	MICS	2014	3551	*12.2*	*37.5*	*13.7*	*43.5*	44.1
Slovakia		2016		*9.3*	*24.5*	*11.0*	*28.8*	*37.9*
Slovenia		2016		*4.1*	*13.2*	*4.9*	*15.7*	*22.0*
Ukraine	MICS	2012	6406	*19.4*	*32.9*	*22.6*	*40.6*	34.8
Western Europe								
Austria		2016		*5.6*	*11.9*	*6.5*	*14.2*	*19.4*
Belgium		2016		*6.1*	*13.0*	*7.2*	*15.7*	*20.5*
Denmark		2016		*5.9*	*12.3*	*6.7*	*14.7*	*18.3*
Finland		2016		*3.9*	*9.0*	*4.7*	*11.0*	*16.9*
France		2016		*6.1*	*12.2*	*7.0*	*14.7*	*19.1*
Germany		2016		*5.3*	*10.3*	*6.2*	*12.5*	*16.1*
Greece		2016		*5.1*	*14.2*	*5.8*	*16.2*	*21.6*
Iceland		2016		*3.3*	*9.5*	*4.4*	*12.2*	*18.2*
Ireland		2016		*5.8*	*13.7*	*6.6*	*16.3*	*21.6*
Italy		2016		*4.6*	*10.5*	*5.2*	*12.2*	*15.4*
Netherlands		2016		*5.8*	*11.6*	*6.6*	*14.0*	*16.8*
Norway		2016		*4.6*	*10.9*	*5.3*	*13.6*	*19.2*
Portugal		2016		*4.9*	*15.0*	*5.9*	*18.8*	*25.1*
Turkey	DHS	2013	6509	51.8	142.7	59.2	157.3	179.8
Spain		2016		*4.3*	*9.6*	*5.0*	*11.6*	*14.9*
Sweden		2016		*4.1*	*9.4*	*4.8*	*11.2*	*15.8*
Switzerland		2016		*5.8*	*10.8*	*6.5*	*12.9*	*16.1*
United Kingdom		2016		*7.7*	*14.2*	*8.7*	*16.7*	*21.1*
Latin America and the Caribbean								
Argentina		2016		*27.8*	*59.5*	*31.7*	*69.2*	*84.8*
Belize	MICS	2015	3199	*40.8*	*100.0*	*46.6*	*118.4*	136.7
Bolivia		2016		*96.6*	*238.6*	*149.4*	*358.6*	*408.1*
Brazil		2016		*39.8*	*98.9*	*46.4*	*116.7*	*139.5*
Chile		2016		*13.5*	*31.5*	*15.8*	*37.7*	*48.9*
Colombia	DHS	2015	24 351	38.4	59.1	43.9	70.9	104.6
Costa Rica		2016		*18.8*	*39.2*	*22.6*	*47.3*	*63.2*
Cuba	MICS	2014	7376	*9.5*	*19.7*	*11.5*	*25.8*	23.3
Dominican Republic	DHS	2013	7493	88.6	152.9	102.4	194.0	228.7
Ecuador		2016		*41.2*	*106.8*	*49.6*	*133.9*	*167.4*
El Salvador	MICS	2014	9423	*43.4*	*115.4*	*49.7*	*142.7*	179.1
Guatemala	DHS	2015	16 236	93.8	200.8	114.6	254.7	302.2
Guyana	MICS	2014	3607	*74.4*	*118.6*	*90.0*	*148.0*	233.2
French Guiana		2016		*28.9*	*70.7*	*32.7*	*81.7*	*90.9*
Haiti	DHS	2017	8325	131.3	276.8	175.7	362.0	416.9
Honduras	DHS	2012	14 790	69.5	150.2	84.9	183.5	237.8

(continued) Table S1. List of countries, surveys, years, sample size, and estimates

				mIM		mU5M		mOM
	Source	Year	Sample	20-44	45-49	20-44	45-49	45-49
Jamaica		2016		*33.2*	*62.5*	*38.3*	*73.6*	*90.9*
Mexico		2016		*36.9*	*85.3*	*41.8*	*99.8*	*121.4*
Nicaragua		2016		*50.6*	*145.2*	*59.5*	*181.1*	*220.2*
Panama		2016		*40.4*	*73.0*	*50.7*	*92.4*	*118.7*
Paraguay	MICS	2016	5202	*52.0*	*109.8*	*60.1*	*131.0*	172.0
Peru	DHS	2012	16 048	64.5	147.7	81.9	194.5	221.3
Puerto Rico		2016		*12.9*	*26.0*	*14.6*	*30.6*	*44.2*
Suriname	MICS	2018	4856	*53.3*	*106.9*	*58.4*	*120.6*	90.7
Trinidad and Tobago	MICS	2011	2408	*49.2*	*66.3*	*55.0*	*75.2*	103.0
Uruguay		2016		*21.6*	*44.3*	*25.0*	*51.7*	*63.6*
Venezuela		2016		*35.3*	*65.1*	*40.8*	*76.7*	*111.4*
North America								
Canada		2016		*7.7*	*12.9*	*8.5*	*15.1*	*20.1*
United States	NSFG	2013	5588	7.2	*19.9*	9.3	*23.6*	*33.7*
Oceania								
Australia		2016		*6.5*	*13.8*	*7.5*	*16.6*	*21.5*
New Zealand		2016		*8.2*	*16.6*	*9.7*	*20.4*	*28.6*
Papua New Guinea	DHS	2016	10 054	100.5	156.0	131.5	197.3	252.6

Supplementary Figure S1. Correspondence between survey (square) and kin-cohort (diamonds) estimates of the mIM (for mothers age 20-44 in column 1 and 45-49 in column 2), mU5M (for mothers age 20-44 in column 3 and 45-49 in column 4), and mOM (for mothers age 45-49 in column 5) for 45 countries and territories in Asia and the Pacific (row 1), Europe, North America, and Oceania (row 2), and Latin America and the Caribbean (row 3)