**Global Burden of Maternal Bereavement:**

**A Worldwide Analysis of Maternal Cumulative Prevalence of Child Mortality**

**Summary**

**Background**

Child mortality rates have declined worldwide over the past several decades. Even so, millions of parents lose children each year, resulting in the accumulation of bereaved parents who are at risk of associated health and social challenges. Developing a working understanding of the population prevalence of bereaved parents is essential to understand the full extent of child loss around the globe, and inequality in the burden of loss.

**Methods**

We generate estimates of the cumulative prevalence of bereaved mothers for 168 countries. We present three metrics that capture the maternal cumulative prevalence of infant mortality, under-five mortality, and offspring mortality. We generate these estimates using an indirect, kin-cohort approach, and direct estimation from nationally representative surveys.

**Findings**

There is startling inequality in the burden of bereavement across countries, with an exceptionally high burden in several African and Asian countries where upwards of one-third to one-half of mothers have lost a child.

**Interpretation**

mortality and fertility trends translate into large disparities in the population prevalence of bereaved parents. Although it is well known that infants and children face strikingly different risk of mortality depending on where they are born, this study shows that the differential risk of child loss that mothers face is even greater due to confluence of mortality and fertility regimes.

Health scholars have long recognized that the death of a child is a life-event that elevates parents’ risk for physical and mental health complications. Yet, we lack an understanding of the population prevalence of bereaved parents worldwide. Such estimates are important for understanding how annualized infant, under-five, and adolescent mortality rates accumulate in parents’ lives (Smith-Greenaway & Trinitapoli 2020), potentially affecting their own health and the kinds of health resources that they require.

Quantifying the cumulative prevalence of bereaved parents could inform assessments of the need for targeted interventions to address the mental and physical health challenges they face. Bereaved parents experience elevated risk of suicidal ideation, loneliness, insomnia, depression, anxiety, distress, somatic symptoms, and social dysfunction (Lee et al 2014, Mills et al 2014, Rogers et al 2008, Song et al 2010, Wijngaards-de et al 2005). When a child dies, many parents withdraw from social networks because they feel misunderstood or stigmatized (Hastings 2000, Riches & Dawson 1996). Some parents believe that others trivialize their experiences and emotional responses (Meyer et al 2016) or feel psychologically drained by social situations (McBride & Toller 2011, Toller 2005). Bereaved parents are also at higher risk of physical health problems than non-bereaved parents (Murphy et al 1998, Rostila et al 2012, Li et al 2003, Hendrickson 2009, Espinosa & Evans 2013). Following a child’s death, parents have a range of adverse physical symptoms including higher rates of disability and illness, resulting in their greater use of medical services. Moreover, compared to non-bereaved individuals, bereaved mothers experience excess mortality due to both natural and unnatural causes for upwards of 18 years following their child’s death (Li et al 1995, 2003).

Beyond the health implications of losing a child, bereavement further corresponds with the safety, health, and stability of women’s marriages. In North America and Europe, bereaved parents have a higher risk of divorce and separation (Lyngstad 2013, Rogers et al 2008) and lower marital satisfaction than nonbereaved parents (Arnold et al 2005, Dyregrov & Gjestad 2011, Murphy et al 2003, Oliver 1999). In Central and West Africa, bereaved mothers are at elevated risk of the victim of intimate partner violence (Weitzman & Smith-Greenaway 2020).

Thus, in this paper, we offer the first, global analysis of the prevalence of bereaved parents, specifically, mothers. By leveraging data from 168 countries, the study offers a worldwide perspective of the bereavement burden, and its unequal distribution.

**Methods**

To quantify the burden of bereavement worldwide, we generate three indicators that capture the cumulative prevalence of mothers who have lost at least one infant, under-five year old, or any age child. Following suit of Smith-Greenaway & Trinitapoli (2020), we label these indicators as follows: the maternal cumulative prevalence of infant mortality (mIM), under-five mortality (mU5M), and offspring mortality (mOM). We calculate these three measures for two key groups of mothers in 168 countries: mothers who are in the peak of their reproductive years (ages 20-44), as well as those who have recently completed, or are soon to complete, childbearing (ages 45-49).

**Data Sources**

We introduce a new, indirect estimation technique to calculate the mIM, mU5M, and mOM, and make use of nationally representative surveys to examine the accuracy this approach. Specifically, we make use of Demographic and Health Surveys (DHS)[[1]](#footnote-1) and Multiple Indicator Cluster Surveys (MICS), which are available in 88 low- and middle-income countries[[2]](#footnote-2). To examine the accuracy of our indirect estimation strategy, we make use of the most recent survey in each country collected at any point since 2010. In the United States, we also use of the National Survey of Family Growth (NSFG)[[3]](#footnote-3).

To calculate the mIM, mU5M, and mOM, we first restrict samples to women who have had at least one birth, given these are the women at risk of child loss. Using information from women’s reproductive histories, including whether each of their children are alive and, if not, the age at which the deceased child died, we calculate the mIM, mU5M, and mOM. Specifically, for the mIM, we tabulate the prevalence of mothers who have experienced the death of at least one infant. We sum the number of mothers who had a child die before age 1 among those who ever had a live birth and express this per 1,000 mothers. Next, to estimate the mU5M[[4]](#footnote-4), we do the same for mothers who have ever had a child die before reaching age 5. Finally, to the mOM indexes the prevalence of mothers who have experienced a child death, regardless of the child’s age at the time of death. We calculate the mOM for 45- to 49-year-old mothers. See Supplementary Table 2 for a list of countries, data sources, survey years, and analytic sample sizes.

Because nationally representative reproductive history data that are needed to directly calculate these indicators are not available worldwide, we offer an indirect, kin-cohort approach to calculate the mIM, mU5M, and mOM. Specifically, we propose an extension to the Goodman-Keyfitz-Pullum kinship equations (GKP equations) (Keyfitz 1985), to estimate the cumulative number of offspring deaths experienced by a woman surviving to age *a* as follows:

(1)

where for infant deaths, for child deaths and 00 for all-age offspring deaths. We restrict the female reproductive age to , so that for all cases.

In order to determine the prevalence of bereaved women in a population, we start by considering the age-specific probability that an average woman will experience the death of a child:

(2)

where is the hazard rate of experiencing the death of a child younger than *k* (Wachter 2014). We create a life table (Preston, Heuveline, and Guillot 2001) with a unit radix where is the probability of losing a child. We define as the fraction of women aged *a* in cohort *c* who ever experienced the death of a child younger than *k*. Next, we account for the mortality of women with the help of the fraction of women that survived up to age *a* after the start of reproductive age in each birth cohort (where ). We approximate this using country-specific period life tables from the UN WPP. The proportion of women (per 1,000 mothers) who have ever lost one or more children younger than *k* is:

. (3)

To estimate an equivalent measure for mothers, we rescale our estimates using a similar life table approach. We consider fertility as a “hazard rate” to approximate the number of women that “survive” without having children (i.e. remain childless) after experiencing a set of age-specific fertility rates. The fraction of women who have ever been mothers is approximated as 1 minus the fraction of childless women. We can now define, for a given cohort, the proportion of mothers (per 1,000 mothers) who have ever lost one or more children younger than *k*:

. (4)

We generate period estimates of the prevalence of bereaved mothers, comparable to the empirical survey estimates, using different combinations of cohort and age.

**Results**

Figure 1 depicts the mIM to demonstrate the prevalence of mothers who have experienced an infant loss. Panel A depicts the mIM values for younger mothers ages 20-44 (in 2016), whereas panel B presents mIM values for older mothers ages 45-49 years old. In several countries throughout Europe and select countries in Asia, fewer than 1% (i.e., 10 per 1,000) of mothers 20-44 and 2% of mothers 45-49 (i.e., 20 per 1,000 mothers ages 45-49) have ever lost an infant. Yet, in more than half of the 168 countries, over 45 per 1,000 young mothers and 160 per 1,000 older mothers have experienced an infant die. In several countries throughout the Middle East and Northern and sub-Saharan Africa, more than 150 per 1,000 younger mothers and over 300 per 1,000 older mothers have lost an infant. Angola has the highest mIM value for reproductive age mothers (335.6 per 1,000 mothers). Compared to the mothers in Hong Kong, where 2 out of 1,000 young mothers have lost an infant, reproductive age mothers in Angola are 124 times more likely to have lost an infant than those in Hong Kong, and older mother are 85 times more likely in Angola to have ever lost an infant compared to similarly aged mothers in Hong Kong. Relative to the infant mortality rate, which is 20 times higher in Angola relative to Hong, these estimates confirm that cross-country inequality in mothers’ experience of loss is even greater.

Figure 2 depicts the mU5M but, again for younger (panel A) and older (panel B) mothers…

These estimates further confirm that the gap in the under-five mortality rate (U5MR) is far smaller than the gap in the mU5M. For example, comparing U5MRs confirms that a child born in Niger is roughly 41 times more likely to die than a child born in Hong Kong. Yet, comparing how these annualized rates accumulate in mothers experience of loss shows even greater inequality: a mother in Niger is roughly 157 times more likely to experience a child die before age five than a mother in Hong Kong.

Figure 3 depicts the burden of all offspring mortality (mOM), regardless of the age at which the child died. In select countries across Asia and Africa, fewer than 20 per 1,000 mothers have ever lost a child. In several countries across the globe, more than 160 per 1,000 mothers have lost a child. In as many as 26 countries in Africa and the Middle East, more than 500 per 1,000 mothers—that is, more than one-half of mothers—have experienced a child die.

Comparing these indirectly calculated estimates to estimates based on survey data for 89 countries (see Supplementary Table 2) confirms high comparability. The kin-cohort method estimates are, however, consistently higher than the results produced from surveys. This is likely due to two factors. First, the survey estimates are based on women’s self-reports, which tend to undercount deaths. Our survey estimates are thus conservative, whereas the kin-cohort estimates are not susceptible to such error. Second, although we rely on nationally representative surveys, the estimates could be biased by the systematic under-representation of women in ethnic, religious, or linguistic groups that are difficult to reach, or those residing in regions of their country affected by violence or unrest. Given that children of such mothers likely have higher mortality rates than the national average, this could further lead surveys to generate conservative estimates—a problem the kin-cohort method addresses. Note that further estimates confirm that the kin-cohort technique used here is a major improvement over an adapted version of an indirect technique for estimating maternal mortality (Smith-Greenaway & Trinitapoli 2020).[[5]](#footnote-5)

**Discussion**

This study demonstrates the value of extending beyond our focus on child-centered mortality indices to consider the burden of child loss as experienced by mothers. The results demonstrate the disproportionate concentration of bereaved mothers in lower-income countries across sub-Saharan Africa and the Middle East. These are the regions of the world where we know the least about bereavement or its consequences. Most research on bereavement focuses on populations in high-income countries, attesting to the need for further studies on the consequences of child loss in the world regions where this maternal experience is concentrated.

The study further demonstrates that the maternal-oriented indicators reveal even more global inequality than orthodox, child-centered indicators.

In addition to demonstrating the need for a better working understanding of bereavement and its health and social consequences in the countries and regions where it is concentrated, the study also highlights the need to consider bereavement as potentially taxing already burdened healthcare systems. The persistently high mortality—and the corresponding trauma and grief it entails—may contribute to further health problems among adults in these settings. As such, the study re-emphasizes the need to focus intently on reducing premature deaths among children—a reality that has the potential to also dramatically improve the wellbeing of adults.

**References**

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| Table 1. Full Estimates of Maternal Cumulative Prevalence Estimates of Infant, Under-Five, and Offspring Mortality in 2016 | | | | | | | |
| using the Kin-Cohort Method |  |  |  |  |  |  |  |
|  | **mIMkin-cohort** | |  | **mu5Mkin-cohort** | |  | **mOM**kin-cohort |
|  | 20-44 yr olds | 45-49 yr olds |  | 20-44 yr olds | 45-49 yr olds |  | 45-49 yr olds |
| **Africa** |  |  |  |  |  |  |  |
| Algeria | 50.97 | 121.67 |  | 57.38 | 146.10 |  | 163.67 |
| Angola | 322.68 | 510.18 |  | 408.35 | 630.67 |  | 667.97 |
| Benin | 100.38 | 127.09 |  | 126.95 | 175.76 |  | 211.54 |
| Botswana | 237.80 | 395.06 |  | 351.33 | 587.39 |  | 636.44 |
| Burkina Faso | 197.45 | 383.28 |  | 272.68 | 520.77 |  | 584.27 |
| Burundi | 232.24 | 381.16 |  | 327.57 | 529.76 |  | 586.53 |
| Cameroon | 234.97 | 365.99 |  | 318.32 | 490.05 |  | 544.73 |
| Central African Republic | 263.70 | 322.72 |  | 373.59 | 443.38 |  | 498.71 |
| Chad | 321.04 | 439.57 |  | 452.68 | 578.53 |  | 628.36 |
| Comoros | 171.14 | 307.31 |  | 218.16 | 395.70 |  | 441.69 |
| Cote d'Ivoire | 213.36 | 336.93 |  | 293.74 | 451.70 |  | 513.27 |
| Democratic Republic of the Congo | 269.14 | 430.45 |  | 375.22 | 580.49 |  | 632.88 |
| Republic of the Congo | 147.63 | 228.31 |  | 194.75 | 314.86 |  | 374.31 |
| Djibouti | 108.45 | 249.91 |  | 151.69 | 355.00 |  | 421.81 |
| Egypt | 58.01 | 169.21 |  | 71.46 | 215.64 |  | 238.15 |
| Equatorial Guinea | 244.06 | 375.61 |  | 329.98 | 502.21 |  | 551.91 |
| Eritrea | 139.64 | 288.51 |  | 172.47 | 376.83 |  | 431.10 |
| Eswatini | 152.56 | 150.97 |  | 207.15 | 210.27 |  | 257.30 |
| Ethiopia | 175.33 | 367.59 |  | 241.04 | 498.61 |  | 556.50 |
| Gabon | 129.93 | 233.59 |  | 171.57 | 313.25 |  | 374.68 |
| Gambia | 164.34 | 305.14 |  | 239.53 | 479.68 |  | 548.23 |
| Ghana | 129.36 | 250.44 |  | 178.46 | 354.77 |  | 425.95 |
| Guinea | 225.94 | 422.48 |  | 321.69 | 577.15 |  | 625.77 |
| Guinea-Bissau | 227.83 | 404.38 |  | 309.35 | 539.54 |  | 591.77 |
| Kenya | 141.67 | 250.94 |  | 186.47 | 340.52 |  | 402.97 |
| Lesotho | 153.09 | 150.83 |  | 216.10 | 213.65 |  | 267.95 |
| Liberia | 216.99 | 438.96 |  | 289.43 | 578.52 |  | 619.21 |
| Libya | 23.94 | 81.75 |  | 27.60 | 96.13 |  | 121.96 |
| Madagascar | 139.66 | 308.54 |  | 191.27 | 416.11 |  | 485.22 |
| Malawi | 207.56 | 356.26 |  | 279.68 | 475.03 |  | 519.50 |
| Mali | 294.78 | 465.05 |  | 426.36 | 649.64 |  | 687.93 |
| Mauritania | 172.15 | 297.44 |  | 250.36 | 435.04 |  | 466.58 |
| Morocco | 51.78 | 130.14 |  | 60.43 | 159.66 |  | 176.86 |
| Mozambique | 233.55 | 373.08 |  | 312.29 | 497.17 |  | 537.84 |
| Namibia | 100.35 | 140.52 |  | 130.39 | 191.37 |  | 241.23 |
| Niger | 261.10 | 473.18 |  | 444.23 | 713.84 |  | 741.43 |
| Nigeria | 244.99 | 404.25 |  | 344.14 | 547.92 |  | 614.35 |
| Rwanda | 151.85 | 391.88 |  | 196.18 | 561.46 |  | 600.51 |
| Sao Tome and Principe | 128.69 | 292.59 |  | 154.66 | 365.77 |  | 405.24 |
| Senegal | 135.00 | 284.25 |  | 194.16 | 457.98 |  | 513.09 |
| Sierra Leone | 300.49 | 418.00 |  | 389.83 | 525.95 |  | 571.22 |
| Somalia | 291.31 | 421.48 |  | 414.51 | 572.33 |  | 628.88 |
| South Africa | 86.69 | 112.39 |  | 112.87 | 154.62 |  | 200.85 |
| South Sudan | 236.42 | 395.95 |  | 327.59 | 533.64 |  | 590.25 |
| Sudan | 158.03 | 281.55 |  | 221.38 | 401.77 |  | 466.01 |
| Tanzania | 173.72 | 321.83 |  | 229.60 | 431.72 |  | 484.56 |
| Togo | 176.21 | 302.27 |  | 245.90 | 436.07 |  | 510.83 |
| Tunisia | 27.44 | 80.62 |  | 28.79 | 89.85 |  | 100.49 |
| Uganda | 232.15 | 367.67 |  | 307.83 | 490.26 |  | 541.23 |
| Zambia | 205.27 | 328.58 |  | 272.46 | 440.58 |  | 485.36 |
| Zimbabwe | 146.18 | 142.01 |  | 199.83 | 199.15 |  | 246.19 |
| **Asia** |  |  |  |  |  |  |  |
| Afghanistan | 238.25 | 433.38 |  | 303.18 | 541.95 |  | 583.63 |
| Armenia | 38.88 | 95.74 |  | 44.13 | 111.25 |  | 117.68 |
| Azerbaijan | 79.46 | 181.64 |  | 90.67 | 218.16 |  | 226.64 |
| Bangladesh | 97.70 | 248.45 |  | 120.29 | 325.96 |  | 357.88 |
| Bhutan | 83.69 | 217.04 |  | 100.86 | 310.71 |  | 361.41 |
| Cambodia | 97.57 | 250.53 |  | 110.88 | 316.87 |  | 382.68 |
| China | 31.90 | 84.42 |  | 36.09 | 102.67 |  | 112.31 |
| Cyprus | 6.90 | 20.32 |  | 7.96 | 23.98 |  | 27.67 |
| Georgia | 34.78 | 85.10 |  | 38.57 | 93.57 |  | 103.85 |
| Hong Kong | 2.29 | 6.09 |  | 3.28 | 8.20 |  | 10.75 |
| India | 118.82 | 233.23 |  | 147.53 | 306.46 |  | 339.19 |
| Indonesia | 60.44 | 131.60 |  | 71.78 | 166.74 |  | 192.13 |
| Islamic Republic of Iran | 32.87 | 103.72 |  | 37.48 | 126.45 |  | 152.59 |
| Iraq | 86.19 | 160.64 |  | 101.73 | 197.38 |  | 232.71 |
| Israel | 8.23 | 22.46 |  | 9.82 | 27.26 |  | 34.30 |
| Japan | 3.40 | 7.05 |  | 4.41 | 9.62 |  | 13.46 |
| Jordan | 47.55 | 111.10 |  | 53.82 | 128.37 |  | 146.95 |
| Kazakhstan | 45.40 | 114.11 |  | 51.97 | 135.52 |  | 152.61 |
| Kuwait | 17.73 | 36.48 |  | 20.10 | 42.01 |  | 53.23 |
| Kyrgyzstan | 65.00 | 167.46 |  | 73.37 | 195.72 |  | 210.86 |
| Lao People's Democratic Republic | 135.26 | 297.62 |  | 170.28 | 387.08 |  | 434.57 |
| Lebanon | 19.35 | 60.03 |  | 21.79 | 69.74 |  | 79.56 |
| Malaysia | 11.88 | 32.33 |  | 14.04 | 39.29 |  | 56.15 |
| Maldives | 28.06 | 187.55 |  | 31.66 | 236.88 |  | 260.02 |
| Mongolia | 60.94 | 166.59 |  | 71.73 | 211.32 |  | 227.19 |
| Myanmar | 91.40 | 171.69 |  | 114.03 | 223.89 |  | 265.69 |
| Nepal | 103.75 | 257.53 |  | 126.81 | 333.34 |  | 369.91 |
| North Korea | 40.93 | 108.12 |  | 49.82 | 142.48 |  | 166.18 |
| Oman | 21.53 | 107.63 |  | 24.63 | 131.96 |  | 165.33 |
| Pakistan | 196.58 | 370.02 |  | 233.61 | 445.80 |  | 469.50 |
| Philippines | 59.11 | 120.85 |  | 73.91 | 158.26 |  | 189.84 |
| Qatar | 14.73 | 50.98 |  | 16.81 | 58.69 |  | 74.89 |
| Saudi Arabia | 22.04 | 100.58 |  | 24.52 | 117.69 |  | 154.98 |
| Singapore | 2.93 | 7.25 |  | 3.48 | 9.17 |  | 13.33 |
| South Korea | 4.28 | 17.04 |  | 5.10 | 21.65 |  | 28.42 |
| Sri Lanka | 18.99 | 41.90 |  | 21.12 | 51.04 |  | 67.27 |
| Palestinian Territory | 64.87 | 153.47 |  | 74.52 | 180.88 |  | 206.22 |
| Syrian Arab Republic | 41.01 | 94.13 |  | 46.57 | 110.22 |  | 162.27 |
| Taiwan | 6.68 | 13.34 |  | 8.05 | 18.34 |  | 26.49 |
| Tajikistan | 113.58 | 271.30 |  | 130.88 | 344.87 |  | 374.04 |
| Thailand | 21.39 | 50.13 |  | 24.04 | 58.49 |  | 83.70 |
| Timor-Leste | 154.06 | 368.79 |  | 186.27 | 459.94 |  | 493.83 |
| Turkey | 33.70 | 130.58 |  | 44.97 | 163.19 |  | 200.64 |
| Turkmenistan | 124.58 | 215.99 |  | 144.55 | 260.55 |  | 278.25 |
| United Arab Emirates | 13.68 | 36.30 |  | 15.57 | 41.63 |  | 59.91 |
| Uzbekistan | 85.83 | 185.30 |  | 99.71 | 225.47 |  | 238.50 |
| Vietnam | 38.24 | 78.14 |  | 46.38 | 100.27 |  | 126.62 |
| Yemen | 140.62 | 357.92 |  | 174.36 | 452.08 |  | 501.37 |
| **Europe** |  |  |  |  |  |  |  |
| Albania | 25.70 | 74.33 |  | 30.90 | 87.55 |  | 99.55 |
| Austria | 5.60 | 11.89 |  | 6.48 | 14.23 |  | 19.37 |
| Belarus | 9.95 | 28.77 |  | 12.18 | 34.90 |  | 48.27 |
| Belgium | 6.07 | 13.03 |  | 7.20 | 15.69 |  | 20.50 |
| Bosnia & Herzegovina | 13.31 | 30.69 |  | 15.04 | 35.68 |  | 42.19 |
| Bulgaria | 16.47 | 29.92 |  | 19.21 | 37.33 |  | 47.75 |
| Croatia | 8.33 | 19.46 |  | 9.51 | 22.38 |  | 28.90 |
| Czech Republic | 4.50 | 16.81 |  | 5.32 | 19.86 |  | 28.05 |
| Denmark | 5.89 | 12.29 |  | 6.67 | 14.75 |  | 18.28 |
| Estonia | 7.33 | 28.66 |  | 9.01 | 34.74 |  | 47.60 |
| Finland | 3.93 | 9.04 |  | 4.73 | 10.96 |  | 16.93 |
| France | 6.09 | 12.18 |  | 7.03 | 14.68 |  | 19.11 |
| Germany | 5.33 | 10.31 |  | 6.17 | 12.49 |  | 16.08 |
| Greece | 5.08 | 14.25 |  | 5.77 | 16.22 |  | 21.56 |
| Hungary | 8.36 | 25.44 |  | 9.50 | 29.13 |  | 35.81 |
| Iceland | 3.29 | 9.55 |  | 4.37 | 12.21 |  | 18.21 |
| Ireland | 5.75 | 13.74 |  | 6.59 | 16.30 |  | 21.59 |
| Italy | 4.56 | 10.46 |  | 5.17 | 12.15 |  | 15.43 |
| Latvia | 10.97 | 29.97 |  | 13.44 | 36.71 |  | 49.50 |
| Lithuania | 9.15 | 27.23 |  | 10.80 | 32.87 |  | 47.23 |
| Macedonia | 18.32 | 58.83 |  | 19.99 | 63.51 |  | 68.86 |
| Moldova | 25.96 | 59.98 |  | 30.55 | 72.13 |  | 84.33 |
| Montenegro | 13.93 | 35.54 |  | 15.26 | 39.17 |  | 45.96 |
| Netherlands | 5.76 | 11.60 |  | 6.60 | 13.99 |  | 16.79 |
| Norway | 4.57 | 10.92 |  | 5.33 | 13.56 |  | 19.16 |
| Poland | 8.17 | 30.40 |  | 9.25 | 34.12 |  | 43.83 |
| Portugal | 4.95 | 14.96 |  | 5.86 | 18.75 |  | 25.13 |
| Romania | 19.16 | 44.26 |  | 21.96 | 54.14 |  | 65.26 |
| Russian Federation | 18.35 | 40.42 |  | 21.66 | 48.13 |  | 68.34 |
| Serbia | 12.16 | 37.54 |  | 13.68 | 43.47 |  | 51.34 |
| Slovakia | 9.34 | 24.48 |  | 10.95 | 28.83 |  | 37.87 |
| Slovenia | 4.14 | 13.22 |  | 4.89 | 15.74 |  | 21.96 |
| Spain | 4.26 | 9.59 |  | 4.97 | 11.64 |  | 14.88 |
| Sweden | 4.07 | 9.37 |  | 4.75 | 11.22 |  | 15.84 |
| Switzerland | 5.85 | 10.79 |  | 6.46 | 12.90 |  | 16.07 |
| Ukraine | 19.41 | 32.91 |  | 22.57 | 40.59 |  | 56.76 |
| United Kingdom | 7.65 | 14.22 |  | 8.70 | 16.70 |  | 21.10 |
| **Latin America & the Caribbean** |  |  |  |  |  |  |  |
| Argentina | 27.76 | 59.53 |  | 31.69 | 69.18 |  | 84.77 |
| Belize | 40.83 | 100.01 |  | 46.64 | 118.40 |  | 164.13 |
| Bolivia | 96.63 | 238.65 |  | 149.45 | 358.63 |  | 408.10 |
| Brazil | 39.81 | 98.94 |  | 46.41 | 116.73 |  | 139.46 |
| Chile | 13.53 | 31.51 |  | 15.84 | 37.71 |  | 48.94 |
| Colombia | 33.54 | 66.38 |  | 38.58 | 78.84 |  | 109.18 |
| Costa Rica | 18.76 | 39.15 |  | 22.59 | 47.27 |  | 63.15 |
| Cuba | 9.50 | 19.74 |  | 11.54 | 25.77 |  | 36.04 |
| Dominican Republic | 69.70 | 134.47 |  | 76.25 | 149.40 |  | 173.75 |
| Ecuador | 41.23 | 106.78 |  | 49.57 | 133.88 |  | 167.36 |
| El Salvador | 43.43 | 115.36 |  | 49.67 | 142.73 |  | 187.20 |
| French Guiana | 28.94 | 70.71 |  | 32.71 | 81.71 |  | 90.88 |
| Guatemala | 79.35 | 198.49 |  | 94.95 | 247.68 |  | 290.11 |
| Guyana | 74.43 | 118.62 |  | 90.03 | 148.01 |  | 185.64 |
| Haiti | 138.16 | 265.85 |  | 191.57 | 358.40 |  | 424.96 |
| Honduras | 56.64 | 147.41 |  | 77.75 | 199.24 |  | 243.81 |
| Jamaica | 33.20 | 62.49 |  | 38.25 | 73.57 |  | 90.90 |
| Mexico | 36.90 | 85.28 |  | 41.80 | 99.81 |  | 121.35 |
| Nicaragua | 50.62 | 145.20 |  | 59.55 | 181.06 |  | 220.19 |
| Panama | 40.44 | 72.96 |  | 50.70 | 92.40 |  | 118.73 |
| Paraguay | 52.02 | 109.78 |  | 60.10 | 131.01 |  | 167.71 |
| Peru | 37.57 | 122.35 |  | 46.16 | 157.66 |  | 186.72 |
| Puerto Rico | 12.92 | 25.97 |  | 14.58 | 30.60 |  | 44.21 |
| Suriname | 53.27 | 106.95 |  | 58.42 | 120.62 |  | 143.03 |
| Trinidad and Tobago | 49.21 | 66.26 |  | 54.98 | 75.17 |  | 93.27 |
| Uruguay | 21.57 | 44.33 |  | 25.02 | 51.68 |  | 63.55 |
| Venezuela | 35.33 | 65.15 |  | 40.79 | 76.71 |  | 111.41 |
| **North America** |  |  |  |  |  |  |  |
| Canada | 7.67 | 12.85 |  | 8.53 | 15.13 |  | 20.05 |
| United States | 12.11 | 19.95 |  | 13.90 | 23.63 |  | 33.71 |
| **Oceania** |  |  |  |  |  |  |  |
| Australia | 6.53 | 13.75 |  | 7.50 | 16.58 |  | 21.46 |
| New Zealand | 8.19 | 16.65 |  | 9.70 | 20.43 |  | 28.57 |
| Papua New Guinea | 134.06 | 224.95 |  | 165.40 | 282.60 |  | 327.69 |

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| --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- |
| Table 2. Maternal Cumulative Prevalence Estimates of Infant, Under-Five, and Offspring Mortality using the Kin-Cohort Method and Direct Survey Estimation Based on DHS and MICS data for 90 countries | | | | | | | | | | | | | |
|  |  |  |  | mIM | | mU5M | | mOM | mIMkin-cohort | | mU5Mkin-cohort | | mOMkin-cohort |
|  | Source | Year | Sample | 20-44 | 45-49 | 20-44 | 45-49 | 45-49 | 20-44 | 45-49 | 20-44 | 45-49 | 45-49 |
| **Africa** |  |  |  |  |  |  |  |  |  |  |  |  |  |
| Algeria | MICS | 2012 | 17,540 |  |  |  |  | 150.52 | 50.97 | 121.67 | 57.38 | 146.10 | 163.67 |
| Angola | DHS | 2015 | 10,054 | 168.46 | 310.46 | 224.70 | 441.82 | 484.08 | 335.63 | 514.98 | 426.11 | 635.48 | 672.23 |
| Benin | DHS | 2017 | 11,247 | 177.13 | 276.73 | 258.85 | 411.84 | 476.89 | 227.28 | 373.97 | 320.67 | 520.86 | 578.27 |
| Burkina Faso | DHS | 2010 | 12,654 | 242.87 | 414.52 | 372.03 | 599.19 | 665.74 | 279.89 | 434.26 | 436.84 | 634.53 | 676.96 |
| Burundi | DHS | 2017 | 10,845 | 188.31 | 349.30 | 258.50 | 529.74 | 608.16 | 187.61 | 375.60 | 257.84 | 511.41 | 576.87 |
| Cameroon | DHS | 2011 | 10,225 | 197.69 | 311.76 | 305.57 | 446.49 | 530.42 | 275.01 | 385.62 | 373.27 | 513.23 | 567.32 |
| Central African Republic | MICS | 2010 | 8,403 |  |  |  |  | 688.90 | 263.70 | 322.72 | 373.59 | 443.38 | 498.71 |
| Chad | DHS | 2015 | 13,012 | 273.99 | 382.60 | 402.55 | 563.75 | 632.52 | 329.70 | 443.80 | 463.47 | 582.81 | 631.36 |
| Comoros | DHS | 2012 | 2,807 | 110.51 | 203.44 | 135.51 | 254.47 | 297.91 | 187.14 | 338.56 | 240.60 | 434.02 | 484.13 |
| Cote d'Ivoire | DHS | 2012 | 7,050 | 198.91 | 313.74 | 272.26 | 424.31 | 516.02 | 213.36 | 336.93 | 293.74 | 451.70 | 513.27 |
| Democratic Republic of the Congo | DHS | 2013 | 13,258 | 208.51 | 340.30 | 294.43 | 484.46 | 557.82 | 288.08 | 439.21 | 401.93 | 590.24 | 641.10 |
| Congo, Republic of | DHS | 2011 | 8,058 | 132.44 | 220.93 | 198.42 | 350.68 | 428.72 | 176.34 | 234.54 | 238.70 | 324.05 | 388.59 |
| Egypt | DHS | 2014 | 19,447 | 69.96 | 162.46 | 80.77 | 195.93 | 219.99 | 62.92 | 196.06 | 77.70 | 249.96 | 274.26 |
| Eswatini | MICS | 2014 | 3,140 |  |  |  |  | 365.69 | 152.56 | 150.97 | 207.15 | 210.27 | 257.30 |
| Ethiopia | DHS | 2016 | 9,915 | 214.17 | 385.03 | 264.09 | 520.30 | 593.60 | 175.33 | 367.59 | 241.04 | 498.61 | 556.50 |
| Gabon | DHS | 2012 | 5,851 | 110.34 | 201.41 | 149.93 | 292.40 | 383.71 | 148.11 | 256.62 | 198.28 | 342.35 | 405.78 |
| Gambia | DHS | 2013 | 6,471 | 127.59 | 246.20 | 183.45 | 373.83 | 420.55 | 176.67 | 321.65 | 266.37 | 512.40 | 576.32 |
| Ghana | DHS | 2014 | 6,327 | 134.70 | 250.71 | 189.13 | 364.30 | 419.45 | 139.19 | 264.91 | 193.47 | 374.98 | 446.73 |
| Guinea | DHS | 2012 | 6,394 | 237.02 | 379.67 | 335.86 | 540.13 | 612.18 | 265.24 | 456.91 | 380.20 | 613.63 | 654.03 |
| Kenya | DHS | 2014 | 22,347 | 118.64 | 188.80 | 155.52 | 264.55 | 338.50 | 154.62 | 260.02 | 206.10 | 351.84 | 417.63 |
| Lesotho | DHS | 2014 | 4,312 | 135.35 | 218.78 | 167.54 | 270.50 | 368.21 | 155.97 | 155.06 | 222.23 | 218.57 | 277.25 |
| Liberia | DHS | 2013 | 6,966 | 223.97 | 465.34 | 318.44 | 597.34 | 653.53 | 255.05 | 464.56 | 340.96 | 609.21 | 648.98 |
| Madagascar | MICS | 2018 | 11,889 |  |  |  |  | 339.78 | 139.66 | 308.54 | 191.27 | 416.11 | 485.22 |
| Malawi | DHS | 2015 | 17,834 | 151.22 | 340.66 | 222.60 | 502.08 | 564.38 | 217.84 | 361.60 | 295.10 | 481.13 | 524.82 |
| Mali | DHS | 2012 | 7,858 | 191.42 | 253.15 | 263.00 | 348.30 | 377.16 | 328.40 | 487.84 | 484.42 | 672.54 | 704.22 |
| Mozambique | DHS | 2011 | 9,745 | 228.48 | 338.55 | 295.36 | 475.95 | 550.50 | 282.94 | 411.09 | 382.42 | 545.79 | 584.76 |
| Namibia | DHS | 2013 | 6,167 | 90.04 | 137.07 | 118.08 | 191.33 | 243.33 | 105.06 | 151.74 | 139.50 | 206.20 | 264.22 |
| Niger | DHS | 2012 | 8,656 | 260.31 | 434.96 | 437.17 | 705.73 | 792.63 | 300.10 | 501.13 | 516.25 | 736.58 | 758.40 |
| Nigeria | DHS | 2013 | 26,174 | 227.05 | 378.80 | 334.04 | 524.61 | 579.88 | 268.63 | 420.66 | 376.18 | 566.95 | 628.64 |
| Rwanda | DHS | 2015 | 8,587 | 150.86 | 370.01 | 214.93 | 553.32 | 623.08 | 164.96 | 401.30 | 214.82 | 574.97 | 615.49 |
| Sao Tome and Principe | MICS | 2014 | 2,075 |  |  |  |  | 373.57 | 128.69 | 292.59 | 154.66 | 365.77 | 405.24 |
| Senegal | DHS | 2017 | 10,531 | 142.46 | 236.31 | 193.29 | 365.94 | 429.13 | 129.26 | 276.79 | 182.60 | 444.87 | 499.78 |
| Sierra Leone | DHS | 2013 | 11,468 | 303.31 | 460.66 | 398.58 | 614.48 | 670.26 | 326.94 | 436.89 | 426.97 | 544.68 | 587.37 |
| Somalia | MICS | 2011 | 3,204 |  |  |  |  | 443.42 | 291.31 | 421.48 | 414.51 | 572.33 | 628.88 |
| South Africa | DHS | 2016 | 5,919 | 74.13 | 98.62 | 86.87 | 131.77 | 171.97 | 86.69 | 112.39 | 112.87 | 154.62 | 200.85 |
| South Sudan | MICS | 2014 | 7,709 |  |  |  |  | 398.15 | 236.42 | 395.95 | 327.59 | 533.64 | 590.25 |
| Sudan | MICS | 2014 | 11,250 |  |  |  |  | 403.54 | 158.03 | 281.55 | 221.38 | 401.77 | 466.01 |
| Tanzania | DHS | 2015 | 9,168 | 167.64 | 333.69 | 226.70 | 455.36 | 509.19 | 180.59 | 327.53 | 239.18 | 439.12 | 492.22 |
| Togo | DHS | 2014 | 6,702 | 150.64 | 253.17 | 225.09 | 387.48 | 483.70 | 186.81 | 314.51 | 261.89 | 455.02 | 529.59 |
| Tunisia | MICS | 2011 | 5,316 |  |  |  |  | 63.60 | 27.44 | 80.62 | 28.79 | 89.85 | 100.49 |
| Uganda | DHS | 2016 | 12,908 | 185.09 | 368.83 | 254.08 | 521.95 | 595.02 | 232.15 | 367.67 | 307.83 | 490.26 | 541.23 |
| Zambia | DHS | 2014 | 11,562 | 177.96 | 330.83 | 259.15 | 487.12 | 555.08 | 224.34 | 331.86 | 301.49 | 443.80 | 489.22 |
| Zimbabwe | DHS | 2015 | 6,893 | 130.30 | 136.46 | 170.42 | 193.34 | 258.99 | 147.80 | 140.70 | 203.66 | 196.94 | 246.46 |
| **Asia** |  |  |  |  |  |  |  |  |  |  |  |  |  |
| Afghanistan | MICS | 2011 | 12,956 |  |  |  |  | 440.37 | 238.25 | 433.38 | 303.18 | 541.95 | 583.63 |
| Armenia | DHS | 2016 | 4,064 | 24.66 | 43.56 | 27.88 | 45.42 | 56.98 | 38.88 | 95.74 | 44.13 | 111.25 | 117.68 |
| Bangladesh | DHS | 2014 | 15,018 | 133.78 | 292.76 | 157.95 | 363.21 | 414.05 | 110.54 | 276.04 | 137.77 | 362.65 | 395.49 |
| Bhutan | MICS | 2010 | 10,168 |  |  |  |  | 390.09 | 83.69 | 217.04 | 100.86 | 310.71 | 361.41 |
| Cambodia | DHS | 2014 | 11,492 | 99.64 | 259.98 | 117.90 | 322.85 | 371.08 | 113.61 | 272.79 | 131.24 | 344.28 | 414.16 |
| India | DHS | 2016 | 470,695 | 96.75 | 145.37 | 114.53 | 182.59 | 224.61 | 118.82 | 233.23 | 147.53 | 306.46 | 339.19 |
| Indonesia | DHS | 2017 | 33,781 | 65.67 | 135.34 | 78.14 | 163.07 | 194.46 | 57.88 | 124.81 | 68.80 | 157.48 | 181.73 |
| Iraq | MICS | 2011 | 17,914 |  |  |  |  | 186.44 | 86.19 | 160.64 | 101.73 | 197.38 | 232.71 |
| Jordan | DHS | 2017 | 12,719 | 41.71 | 54.10 | 46.06 | 69.92 | 83.24 | 45.41 | 106.33 | 51.42 | 122.85 | 140.70 |
| Kazakhstan | MICS | 2015 | 9,226 |  |  |  |  | 121.60 | 45.40 | 114.11 | 51.97 | 135.52 | 152.61 |
| Kyrgyzstan | DHS | 2012 | 5,528 | 67.32 | 115.43 | 78.11 | 138.32 | 153.46 | 82.85 | 200.47 | 93.69 | 233.42 | 248.88 |
| Lao People's Dem. Republic | MICS | 2017 | 17,433 |  |  |  |  | 289.98 | 135.26 | 297.62 | 170.28 | 387.08 | 434.57 |
| Maldives | DHS | 2017 | 5,393 | 39.90 | 111.75 | 46.44 | 128.88 | 152.63 | 24.96 | 169.90 | 28.10 | 213.64 | 235.85 |
| Mauritania | MICS | 2015 | 8,811 |  |  |  |  | 363.41 | 172.15 | 297.44 | 250.36 | 435.04 | 466.58 |
| Mongolia | MICS | 2014 | 9,776 |  |  |  |  | 238.63 | 60.94 | 166.59 | 71.73 | 211.32 | 227.19 |
| Myanmar | DHS | 2016 | 7,700 | 138.86 | 222.62 | 158.99 | 271.53 | 321.73 | 91.40 | 171.69 | 114.03 | 223.89 | 265.69 |
| Nepal | MICS | 2015 | 9,701 |  |  |  |  | 265.26 | 103.75 | 257.53 | 126.81 | 333.34 | 369.91 |
| Pakistan | DHS | 2018 | 12,801 | 180.40 | 293.64 | 205.10 | 335.37 | 378.98 | 186.20 | 350.66 | 220.53 | 422.81 | 445.88 |
| Philippines | DHS | 2017 | 15,473 | 53.52 | 67.81 | 63.29 | 97.77 | 126.41 | 56.98 | 116.53 | 71.54 | 152.11 | 183.52 |
| Tajikistan | DHS | 2017 | 7,380 | 81.34 | 175.10 | 93.52 | 205.56 | 226.23 | 108.99 | 261.71 | 124.24 | 331.95 | 358.52 |
| Thailand | MICS | 2015 | 17,533 |  |  |  |  | 51.70 | 21.39 | 50.13 | 24.04 | 58.49 | 83.70 |
| Timor-Leste | DHS | 2016 | 7,322 | 100.13 | 169.66 | 123.31 | 201.61 | 274.65 | 154.06 | 368.79 | 186.27 | 459.94 | 493.83 |
| Turkmenistan | MICS | 2015 | 4,901 |  |  |  |  | 160.91 | 124.58 | 215.99 | 144.55 | 260.55 | 278.25 |
| Turkey | DHS | 2013 | 6,509 | 51.84 | 142.68 | 59.21 | 157.27 | 179.79 | 44.00 | 163.65 | 57.68 | 201.33 | 246.35 |
| Vietnam | MICS | 2013 | 6,999 |  |  |  | 119.07 | 119.07 | 38.24 | 78.14 | 46.38 | 100.27 | 126.62 |
| Yemen | DHS | 2013 | 17,647 | 140.74 | 351.94 | 162.88 | 415.40 | 456.50 | 165.29 | 396.66 | 206.61 | 498.52 | 546.07 |
| **Europe** |  |  |  |  |  |  |  |  |  |  |  |  |  |
| Albania | DHS | 2017 | 7,188 | 13.92 | 29.88 | 15.59 | 31.61 | 40.37 | 23.68 | 70.51 | 28.96 | 83.02 | 94.77 |
| Montenegro | MICS | 2013 | 2,166 |  |  |  |  | 43.78 | 13.93 | 35.54 | 15.26 | 39.17 | 45.96 |
| Serbia | MICS | 2014 | 3,551 |  |  |  |  | 44.09 | 12.16 | 37.54 | 13.68 | 43.47 | 51.34 |
| Moldova, Republic of | MICS | 2012 | 4,083 |  |  |  |  | 108.25 | 25.96 | 59.98 | 30.55 | 72.13 | 84.33 |
| Ukraine | MICS | 2012 | 6,406 |  |  |  |  | 34.75 | 19.41 | 32.91 | 22.57 | 40.59 | 56.76 |
| **Latin America & the Caribbean** |  |  |  |  |  |  |  |  |  |  |  |  |  |
| Belize | MICS | 2015 | 3,199 |  |  |  |  | 136.74 | 40.83 | 100.01 | 46.64 | 118.40 | 164.13 |
| Colombia | DHS | 2015 | 24,351 | 38.35 | 59.07 | 43.90 | 70.92 | 104.55 | 34.90 | 69.10 | 40.18 | 82.24 | 113.28 |
| Cuba | MICS | 2014 | 7,376 |  |  |  |  | 23.33 | 9.50 | 19.74 | 11.54 | 25.77 | 36.04 |
| Dominican Republic | DHS | 2013 | 7,493 | 88.64 | 152.89 | 102.40 | 194.04 | 228.71 | 76.87 | 154.24 | 83.88 | 171.59 | 196.84 |
| El Salvador | MICS | 2014 | 9,423 |  |  |  |  | 179.13 | 43.43 | 115.36 | 49.67 | 142.73 | 187.20 |
| Guatemala | DHS | 2015 | 16,236 | 93.83 | 200.78 | 114.59 | 254.66 | 302.15 | 83.77 | 207.98 | 100.39 | 260.13 | 303.11 |
| Guyana | MICS | 2014 | 3,607 |  |  |  |  | 233.24 | 74.43 | 118.62 | 90.03 | 148.01 | 185.64 |
| Haiti | DHS | 2017 | 8,325 | 131.31 | 276.84 | 175.70 | 361.97 | 416.91 | 134.73 | 257.58 | 187.14 | 348.76 | 414.96 |
| Honduras | DHS | 2012 | 14,790 | 69.48 | 150.21 | 84.85 | 183.48 | 237.79 | 72.48 | 180.73 | 99.42 | 243.40 | 288.38 |
| Paraguay | MICS | 2016 | 5,202 |  |  |  |  | 172.01 | 52.02 | 109.78 | 60.10 | 131.01 | 167.71 |
| Peru | DHS | 2012 | 16,048 | 64.47 | 147.67 | 81.93 | 194.48 | 221.33 | 49.39 | 160.75 | 60.74 | 210.20 | 242.41 |
| Suriname | MICS | 2018 | 4,856 |  |  |  |  | 90.68 | 53.27 | 106.95 | 58.42 | 120.62 | 143.03 |
| Trinidad and Tobago | MICS | 2011 | 2,408 |  |  |  |  | 102.95 | 49.21 | 66.26 | 54.98 | 75.17 | 93.27 |
| **North America** |  |  |  |  |  |  |  |  |  |  |  |  |  |
| United States | NSFG | 2013 | 5,588 |  |  |  |  | 4.48 | 12.11 | 19.95 | 13.90 | 23.63 | 33.71 |
| **Oceania** |  |  |  |  |  |  |  |  |  |  |  |  |  |
| Papua New Guinea | DHS | 2016 | 10,054 | 100.51 | 155.98 | 131.53 | 197.31 | 252.63 | 134.06 | 224.95 | 165.40 | 282.60 | 327.69 |

1. DHS are nationally representative household surveys that collect detailed information from various household members, including women ages 15-49. The public use surveys, funded by the United States Agency for International Development (USAID) are available at <https://dhsprogram.com/>. [↑](#footnote-ref-1)
2. MICS are nationally representative household survey. The public use surveys, funded by UNICEF, are available at <https://mics.unicef.org/>. [↑](#footnote-ref-2)
3. NSFG collects reproductive history calendars from women ages 15-44 years old. The public use surveys are available at <https://www.cdc.gov/nchs/nsfg/index.htm>. [↑](#footnote-ref-3)
4. For select countries wherein we rely on MICS data, we lack mIM and mU5M estimates because information on the age of the child at the time of death was not included. [↑](#footnote-ref-4)
5. That approach makes use of data on a country’s IMR, U5MR, and TFR to estimate the mIM and mU5M for 45-to-49-year-old mothers. Specifically, we estimate the indirect mIM as mIM’ = 1 − ((1 − IMR)TFR)and the indirect mu5M as mU5M’ = 1−((1 − U5MR) TFR . This approach is shown to less accurately reflect the survey-based estimates than the kin-cohort method. [↑](#footnote-ref-5)