# TRENDS IN MATERNAL MORTALITY

# 2000 to 2017

Estimates by WHO, UNICEF, UNFPA,
World Bank Group and
the United Nations Population Division

LAUNCH VERSION

World Health Organization
unicef for every child
UNFPA
WORLD BANK GROUP
United Nations

# TRENDS IN MATERNAL MORTALITY: 2000 TO 2017

## Estimates by WHO, UNICEF, UNFPA, World Bank Group and the United Nations Population Division

World Health Organization

unicef
for every child

UNFPA

WORLD BANK GROUP

United Nations

Trends in maternal mortality 2000 to 2017: estimates by WHO, UNICEF, UNFPA, World Bank Group and the United Nations Population Division

ISBN 978-92-4-151648-8



**Suggested citation.** Trends in maternal mortality 2000 to 2017: estimates by WHO, UNICEF, UNFPA, World Bank Group and the United Nations Population Division. Geneva: World Health Organization; 2019. Licence: CC BY-NC-SA 3.0 IGO.

**Cataloguing-in-Publication (CIP) data.** CIP data are available at http://apps.who.int/iris.

**Sales, rights and licensing.** To purchase WHO publications, see http://apps.who.int/bookorders. To submit requests for commercial use and queries on rights and licensing, see http://www.who.int/about/licensing.



Technical and copyediting: Green Ink (www.greenink.co.uk).

Design and layout: Anne-Marie Labouche

# CONTENTS



Additional relevant materials including links to the full database, country profiles and all model specification codes, as well as language editions of this report (when available) can be found at: www.who.int/reproductivehealth/publications/maternal-mortality-2017/en/

## LIST OF TABLES

## LIST OF ANNEXES

# ACKNOWLEDGMENTS

The United Nations Maternal Mortality Estimation Inter-Agency Group (UN MMEIG), together with its independent external Technical Advisory Group (TAG), collaborated in developing these maternal mortality estimates.

From each of the constituent agencies that form the UN MMEIG, the following individuals worked on the compilation of this report:[1]

- World Health Organization (WHO): Doris Chou, Ann-Beth Moller and Lale Say
- United Nations Children's Fund (UNICEF): Liliana Carvajal-Aguirre and Jennifer Requejo
- United Nations Population Fund (UNFPA): Tapiwa Jhamba
- United Nations Population Division (UNPD, a division of the United Nations Department of Economic and Social Affairs [UN DESA]): Kirill Andreev, Lina Bassarsky, Victor Gaigbe-Togbe and Patrick Gerland
- The World Bank Group: Charles Kouame, Samuel Mills and Emi Suzuki.

The members of the TAG provided independent technical advice:

- Saifuddin Ahmed, of Johns Hopkins Bloomberg School of Public Health, United States of America (USA)
- Peter Byass, of the Umeå Centre for Global Health Research, Umeå University, Sweden
- Thomas W. Pullum, of the Demographic and Health Surveys (DHS) Program, ICF, USA.

In addition, independent expert consultants for this project were:

- Tim Colbourn, of University College London, United Kingdom of Great Britain and Northern Ireland
- Jeff Eaton, of Imperial College London, United Kingdom
- Alison Gemmill and Stéphane Helleringer, of Johns Hopkins University, USA
- Marie Klingberg Alvin, of Dalarna University/Högskolan Dalarna, Sweden
- Laina Mercer, of PATH, USA
- Helena Nordenstedt, of the Karolinska Institutet, Sweden
- Jon Wakefield, of the University of Washington, USA.

The TAG is grateful for the review and support of a working group on maternal mortality in censuses. The work was supported by funding from the United States Agency for International Development (USAID) through MEASURE Evaluation (cooperative agreement AID-OAA-L-14-00004). The members of the working group were:

- Liliana Carvajal-Aguirre, of UNICEF
- Doris Chou, of WHO
- Patrick Gerland, of UNPD
- Peter Johnson (retired), Nobuko Mizoguchi and Loraine West (retired) of the United States Census Bureau, USA
- Qingfeng Li, of Johns Hopkins Bloomberg School of Public Health, USA
- Kavita Singh Ongechi, of the University of North Carolina at Chapel Hill, USA.

We are also grateful to the WHO Department of Governing Bodies and External Relations. Country offices for WHO, UNICEF, UNFPA and the World Bank Group are all gratefully acknowledged for facilitating the country consultations.

[1] All lists of names are given in alphabetical order by last name.

Thanks are also due to the following WHO regional office staff:

- Regional Office for Africa: Elongo Lokombe, Triphonie Nkurunziza, Léopold Ouedraogo and Prosper Tumusiime
- Regional Office for the Americas (Pan American Health Organization [PAHO]): Adrienne Lavita Cox, Bremen de Mucio, Patricia Lorena Ruiz Luna, Antonio Sanhueza and Suzanne Serruya
- Regional Office for South-East Asia: C. Anoma Jayathilaka, Mark Landry and Neena Raina
- Regional Office for Europe: Nino Berdzuli, Kristina Mauer-Stender, David Novillo and Claudia Stein
- Regional Office for the Eastern Mediterranean: Karima Gholbzouri, Ramez Khairi Mahaini and Arash Rashidian
- Regional Office for the Western Pacific: Jun Gao, Priya Mannava and Howard Sobel.

In addition, WHO provided translation services for documents disseminated during the country consultations. Thanks to Patricia Lorena Ruiz Luna, Antonio Sanhueza and Rosina Romero, of PAHO, for all their translation support for communications during the country consultations. Thank you to all government technical focal persons for maternal mortality and the Sustainable Development Goal (SDG) focal points who reviewed the preliminary maternal mortality estimates and provided valuable feedback and input.

Financial support was provided by WHO, through the Department of Reproductive Health and Research and HRP (the UNDP-UNFPA-UNICEF-WHO-World Bank Special Programme of Research, Development and Research Training in Human Reproduction), USAID and the University of Massachusetts, Amherst, USA.

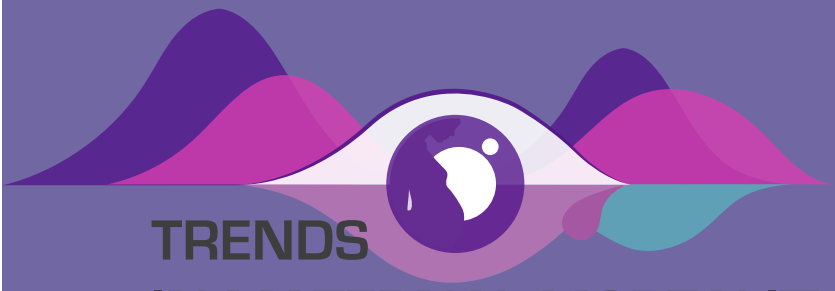
Thanks also go to Alison Gemmill and Kerry Wong for helping with the country profiles; to Jenny Cresswell, Carolin Ekman and Doris Hanappi for helping with data review; to Florence Rusciano for assistance with creation of maps; and to Catherine Hamill, Svetlin Kolev and Christine Meynent for assistance with related webpages. This report was prepared by Doris Chou, Ann-Beth Moller and Lale Say of the WHO Department of Reproductive Health and Research; Leontine Alkema and Emily Peterson of the University of Massachusetts, USA; and Jane Patten of Green Ink, United Kingdom.

For any further information relating to this report, you may contact Doris Chou (email: choud@who.int) and Lale Say (email: sayl@who.int) of the WHO Department of Reproductive Health and Research.

# ACRONYMS AND ABBREVIATIONS

| | |
|---|---|
| **ARR** | annual rate of reduction |
| **ASFR** | age-specific fertility rates |
| **BMat** | Bayesian maternal mortality estimation model |
| **CEMD** | confidential enquiry into maternal deaths |
| **CRVS** | civil registration and vital statistics |
| **DHS** | Demographic and Health Survey |
| **EPMM** | ending preventable maternal mortality |
| **F+/F–** | false positive/false negative |
| **GDP** | gross domestic product per capita based on PPP conversion |
| **GFR** | general fertility rate |
| **ICD** | International statistical classification of diseases and related health problems[2] |
| **ICD-MM** | ICD-maternal mortality (refers to WHO publication: *Application of ICD-10 to deaths during pregnancy, childbirth and the puerperium: ICD-MM)* |
| **MDG** | Millennium Development Goal |
| **MDSR** | maternal death surveillance and response |
| **MICS** | Multiple Indicator Cluster Survey |
| **MMR** | maternal mortality ratio |
| **MMRate** | maternal mortality rate |
| **PM** | proportion maternal (i.e. proportion of deaths among women of reproductive age that are due to maternal causes) |
| **PPP** | purchasing power parity |
| **SBA** | skilled birth attendant |
| **SDG** | Sustainable Development Goal |
| **T+/T–** | true positive/true negative |
| **TAG** | technical advisory group |
| **UI** | uncertainty interval |
| **UNAIDS** | Joint United Nations Programme on HIV/AIDS |
| **UNFPA** | United Nations Population Fund |
| **UNICEF** | United Nations Children's Fund |
| **UN MMEIG** | United Nations Maternal Mortality Estimation Inter-Agency Group |
| **UNPD** | United Nations Population Division (in the Department of Economic and Social Affairs) |
| **WHO** | World Health Organization |

[2] ICD-9, ICD-10 and ICD-11 are all referred to in this document; the numbers indicate the revision (edition) number.



# TRENDS IN MATERIAL MORTALITY

# EXECUTIVE SUMMARY

The Sustainable Development Goals (SDGs) were launched on 25 September 2015 and came into force on 1 January 2016 for the 15-year period until 31 December 2030. Among the 17 SDGs, the direct health-related targets come under **SDG 3: Ensure healthy lives and promote well-being for all at all ages.** With the adoption of the SDGs, the United Nations Member States extended the global commitments they had made in 2000 to the Millennium Development Goals (MDGs), which covered the period until 2015.

In anticipation of the launch of the SDGs, the World Health Organization (WHO) and partners released a consensus statement and full strategy paper on ending preventable maternal mortality (EPMM). The EPMM target for reducing the global maternal mortality ratio (MMR) by 2030 was adopted as **SDG target 3.1: reduce global MMR to less than 70 per 100 000 live births by 2030.**

Having targets for mortality reduction is important, but accurate measurement of maternal mortality remains challenging and many deaths still go uncounted. Many countries still lack well functioning civil registration and vital statistics (CRVS) systems, and where such systems do exist, reporting errors – whether incompleteness (unregistered deaths, also known as "missing") or misclassification of cause of death – continue to pose a major challenge to data accuracy.

## Methods and interpretation

The United Nations Maternal Mortality Estimation Inter-Agency Group (UN MMEIG) – comprising WHO, the United Nations Children's Fund (UNICEF), the United Nations Population Fund (UNFPA), the World Bank Group and the United Nations Population Division (UNPD) of the Department of Economic and Social Affairs – has collaborated with external technical experts on a new round of estimates for 2000–2017. To provide increasingly accurate MMR estimates, the previous estimation methods have been refined to optimize use of country-level data. Consultations with countries were carried out during May and June 2019. This process generated additional data for inclusion in the maternal mortality estimation model, demonstrating widespread expansion of in-country efforts to monitor maternal mortality.

This report presents internationally comparable global, regional and country-level estimates and trends for maternal mortality between 2000 and 2017.[3] Countries and territories included in the analyses are WHO Member States with populations over 100 000, plus two territories (Puerto Rico, and the West Bank and Gaza Strip)[4]. The results described in this report are the first available estimates for maternal mortality in the SDG reporting period; but since two years (2016 and 2017) is not sufficient to show trends, estimates have been developed and presented covering the period 2000 to 2017. The new estimates presented in this report supersede all previously published estimates for years that fall within the same time period. Care should be taken to use only these estimates for the interpretation of trends in maternal mortality from 2000 to 2017; due to modifications in methodology and data availability, differences between these and previous estimates should not be interpreted as representing time trends. In addition, when interpreting changes in MMRs over time, one should take into consideration that it is easier to reduce the MMR when the level is high than when the MMR level is already low. The full database, country profiles and all model specification codes used are available online.[5]

## Global estimates for 2017 and trends for 2000–2017

The global estimates for the year 2017 indicate that there were 295 000 (UI 279 000 to 340 000)[6] maternal deaths; 35% lower than in 2000 when there were an estimated 451 000 (UI 431 000 to 485 000) maternal deaths. The global MMR in 2017 is estimated at 211 (UI 199 to 243) maternal deaths per 100 000 live births, representing a 38% reduction since 2000, when it was estimated at 342. The average annual rate of reduction (ARR) in global MMR during the 2000–2017 period was 2.9%; this means that, on average, the global MMR declined by 2.9% every year between 2000 and 2017. The global lifetime risk of maternal mortality for a 15-year-old girl in 2017 was estimated at 1 in 190; nearly half of the level of risk in 2000: 1 in 100. The overall proportion of deaths to women of reproductive age (15–49 years) that are due to maternal causes (PM) was estimated at 9.2% (UI 8.7% to 10.6%) in 2017 – down by 26.3% since 2000. This means that compared with other causes of death to women of reproductive age, the fraction attributed to maternal causes is decreasing. In addition, the effect of HIV on maternal mortality in 2017 appears to be less pronounced than in earlier years; HIV-related indirect maternal

[3] Estimates have been computed to ensure comparability across countries, thus they are not necessarily the same as official statistics of the countries, which may use alternative rigorous methods.

[4] Puerto Rico is an Associate Member, and the West Bank and Gaza Strip is a member in the regional committee for the WHO Eastern Mediterranean Region.

[5] Available at: www.who.int/reproductivehealth/publications/maternal-mortality-2017/en/

[6] All uncertainty intervals (UIs) reported are 80% UI. The data can be interpreted as meaning that there is an 80% chance that the true value lies within the UI, a 10% chance that the true value lies below the lower limit and a 10% chance that the true value lies above the upper limit.

deaths now account for approximately 1% of all maternal deaths compared with 2.5% in 2005, at the peak of the epidemic.

## Regional and country-level estimates for 2017

MMR in the world's least developed countries (LDCs) is high,[7] estimated at 415 maternal deaths per 100 000 live births (UI 396 to 477), which is more than 40 times higher than that for MMR the in Europe (10; UI 9 to 11), and almost 60 times higher than in Australia and New Zealand (7; UI 6 to 8). In the world's LDCs, where an estimated 130 000 maternal deaths occurred in 2017, the estimated lifetime risk of maternal death was 1 in 56. Sub-Saharan Africa is the only region with very high MMR for 2017, estimated at 542 (UI 498 to 649), while the lifetime risk of maternal death was 1 in 37, compared with just 1 in 7800 in Australia and New Zealand. Moderate MMR (100–299) was estimated in Northern Africa, Oceania (excluding Australia and New Zealand), Southern Asia, South-Eastern Asia and in small island developing states. Four subregions (Australia and New Zealand, Central Asia, Eastern Asia, Western Asia) and two regions (Latin America and the Caribbean, and Europe and Northern America) have low MMR (< 100 maternal deaths per 100 000 live births).

Sub-Saharan Africa and Southern Asia accounted for approximately 86% (254 000) of the estimated global maternal deaths in 2017 with sub-Saharan Africa alone accounting for roughly 66% (196 000), while Southern Asia accounted for nearly 20% (58 000). South-Eastern Asia, in addition, accounted for over 5% of global maternal deaths (16 000).

Three countries are estimated to have had extremely high MMR in 2017 (defined as over 1000 maternal deaths per 100 000 live births): South Sudan (1150; UI 789 to 1710), Chad (1140; UI 847 to 1590) and Sierra Leone (1120; UI 808 to 1620). Sixteen other countries, all also in sub-Saharan Africa except for one (Afghanistan), had very high MMR in 2017 (i.e. estimates ranging between 500 and 999). Only three countries in sub-Saharan Africa had low MMR: Mauritius (61; UI 46 to 85), Cabo Verde (58; UI 45 to 75) and Seychelles (53; UI 26 to 109). Only one country outside the sub-Saharan African region had high MMR: Haiti (480; UI 346 to 718). Ninety countries were estimated to have MMR of 50 or less in 2017.

Nigeria and India had the highest estimated numbers of maternal deaths, accounting for approximately one third (35%) of estimated global maternal deaths in 2017, with approximately 67 000 and 35 000 maternal deaths (23% and 12% of global maternal deaths), respectively. Three other countries also had 10 000 maternal deaths or more: the Democratic Republic of the Congo (16 000), Ethiopia (14 000) and the United Republic of Tanzania (11 000). Sixty-one countries were estimated to have had just 10 or fewer maternal deaths in 2017.

In 2017, according to the Fragile States Index, 15 countries were considered to be "very high alert" or "high alert"[8] (from highest to lowest: South Sudan, Somalia, Central African Republic, Yemen, Syrian Arab Republic, Sudan, the Democratic Republic of the Congo, Chad, Afghanistan, Iraq, Haiti, Guinea,

[7] For the purpose of categorization, MMR is considered to be low if it is less than 100, moderate if it is 100–299, high if it is 300–499, very high if it is 500–999 and extremely high if it is equal to or higher than 1000 maternal deaths per 100 000 live births.

[8] The Fragile States Index is an assessment of 178 countries based on 12 cohesion, economic, social and political indicators, resulting in a score that indicates their susceptibility to instability. Further information about indicators and methodology is available at: https://fragilestatesindex.org/. At the top of the range (most fragile), the scores are categorized as follows: > 110 = very high alert; 100–110 = high alert. These two categories include the 15 most fragile countries mentioned here. There are 10 other categories ranging from "very sustainable" to "alert", which include the remaining 163 countries.

Nigeria, Zimbabwe and Ethiopia), and these 15 countries had MMRs in 2017 ranging from 31 (Syrian Arab Republic) to 1150 (South Sudan).

## Regional and country-level trends, 2000–2017

Between 2000 and 2017, the subregion of Southern Asia achieved the greatest overall percentage reduction in MMR: 59% (from 384 to 157). This equates to an average ARR of 5.3%. Four other subregions roughly halved their MMRs during this period: Central Asia (52%), Eastern Asia (50%), Europe (53%) and Northern Africa (54%). MMR in LDCs also declined by 46%. Despite its very high MMR in 2017, sub-Saharan Africa as a region also achieved a substantial reduction in MMR of roughly 38% since 2000. Notably, one subregion with very low MMR (12) in 2000 – Northern America – had an increase in MMR of almost 52% during this period, rising to 18 in 2017. This is likely related to already low levels of MMR, as well as improvements in data collection, changes in life expectancy and/or changes in disparities between subpopulations.

The greatest declines in proportion of deaths among women of reproductive age that are due to maternal causes (PM) occurred in two regions: Central and Southern Asia (56.4%), and Northern Africa and Western Asia (42.6%). Almost no change was seen in PM in Europe and Northern America.

The 10 countries with the highest MMRs in 2017 (in order from highest to lowest: South Sudan, Chad, Sierra Leone, Nigeria, Central African Republic, Somalia, Mauritania, Guinea-Bissau, Liberia, Afghanistan) all have ARRs between 2000 and 2017 of less than 5%. When comparing the ARRs between the year ranges of 2000–2010 and 2010–2017, these 10 countries have also had stagnant or slowing levels of ARR and therefore remain at greatest risk. The impact of interruptions or loss of quality health services must be considered in crisis and other unstable situations.

Countries that achieved the highest ARRs between 2000 and 2017 (an average ARR of 7% or above), starting with the highest, were Belarus, Kazakhstan, Timor-Leste, Rwanda, Turkmenistan, Mongolia, Angola and Estonia. In considering the uncertainty intervals around their average ARRs, we can only be very sure about this high level of acceleration in Belarus, Kazakhstan, Timor-Leste and Rwanda. In 13 countries, MMR increased in the same period. In considering the uncertainty around the rate and direction of change, we believe there have been true MMR increases in the United States of America and the Dominican Republic. These findings must be considered in context – as many factors may drive positive and negative trends in maternal mortality.

## Conclusions

The SDGs include a direct emphasis on reducing maternal mortality while also highlighting the importance of moving beyond survival. Despite the ambition to end preventable maternal deaths by 2030, the world will fall short of this target by more than 1 million lives with the current pace of progress. There is a continued urgent need for maternal health and survival to remain high on the global health and development agenda; the state of maternal health interacts with and reflects efforts to improve the accessibility and quality of care. The 2018 Declaration of Astana repositioned primary health care as the most (cost) effective and inclusive means of delivering health services to achieve the SDGs. Primary health care is thereby considered the cornerstone for achieving universal health coverage (UHC), which only exists when all people receive the quality health services they need without suffering financial hardship. Health services that are unavailable/inaccessible or of poor quality, however, will not support the achievement of UHC, as

envisioned. Efforts to increase the provision of skilled and competent care to more women, before, during and after childbirth, must also be seen in the context of external forces including but not limited to climate change, migration and humanitarian crises – not only because of the environmental risks presented, but also because of their contribution to health complications.

In addition, governments are called upon to establish well functioning CRVS systems with accurate attribution of cause of death. Improvements in measurement must be driven by action at the country level, with governments creating systems to capture data specific to their information needs; systems that must also meet the standards required for international comparability. Globally, standardized methods for preventing errors in CRVS reporting (i.e. incompleteness and misclassification) should be established to enhance international comparability.

In consideration of the above, it must be noted that this report on the levels and trends of maternal mortality provides just one critical facet of information, which synthesizes and draws from the available data, to assess one aspect of global progress towards achieving global goals for improved health and sustainable development. In the context of efforts to achieve UHC, improving maternal health is critical to fulfilling the aspiration to reach SDG 3. One can only hope that the global community will not be indifferent to the shortfalls that are expected if we cannot improve the current rate of reduction in maternal mortality. Ultimately, we need to expand horizons beyond a sole focus on mortality, to look at the broader aspects – country and regional situations and trends including health systems, UHC, quality of care, morbidity levels and socioeconomic determinants of women's empowerment and education – and ensure that appropriate action is taken to support family planning, healthy pregnancy and safe childbirth.

# 01 TRENDS IN MATERNAL MORTALITY

# INTRODUCTION

The Sustainable Development Goals (SDGs) were launched on 25 September 2015 with the adoption of the General Assembly resolution *Transforming our world: the 2030 Agenda for Sustainable Development (1)*, and they came into force on 1 January 2016 for the 15-year period until 31 December 2030. Among the 17 SDGs, the direct health-related targets come under SDG 3: Ensure healthy lives and promote well-being for all at all ages *(2)*. With the adoption of the SDGs, the United Nations Member States extended the global commitments they had made in 2000 to the Millennium Development Goals (MDGs), which were established after the Millennium Declaration in September 2000, and covered the period until 2015 *(3)*. Among the eight MDGs, MDG 5 was "Improve maternal health", and MDG target 5.A was to reduce the 1990 maternal mortality ratio (MMR) by three quarters by 2015 *(4)*. The previous report, published in November 2015, provided estimates and trends for maternal mortality for the period 1990 to 2015 *(5)*; the estimates reported in this new edition supersede those and all earlier estimates.

In 2014, in anticipation of the launch of the SDGs, the World Health Organization (WHO) released a consensus statement on *Targets and strategies for ending preventable maternal mortality* (EPMM) *(6)*, followed by a full strategy paper in 2015 *(7)*, endorsed

by the United Nations Children's Fund (UNICEF), the United Nations Population Fund (UNFPA), the World Bank Group, the United States Agency for International Development (USAID), and a number of international professional organizations and maternal health programmes. The EPMM target for MMR for 2030 was adopted as the SDG updated MMR target: reduce global MMR to less than 70 by 2030 (SDG target 3.1) *(2,7,8)*. Meeting this target will require average reductions of about three times the annual rate of reduction achieved during the MDG era *(5)* – an enormous challenge. A supplementary national target was also set in the EPMM strategy paper: By 2030, no country should have an MMR greater than 140, a number twice the global target *(7)*. Collective action by all countries will be needed to reduce national MMR levels in order to bring the global MMR down to less than 70 by 2030. Guided by this EPMM and SDG target, countries have been setting their own national targets for 2030, depending on whether their baseline level of MMR in 2010 was greater or less than 420; if greater than 420, their target is to reach MMR of 140 or less by 2030; if less than 420, their target is to reduce MMR by at least two thirds by 2030 *(7)*. Countries are also called upon to achieve equity in MMR for vulnerable populations within each country *(7)*.

A major initiative established to galvanize efforts in the years counting down to the conclusion of the MDGs was the United Nations Secretary-General's Global Strategy for Women's and Children's Health ("the Global Strategy"), launched in 2010 *(9)*. At the end of the MDG era, the Global Strategy was updated to include adolescents; the Global Strategy for Women's, Children's and Adolescents' Health (2016–2030) has as its objectives "survive, thrive and transform" and is aligned with the timeline and priorities of the SDGs *(10)*. In 2016, WHO published the *Indicator and monitoring framework for the Global Strategy for Women's, Children's and Adolescents' Health (2016–2030)*, which is aligned with and builds upon the SDG 3 targets and time frame, and its five key indicators for the "survive" objective are MMR (SDG indicator 3.1.1), under-five mortality rate (SDG indicator 3.2.1), neonatal mortality rate (SDG indicator 3.2.2), stillbirth rate and adolescent mortality rate (the last two are not SDG indicators) *(11)*.

Having targets for mortality reduction is important, but it must be acknowledged that accurate measurement of maternal mortality remains challenging and many deaths still go uncounted. Planning and accountability for improving maternal health, and assessment of SDG target 3.1, require accurate and internationally comparable measures of maternal mortality. Many countries have made notable progress in collecting data through civil registration and vital statistics (CRVS) systems, surveys, censuses and specialized studies over the past decade. This laudable increase in efforts to document maternal deaths provides valuable new data, but the diversity of methods used to assess maternal mortality in the absence of well functioning CRVS systems continues to prevent direct comparisons among the data generated. Further country-driven efforts are still needed to establish and strengthen CRVS systems so that all births, deaths and causes of death are accurately recorded. The updated Global Strategy calls for expansion of CRVS systems to increase access to services and entitlements, and in February 2018, UNICEF and WHO committed to working with governments and partners to strengthen CRVS systems *(12)*. As of March 2018, the World Bank Group reported that over 110 low- and middle-income countries had deficient CRVS systems *(13)*. One of the cross-cutting actions called for in the 2015 EPMM strategy paper was to "Improve metrics, measurement systems and data quality" to ensure that all maternal and newborn deaths are counted: "Counting every maternal and perinatal death through the establishment of effective national surveillance and civil

registration systems in every country … is a priority" *(7)*. As tools for this, the strategy paper pointed to standard definitions for causes of death available in the current *International statistical classification of diseases and related health problems* (ICD) manual along with guidance in *The WHO application of ICD-10 to deaths during pregnancy, childbirth and puerperium: ICD-MM (14)*, as well as use of maternal death surveillance and response (MDSR) systems, perinatal death surveillance, confidential enquiries into maternal deaths (CEMD), and other sources of data. However, many countries still lack functional CRVS systems, and where such systems do exist, reporting errors – whether incompleteness (i.e. unregistered deaths, which are also known as "missing") or misclassification of cause of death – continue to pose a major challenge to data accuracy *(15)*.

The United Nations Maternal Mortality Estimation Inter-Agency Group (UN MMEIG) – comprising WHO, UNICEF, UNFPA, the World Bank Group and the United Nations Population Division (UNPD) of the Department of Economic and Social Affairs – has collaborated with external technical experts on a new round of country-level estimates of maternal mortality between 2000 and 2017. An independent technical advisory group (TAG), composed of demographers, epidemiologists and statisticians, provides technical advice. The estimates for 2000–2017 presented in this report are the ninth in a series of analyses by WHO, UNICEF and other United Nations partner agencies to examine global, regional and country progress in reducing maternal mortality *(5, 16–22)*. To provide increasingly accurate estimates of MMR, the previous estimation methods have been refined to optimize use of country-level data.

Consultations with countries were carried out during May and June 2019, following the development of preliminary MMR estimates for the years 2000–2017. WHO Member States that nominated technical focal persons for maternal mortality or that had existing SDG focal points were provided with estimates for their country and a detailed description of the UN MMEIG processes and methods for estimating levels and trends of maternal mortality. These consultations gave countries the opportunity to review the draft country estimates, data sources and methods; to provide the UN MMEIG with additional primary data sources that may not have been previously reported or used in the analyses; to build shared understanding of the strengths and weaknesses of the available data and the estimation process; and to establish a broad sense of ownership of the results. These country consultations generated additional data for inclusion in the estimation model, demonstrating widespread expansion of in-country efforts to monitor maternal mortality. Annex 1 presents a summary of the process and results of the country consultations.

This report presents global, regional and country-level estimates and trends for maternal mortality between 2000 and 2017. Chapter 2 provides the definitions of key terms and describes the key measures relevant to maternal mortality. Chapter 3 describes in detail the methodology employed to develop the estimates. Chapter 4 presents the estimates and trends at the global, regional and country levels. Chapter 5 assesses performance so far towards SDG target 3.1, discusses the implications of the estimates for future efforts towards achieving the target, and underlines the importance of improved data quality for estimating maternal mortality. Chapter 6 presents conclusions. The first four annexes to this report describe the country consultation process, present an overview of the common approaches for measuring maternal mortality, describe the methods used to derive a complete series of annual estimates for each predictor variable, and to calculate maternal mortality during crisis years. Finally,

Annexes 5–17 present the MMR estimates and trends for the different regional groupings for SDG reporting and for WHO, UNICEF, UNFPA, the World Bank Group and UNPD, as well as the country-level estimates and trends.

## References


1. Transforming our world: the 2030 Agenda for Sustainable Development 2015. Resolution adopted by the General Assembly on 25 September 2015. United Nations General Assembly, Seventieth session. New York (NY): United Nations; 2015 (A/RES/70/1; http://www.un.org/ga/search/view_doc.asp?symbol=A/RES/70/1, accessed 28 May 2019).

2. Sustainable Development Goal 3. In: Sustainable Development Goals Knowledge Platform [website]. New York (NY): United Nations; 2019 (https://sustainabledevelopment.un.org/SDG3, accessed 10 June 2019).

3. Conferences, meetings and events: Millennium Summit (6–8 September 2000). In: United Nations [website]. New York (NY): United Nations; undated (https://www.un.org/en/events/pastevents/millennium_summit.shtml, accessed 5 June 2019).

4. Goal 5: Improve maternal health. In: United Nations [website]. undated (https://www.un.org/millenniumgoals/maternal.shtml, accessed 5 June 2019).

5. World Health Organization (WHO), United Nations Children's Fund (UNICEF), United Nations Population Fund (UNFPA), World Bank Group, United Nations Population Division. Trends in maternal mortality: 1990 to 2015: estimates by WHO, UNICEF, UNFPA, World Bank Group and the United Nations Population Division. Geneva: World Health Organization; 2015 (https://www.who.int/reproductivehealth/publications/monitoring/maternal-mortality-2015/en/, accessed 4 September 2019).

6. Targets and strategies for ending preventable maternal mortality: consensus statement. Geneva: World Health Organization; 2014 (https://www.who.int/reproductivehealth/publications/maternal_perinatal_health/consensus-statement/en/, accessed 5 June 2019).

7. Strategies towards ending preventable maternal mortality (EPMM). Geneva: World Health Organization; 2015 (http://www.everywomaneverychild.org/images/EPMM_final_report_2015.pdf, accessed 5 November 2015).

8. Boldosser-Boesch A, Brun M, Carvajal L, Chou D, de Bernis L, Fogg K, et al. Setting maternal mortality targets for the SDGs. Lancet. 2017;389(10070):696-697. doi:10.1016/S0140-6736(17)30337-9.

9. Ki-moon B. Global strategy for women's and children's health. New York (NY): United Nations; 2010 (http://www.who.int/pmnch/knowledge/publications/fulldocument_globalstrategy/en/, accessed 3 December 2015).

10. Global strategy for women's, children's and adolescents' health (2016–2030). New York (NY): Every Woman Every Child; 2015 (http://globalstrategy.everywomaneverychild.org/, accessed 10 June 2019).

11. Indicator and monitoring framework for the Global Strategy for Women's, Children's and Adolescents' Health (2016–2030). Geneva: World Health Organization; 2016 (http://www.who.int/life-course/publications/gs-Indicator-and-monitoring-framework.pdf, accessed 25 July 2019).

12. The future for women and children: UNICEF and WHO joint statement on strengthening civil registration and vital statistics (CRVS). New York (NY) and Geneva: United Nations Children's Fund and World Health Organization; 2018 (https://www.who.int/healthinfo/civil_registration/WHO_UNICEF_Statement_CRVS_2018.pdf, accessed 29 August 2019).

13. Global civil registration and vital statistics: about CRVS. In: World Bank: Brief [website]. The World Bank Group; 2018 (https://www.worldbank.org/en/topic/health/brief/global-civil-registration-and-vital-statistics, accessed 29 August 2019).

14. The WHO application of ICD-10 to deaths during pregnancy, childbirth and puerperium: ICD-MM. Geneva: World Health Organization; 2012 (https://www.who.int/reproductivehealth/publications/monitoring/9789241548458/en/, accessed 5 June 2019).

15. World Bank Group, World Health Organization. Global civil registration and vital statistics: scaling up investment plan 2015–2024. Geneva: World Health Organization; 2014 (https://www.who.int/healthinfo/civil_registration/WB-WHO_ScalingUp_InvestmentPlan_2015_2024.pdf, accessed 5 June 2019).

16. World Health Organization (WHO) Maternal Health and Safe Motherhood Programme, United Nations Children's Fund (UNICEF). Revised 1990 estimates of maternal mortality: a new approach by WHO and UNICEF. Geneva: WHO; 1996 (http://apps.who.int/iris/bitstream/10665/63597/1/WHO_FRH_MSM_96.11.pdf, accessed 28 May 2019).

17. World Health Organization (WHO), United Nations Children's Fund (UNICEF), United Nations Population Fund (UNFPA). Maternal mortality in 1995: estimates developed by WHO, UNICEF and UNFPA. Geneva: World Health Organization; 2001 (https://apps.who.int/iris/handle/10665/66837, accessed 28 May 2019).

18. World Health Organization (WHO), United Nations Children's Fund (UNICEF), United Nations Population Fund (UNFPA). Maternal mortality in 2000: estimates developed by WHO, UNICEF and UNFPA. Geneva: World Health Organization; 2004 (http://apps.who.int/iris/bitstream/10665/68382/1/a81531.pdf, accessed 5 November 2015).

19. World Health Organization (WHO), United Nations Children's Fund (UNICEF), United Nations Population Fund (UNFPA), World Bank. Maternal mortality in 2005: estimates developed by WHO, UNICEF, UNFPA and the World Bank. Geneva: WHO; 2007 (https://www.who.int/whosis/mme_2005.pdf, accessed 28 May 2019).

20. World Health Organization (WHO), United Nations Children's Fund (UNICEF), United Nations Population Fund (UNFPA), World Bank. Trends in maternal mortality: 1990 to 2008: estimates developed by WHO, UNICEF, UNFPA and the World Bank. Geneva: WHO; 2010 (https://apps.who.int/iris/bitstream/handle/10665/44423/9789241500265_eng.pdf, accessed 28 May 2019).

21. World Health Organization (WHO), United Nations Children's Fund (UNICEF), United Nations Population Fund (UNFPA), World Bank. Trends in maternal mortality: 1990 to 2010: WHO, UNICEF, UNFPA and the World Bank estimates. Geneva: WHO; 2012 (http://apps.who.int/iris/bitstream/10665/44874/1/9789241503631_eng.pdf, accessed 28 May 2019).

22. World Health Organization (WHO), United Nations Children's Fund (UNICEF), United Nations Population Fund (UNFPA), World Bank, United Nations Population Division. Trends in maternal mortality: 1990 to 2013: estimates by WHO, UNICEF, UNFPA, the World Bank and the United Nations Population Division. Geneva: WHO; 2014 (http://apps.who.int/iris/bitstream/10665/112682/2/9789241507226_eng.pdf, accessed 28 May 2019).

02

# TRENDS IN MATERNAL MORTALITY

# DEFINITIONS AND MEASURES

CONTENT

## 2.1 Definitions for key terms used in this report

In the *International statistical classification of diseases and related health problems* (ICD)[9] *(1)*, WHO defines **maternal death** as:

the death of a woman while pregnant or within 42 days of termination of pregnancy, irrespective of the duration and site of the pregnancy, from any cause related to or aggravated by the pregnancy or its management but not from unintentional or incidental causes.[10]

This definition allows identification of a maternal death, based on the cause of the death being identified as either a direct or indirect maternal cause.

**Direct obstetric deaths (or direct maternal deaths)** are those "resulting from obstetric complications of the pregnant state (pregnancy, labour and puerperium), and from interventions, omissions, incorrect treatment, or from a chain of events resulting from any of the above" *(1)*. Deaths due to obstetric haemorrhage or hypertensive disorders in pregnancy, for example, or those due to complications of anaesthesia or caesarean section are classified as direct maternal deaths.

**Indirect obstetric deaths (or indirect maternal deaths)** are those maternal deaths "resulting from previous existing disease or disease that developed during pregnancy and not due to direct obstetric causes but were aggravated by the physiologic effects of pregnancy" *(1)*. For example, deaths due to aggravation (by pregnancy) of an existing cardiac or renal disease are considered indirect maternal deaths.

**A late maternal death** is "the death of a woman from direct or indirect obstetric causes, more than 42 days but less than one year after termination of pregnancy" *(1)*. Like maternal deaths, late maternal deaths also include both direct and indirect maternal/obstetric deaths. Complications of pregnancy or childbirth can lead to death beyond the six-week (42-day) postpartum period, and the increased availability of modern life-sustaining procedures and technologies enables more women to survive adverse outcomes of pregnancy and delivery, and also delays some deaths beyond that postpartum period. Specific codes for "late maternal deaths" are included in the ICD-10 (O96 and O97) to capture these delayed maternal deaths, which may not be categorized as maternal deaths in CRVS systems despite being caused by pregnancy-related events *(2)*.

Maternal deaths and late maternal deaths are combined in the 11th revision of the ICD under the new grouping of **"comprehensive maternal deaths"** *(1)*.

**A death occurring during pregnancy, childbirth and puerperium** (also known as a **pregnancy-related death**) is defined as: "the death of a woman while pregnant or within 42 days of termination of pregnancy, irrespective of the cause of death (obstetric and non-obstetric)" *(1)*; this definition includes unintentional/accidental and incidental causes. This definition allows measurement of deaths that occur during pregnancy, childbirth and puerperium while acknowledging that such measurements do not strictly conform

[9] ICD-11 (the 11th revision of the ICD) was adopted by the World Health Assembly in May 2019 and comes into effect on 1 January 2022. Further information is available at: www.who.int/classifications/icd/en/. The coding rules related to maternal mortality are being edited to fully match the new structure of ICD-11, but without changing the resulting statistics. At the time of this writing, therefore, information about ICD codes relates to ICD-10 (the 10th revision of the ICD) *(2)*. The ICD-11 rules can be accessed in the reference guide of ICD-11, at https://icd.who.int.

[10] Care has been taken to ensure that the definition of maternal death used for international comparison of mortality statistics remains stable over time, but the word "unintentional" has been used in the ICD-11 definition *(1)* in place of the word "accidental" which was previously used, in ICD-10 *(2)*.

to the standard "maternal death" concept in settings where accurate information about causes of death based on medical certification is unavailable. For instance, in maternal mortality surveys (such as those employing the sisterhood method), relatives of a woman of reproductive age who has died are asked about her pregnancy status at the time of death without eliciting any further information on the cause or circumstances of the death. These surveys usually measure deaths to women during pregnancy, childbirth and puerperium (pregnancy-related deaths) rather than maternal deaths.

**HIV-related indirect maternal deaths** are deaths to HIV-positive women caused by the aggravating effect(s) of pregnancy on HIV; where the interaction between pregnancy and HIV becomes the underlying cause of death, these are counted as indirect maternal deaths. There is an ICD code – O98.7 (HIV disease complicating pregnancy, childbirth and the puerperium) – for identifying HIV-related indirect maternal deaths.[11]

**Incidental HIV deaths** are deaths caused by HIV/AIDS which occur to women who happen to be pregnant, in labour or postpartum (also defined as "HIV-related deaths to women during pregnancy, delivery or puerperium" *[3]*); these are not maternal deaths and would not be included in the calculation of MMR.

All the types and definitions of deaths described above (as used in this report) are summarized in Table 2.1.

## 2.2 Measures of maternal mortality used in this report

As indicated in the ICD-11 (and previously in the ICD-10), only maternal deaths occurring up to 42 days postpartum are considered relevant for the purposes of international reporting and for the calculation of maternal mortality ratios and rates (i.e. excluding late maternal deaths).[12,13]

**The number of maternal deaths** in a population (during a specified time period, usually one calendar year) reflects two factors: (i) the risk of mortality associated with a single pregnancy or a single birth (whether live birth or stillbirth); and (ii) the fertility level (i.e. the number of pregnancies or births that are experienced by women of reproductive age, i.e. age 15–49 years).

The **maternal mortality ratio (MMR)** is defined as the number of maternal deaths during a given time period per 100 000 live births during the same time period; thus, it quantifies the risk of maternal death relative to the number of live births, and essentially captures the first factor mentioned above.

By contrast, the **maternal mortality rate (MMRate)** is defined and calculated as the number of maternal deaths divided by person-years lived by women of reproductive age in a population. The MMRate captures both the risk of maternal death per pregnancy or per birth (whether live birth or stillbirth), and the level of fertility in the population (i.e. both factors mentioned above).

In addition, it is possible to calculate the **adult lifetime risk of maternal death** for women in the population, defined as the probability that a 15-year-old girl (in the year of the estimate) will eventually die from a maternal cause. This indicator takes into account competing causes

[11] Search for O98.7 at the current (2016) version of ICD-10: https://icd.who.int/browse10/2016/en.

[12] ICD-11, Part 2, section 2.28.5.7: "International reporting of maternal mortality: For the purpose of the international reporting of maternal mortality, only those maternal deaths occurring before the end of the 42-day reference period should be included in the calculation of the various ratios and rates, although the recording of later deaths is useful for national analytical purposes" *(1)*.

[13] Late maternal deaths coded to O96 (late maternal deaths) and O97 (late maternal deaths due to sequalae of complications) are also of interest for national- and international-level analysis, but are not reported in this publication.

**Table 2.1. Types and definitions of deaths occurring during pregnancy, childbirth and puerperium (also known as "pregnancy-related deaths")**

| | Maternal deaths | Non-maternal deaths |
|---|---|---|
| **Non-HIV-related deaths** (the woman may or may not have had HIV) | **Non-HIV-related maternal deaths:**<br>• **Maternal death** – *the death of a woman while pregnant or within 42 days of termination of pregnancy, irrespective of the duration and site of the pregnancy, from any cause related to or aggravated by the pregnancy or its management but not from unintentional or incidental causes*<br>— **Direct obstetric/maternal deaths** – *deaths resulting from complications of pregnancy/delivery/postpartum (up to 42 days), from interventions, omissions or incorrect treatment, or from a chain of events resulting from any of the above*<br>— **Indirect obstetric/maternal deaths** – *deaths due to a disease (other than HIV) aggravated by the effects of pregnancy*<br>• **Late maternal deaths** – *direct or indirect maternal deaths occurring from 42 days to 1 year after termination of pregnancy* | **Non-HIV-related, non-maternal deaths** – *deaths to pregnant and postpartum women from unintentional/accidental or incidental causes other than HIV* |
| **HIV-related deaths** (the woman was known to have had HIV) | **HIV-related maternal deaths:**<br>• **HIV-related indirect maternal deaths** – *deaths to HIV-positive women caused by the aggravating effects of pregnancy on HIV*<br>• **HIV-related indirect late maternal deaths** – *deaths to HIV-positive women 42 days to 1 year after termination of pregnancy, caused by the aggravating effects of pregnancy on HIV* | **HIV-related, non-maternal deaths:**<br>• **Incidental HIV deaths** – *deaths caused by HIV/AIDS which occur to women who happen to be pregnant, in labour or postpartum* |

of death *(4)*. The formula for calculating this measure is given in Chapter 3, section 3.3.3.

An alternative measure of maternal mortality, **the proportion maternal (PM)**, is the proportion of deaths among women of reproductive age that are due to maternal causes; PM is calculated as the number of maternal deaths in a given time period divided by the total deaths among women aged 15–49 years in that time period. Although by definition PM refers strictly to maternal deaths (and the estimation model described in Chapter 3 is based on this definition), some observed (documented) PMs actually use a "pregnancy-related" definition (and not all pregnancy-related deaths are maternal deaths, as defined in section 2.1 above), such that the model has to account for the difference in definitions (see Chapter 3, section 3.3.2: BMat model).

For further information on ICD coding and approaches to measuring maternal mortality, see Annex 2.

## Box A2.1. STATISTICAL MEASURES OF MATERNAL MORTALITY

**Maternal mortality ratio (MMR):**

Number of maternal deaths during a given time period per 100 000 live births during the same time period *(5)*.

**Maternal mortality rate (MMRate):**

Number of maternal deaths during a given time period divided by person-years lived by women of reproductive age (age 15–49 years) in a population during the same time period *(6)*.

**Adult lifetime risk of maternal death:**

The probability that a 15-year-old woman will eventually die from a maternal cause *(4)*.

**The proportion of deaths among women of reproductive age that are due to maternal causes (proportion maternal; PM):**

The number of maternal deaths divided by the total deaths among women aged 15–49 years *(5)*.

## References


1. 2.28.5 Standards and reporting requirements related for maternal mortality. In: ICD-11 Reference guide, Part 2. Geneva: World Health Organization; 2019 (https://icd.who.int/icd11refguide/en/index.html#2.28.5StandardsMarternalMortaltiy|standards-and-reporting-requirements-related-for-maternal-mortality|c2-28-5, accessed 12 July 2019).

2. International statistical classification of diseases and related health problems, 10th revision. Volume 2: Instruction manual. Geneva; World Health Organization; 2010 (https://www.who.int/classifications/icd/ICD10Volume2_en_2010.pdf, accessed 10 June 2019).

3. The WHO application of ICD-10 to deaths during pregnancy, childbirth and puerperium: ICD-MM. Geneva: World Health Organization; 2012 (https://www.who.int/reproductivehealth/publications/monitoring/9789241548458/en/, accessed 4 September 2019).

4. Wilmoth J. The lifetime risk of maternal mortality: concept and measurement. Bull World Health Organ. 2009;87:256-62. doi:10.2471/BLT.07.048280.

5. World Health Organization (WHO), United Nations Children's Fund (UNICEF), United Nations Population Fund (UNFPA), World Bank Group, United Nations Population Division. Trends in maternal mortality: 1990 to 2015: estimates by WHO, UNICEF, UNFPA, World Bank Group and the United Nations Population Division. Geneva: WHO; 2015 (https://www.who.int/reproductivehealth/publications/monitoring/maternal-mortality-2015/en/, accessed 4 September 2019).

6. Wilmoth J, Mizoguchi N, Oestergaard M, Say L, Mathers C, Zureick-Brown S, et al. A new method for deriving global estimates of maternal mortality. Stat Politics Policy. 2012;3(2):2151-7509.1038.

# 03 TRENDS IN MATERNAL MORTALITY METHODS

CONTENT



Previously, in 2010, 2012, 2014 and 2015, the United Nations Maternal Mortality Estimation Inter-Agency Group (UN MMEIG) published reports on maternal mortality trends (including data up to 2008, 2010, 2013 and 2015, respectively) with advice from an external technical advisory group (TAG) *(1–4)*. The methods described here for developing estimates of levels and trends of maternal mortality between 2000 and 2017 build upon the methods used in those previous rounds *(5,6,7)*. The key change to the estimation methodology and resulting estimates in this round is described in section 3.3 (Statistical methods) and concerns the adjustment of data from countries' civil registration and vital statistics (CRVS) systems (section 3.3.1). CRVS data have been adjusted in previous rounds to account for unregistered and/or misclassified maternal deaths (see definitions in Box 3.1). The UN MMEIG has considered concerns from Member States about how this adjustment was calculated, and how it may or may not have reflected improvements in data collection and data quality related to maternal mortality over time.

Combined with the updated global maternal mortality database,[14] the UN MMEIG Bayesian

[14] WHO Mortality Database: https://www.who.int/healthinfo/mortality_data/en/ (select indicator for "pregnancy, childbirth and the puerperium").

## Box 3.1. DEFINITIONS OF INCOMPLETENESS (UNREGISTERED) AND MISCLASSIFICATION OF MATERNAL DEATHS*

### Incompleteness

Incompleteness refers to unregistered deaths (also known as "missing") – i.e. deaths not registered in the CRVS system – resulting in an incomplete CRVS system. This can arise due to both incomplete identification/registration of individual deaths in each country and incomplete coverage of the national CRVS system within each country.

*We distinguish between non-maternal deaths not registered in the CRVS system (U–), and maternal deaths not registered in the CRVS system (U+) (see section 3.3.1.a).*

### Misclassification

Misclassification refers to incorrect coding of deaths registered within the CRVS system, due either to error in the medical certification of cause of death or error in applying the ICD code.

*We distinguish between maternal deaths incorrectly classified as non-maternal deaths (false negatives; F–), and non-maternal deaths incorrectly classified as maternal deaths (false positives, F+) (see section 3.3.1.a).*

* Incompleteness and misclassification are often referred to collectively or individually as "underreporting", but we suggest not to use this term and instead to be clear about exactly which issue is being referred to, whether incompleteness (unregistered), misclassification, or both.

maternal mortality estimation (BMat) model (see section 3.3.2) provides the most up-to-date maternal mortality estimates yet for the entire 2000–2017 timespan. These results supersede all previously published estimates for years within that time period, and due to modifications in methodology and data availability, differences between these and previous estimates should not be interpreted as representing time trends. The full database, country profiles and all model specification codes used are available online.[15]

## 3.1 Data inputs for the estimation process

### 3.1.1 Data sources

Maternal mortality ratio (MMR) estimates are based on a variety of data sources – including data from CRVS systems, which are the preferred data source (considered to be the gold standard for mortality data), population-based household surveys using the sisterhood method, reproductive-age mortality studies (RAMOS), confidential enquires into maternal deaths (CEMD), verbal autopsies, censuses and other specialized maternal mortality studies conducted at the national level. What is needed for the country-level estimates is a robust, accurate, nationally

[15] Available at: www.who.int/reproductivehealth/publications/maternal-mortality-2017/en/.

representative data source, for which there is clear information about the data collection and checking methods; this data source may or may not be the national CRVS system. The UN MMEIG global maternal mortality estimation input database has been updated since the last round of estimates in 2015. The new draft estimates were shared with countries during the 2019 country consultation period May–June 2019 (see Annex 1), after which the estimates and the database were updated again in July 2019 prior to the final run of the UN MMEIG BMat model.

**a. Civil registration and vital statistics (CRVS)**

For countries that routinely register deaths and apply the medical certificate of cause of death (MCCD), maternal deaths may be incorrectly reported due to unregistered deaths and/or deaths that are misclassified in terms of ICD coding. To account for potential unregistered deaths as well as misclassification in CRVS data, an adjustment is calculated for each CRVS input data point (see section 3.3.1) before it is included in the BMat model (see section 3.3.2).

For each country with CRVS data, the level of completeness of the CRVS, in terms of registration of all deaths to females of reproductive age (i.e. fewer unregistered deaths means the CRVS data are more complete), is estimated as follows.

- We calculate the annual ratio of female deaths reported in the CRVS system divided by female deaths estimated by WHO for all years with CRVS data, based on a moving window of five-year periods (five-year periods are used to obtain smoothed estimates of completeness) *(8)*.
- If the ratio (in particular, the upper bound of the 80% uncertainty interval on the ratio) is greater than 0.95 for all years with CRVS data, we assume that the CRVS is complete in the country.
- If the ratio is less than 0.95 for one or more years, the completeness is given by the ratio for each individual year.
- After obtaining an estimate of completeness, we combine this estimate with the proportion of deaths that have been assigned to an ill defined code. We exclude observations for which the estimated percentage of deaths that are assigned to a well defined code is lower than 60%. In other words, if completeness proportion*(1 – proportion ill defined)*100% >60%, the observation is included *(4)*.

**b. Specialized studies on maternal mortality**

Over recent decades, efforts have been undertaken in certain settings to measure maternal mortality using CRVS data in combination with further data collection on maternal deaths, sometimes also enhancing the quality of the CRVS systems. In some cases, a specialized study is conducted for the purpose of assessing the extent of misclassification within the CRVS system (i.e. independent assessment of cause of death classification among the deaths that were registered as maternal deaths – to check if they are “true positives” – and among other registered deaths to women of reproductive age that were not registered as maternal deaths but which might have been “false negatives”). CEMD is an example of a method used for these types of studies. In other cases, a specialized study is conducted to assess the extent of “missingness” of maternal deaths in the CRVS system, by using other methods to document additional unregistered maternal deaths that have occurred in a specified geographic area (e.g. RAMOS).

These data sources typically expand the scope of their reviews to the entire number of deaths among women of reproductive age (15–49 years) in a country and triangulate information from sources including, but not

limited to: medical/hospital records, police records, surveillance systems, national registries, death certificates, census, medical autopsy, and administrative reviews between national statistical offices and ministries of health. The information reported by these specialized studies varies greatly, and includes any combination of the following: total number of deaths to women of reproductive age and/or total number of maternal deaths; all causes of death correctly documented among all women of reproductive age and/or all causes of maternal deaths; unregistered deaths to women of reproductive age and/or unregistered maternal deaths. In these situations, it is agreed that no adjustment factor needs to be applied, and so observations from specialized studies are included in the BMat model (see section 3.3.2) without adjustment.

**c. Other data sources for maternal mortality**

Other available data sources include data from surveillance sites or systems, population-based surveys and censuses. From these data sources, for the purposes of estimation, the observed proportion of maternal deaths (PM) among all deaths to women aged 15–49 years was taken as the preferred indicator for use in estimating maternal mortality.

The PM is preferred over observed MMRs or other summary outcomes because it is less affected by unregistered deaths: deaths to women aged 15–49 that are unregistered would potentially affect the numerator and the denominator of the PM proportionately if causes of death are not unregistered differentially. Therefore, in processing data related to maternal mortality, observed PMs took priority over observed MMRs, and for each observed PM, the corresponding MMR is calculated based on the United Nations Population Division (UNPD) estimates of live births *(9)* and all-cause deaths among females aged 15–49 (WHO estimates) *(8)* for the respective country-period. If only the MMR was available from the data source, the observed MMR was converted into a PM, again using estimates of all-cause deaths among females aged 15–49 and live births. An upward adjustment of 10% was applied to all observations that were not obtained from CRVS or specialized studies, to account for deaths early in pregnancy that might not have been captured *(4)*.

The available data sources provide calculated PMs according to two definitions: "maternal" or "pregnancy-related" deaths (see Chapter 2). PMs for pregnancy-related deaths excluding accidents were taken as measures of maternal PM without further adjustment. Based on an analysis of measured levels of maternal versus pregnancy-related death from sources where both quantities were reported, and of injury death rates among women of reproductive age using WHO estimates of cause-specific mortality for Member States, the UN MMEIG/TAG agreed to estimate "maternal" deaths from the PM for "pregnancy-related" deaths, based on assumptions that incidental or accidental deaths (i.e. not maternal deaths) comprise 10% of pregnancy-related deaths (excluding HIV-related deaths) in sub-Saharan African countries, and 15% in other low- and middle-income countries *(1)*.

Table 3.1 gives an overview of data used to produce maternal mortality estimates. Further information about sources of maternal mortality data is provided in Annex 2.

### 3.1.2 Uncertainty associated with observations and adjustments

All observed death counts and PMs are subject to random error, in the form of sampling error (for PMs obtained from surveys), stochastic error (for PMs obtained from a small number of deaths) and/or non-sampling error (i.e. random errors that may occur at any point during the data-collection process).

**Table 3.1. Maternal mortality data records by source type used in generating the 2000–2017 estimates for maternal mortality**

| Source type | Number of records | Number of country-years |
|---|---|---|
| Civil registration and vital statistics (CRVS) | 2204 | 2204 |
| Specialized studies on maternal mortality | 376 | 534 |
| Other sources – reporting on maternal mortality | 188 | 216 |
| Other sources – reporting on pregnancy-related mortality | 207 | 1169 |
| All | 2975 | 4123[a] |

[a] The sum of country-years of data has been rounded.

To account for the uncertainty associated with these errors, and thus the uncertainty associated with the PM, error variances were calculated. For observations from CRVS or confidential enquiries, stochastic error variances were obtained, which quantify the uncertainty associated with the true risk of a maternal death, based on the available data. For observed PMs from surveys and other maternal mortality studies, the error variance was a combination of the sampling variance associated with the survey and an additional non-sampling error. The non-sampling error was estimated based on the UN MMEIG maternal mortality database *(5)*. For all observed PMs, the error variances were taken into account when obtaining PM and thus MMR estimates: observations with smaller error variances are more informative of the true PM and will thus carry a greater weight in determining the estimates compared with observations with larger error variances. Additionally, uncertainty associated with adjustments (e.g. the CRVS adjustment as per the new approach described in section 3.3.1, and adjustment of observations which report "pregnancy-related" deaths) was accounted for. Lastly, uncertainty due to capturing only a subset of all deaths was accounted for with regard to data from incomplete CRVS systems, and specialized studies with study populations that were limited to a subset of all-cause deaths.

The WHO life tables *(8)* include "mortality shocks". Annex 3 describes how these are dealt with in the context of maternal mortality.

## 3.2. Other data inputs to the model

### 3.2.1 Data on all deaths to women aged 15–49 years and HIV-related mortality

We used a set of consistent external estimates for deaths due to HIV from the Joint United Nations Programme on HIV/AIDS (UNAIDS) *(10)* and estimates for deaths among females aged 15–49 years from WHO life tables *(8)*. These agencies revise their estimates on a regular basis to take into account new data and improved methods. Any comments regarding these input indicators should be addressed to the respective agencies.[16]

[16] For UNAIDS mortality estimates: aidsinfo@unaids.org; for WHO life tables: healthstat@who.int.

### 3.2.2 Live births data

For the preliminary MMR estimates shared during the 2019 country consultations, inputs for live births were taken from the UNPD's 2019 revision of World population prospects *(9)*. In this publication, the UNPD produced estimates of population and related indicators (e.g. births and deaths) for countries or areas, covering five-year periods from 1950–1955 through to 2010–2015, as well as projections covering five-year periods from 2015–2020 through to 2095–2100. For countries with well functioning CRVS systems, UNPD used data on births by age of the mother together with population data by age and sex from censuses and official statistics to estimate age-specific fertility rates (ASFR) for each historical and future five-year period. The population estimation and projection procedure used the ASFR and other inputs such as age- and sex-specific mortality rates to generate a consistent time series of population size, age distribution, and the demographic components of population change (births, deaths and migration). Annual estimates of births are obtained by interpolating the five-year estimates of the number of births output, using the population estimation and projection procedure. As a result, the annually interpolated national estimates do not necessarily match the annual numbers of births reported in the individual countries' CRVS systems.[17]

### 3.2.3 Predictor variables in the maternal mortality model

The predictor variables used in the BMat model fall into three categories: indicators of socioeconomic development, measures of fertility and process variables. In the final model, the gross domestic product per capita (GDP) represents socioeconomic development, fertility is measured by the general fertility rate (GFR), and the proportion of live births with a skilled birth attendant (SBA) at the time of delivery serves as a direct measure of the conditions under which births occur in a given population *(6)*.

Time series of annual estimates for the following three predictor variables (covariates) were constructed from 1990 to 2017.

- Gross domestic product (GDP) per capita, measured in purchasing power parity (PPP) equivalent US dollars using 2011 as the baseline, was generated based on data from the World Bank Group *(11)*.
- General fertility rate (GFR) was computed from data on live births and population size (number of women aged 15–49) from UNPD's 2019 revision of *World population prospects (9)*.
- Skilled birth attendant (SBA) data consist of time series derived using all available data from population-based national household survey data and countries' routine reporting mechanisms (WHO and UNICEF Joint Skilled Birth Attendant database *[12]*).

For further details related to the predictor variables, please refer to Annex 4.

## 3.3. Statistical methods

We use two models, for different purposes.

1. **The CRVS model:** For countries that have a CRVS system, we use a Bayesian CRVS adjustment model to account for errors in reporting of maternal death in the CRVS to obtain the CRVS adjustment factors.

2. **The BMat model:** For all countries, we use a Bayesian maternal mortality estimation model to estimate the MMR for each country-year of interest.

To estimate MMR for country-years, we first use the CRVS model to obtain the CRVS adjustment factors. These adjustment factors

[17] Any comments regarding the estimates of live births from UNPD should be addressed to: population@un.org.

are then applied in the BMat model to estimate the MMR for each country-year of interest (see Figure 3.1). The CRVS model is described in section 3.3.1, followed by the description of the BMat model in section 3.3.2.

### 3.3.1 Bayesian CRVS adjustment model to account for errors in reporting of maternal death in the CRVS system (the CRVS model)

Relying on maternal deaths as reported in the CRVS system means there is a potential for error due to unregistered maternal deaths and/or misclassification of the cause of death within the CRVS system. Therefore, an adjustment factor is obtained for CRVS data before it is included in the BMat model (section 3.3.2).

This section explains:

a. Types of reporting errors encountered in CRVS systems

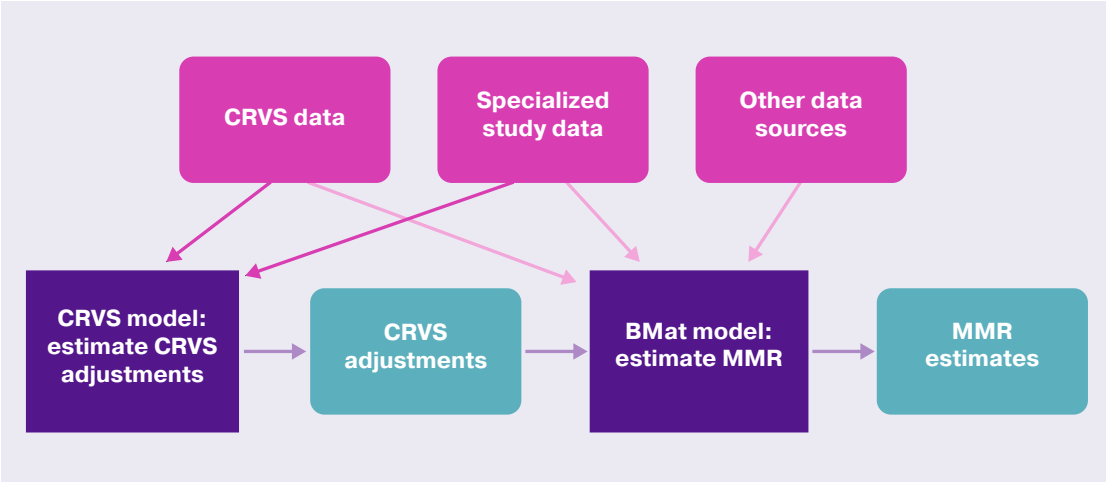
b. Summary metrics for reporting errors

c. Deriving sensitivity, specificity and CRVS adjustments from the CRVS model

d. Comparison with previous UN MMEIG approach to estimate CRVS adjustment factors.

The model used to estimate the CRVS data-quality parameters, and corresponding adjustment factors for CRVS data in BMat are summarized here below (subsections a–d) and described in detail in a separate publication by Peterson et al. *(13)*.

**Figure 3.1. Overview of modelling steps for MMR estimation**




BMat: Bayesian maternal mortality estimation (model); CRVS: civil registration and vital statistics; MMR: maternal mortality ratio

**a. Types of reporting errors encountered in CRVS systems**

Definitions of reporting errors (incomplete/unregistered and misclassification) are provided earlier in this chapter in Box 3.1 and are discussed further below.

*i. Reporting errors within the CRVS system (misclassification)*

Within the CRVS system, incorrect reporting of maternal deaths can be attributed to misclassification in two ways, using the following notation:

F+ (false positive) = non-maternal deaths misclassified in the CRVS system as maternal deaths

F– (false negative) = maternal deaths misclassified in the CRVS system as non-maternal deaths.

The remaining deaths are those that have been correctly classified within the CRVS system; these can also be assigned to two groups, using the following notation:

T+ (true positive) = maternal deaths correctly classified in the CRVS system as maternal deaths

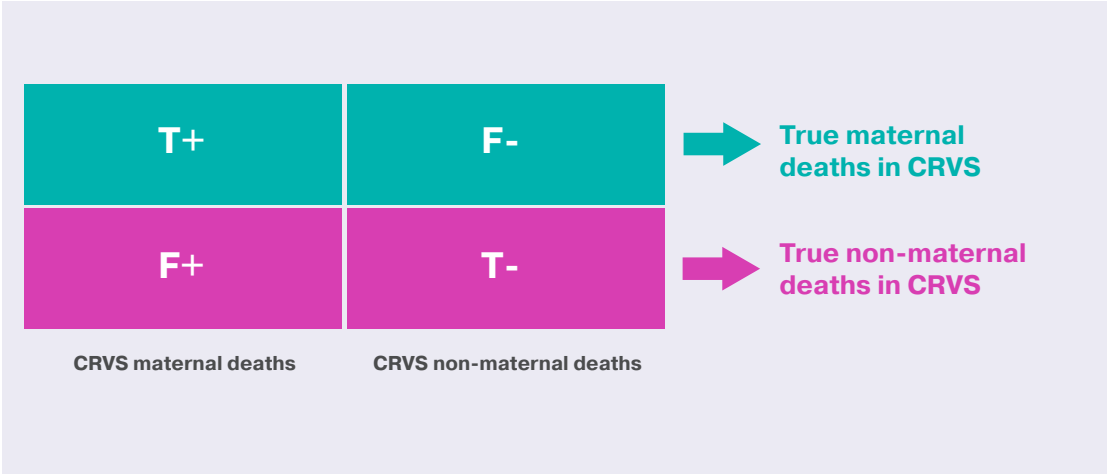
T– (true negative) = non-maternal deaths correctly classified in the CRVS system as non-maternal deaths.

The four-box diagram in Figure 3.2 summarizes what is correctly classified and what is misclassified in the CRVS system, using the notation provided above.

The observed PM – the proportion of deaths among women of reproductive age that are due to maternal causes – reported in the CRVS is given by $\frac{T^+ + F^+}{T^+ + F^+ + F^- + T^-}$ while the true PM from CRVS data is $\frac{T^+ + F^-}{T^+ + F^+ + F^- + T^-}$.

The UN MMEIG approach to adjust for this potential difference between true and observed PM is explained in section 3.3.1, subsections b and c, below.

**Figure 3.2. Four-box diagram of breakdown of the total number of deaths to females of reproductive age (15–49 years) as reported in the CRVS, by CRVS cause-of-death classification**



*ii. Deaths that are not reported in the CRVS (incompleteness)*

In cases where the CRVS system does not capture all deaths to females of reproductive age (i.e. the CRVS is incomplete), we refer to these maternal and non-maternal deaths as unregistered (U) deaths. We distinguish two types of unregistered deaths among females of reproductive age, using the following notation:

U– = non-maternal deaths not registered in the CRVS system, and

U+ = maternal deaths not registered in the CRVS system.

We extend the four-box representation to incorporate these unregistered maternal (U+) and non-maternal (U–) deaths (six-box diagram), as shown in Figure 3.3.

**b. Summary metrics for reporting errors**

*i. Reporting within the CRVS*

We summarize the occurrence of misclassification errors in the CRVS into the following two metrics:

(1) Sensitivity (Se): proportion of correctly classified maternal deaths out of all true maternal deaths, and

(2) Specificity (Sp): proportion of correctly classified non-maternal deaths out of all true non-maternal deaths.

These metrics combined summarize the ability of the CRVS system to correctly identify a true maternal and true non-maternal death. The formulas, using the notation introduced in subsection a above, are as follows:

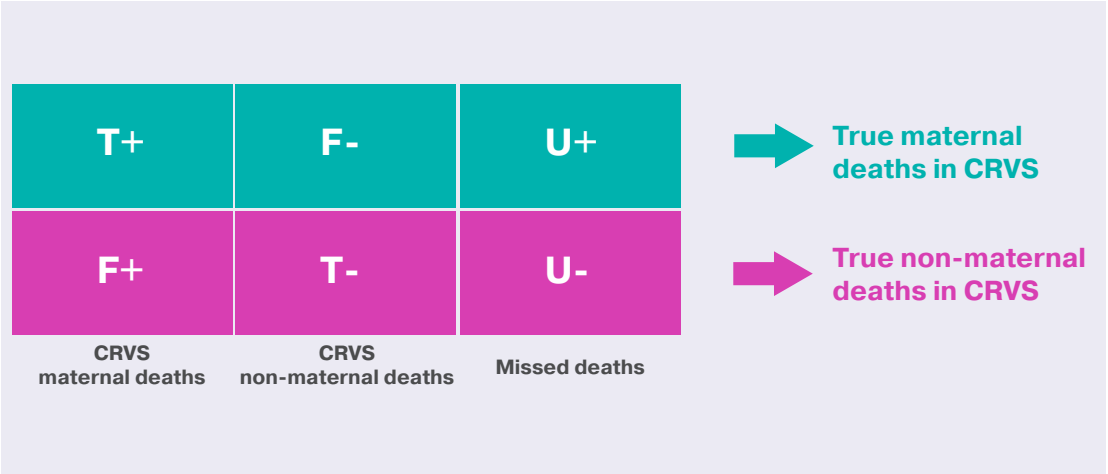
$$\text{Sensitivity} = \frac{T^+}{T^+ + F^-}$$

$$\text{Specificity} = \frac{T^-}{T^- + F^+}$$

The third metric related to reporting errors in the CRVS is the adjustment factor:

(3) CRVS adjustment factor: adjustment factor associated with CRVS-reported PM, to account for the difference between CRVS-reported PM and true PM.

**Figure 3.3. Six-box diagram of breakdown of the total number of deaths to females of reproductive age (15–49 years), by CRVS cause-of-death classification (T/F) and reporting status (U)**



For country-years with complete CRVS (i.e. all maternal deaths are registered in that country's CRVS system for those years), CRVS adjustment factors can be calculated for all country-years using their respective estimates of Se, Sp, and true proportional maternal (true PM), based on the following relation:

Expected CRVS-reported PM =
Se * true PM + (1 - Sp) * (1 – true PM),

such that the CRVS adjustment factor is given by

CRVS adjustment factor =
true PM/ (Se * true PM + (1 - Sp) * (1 – true PM))

*ii. Reporting in incomplete CRVS systems*

Reporting errors related to unregistered maternal deaths (i.e. incomplete CRVS data) are summarized in terms of the ratio between:

- true PM in (PM-in) = the true PM among deaths captured in the CRVS (so the true number of maternal deaths in the CRVS over the total number of deaths captured in the CRVS);
- true PM out (PM-out) = the PM among deaths not captured in the CRVS.

such that:

True PM among all deaths =
COM*PM-in + (1 - COM)*PM-out

where COM stands for completeness of the CRVS data (in terms of reporting all female deaths of reproductive age) as discussed in section 3.1.1(a).

For country-years with incomplete CRVS (i.e. not all maternal deaths are registered in that country's CRVS system for those years; COM < 100%), we investigated the feasibility of estimating the odds ratio of the two PMs, but data were too limited for inference on this ratio. Instead, we assumed that PM-in equals PM-out and accounted for additional uncertainty related to the unknown true ratio when deriving the CRVS adjustment for country-years with incomplete CRVS.

**c. Deriving sensitivity, specificity and CRVS adjustments from the CRVS model**

*i. CRVS model estimates of sensitivity and specificity*

The CRVS model obtains estimates of sensitivity and specificity for all country-years with CRVS data. Based on these estimates, corresponding estimates of the adjustment factor for country-years with complete CRVS can be obtained.

For all countries with specialized studies to inform Se and Sp, we model Se as well as Sp with a country-specific intercept in the midyear of their respective observation period. The country-specific intercept is estimated with a multilevel model, such that estimates for countries with specialized studies are informed by those data while estimates for countries with limited or no data are informed by information from other countries. Se and Sp values for the remaining years before and after the reference year were obtained through a so-called random walk model set-up. In the random walk set-up, point estimates of Se and Sp are kept constant unless country-specific data suggest a change. For countries with specialized studies, the estimates are data driven and informed by the combinations of Se and Sp as indicated by the studies.

In the model for Se and Sp, Se is constrained to be between 0.1 and 1 and Sp is constrained to be between 0.95 and 1. These bounds were chosen to avoid extrapolations for countries with limited data to values that are more extreme than those observed in the data.

We considered predictor variables to capture changes in sensitivity and specificity over time within countries, and differences across countries. The following predictor variables were considered as candidate predictor variables:

- GFR
- GDP per capita
- CRVS completeness (COM)
- proportion of causes in the CRVS that are ill defined ("R" codes in CRVS)
- ICD coding (use of ICD-9 or ICD-10)
- proportion of CRVS deaths that fall under noncommunicable disease causes of death.

However, none of the candidate predictor variables showed a substantively meaningful relationship with the parameters of interest, hence no predictor variables were used.

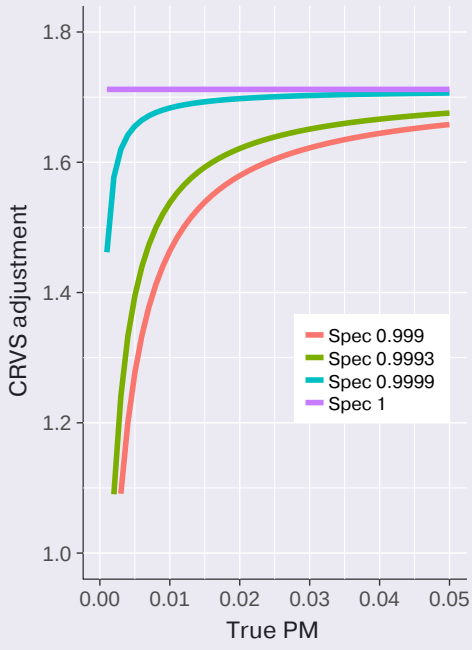
### *ii. CRVS model estimates of CRVS adjustment factors*

The CRVS model was fitted to specialized study data, collected by review *( 13)*, and CRVS data for the corresponding periods. The CRVS yields estimates of sensitivity and specificity based on two scenarios.

- For countries with data from specialized studies, the model is fitted to those data, and the estimates for the CRVS adjustment in the corresponding years will be consistent with the empiric country-level data.
- For countries without specialized studies, the estimates for sensitivity and specificity are equivalent to global estimates of sensitivity and specificity, obtained from fitting the model to the global database (the envelope of all specialized studies). The resulting estimates of Se and Sp are constant with time, as global estimates are also constant with time.

Figure 3.4 shows the relationship between true PM and the estimated CRVS adjustment factors, for specific values of Sp to illustrate their effect on the CRVS adjustment factor. When Sp = 1, the CRVS adjustment factor = 1/Se, hence lower Se results in a higher adjustment, conversely higher Se results in a lower adjustment. When Sp < 1, while keeping Se fixed, the adjustment factor decreases with decreasing true PM. This effect is due to an increasing share of false positive maternal deaths among all deaths, and a decreasing share of false negative deaths, or, in other words, as the true PM decreases, the proportion of non-maternal deaths reported as maternal increases while the proportion of maternal deaths reported as non-maternal decreases. This relationship implies that keeping specificity and sensitivity constant in extrapolations in countries with specialized studies, or for countries without any studies, will result in changing adjustment factors as the true PM changes.

**Figure 3.4. CRVS adjustment based on the CRVS model for different values of specificity, calculated at different levels of true PM when sensitivity is fixed at 0.586[a]**




Spec: specificity
PM: proportion maternal

[a] Based on the CRVS model, we estimated that 58.6% of maternal deaths are identified correctly in the CRVS.

**d. Comparison with previous UN MMEIG approach to estimate CRVS adjustment factors**

The CRVS adjustment model, described in subsection c (immediately above), yields estimates of sensitivity, specificity and CRVS adjustments for all country-years without specialized study data. In the previous round of estimates, the UN MMEIG CRVS adjustment was set to 1.5 for countries without specialized studies. For countries with at least one specialized study, the adjustment was calculated for countries with specialized studies by the ratio of true PM reported in the study to CRVS-based PM, i.e. the ratio of the proportion of true maternal deaths out of all female deaths to the proportion of CRVS-reported maternal deaths out of all CRVS-reported female deaths. The CRVS adjustment ratio was kept constant in forward extrapolations.

Limitations of the previous approach include the following.

- The use of a constant CRVS adjustment factor in extrapolations results in an overestimation of the adjustment factor if, in reality, specificity is constant and the true PM decreases (as illustrated in Figure 3.4 for adjustments based on the CRVS model).
- The uncertainty in the adjustment factor had not been assessed. Instead, the uncertainty of the adjustment factor was assumed to be around 50% of the point estimate for all country-years. The uncertainty is likely to vary across countries and with time, depending on data availability and the country-specific setting.
- The value of 1.5 was based on the median of a set of studies. The assessment did not account for differences that may be due to different settings (i.e. high-fertility settings versus low-fertility settings, completeness of CRVS). The set of studies included multiple observations from the same countries (so the 1.5 is not the median across countries).

The new approach improves upon these limitations through an assessment of variability across countries and within countries over time, in terms of the sensitivity and specificity of maternal death classification, extrapolations that are based on Se and Sp, and an assessment of uncertainty associated with these metrics and the resulting CRVS adjustment factor. We also explored the use of predictor variables to obtain more country-specific adjustments for countries with limited data, although, ultimately, no predictor variables were used *( 13)*.

### 3.3.2 Bayesian maternal mortality estimation model (the BMat model)

Estimation and projection of maternal mortality indicators was undertaken using the BMat model. This model is intended to ensure that the MMR estimation approach is consistent across all countries but remains flexible in that it is based on covariate-driven trends to inform estimates in countries or country-periods with limited information; captures observed trends in countries with longer time series of observations; and takes into account the differences in stochastic and sampling errors across observations.

In the BMat, the MMR for each country-year is modelled as the sum of the HIV MMR (i.e. the portion of MMR that is due to HIV-related maternal deaths) and the non-HIV MMR (i.e. the portion of MMR that is due to non-HIV-related maternal deaths):

MMR = Non-HIV MMR + HIV MMR,

where non-HIV-related maternal deaths refer to maternal deaths due to direct obstetric causes or to indirect causes other than HIV, while HIV-related maternal deaths are those

HIV-related deaths for which pregnancy was a substantial aggravating factor (also known as HIV-related indirect maternal deaths) (see definitions in Chapter 2).

The estimation of the HIV-related indirect maternal deaths follows the same procedure as used in the previous edition of this publication, as summarized in subsection b *(4)*.

In the BMat model, the non-HIV MMR is estimated as follows:

Non-HIV MMR(t) = Expected non-HIV MMR(t) * Data-driven multiplier(t)

where the expected non-HIV MMR(t) is estimated from a hierarchical regression model using covariates (predictor variables) and country-specific intercepts (described below in subsection a). The data-driven multiplier(t) allows for deviations away from the rate of change in MMR implied by the expected non-HIV MMR, as indicated by country-year-specific data points. For example, if data suggested that the non-HIV MMR decreased (or increased) much faster in year t than expected based on predictor variables, the data-driven multiplier for that year is estimated to be greater (or smaller) than 1. This data-driven multiplier is modelled with a flexible time-series model, which fluctuates around 1, such that the predictor variables in the regression model determine the estimated change when data are absent.

The estimation of the non-HIV MMR follows from the estimation of the number of non-HIV maternal deaths, explained in subsection b.

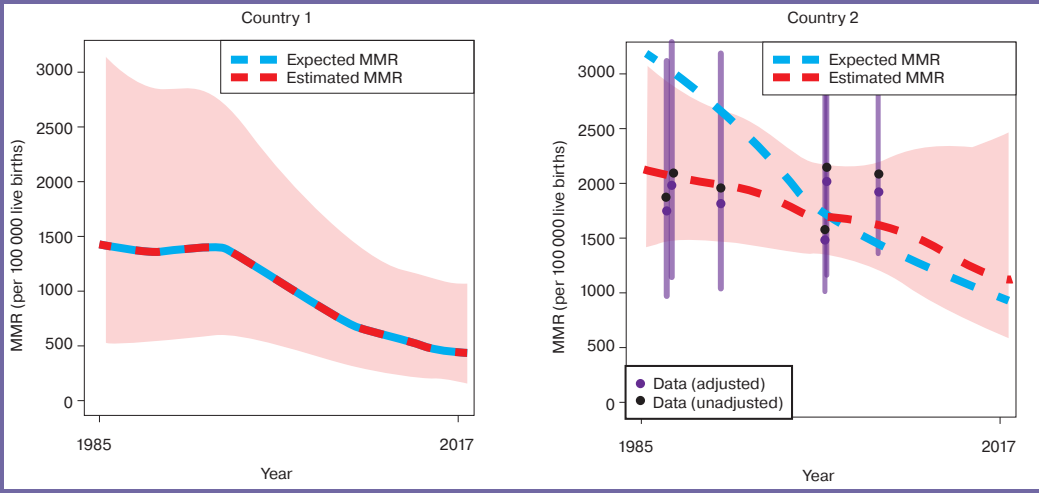
The model is fitted to all data available in the country (see Figure 3.1), taking into account adjustments and uncertainty associated with the data points. CRVS observations are adjusted using the estimates of sensitivity and specificity as described earlier, in section 3.3.1. Specialized studies are not adjusted. Other data are adjusted as described in section 3.1.1, subsection b. In the model, standard and stochastic errors for observations, which reflect the uncertainty associated with observations, are taken into account when obtaining PM and thus MMR estimates (see section 3.1.1, subsection c). Observations with smaller error variances are more informative of the true PM and will thus carry a greater weight in determining the estimates as compared to observations with larger error variances.

In countries with high-quality data with little uncertainty, the final BMat estimates will closely track the country data. However, in the absence of data, or when data are very uncertain, the predictor variables play an important role and inform the estimated trend in MMR.

#### a. Estimation of expected non-HIV-related maternal deaths

A hierarchical regression model was used to obtain the expected number of non-HIV-related maternal deaths for each country-year and associated non-HIV MMR. The model predicts the proportion of deaths to women of reproductive age that are due to maternal causes (PM) using three predictor variables: the GDP per capita, the GFR, and the presence of a skilled birth attendant (SBA) as a proportion of live births. These specific predictor variables were chosen from a broader list of potential predictor variables which fell into three groups: indicators of social and economic development (such as GDP, human development index, life expectancy), process variables (SBA, antenatal care, proportion of institutional births, etc.) and risk exposure (fertility level).

## Box 3.2. ILLUSTRATION OF THE BMAT MODEL




The figure in this box illustrates MMR estimates for Country 1, a country without any observed MMR data, and Country 2, which has data. For both countries, the red dashed line illustrates the final estimates for the MMR, and red shaded areas illustrate the uncertainty associated with the estimates. The blue dashed line illustrates the covariate-driven "expected MMR" that would be estimated by the model if a country did not have data to inform its trend. Black dots illustrate MMR data points (usually obtained from observed PMs as explained in the data section). For each data point, its corresponding "adjusted value", which is the data after accounting for biases, is plotted in purple, together with associated uncertainty about the true PM (purple vertical lines).

For countries such as Country 1 without data points, the country-specific multiplier for the change in the non-HIV MMR is equal to 1 for the entire period, and so the final MMR estimate is given by the expected MMR estimate (the red and blue lines are identical). For Country 2, the available data points suggest a different trend in the MMR as compared to the trend suggested by the covariates (predictor variables) in the regression model (blue line). The final estimates in red better reflect the observed trend in the country's data.

Projections beyond the most recent observation for all countries are determined by the rate of change in the expected MMR (blue line) and the country-specific multiplier: the latter converges slowly to one, thus the rate of change in the projections converges to the rate of change in the expected MMR.

The model is summarized as follows:

$$\log(EPM^{NA}) = b_0 + b_1 \log(GDP) + b_2 \log(GFR) + b_3 SBA + \gamma_j + \varphi_k$$

where

$EPM^{NA}$ = the expected proportion of non-HIV-related deaths to women aged 15–49 years that are due to maternal causes [NA = non-HIV; formerly it referred to "non-AIDS"]

GDP = gross domestic product per capita (in 2011 PPP US dollars)

GFR = general fertility rate (live births per woman aged 15–49 years)

SBA = proportion of births attended by skilled health personnel

$\gamma_j$ = random intercept term for country j

$\varphi_k$ = random intercept term for region k.

For countries with data available on maternal mortality, the expected proportion of non-HIV-related maternal deaths was based on country and regional random effects, whereas for countries with no data available, predictions were derived using regional random effects only.

The resulting estimates of the $EPM^{NA}$ were used to obtain the expected non-HIV MMR through the following relationship:

Expected non-HIV MMR = $EPM^{NA}$*(1-a)*E/B,

where

a = the proportion of HIV-related deaths among all deaths to women aged 15–49 years
E = the total number of deaths to women of reproductive age
B = the number of births.

**b. Estimation of HIV-related indirect maternal deaths**

For countries with generalized HIV epidemics and high HIV prevalence, HIV/AIDS is a leading cause of death during pregnancy and post-delivery. There is also some evidence from community studies that women with HIV infection have a higher risk of maternal death, although this may be offset by lower fertility. If HIV is prevalent, there will also be more incidental HIV deaths among pregnant and postpartum women. When estimating maternal mortality in these countries, it is, thus, important to differentiate between incidental HIV deaths (non-maternal deaths) and HIV-related indirect maternal deaths (maternal deaths caused by the aggravating effects of pregnancy on HIV) among HIV-positive pregnant and postpartum women who have died (i.e. among all HIV-related deaths occurring during pregnancy, childbirth and puerperium).[18]

The number of HIV-related indirect maternal deaths $D^{HIV}$, is estimated by:

$$D^{HIV} = a \cdot E \cdot v \cdot u$$

where

a*E = the total number of HIV-related deaths among all deaths to women aged 15–49.

$v$ = is the proportion of HIV-related deaths to women aged 15–49 that occur during pregnancy. The value of *v* can be computed as follows: $v = c\,k\,GFR / [1 + c(k\text{-}1)\,GFR]$ where GFR is the general fertility rate, and where *c* is the average exposure time (in years) to the risk of pregnancy-related mortality per live birth (set equal to 1 for this analysis), and where *k* is the relative risk of dying from AIDS for a pregnant versus a non-pregnant woman (reflecting both the decreased fertility of HIV-positive women and the increased mortality risk of HIV-positive pregnant women). The value of *k* was set at 0.3 *(14)*.

[18] See definitions in Chapter 2.

$u$ = is the fraction of pregnancy-related AIDS deaths assumed to be indirect maternal deaths. The UN MMEIG/TAG reviewed available study data on AIDS deaths among pregnant women and recommended using $u$ = 0.3 *(14)*.

For observed PMs, we assumed that the total reported maternal deaths are a combination of the proportion of reported non-HIV-related maternal deaths and the proportion of reported HIV-related (indirect) maternal deaths, where the latter is given by a*v for observations with a "pregnancy-related death" definition and a*v*u for observations with a "maternal death" definition.

### 3.3.3 Maternal mortality indicators estimated by the model

The immediate outputs of the BMat model were estimates in the form of PMs. These values were then converted to estimates of the MMR[19] as follows:

MMR = PM(D/B)

where D is the number of deaths in women aged 15–49 years and B is the number of live births for the country-year corresponding to the estimate.

Based on MMR estimates, the annual rate of MMR reduction (ARR) and the maternal mortality rate (MMRate; the number of maternal deaths divided by person-years lived by women of reproductive age) were calculated. The ARR was calculated as follows:

ARR = log(MMRt2/MMRt1)/(t1–t2)

where t1 and t2 refer to different years with t1 < t2.

The MMRate was calculated by using the number of maternal deaths divided by the number of women aged 15–49 in the population, as estimated by UNPD in the 2019 revision of *World population prospects (9)*.

The MMRate was used to calculate the adult lifetime risk of maternal mortality (i.e. the probability that a 15-year-old girl will die eventually from a maternal cause). In countries where there is a high risk of maternal death, there is also an elevated likelihood of girls dying before reaching reproductive age. For this reason, it makes sense to consider the lifetime risk of maternal mortality conditional on a girl's survival to adulthood. The formula used yields an estimate of the lifetime risk that takes into account competing causes of death:

Lifetime risk of maternal mortality = $(T_{15}–T_{50})/ \ell_{15}$ x MMRate

where $\ell_{15}$ equals the probability of survival from birth until age 15 years, and $(T_{15} – T_{50})/ \ell_{15}$ equals the average number of years lived between ages 15 and 50 years (up to a maximum of 35 years) among survivors to age 15 years. The values for $\ell_{15}$, $T_{15}$ and $T_{50}$ are life-table quantities for the female population during the period in question *(15)*. The ratio $(T_{15} – T_{50})/ \ell_{15}$ was taken from life tables that include deaths due to mortality shocks, i.e. the ratio represents the average number of years lived between ages 15 and 50 years among survivors to age 15 years in the presence of the mortality shock. Hence the lifetime risk in years with mortality shocks represents the risk of dying from a maternal cause in the presence of the mortality shock (see Annex 3 for more information about mortality shocks).

Regional maternal mortality estimates (according to the United Nations SDG, UNFPA, UNICEF, UNPD, WHO and the World Bank Group regional groupings) were also computed. The MMR in a given region was computed as the estimated total number of maternal deaths divided by the number of live births for that region. Additionally, the lifetime risk of maternal mortality was based on the weighted average of $(T_{15}–T_{50})/ \ell_{15}$ for a given region, multiplied by the MMRate of that region.

[19] Definitions of all the measures are provided in Chapter 2.

For all outcomes of interest, uncertainty was assessed and reported in terms of uncertainty intervals. So-called "80% credible intervals" are used, which have an 80% probability of containing the truth.

## References


1. World Health Organization (WHO), United Nations Children's Fund (UNICEF), United Nations Population Fund (UNFPA), World Bank. Trends in maternal mortality: 1990 to 2008: estimates developed by WHO, UNICEF, UNFPA and the World Bank. Geneva: WHO; 2010 (https://apps.who.int/iris/bitstream/handle/10665/44423/9789241500265_eng.pdf, accessed 28 May 2019).

2. World Health Organization (WHO), United Nations Children's Fund (UNICEF), United Nations Population Fund (UNFPA), World Bank. Trends in maternal mortality: 1990 to 2010: WHO, UNICEF, UNFPA and the World Bank estimates. Geneva: WHO; 2012 (http://apps.who.int/iris/bitstream/10665/44874/1/9789241503631_eng.pdf, accessed 28 May 2019).

3. World Health Organization (WHO), United Nations Children's Fund (UNICEF), United Nations Population Fund (UNFPA), World Bank, United Nations Population Division. Trends in maternal mortality: 1990 to 2013: estimates by WHO, UNICEF, UNFPA, the World Bank and the United Nations Population Division. Geneva: WHO; 2014 (http://apps.who.int/iris/bitstream/10665/112682/2/9789241507226_eng.pdf, accessed 28 May 2019).

4. World Health Organization (WHO), United Nations Children's Fund (UNICEF), United Nations Population Fund (UNFPA), World Bank Group, United Nations Population Division. Trends in maternal mortality: 1990 to 2015: estimates by WHO, UNICEF, UNFPA, World Bank Group and the United Nations Population Division. Geneva: WHO; 2015 (https://www.who.int/reproductivehealth/publications/monitoring/maternal-mortality-2015/en/, accessed 4 September 2019).

5. Alkema L, Zhang S, Chou D, Gemmill A, Moller AB, Ma Fat D, et al. A Bayesian approach to the global estimation of maternal mortality. Ann Appl Stat. 2017;11(3):1245-74. doi:10.1214/16-aoas1014.

6. Wilmoth J, Mizoguchi N, Oestergaard M, Say L, Mathers C, Zureick-Brown S, et al. A new method for deriving global estimates of maternal mortality. Stat Politics Policy. 2012;3(2):2151-7509.1038. (https://www.ncbi.nlm.nih.gov/pubmed/24416714, accessed 18 August 2019).

7. Wilmoth J, Mizoguchi N, Oestergaard M, Say L, Mathers C, Zureick-Brown S, et al. A new method for deriving global estimates of maternal mortality: supplemental report. 2012:1–31 (https://www.who.int/reproductivehealth/publications/monitoring/supplemental_rpt.pdf, accessed 20 June 2019).

8. Life tables. In: Global Health Observatory (GHO) data [website]. Geneva: World Health Organization; 2019 (https://www.who.int/gho/mortality_burden_disease/life_tables/life_tables/en/, accessed 18 June 2019).

9. World population prospects: the 2019 revision. New York (NY): United Nations Population Division, Department of Economic and Social Affairs; 2019 (https://population.un.org/wpp/, accessed 10 June 2019).

10. UNAIDS Data 2017. Geneva: Joint United Nations Programme on HIV/AIDS (UNAIDS); 2017 (https://www.unaids.org/en/resources/documents/2017/2017_data_book, accessed 3 September 2019).

11. DataBank: World Development Indicators [website]. Washington (DC): The World Bank Group; 2019 (https://databank.worldbank. org/source/world-development-indicators, accessed 31 July 2019).

12. World Health Organization (WHO), United Nations Children's Fund (UNICEF). WHO and UNICEF Joint Skilled Birth Attendant (SBA) database. Geneva: WHO; 2019.

13. Peterson E, Chou D, Gemmill A, Moller AB, Say L, Alkema L. Estimating maternal mortality using vital registration data: a Bayesian hierarchical bivariate random walk model to estimate sensitivity and specificity of reporting for population-periods without validation data. 2019. https://arxiv.org/abs/1909.08578.

14. Zaba B, Calvert C, Marston M, Isingo R, Nakiyingi-Miiro J, Lutalo T, et al. Effect of HIV infection on pregnancy-related mortality in sub-Saharan Africa: secondary analyses of pooled community-based data from the network for Analysing Longitudinal Population-based HIV/AIDS data on Africa (ALPHA). Lancet. 2013;381(9879):1763-71. doi:10.1016/S0140-6736(13)60803-X.

15. Wilmoth J. The lifetime risk of maternal mortality: concept and measurement. Bull World Health Organ 2009;87:256-62. doi:10.2471/BLT.07.048280.

# 04

## TRENDS IN MATERNAL MORTALITY

# MATERNAL MORTALITY ESTIMATES AND TRENDS: 2000 TO 2017

CONTENT



This chapter presents and describes estimated maternal mortality ratios (MMRs), numbers of maternal deaths, the proportion of maternal deaths among all deaths to women of reproductive age (PM), and the adult lifetime risk of maternal mortality (i.e. the probability that a 15-year-old girl will die eventually from a maternal cause).[20] This chapter also presents and examines trends in these indicators since 2000.

Countries and territories included in all the tables presented in this report are limited to WHO Member States with populations over 100 000 in 2019 (i.e. excluding: Andorra, Cook Islands, Dominica, Marshall Islands, Monaco, Nauru, Niue, Palau, Saint Kitts and Nevis, San Marino, Tuvalu), plus two territories (Puerto Rico, and the West Bank and Gaza Strip).[21]

[20] See Chapter 2 for definitions.

[21] Puerto Rico is an Associate Member, and the West Bank and Gaza Strip is a member in the regional committee for the WHO Eastern Mediterranean Region (EM/RC40/R.2: https://apps.who.int/iris/bitstream/handle/10665/121332/em_rc40_r2_en.pdf). The WHO governing bodies use the name “West Bank and Gaza Strip”.

This results in a total of 185 countries and territories included in the data presented in these tables (including Annexes 5–17).

The numbers provided are the most accurate point estimates possible given the available data. However, these calculations still contain a level of uncertainty that varies depending on the amount and quality of available data used to produce them. The range that an estimated indicator's true value most likely falls within is captured by its 80% uncertainty interval (UI); more information about how to interpret the estimates and UIs is provided in Box 4.1.

The new estimates presented in this report supersede all previously published estimates for years that fall within the same time period, and due to modifications in methodology and data availability, differences between these and previous estimates should not be interpreted as representing time trends. The full database, country profiles and all model specification codes used are available online.[22]

Section 4.1 presents global-, regional- and country-level estimates for 2017, while section 4.2 presents trends between 2000 and 2017.

## 4.1 Maternal mortality estimates for 2017

Globally, an estimated 295 000 (UI 279 000 to 340 000) maternal deaths occurred in 2017, yielding an overall MMR of 211 (UI 199 to 243) maternal deaths per 100 000 live births for the 185 countries and territories covered in this analysis.

For 2017, the global lifetime risk of maternal mortality was estimated at 1 in 190; the overall proportion of deaths to women of reproductive age that are due to maternal causes (PM) was estimated at 9.2% (UI 8.7% to 10.6%).

[22] Available at: www.who.int/reproductivehealth/publications/maternal-mortality-2017/en/

### Box 4.1. ACCURATELY INTERPRETING POINT ESTIMATES AND UNCERTAINTY INTERVALS

All maternal mortality indicators derived from the 2017 estimation round include a point estimate and an 80% uncertainty interval (UI). For those indicators where only point estimates are reported in the text or tables, UIs can be obtained from supplementary material online.[23]

The 80% UIs computed for all the estimates provide the 10th and 90th percentiles of the posterior distributions. This was chosen rather than the more standard 95% UIs because of the substantial uncertainty inherent in maternal mortality outcomes.

Both point estimates and 80% UIs should be taken into account when assessing estimates. Here we can look at one example and how to interpret it:

The estimated 2017 global MMR is 211 (UI 193 to 243).

This means:

- The point estimate is 211 and the 80% UI ranges from 193 to 243.
- There is a 50% chance that the true 2017 global MMR lies above 211, and a 50% chance that the true value lies below 211.
- There is an 80% chance that the true 2017 global MMR lies between 193 and 243.
- There is a 10% chance that the true 2017 global MMR lies above 243, and a 10% chance that the true value lies below 199.

Other accurate interpretations include:

- We are 90% certain that the true 2017 global MMR is at least 193.
- We are 90% certain that the true 2017 global MMR is 243 or less.

The amount of data available for estimating an indicator and the quality of that data determine the width of an indicator's UI. As data availability and quality improve, the certainty increases that an indicator's true value lies close to the point estimate.

[23] Available at: www.who.int/reproductivehealth/publications/maternal-mortality-2017/en/

An estimated 3600 HIV-related indirect maternal deaths occurred in 2017. The global HIV-related indirect MMR was estimated at 3 maternal deaths per 100 000 live births. HIV and pregnancy interaction accounted for 1.22% of maternal deaths globally.

Table 4.1 provides 2017 point estimates of maternal mortality indicators as well as the numbers of maternal deaths by United Nations Sustainable Development Goal (SDG) region, subregion and three other groupings (landlocked developing countries, least developed countries, and small island developing States), discussed in section 4.1.1. It also presents the range of uncertainty for each MMR point estimate. Country-level estimates for 2017 are provided in Annex 5, and discussed in section 4.1.2.

For the purpose of categorization, MMR is considered to be low if it is less than 100, moderate if it is 100–299, high if it is 300–499, very high if it is 500–999 and extremely high if it is greater than or equal to 1000 maternal deaths per 100 000 live births.

### 4.1.1 Regional-level estimates

The overall estimate for MMR in the world's least developed countries (LDCs) in 2017 is high at 415 (UI 396 to 477) maternal deaths per 100 000 live births, which is more than 40 times higher than that of the subregion[24] Europe (10; UI 9 to 11), and almost 60 times higher than in the subregion Australia and New Zealand (7; UI 6 to 8) (see Table 4.1). In the world's LDCs, where an estimated 130 000 maternal deaths occurred in 2017, the estimated lifetime risk of maternal death was 1 in 56.

Sub-Saharan Africa has a very high MMR[25] with a 2017 point estimate of 542 (UI 498 to 649), and the lifetime risk of maternal death was estimated at 1 in 37, compared with just 1 in 7800 in Australia and New Zealand. The PM in sub-Saharan Africa is 18.2%, compared with just 0.5% in Europe.

Five subregions/groups of counties have moderate MMR, with 2017 estimates as follows: Northern Africa 112 (UI 91 to 145), Oceania (excluding Australia and New Zealand) 129 (UI 69 to 267), South-Eastern Asia 137 (UI 115 to 173), Southern Asia 157 (UI 136 to 189) and small island developing States 210 (UI 178 to 277). Four subregions (Australia and New Zealand, Central Asia, Eastern Asia, Western Asia) and two regions (Latin America and the Caribbean, and Europe and Northern America) were estimated to have low MMR (< 100 maternal deaths per 100 000 live births).

Sub-Saharan Africa and Southern Asia accounted for approximately 86% of the estimated global number of maternal deaths in 2017 (254 000) with sub-Saharan Africa alone accounting for roughly 66% (196 000), while Southern Asia accounted for nearly 20% (58 000). South-Eastern Asia, in addition, accounted for over 5% of global maternal deaths (16 000). The rest of the world accounted for the remaining 8.5% of maternal deaths, with the lowest estimated count being in Australia and New Zealand (just 26 maternal deaths). In Europe, there were an estimated 740 maternal deaths in 2017.

With regard to the proportion of deaths to women of reproductive age that are due to maternal causes (PM), in 2017 this was below 10% in all regions and subregions except for sub-Saharan Africa (18.2%), but was high in landlocked developing countries (17.4%) and in LDCs (17.5%). Fifty-nine countries had a

[24] SDG regions and subregions are shown in Tables 4.1, 4.2 and 4.3. The subregions are indented and listed beneath their regions.

[25] Extremely high MMR is considered to be ⩾ 1000, very high MMR is 500–999, high MMR is 300–499, moderate MMR is 100–299, and low MMR is < 100 maternal deaths per 100 000 live births.

PM of 1% or less; with the exception of Japan, Turkmenistan and the United Arab Emirates, all the other countries with PM less than 1% are in Europe.

Table 4.2 shows the HIV-related indirect MMR and the number and percentage of HIV-related indirect maternal deaths[26] by SDG region, subregion and other grouping in 2017. Sub-Saharan Africa accounts for the largest proportion (89%) of global HIV-related indirect maternal deaths: 3200 out of 3600. Europe, however, has by far the highest proportion of HIV-related maternal deaths as a subset of all maternal deaths in that subregion, at 8.9%, with the next highest being 1.6% in sub-Saharan Africa, compared with just 0.13% in Western Asia, and no HIV-related maternal deaths at all in Australia and New Zealand in 2017. The HIV-related indirect MMR for sub-Saharan Africa in 2017 is high, estimated at 9 maternal deaths per 100 000 live births, compared with 1 in South-Eastern Asia, Latin America and the Caribbean, Oceania (excluding Australia and New Zealand), and Europe, and 0 (zero) in all other subregions. Without HIV-related indirect maternal deaths, the MMR for sub-Saharan Africa in 2017 would be 533 maternal deaths per 100 000 live births, instead of 542. Two subregions are estimated to have had more than 100 HIV-related indirect maternal deaths in 2017: Southern Asia and South-Eastern Asia (both 110).

Annexes 6–15 present the MMR point estimates, range of uncertainty, numbers of maternal deaths and lifetime risk of maternal death in 2017, as well as the trends in the estimates of MMR between 2000 and 2017, for WHO, UNICEF, UNFPA, World Bank Group and UNPD regions, respectively.

### 4.1.2 Country-level estimates

Annex 5 provides 2017 point estimates and uncertainty intervals for each country's maternal mortality indicators (MMR and PM), as well as the estimates for numbers of maternal deaths, lifetime risk of maternal death, and percentage of HIV-related indirect maternal deaths. Figure 4.1 displays a map with all countries shaded according to MMR levels in 2017.

Three countries are estimated to have had extremely high maternal mortality in 2017 (defined as over 1000 maternal deaths per 100 000 live births), with the highest MMR being in South Sudan, at 1150 (UI 789 to 1710) maternal deaths per 100 000 live births, followed by Chad (1140; UI 847 to 1590) and Sierra Leone (1120; UI 808 to 1620). Sixteen other countries, all also in sub-Saharan Africa except for one, are estimated to have very high MMR in 2017 (i.e. ranging between 500 and 999): Nigeria (917; UI 658 to 1320), Central African Republic (829; UI 463 to 1470), Somalia (829; UI 385 to 1590), Mauritania (766; UI 528 to 1140), Guinea-Bissau (667; UI 457 to 995), Liberia (661; UI 481 to 943), Afghanistan (638; UI 427 to 1010), Côte d'Ivoire (617; UI 426 to 896), Gambia (597; UI 440 to 808), Guinea (576; UI 437 to 779), Mali (562; UI 419 to 784), Burundi (544; UI 413 to 728), Lesotho (548; UI 391 to 788), Cameroon (529; UI 376 to 790), the United Republic of Tanzania (524; UI 399 to 712) and Niger (509; UI 368 to 724). Only three countries in sub-Saharan Africa have low MMR: Mauritius (61; UI 46 to 85), Cabo Verde (58; UI 45 to 75) and Seychelles (53; UI 26 to 109). Only one country outside the sub-Saharan African region has high MMR: Haiti (480; UI 346 to 718). Ninety countries are estimated to have MMR of 50 or less.

Nigeria and India had the highest numbers of maternal deaths, and accounted for approximately one third (35%) of all estimated global maternal deaths in 2017, with

[26] See definitions in Chapter 2.

**Table 4.1. Estimates of maternal mortality ratio (MMR, maternal deaths per 100 000 live births), number of maternal deaths, lifetime risk and proportion of deaths among women of reproductive age that are due to maternal causes (PM), by United Nations Sustainable Development Goal (SDG) region, subregion and other grouping, 2017**

| SDG region | MMR[a] point estimate and range of uncertainty interval (UI: 80%) | | | Number of maternal deaths[b] | Lifetime risk of maternal death[c] | PM[d] (%) |
|---|---|---|---|---|---|---|
| | Lower UI | MMR point estimate | Upper UI | | | |
| World | 199 | 211 | 243 | 295 000 | 190 | 9.2 |
| Sub-Saharan Africa[e] | 498 | 542 | 649 | 196 000 | 37 | 18.2 |
| Northern Africa and Western Asia | 73 | 84 | 104 | 9 700 | 380 | 5.9 |
| Northern Africa[f] | 91 | 112 | 145 | 6 700 | 260 | 8.4 |
| Western Asia[g] | 45 | 55 | 69 | 3 000 | 650 | 3.6 |
| Central and Southern Asia | 131 | 151 | 181 | 58 000 | 260 | 6.6 |
| Central Asia[h] | 21 | 24 | 28 | 390 | 1 400 | 1.7 |
| Southern Asia[i] | 136 | 157 | 189 | 58 000 | 250 | 6.8 |
| Eastern and South-Eastern Asia | 61 | 69 | 85 | 21 000 | 790 | 3.3 |
| Eastern Asia[j] | 22 | 28 | 35 | 5 300 | 2 200 | 1.5 |
| South-Eastern Asia[k] | 115 | 137 | 173 | 16 000 | 320 | 5.5 |
| Latin America and the Caribbean[l] | 70 | 74 | 81 | 7 800 | 630 | 3.8 |
| Oceania | 34 | 60 | 120 | 400 | 690 | 4.1 |
| Australia and New Zealand | 6 | 7 | 8 | 26 | 7 800 | 0.6 |
| Oceania (excl. Australia and New Zealand)[m] | 69 | 129 | 267 | 380 | 210 | 6.5 |
| Europe and Northern America | 12 | 12 | 14 | 1 500 | 4 800 | 0.6 |
| Europe[n] | 9 | 10 | 11 | 740 | 6 500 | 0.5 |
| Northern America[o] | 16 | 18 | 20 | 760 | 3 100 | 0.9 |
| Landlocked developing countries[p] | 378 | 408 | 484 | 65 000 | 57 | 17.4 |
| Least developed countries[q] | 396 | 415 | 477 | 130 000 | 56 | 17.5 |
| Small island developing States[r] | 178 | 210 | 277 | 2 600 | 190 | 8.5 |

UI: uncertainty interval.

[a] MMR estimates have been rounded according to the following scheme: < 100 rounded to nearest 1; 100–999 rounded to nearest 1; and ⩾ 1000 rounded to nearest 10.

[b] Numbers of maternal deaths have been rounded according to the following scheme: < 100 rounded to nearest 1; 100–999 rounded to nearest 10; 1000–9999 rounded to nearest 100; and ⩾ 10 000 rounded to nearest 1000.

[c] Lifetime risk numbers have been rounded according to the following scheme: < 100 rounded to nearest 1; 100–999 rounded to nearest 10; and ⩾ 1000 rounded to nearest 100.

[d] The number of maternal deaths in a given time period divided by the total deaths among women aged 15–49 years.

[e] Angola, Benin, Botswana, Burkina Faso, Burundi, Cabo Verde, Cameroon, Central African Republic, Chad, Comoros, Congo, Côte d'Ivoire, Democratic Republic of the Congo, Djibouti, Equatorial Guinea, Eritrea, Eswatini, Ethiopia, Gabon, Gambia, Ghana, Guinea, Guinea-Bissau, Kenya, Lesotho, Liberia, Madagascar, Malawi, Mali, Mauritania, Mauritius, Mozambique, Namibia, Niger, Nigeria, Rwanda, Sao Tome and Principe, Senegal, Seychelles, Sierra Leone, Somalia, South Africa, South Sudan, Togo, Uganda, United Republic of Tanzania, Zambia, Zimbabwe.

[f] Algeria, Egypt, Morocco, State of Libya, Sudan, Tunisia.

[g] Armenia, Azerbaijan, Bahrain, Cyprus, Georgia, Iraq, Israel, Jordan, Kuwait, Lebanon, Oman, Qatar, Saudi Arabia, Syrian Arab Republic, Turkey, United Arab Emirates, West Bank and Gaza Strip, Yemen.

[h] Kazakhstan, Kyrgyzstan, Tajikistan, Turkmenistan, Uzbekistan.

[i] Afghanistan, Bangladesh, Bhutan, India, Iran (Islamic Republic of), Maldives, Nepal, Pakistan, Sri Lanka.

[j] China, Democratic People's Republic of Korea, Japan, Mongolia, Republic of Korea.

[k] Brunei Darussalam, Cambodia, Indonesia, Lao People's Democratic Republic, Malaysia, Myanmar, Philippines, Singapore, Thailand, Timor-Leste, Viet Nam.

[l] Antigua and Barbuda, Argentina, Bahamas, Barbados, Belize, Bolivia (Plurinational State of), Brazil, Chile, Colombia, Costa Rica, Cuba, Dominican Republic, Ecuador, El Salvador, Grenada, Guatemala, Guyana, Haiti, Honduras, Jamaica, Mexico, Nicaragua, Panama, Paraguay, Peru, Puerto Rico, Saint Lucia, Saint Vincent and the Grenadines, Suriname, Trinidad and Tobago, Uruguay, Venezuela (Bolivarian Republic of).

[m] Fiji, Kiribati, Micronesia (Federated States of), Papua New Guinea, Samoa, Solomon Islands, Tonga, Vanuatu.

[n] Albania, Austria, Belarus, Belgium, Bosnia and Herzegovina, Bulgaria, Croatia, Czechia, Denmark, Estonia, Finland, France, Germany, Greece, Hungary, Iceland, Ireland, Italy, Latvia, Lithuania, Luxembourg, Malta, Montenegro, Netherlands, Norway, Poland, Portugal, Republic of Moldova, Republic of North Macedonia, Romania, Russian Federation, Serbia, Slovakia, Slovenia, Spain, Sweden, Switzerland, Ukraine, United Kingdom of Great Britain and Northern Ireland.

[o] Canada, United States of America.

[p] Afghanistan, Armenia, Azerbaijan, Bhutan, Bolivia (Plurinational State of), Botswana, Burkina Faso, Burundi, Central African Republic, Eswatini, Ethiopia, Kazakhstan, Kyrgyzstan, Lao People's Democratic Republic, Lesotho, Malawi, Mali, Mongolia, Nepal, Niger, Paraguay, Republic of Moldova, Republic of North Macedonia, Rwanda, South Sudan, Tajikistan, Turkmenistan, Uganda, Uzbekistan, Zambia, Zimbabwe.

[q] Afghanistan, Angola, Bangladesh, Benin, Bhutan, Burkina Faso, Burundi, Cambodia, Central African Republic, Chad, Comoros, Democratic Republic of the Congo, Djibouti, Eritrea, Ethiopia, Gambia, Guinea, Guinea-Bissau, Haiti, Kiribati, Lao People's Democratic Republic, Lesotho, Liberia, Madagascar, Malawi, Mali, Mauritania, Mozambique, Myanmar, Nepal, Niger, Rwanda, Sao Tome and Principe, Senegal, Sierra Leone, Solomon Islands, Somalia, South Sudan, Sudan, Timor-Leste, Togo, Uganda, United Republic of Tanzania, Vanuatu, Yemen, Zambia.

[r] Antigua and Barbuda, Bahamas, Barbados, Belize, Cabo Verde, Comoros, Cuba, Dominican Republic, Fiji, Grenada, Guinea-Bissau, Guyana, Haiti, Jamaica, Kiribati, Maldives, Mauritius, Micronesia (Federated States of), Papua New Guinea, Puerto Rico, Saint Lucia, Saint Vincent and the Grenadines, Samoa, Sao Tome and Principe, Seychelles, Singapore, Solomon Islands, Suriname, Timor-Leste, Tonga, Trinidad and Tobago, Vanuatu.

**Table 4.2. Estimates of maternal mortality ratio (MMR, maternal deaths per 100 000 live births), number of maternal deaths and HIV-related indirect maternal deaths, by United Nations Sustainable Development Goal (SDG) region, subregion and other grouping, 2017**

| SDG region | MMR point estimate[a] | Number of maternal deaths[b] | HIV-related indirect MMR | Number of HIV-related indirect maternal deaths[c] | Percentage of HIV-related indirect maternal deaths[d] (%) |
|---|---|---|---|---|---|
| World | 211 | 295 000 | 3 | 3 600 | 1.2 |
| Sub-Saharan Africa[e] | 542 | 196 000 | 9 | 3 200 | 1.6 |
| Northern Africa and Western Asia | 84 | 9 700 | 0 | 20 | 0.2 |
| Northern Africa[f] | 112 | 6 700 | 0 | 16 | 0.2 |
| Western Asia[g] | 55 | 3 000 | 0 | 4 | 0.1 |
| Central and Southern Asia | 151 | 58 000 | 0 | 110 | 0.2 |
| Central Asia[h] | 24 | 390 | 0 | 4 | 1.0 |
| Southern Asia[i] | 157 | 58 000 | 0 | 110 | 0.2 |
| Eastern and South-Eastern Asia | 69 | 21 000 | 0 | 130 | 0.6 |
| Eastern Asia[j] | 28 | 5 300 | 0 | 13 | 0.3 |
| South-Eastern Asia[k] | 137 | 16 000 | 1 | 110 | 0.7 |
| Latin America and the Caribbean[l] | 74 | 7 800 | 1 | 69 | 0.9 |
| Oceania | 60 | 400 | 1 | 4 | 1.0 |
| Australia and New Zealand | 7 | 26 | 0 | 0 | 0.0 |
| Oceania (exc. Australia and New Zealand)[m] | 129 | 380 | 1 | 4 | 1.1 |
| Europe and Northern America | 12 | 1 500 | 1 | 71 | 4.7 |
| Europe[n] | 10 | 740 | 1 | 66 | 8.9 |
| Northern America[o] | 18 | 760 | 0 | 5 | 0.7 |
| Landlocked developing countries[p] | 408 | 65 000 | 5 | 840 | 1.2 |
| Least developed countries[q] | 415 | 130 000 | 5 | 1 500 | 1.2 |
| Small island developing States[r] | 210 | 2 600 | 3 | 37 | 1.4 |

[a] MMR estimates have been rounded according to the following scheme: < 100 rounded to nearest 1; 100–999 rounded to nearest 1; and ⩾ 1000 rounded to nearest 10.

[b] Numbers of maternal deaths have been rounded according to the following scheme: < 100 rounded to nearest 1; 100–999 rounded to nearest 10; 1000–9999 rounded to nearest 100; and ⩾ 10 000 rounded to nearest 1000.

[c] According to the Joint United Nations Programme on HIV/AIDS (UNAIDS), HIV-related deaths (including HIV-related indirect maternal deaths) include the estimated number of deaths related to HIV infection, including deaths that occur before reaching the clinical stage classified as AIDS.

[d] Percentage of HIV-related indirect maternal deaths (see note c), calculated as a percentage of all maternal deaths.

[e–r] See footnotes for Table 4.1.

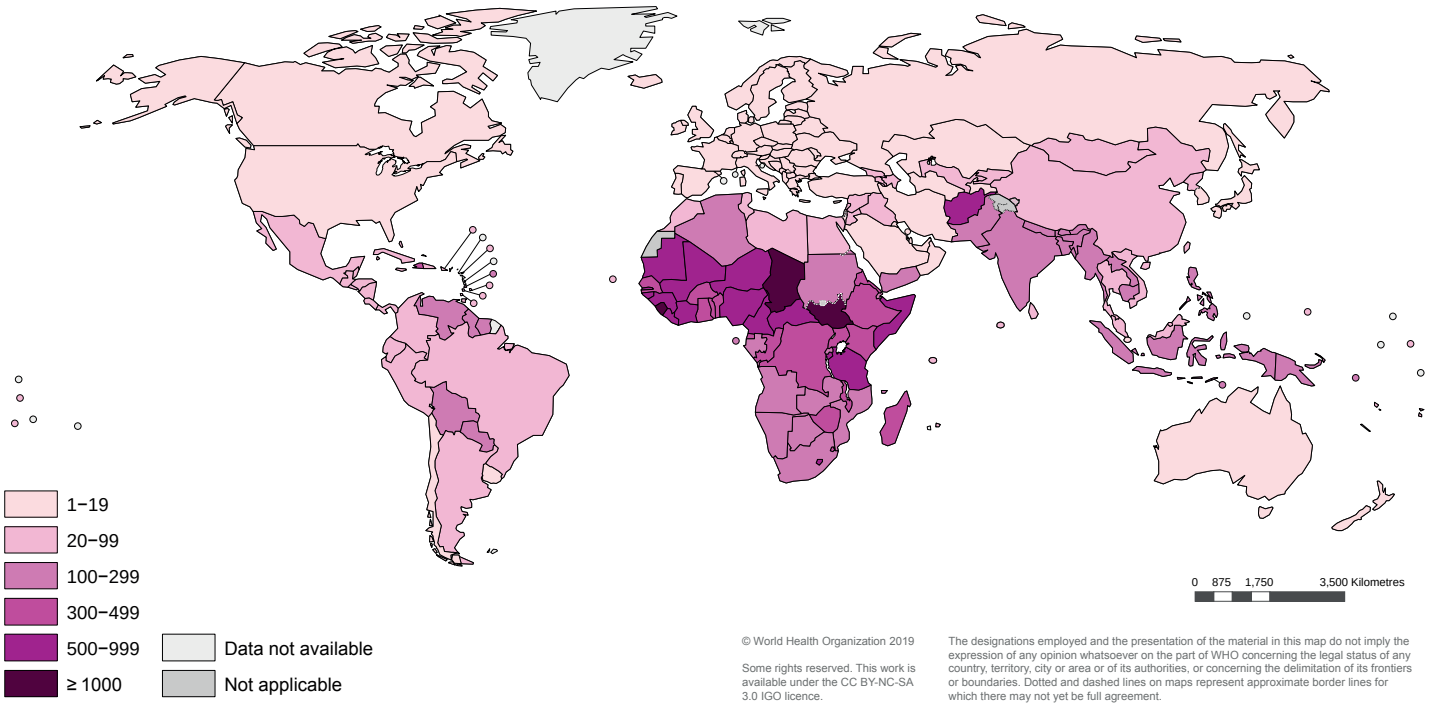
approximately 67 000 (UI 48 000 to 96 000) and 35 000 (UI 28 000 to 43 000) maternal deaths (23% and 12% of global maternal deaths), respectively. Three other countries also had 10 000 maternal deaths or more: the Democratic Republic of the Congo (16 000; UI 12 000 to 24 000), Ethiopia (14 000; UI 10 000 to 20 000) and the United Republic of Tanzania (11 000; UI 8100 to 14 000). Ten other countries had between 5000 and 9999 maternal deaths in 2017 (in order from higher to lower numbers of deaths): Indonesia, Pakistan, Afghanistan, Chad, Uganda, Côte d'Ivoire, Bangladesh, Niger, Somalia, Kenya. Sixty-one countries were estimated to have had just 10 or fewer maternal deaths in 2017.

PM is estimated to be highest in Afghanistan and Mauritania (37% in both), Chad (34%), and Niger and Somalia (31% in both). Eleven other countries have high PMs, in the range of 20–30%: Gambia, South Sudan and Liberia (all 26%), Guinea-Bissau and Mali (both 24%), the Democratic Republic of the Congo and Nigeria (both 23%), the United Republic of Tanzania (22%), and Burundi, Senegal and Sierra Leone (all 21%). PM is less than 1% in 24 countries.

Regarding the estimated lifetime risk of maternal mortality for a 15-year-old girl in 2017, the two countries with the highest estimated risk are Chad (1 in 15) and South Sudan (1 in 18), followed by Sierra Leone and Somalia, both at 1 in 20. The countries with the lowest risk are Italy (1 in 51 300), Poland (1 in 30 300) and Greece (1 in 26 900).

Annex 5 also presents the percentage of HIV-related indirect maternal deaths by country in 2017, for those countries where there was at least 5% prevalence of HIV-related indirect maternal deaths among all maternal deaths in 2017 *(1)*. Although at a regional level the overall proportions of HIV-related indirect maternal

**Figure 4.1. Maternal mortality ratio (MMR, maternal deaths per 100 000 live births), 2017**



deaths out of all maternal deaths are relatively small, for countries with high HIV prevalence they are substantial. In six countries, 15% or more of maternal deaths were estimated to be HIV-related indirect maternal deaths in 2017: South Africa (21%), Turkmenistan, (17%), Belize (17%), Bahamas (16%), and the Russian Federation and Italy (both 15%).

## 4.2 Trends in maternal mortality: 2000 to 2017

Little time has passed between the start of the SDG reporting period on 1 January 2016 and the date of the estimates presented in this report, which are for the year 2017. Therefore, for the purposes of understanding meaningful trends in maternal mortality, we report on progress from 2000 to 2017. This interval also reflects the time period since reporting of health progress on global goals was initiated, with the launch of Millennium Declaration and the MDGs in 2000 *(2)*.

Global MMR in 2017 had declined 38% since 2000, when it was estimated at 342 maternal deaths per 100 000 live births. The average annual rate of reduction in global MMR between 2000 and 2017 was 2.9%; this means that, on average, the global MMR declined by 2.9% every year between 2000 and 2017. The global number of maternal deaths in 2017 was estimated to be 35% lower than in 2000 when there were an estimated 451 000 (UI 431 000 to 485 000) maternal deaths. The overall proportion of deaths to women of reproductive age that are due to maternal causes (PM) was estimated to be 26.3% lower in 2017 than in 2000. The lifetime risk for a 15-year-old girl of dying of a maternal cause nearly halved between 2000 and 2017, globally, from 1 in 100, to 1 in 190.

Globally, following the trend of the HIV epidemic, the number of HIV-related indirect maternal deaths increased until 2005 when this number peaked at an estimated 10 000, before dropping to just over a third of that number (3600) in 2017. The effect of HIV on maternal mortality in 2017 appears to be less pronounced than in earlier years; HIV-related indirect maternal deaths now account for approximately 1% of all maternal deaths compared with approximately 2.5% in 2005, at the peak of the epidemic. This likely reflects improved care and management of HIV disease in general, and during pregnancy in particular. Continued attention to reducing new infections and providing optimal care to people living with HIV will ensure that these health gains are not eroded.

Table 4.3 presents the estimated MMRs and numbers of maternal deaths for 2000 and 2017 along with percentage changes over time for SDG regions, subregions and other groupings, and Annexes 7, 9, 11, 13, 15, 16 and 17 also present maternal mortality trend data for different regional groupings and per country.

When interpreting changes in MMRs over time, one should take into consideration that it is easier to reduce the MMR when the level is high than when the MMR level is already low.

### 4.2.1 Regional-level trends

Between 2000 and 2017, the subregion of Southern Asia achieved the greatest overall percentage reduction in MMR, with a reduction of 59% (from 384 [UI 347 to 432] to 157 [UI 136 to 189] maternal deaths per 100 000 live births), as shown in Table 4.3. This equates to an average annual rate of reduction of 5.3% (UI 4.2 to 6.3). Four other subregions roughly halved their MMRs during this period: Central Asia (52%), Eastern Asia (50%), Europe (53%) and Northern Africa (54%); all of these except Northern Africa already had low MMR (< 100) in 2000. Land-locked developing countries and the least developed countries also reduced their MMRs by almost half: 48% and 46%, respectively.

Despite its very high MMR in 2017, sub-Saharan Africa also achieved a substantial reduction in overall regional MMR of roughly 38% since 2000. In regions where MMR was already very low, less reduction was observed, such as the 11% reduction in Australia and New Zealand (from 8 to 7). However, notably, one subregion with very low MMR in 2000 (12) – Northern America – had an *increase* in MMR of almost 52% during this period, rising to 18 in 2017. This is likely due to already low levels of MMR, as well as improvements in data collection, changes in life expectancy and/or changes in disparities between subpopulations.

The greatest declines in the proportion of maternal deaths among women of reproductive age (PM) occurred in Central and Southern Asia (decline of 56.4%) and Northern Africa and Western Asia (decline of 42.6%). Oceania (excluding Australia and New Zealand), Latin America and the Caribbean, and Eastern and South-Eastern Asia all had declines higher than the world average reduction of 26.3%, with declines of 35.6%, 30.9% and 30.3%, respectively. Almost no change was seen in the PM in Europe and Northern America.

Declines in lifetime risk of maternal death for a 15-year-old girl were greater than the global average decline, between 2000 and 2017, in the regions of Central and Southern Asia (cut to less than a third of the risk) and Northern Africa and Western Asia (cut to less than half), and in the subregion of Oceania (excluding Australia and New Zealand) (cut to less than half). Little change was observed in lifetime risk in the region of Europe and Northern America and in the subregion of Australia and New Zealand.

With regard to HIV, the greatest declines in numbers of HIV-related indirect maternal deaths, after peaking globally in 2005, were observed in the regions of Central and Southern Asia (72% decline), sub-Saharan Africa (65% decline) and Latin American and the Caribbean (59%) and in the subregion of Oceania (excluding Australia and New Zealand) (56%). Lower levels of decline were observed in Eastern and South-Eastern Asia (13%). Notably, numbers of HIV-related indirect maternal deaths nearly doubled in Northern Africa and Western Asia and increased by one third in Europe and Northern America, but the numbers are still relatively low.

Annexes 7, 9, 11, 13, 15 and 16 present the MMR trends and percentage changes in MMR between 2000 and 2017 for WHO, UNICEF, UNFPA, World Bank Group, UNPD and SDG regions, respectively.

### 4.2.2 Country-level trends

Annex 17 presents the MMR trends (point estimates for five different years) and the average annual rates of reduction (ARR) in MMR between 2000 and 2017, as well as the range of the uncertainty intervals on the average ARRs, for each country. Assessment of country-level progress contributing to achieving the SDG target of global MMR less than 70 per 100 000 live births by 2030 (SDG target 3.1) is somewhat premature given the short reporting period since the start of the SDG reporting period (1 January 2016).

The 10 countries with the highest MMRs in 2017 (in order of highest to lowest: South Sudan, Chad, Sierra Leone, Nigeria, Central African Republic, Somalia, Mauritania, Guinea-Bissau, Liberia and Afghanistan) all have average ARRs between 2000 and 2017 of less than 5%. When comparing the average ARRs between the year ranges of 2000–2010 and 2010–2017, these 10 countries have also had stagnant or slowing levels of ARR and therefore remain at greatest risk. The impact of interruptions or loss of quality health services must be considered in crisis and other unstable situations. For countries with low MMR, attention to potential disparities between

**Table 4.3. Comparison of maternal mortality ratio (MMR, maternal deaths per 100 000 live births) and number of maternal deaths, by United Nations Sustainable Development Goal (SDG) region, subregion and other grouping, 2000 and 2017**

| SDG region | 2000 | | 2017 | | Overall percentage change in MMR between 2000 and 2017[c,d] (%) | Average annual rate of reduction in MMR between 2000 and 2017[d] (%) |
|---|---|---|---|---|---|---|
| | MMR point estimate[a] | Number of maternal deaths[b] | MMR point estimate | Number of maternal deaths | | |
| World | 342 | 451 000 | 211 | 295 000 | 38.4 | 2.9 |
| Sub-Saharan Africa[e] | 878 | 234 000 | 542 | 196 000 | 38.3 | 2.8 |
| Northern Africa and Western Asia | 158 | 15 000 | 84 | 9 700 | 46.6 | 3.7 |
| Northern Africa[f] | 244 | 11 000 | 112 | 6 700 | 54.1 | 4.6 |
| Western Asia[g] | 81 | 4 000 | 55 | 3 000 | 32.4 | 2.3 |
| Central and Southern Asia | 375 | 153 000 | 151 | 58 000 | 59.7 | 5.3 |
| Central Asia[h] | 49 | 590 | 24 | 390 | 52.0 | 4.3 |
| Southern Asia[i] | 384 | 152 000 | 157 | 58 000 | 59.2 | 5.3 |
| Eastern and South-Eastern Asia | 114 | 36 000 | 69 | 21 000 | 39.3 | 2.9 |
| Eastern Asia[j] | 56 | 11 000 | 28 | 5 300 | 49.9 | 4.1 |
| South-Eastern Asia[k] | 214 | 25 000 | 137 | 16 000 | 36.0 | 2.6 |
| Latin America and the Caribbean[l] | 96 | 11 000 | 74 | 7 800 | 22.6 | 1.5 |
| Oceania | 106 | 590 | 60 | 400 | 43.0 | 3.3 |
| Australia and New Zealand | 8 | 23 | 7 | 26 | 11.0 | 0.7 |
| Oceania (excl. Australia and New Zealand)[m] | 223 | 560 | 129 | 380 | 42.0 | 3.2 |
| Europe and Northern America | 17 | 2 000 | 12 | 1 500 | 27.5 | 1.9 |
| Europe[n] | 20 | 1 500 | 10 | 740 | 53.4 | 4.5 |
| Northern America[o] | 12 | 500 | 18 | 760 | -52.2 | -2.5 |
| Landlocked developing countries[p] | 788 | 98 000 | 408 | 65 000 | 48.2 | 3.9 |
| Least developed countries[q] | 763 | 194 000 | 415 | 130 000 | 45.6 | 3.6 |
| Small island developing States[r] | 249 | 3 100 | 210 | 2 600 | 15.7 | 1.0 |

[a] MMR point estimates have been rounded according to the following scheme: < 100 rounded to nearest 1; 100–999 rounded to nearest 1; and ⩾ 1000 rounded to nearest 10.

[b] Numbers of maternal deaths have been rounded according to the following scheme: < 100 rounded to nearest 1; 100–999 rounded to nearest 10; 1000–9999 rounded to nearest 100; and ⩾ 10 000 rounded to nearest 1000.

[c] Overall change for the whole period since the first year of the millennium (data from 1 January 2000).

[d] Percentage changes and annual rates of reduction were calculated on rounded numbers.

[e–r] See footnotes for Table 4.1.

subpopuulations and consideration of reducing overall PM will be important.

Countries with the highest rates of reduction between 2000 and 2017 (average ARR of 7% or above), starting with the highest, were Belarus, Kazakhstan, Timor-Leste, Rwanda, Turkmenistan, Mongolia, Angola and Estonia (see Annex 17). In considering the uncertainty around these average ARRs, we can only be very sure about this high level of acceleration (where the lower bound of uncertainty in the ARR is greater than or equal to 7%) in Belarus (13.0%; UI 9.6% to 16.7%), Kazakhstan (10.9%; UI 9.2% to 12.6%), Timor-Leste (9.8%; UI 7.7% to 11.9%) and Rwanda (9.1%; UI 7% to 10.7%). In 13 countries, MMR increased in the same period. In considering the uncertainty around the rate and direction of change, we believe there have been true MMR increases between 2000 and 2017 in the United States of America (ARR –2.6%; UI –3.3% to –1.9%) and the Dominican Republic (ARR –1%; UI –1.6% to –0.5%). Seventy-one countries had MMR greater than or equal to 100 in 2015, and of these only five countries had an overall MMR reduction of at least 66% (i.e. two thirds reduction) between 2000 and 2017: Angola, Cambodia, Nepal, Rwanda and Timor-Leste.

## 4.3 Comparison with previous maternal mortality estimates

The results described in this report include the first available estimates for maternal mortality for years that fall within the SDG reporting period; but since two years (2016 and 2017) is not sufficient to show trends, estimates have been developed and presented covering the period 2000 to 2017. In 2023, halfway through the SDG reporting period, a full review of SDG progress is planned, and at that time it will become possible to present trends from the start of the SDG reporting period (2016 onwards).

Care should be taken to use only these estimates for the interpretation of trends in maternal mortality from 2000 to 2017, rather than extrapolating trends based on comparison with previously published estimates. Please refer to Chapter 3 for full information about the methods used to develop the current estimates for 2000–2017.

### References


1. Life tables. In: Global Health Observatory (GHO) data [website]. Geneva: World Health Organization; 2019 (https://www.who.int/gho/mortality_burden_disease/life_tables/life_tables/en/, accessed 18 June 2019).

2. Millennium Development Goals and Beyond 2015: Background. In: United Nations [website]. United Nations; undated (https://www.un.org/millenniumgoals/bkgd.shtml, accessed 30 August 2019).

# 05

# TRENDS IN MATERIAL MORTALITY

# ASSESSING PROGRESS AND SETTING A TRAJECTORY TOWARDS ENDING PREVENTABLE MATERNAL MORTALITY AND ACHIEVING SDG TARGET 3.1

CONTENTS

## Box 5.1. GLOBAL TARGETS FOR REDUCING MATERNAL MORTALITY

SDG target 3.1: By 2030, reduce the global maternal mortality ratio to less than 70 per 100 000 live births *(1)*.

Ending preventable maternal mortality (EPMM): By 2030, every country should reduce its maternal mortality ratio (MMR) by at least two thirds from the 2010 baseline, and the average global target is an MMR of less than 70 maternal deaths per 100 000 live births.

- EPMM supplementary national target: By 2030, no country should have an MMR higher than 140 deaths per 100 000 live births (twice the global target). Country targets for 2030 depend on baseline levels of MMR, to increase equity in maternal mortality *(2)*.

## 5.1 Transition from MDG to SDG reporting

During the MDG era, which kicked off in 2000 with the United Nations Millennium Declaration, there were just eight MDGs, including MDG 5: Improve maternal health. MDG 5 had two targets: 5.A: Reduce by three quarters, between 1990 and 2015, the maternal mortality ratio (MMR), and 5.B: Achieve by 2015 universal access to reproductive health *(3)*. The baseline year against which all MDG-era progress was assessed was fixed at 1990, and notable progress was made in reducing maternal mortality by 2015, but it was insufficient to meet the MDG target *(4)*. In the transition from MDGs to SDGs, 17 new goals were set, with 13 health-related targets placed under the umbrella of one of those goals: SDG 3: Ensure healthy lives and promote wellbeing for all at all ages. One of those health-related targets is SDG target 3.1, which is the focus of this report: By 2030, reduce the global MMR to less than 70 per 100 000 live births. The focus of attention in the Sustainable Development Agenda also moves beyond individual countries with the poorest health and development outcomes to the contributions of all countries to the global targets of all SDGs, with a view to improved equity. As the SDG reporting period – 2016 to 2030 – progresses and data become consistently available for analysis (i.e. when countries provide more data, disaggregated data and more data points), reporting should also focus on the effect of inequities and how to address them, as articulated within the SDGs.

In the era of the SDGs, an acceleration of current progress is required in order to achieve SDG target 3.1, working towards a vision of ending all preventable maternal mortality (see Box 5.1). By the current projection, achieving this global goal will require countries to reduce their MMRs by at least 6.1% each year between 2016 and 2030. Based on the new point estimates for MMR in 2000 and 2017, only 16 countries (Angola, Belarus, Cambodia, Estonia, Iran, Kazakhstan, Lao People's Democratic Republic, Mongolia, Nepal, Poland, Romania, Russian Federation,

Rwanda, Tajikistan, Timor-Leste and Turkmenistan) have demonstrated this rate (or higher) of average annual reduction of MMR. Highlighting the strategies employed by these and other countries with overall improvements in maternal health can illuminate routes to progress that other countries may find useful. For the countries with the highest MMRs in 2017, substantially higher annual rates of reduction will be required to attain levels below 140 maternal deaths per 100 000 live births in 2030, which is the EPMM supplementary national target (see Box 5.1).

Projections indicate that accomplishing the target of global MMR less than 70 will result in nearly 70% fewer deaths in 2030 than the estimated number in 2015, and will save approximately 1.4 million women's lives between 2016 and 2030, as compared with a situation in which the rate of reduction of MMR since 2015 remains the same as the rate observed in the 2010–2017 period.

Under the scenario where the current pace (i.e. the pace seen during the period 2010–2017) continues during the first half of the SDG reporting period, the global MMR is projected to be approximately 189 in 2023 (at the halfway point), a significant gap from the MMR of 118 which we need to reach by that year in order to be on track to achieve the final SDG target of below 70 by 2030.

**Box 5.2.** STRATEGIC FRAMEWORK FOR ENDING PREVENTABLE MATERNAL MORTALITY (EPMM)

**Guiding principles for EPMM**

- Empower women, girls and communities.
- Protect and support the mother–baby dyad.
- Ensure country ownership, leadership and supportive legal, technical and financial frameworks.
- Apply a human rights framework to ensure that high-quality reproductive, maternal and newborn health care is available, accessible and acceptable to all who need it.

**Cross-cutting actions for EPMM**

- Improve metrics, measurement systems and data quality to ensure that all maternal and newborn deaths are counted.
- Allocate adequate resources and effective health care financing.

**Five strategic objectives for EPMM**

- Address inequities in access to and quality of sexual, reproductive, maternal and newborn health care.
- Ensure universal health coverage for comprehensive sexual, reproductive, maternal and newborn health care.
- Address all causes of maternal mortality, reproductive and maternal morbidities, and related disabilities.
- Strengthen health systems to respond to the needs and priorities of women and girls.
- Ensure accountability to improve quality of care and equity.

*Source:* WHO 2015

## 5.2. Strategies for improving maternal health: 2016 to 2030

The Global Strategy for Women's, Children's and Adolescents' Health describes the vision for improving the health of every woman and every child, everywhere, between 2016 and 2030 *(6)*. Some of the drivers of success in reducing maternal mortality range from making improvements at the provider and health system level, to implementing interventions aimed at reducing social and structural barriers. These strategies are part of the EPMM strategic framework for policy and programme planning, which is informed by a set of four guiding principles (see Box 5.2) *(2)*.

### 5.2.1 Specialized population groups: humanitarian and crisis settings, vulnerable populations and late maternal deaths

Examining countries that have experienced little to no reduction in maternal mortality since 2000 reveals a number of factors that impede progress, both for those with high levels of maternal mortality, and those where national levels are already low, but where levels in certain subpopulations are high.

Emergent humanitarian settings and situations of conflict, post-conflict and disaster significantly hinder progress. The Fragile States Index assesses and ranks 178 countries, based on 12 cohesion, economic, social and political indicators, resulting in a score that indicates their susceptibility to instability.[27] In 2017, the 178 countries ranged in rank from South Sudan (1st, most fragile, score = 113.9) to Finland (178th, least fragile, score = 18.7). Six countries were considered to be "very high alert" (from highest to lowest: South Sudan, Somalia, Central African Republic, Yemen, Syrian Arab Republic, Sudan) while nine were categorized as "high alert" (Democratic Republic of the Congo, Chad, Afghanistan, Iraq, Haiti, Guinea, Nigeria, Zimbabwe, Ethiopia) *(7)*.[28] These 15 countries had MMRs in 2017 ranging from 31 (Syrian Arab Republic) to 1150 (South Sudan); this is in contrast to MMR of 3 in the single "very sustainable" country (Finland), and MMRs ranging from 2 (Norway) to 10 (Canada) in the 14 countries labelled as "sustainable"*(7)*.[29] In crisis and disaster settings, the breakdown of health systems can cause a dramatic rise in deaths due to complications that would be easily treatable under stable conditions (see Annex 3).

Many of the most vulnerable populations are not represented in the current global data, as there are simply no systems in place for many such populations. Even for countries with good overall progress indicators, the national-level data often mask extreme disparities that exist between population groups within these countries. For example, new data on maternal deaths in Australia suggest that Aboriginal and Torres Strait Islander women have a higher incidence of maternal death than other non-Indigenous women. Data suggest that the MMR was 4.6 times higher for Indigenous women compared with non-Indigenous women in 2016: 31.6 versus 6.9 maternal deaths per 100 000 live births *(8)*. Another study, from the USA, found that during 2007–2016, black and American Indian/Alaska Native women had significantly more maternal deaths (including late maternal deaths) per 100 000 births than did white, Hispanic and Asian/Pacific Islander women. These differences persisted over time and across age groups and education levels *(9)*. Marginalized subpopulations often lack representation in the data, and disparities may not be evident without disaggregating the

[27] Further information about indicators and methodology is available at: https://fragilestatesindex.org/.

[28] At the top of the range (most fragile), the scores are categorized as follows: > 110 = very high alert; 100–110 = high alert. These two categories, in 2017, include the 15 most fragile countries, as mentioned here. There are 10 other categories ranging from "very sustainable" to "alert", which include the remaining 163 countries *(7)*.

[29] Analysis using 2017 data from this current report against the countries/categories presented in the 2017 Fragile States Index *(7)*.

data. This lack of accurate and representative information makes it nearly impossible to determine how to best address the maternal health needs among the most vulnerable.

An emerging challenge is increasing late maternal mortality, a phenomenon referred to as part of the "obstetric transition" *(10)*. A late maternal death refers to a death from direct or indirect obstetric causes that occurs more than 42 days but less than one year after termination of pregnancy (see Chapter 2 for this and other definitions). As health systems improve and are better able to manage the immediate complications of labour and childbirth, more deaths within the first 48 hours of delivery and within the first 42 days postpartum may be averted, but the proportion of mortality (and also morbidity) caused by late maternal sequelae or late maternal complications will tend to increase. With the understanding that further analysis of this subset of deaths is warranted, the definitions related to deaths occurring during pregnancy, childbirth and the puerperium were expanded in the ICD-11 to include a new group called "comprehensive maternal deaths", which includes late maternal deaths along with other maternal deaths. The intention is to facilitate further analysis of the timing of maternal deaths (including disaggregation of data). Monitoring overall maternal health is increasingly important for ensuring accurate documentation to detect shifting dynamics in maternal morbidity and mortality, up to a year after termination of pregnancy. More and more countries are collecting and reporting on this information; as of October 2018, 61 out of 142 (43%) countries included in the global maternal mortality database[30] had data on late maternal deaths (ICD codes O96 and O97). However, this report does not present data on late maternal deaths; analyses of these data are planned for future reports on maternal mortality.

[30] WHO Mortality Database: https://www.who.int/healthinfo/mortality_data/en/ (select indicator for "pregnancy, childbirth and the puerperium").

### 5.2.2 Challenges remain: need for improved civil registration and vital statistics (CRVS) systems and other data sources

Impressive efforts to establish and improve CRVS systems or implement alternative methods of rigorously recording maternal deaths have been made in recent years, including the expansion of the use of confidential enquiries into maternal death (CEMD) and maternal death surveillance and response (MDSR) in an increasing number of countries (see Annex 2 for further information on these and other methods of gathering accurate data on maternal mortality). The efforts of countries to produce high-quality data and correct for errors in maternal death classification have prompted the development of refined estimation methods that fully utilize country-level data to produce a more accurate and realistic picture of global maternal mortality trends.

Given the high percentage of births and maternal deaths that occur outside of health-care facilities, there is a critical need to obtain and communicate vital events data from the community level. Digital solutions delivered via mobile devices (mHealth tools) that connect front-line health workers to national health systems can simultaneously improve health-care service delivery, strengthen accountability and generate real-time data *(11)*. A growing proportion of these digital tools focus on registration of pregnancies and notification of births and deaths, linking information directly to facility-, district- and national-level routine reporting systems and vital events registers *(12)*. Pilot tests of digital tools integrated with national routine reporting systems are under way across many countries in Asia and Africa.

Yet, while the estimates presented in this report provide a valuable basis for policy and programme planning guidance, still the

fact remains that many women who die from maternal causes go uncounted, such that even more efforts are needed to improve data collection/recording systems. The broad uncertainty intervals associated with the estimates presented throughout this report directly reflect the critical need for better data on maternal mortality. Of the various sources of data that can be used for producing MMR estimates (i.e. CRVS, population-based household surveys, reproductive-age mortality studies [RAMOS], CEMD, verbal autopsies, censuses and other specialized maternal mortality studies), complete, accurate and validated CRVS systems are the best sources, where available. Governments are called upon to establish well functioning CRVS systems with accurate attribution of cause of death. Improvements in measurement must be driven by action at the country level, with governments creating systems to capture data specific to their information needs; systems that must also meet the standards required for international comparability. Globally, standardized methods for preventing errors in CRVS reporting (i.e. incomplete CRVS systems [unregistered deaths] and misclassification of cause of death) should be established to enhance international comparability.

Finally, data that can be disaggregated to examine trends and measure the mortality burden within the most vulnerable and most frequently overlooked populations (see section 5.2.1) are critical for implementing strategies to address inequities and accelerate progress towards maternal mortality reduction. Better data are needed on the maternal mortality burden among sub-populations. For example, among adolescent girls aged 15-19 years,, pregnancy and childbirth complications are the leading cause of death globally *( 13)*[31]. Several countries, particularly those in Latin America and the Caribbean, and in South-East Asia, have already begun reporting data for women and girls outside the standard 15–49 year age interval, documenting the disturbing fact that maternal deaths are occurring among girls even younger than 15.

Ultimately, respect for human rights and human life necessitates improved record-keeping – so that all births, deaths and causes of death are officially accounted for – as well as improved data analysis and disaggregation. For these reasons, improving metrics, measurement systems and data quality are crucial cross-cutting actions for all strategies aimed at ensuring maternal survival *(2)*.

[31] Special tabulations were done, as source does not provide information for ages 15–19 years.

## References


1. Sustainable Development Goal 3. In: Sustainable Development Goals Knowledge Platform [website]. New York (NY): United Nations; 2019 (https://sustainabledevelopment.un.org/SDG3, accessed 10 June 2019).

2. Strategies towards ending preventable maternal mortality (EPMM). Geneva: World Health Organization; 2015 (http://www.everywomaneverychild.gghbgorg/images/EPMM_final_report_2015.pdf, accessed 5 November 2015).

3. Goal 5: Improve maternal health. In: Millennium Development Goals and Beyond 2015 [website]. United Nations; 2015 (https://www.un.org/millenniumgoals/maternal.shtml, accessed 12 September 2019).

4. World Health Organization (WHO), United Nations Children's Fund (UNICEF), United Nations Population Fund (UNFPA), World Bank Group, United Nations Population Division. Trends in maternal mortality: 1990 to 2015: estimates by WHO, UNICEF, UNFPA, World Bank Group and the United Nations Population Division. Geneva: World Health Organization; 2015 (https://www.who.int/reproductivehealth/publications/monitoring/maternal-mortality-2015/en/, accessed 4 September 2019).

5. Alkema L, Chou D, Hogan D, Zhang S, Moller A, Gemmill A, et al. Global, regional, and national levels and trends in maternal mortality between 1990 and 2015, with scenario-based projections to 2030: a systematic analysis by the UN Maternal Mortality Estimation Inter-Agency Group. Lancet. 2016;387(10017):462–74. doi:10.1016/S0140-6736(15)00838-7.

6. Global strategy for women's, children's and adolescents' health (2016–2030). New York (NY): Every Woman Every Child; 2015 (http://globalstrategy.everywomaneverychild.org/, accessed 10 June 2019).

7. Messner JJ, Haken N, Taft P, Blyth H, Maglo M, Murp C, et al. 2017 Fragile States Index. Washington (DC): The Fund for Peace; 2017 (https://fragilestatesindex.org/wp-content/uploads/2017/05/951171705-Fragile-States-Index-Annual-Report-2017.pdf, accessed 4 September 2019).

8. Maternal deaths in Australia 2016. Canberra: Australian Institute of Health and Welfare; 2018 (https://www.aihw.gov.au/reports/mothers-babies/maternal-deaths-in-australia-2016, accessed 3 September 2019).

9. Petersen EE, Davis NL, Goodman D, Cox S, Syverson C, Seedet K, al. Racial/ethnic disparities in pregnancy-related deaths – United States, 2007–2016. MMWR Morb Mortal Wkly Rep. 2019;68:762–5. doi:10.15585/mmwr.mm6835a3.

10. Souza J, Tunçalp Ö, Vogel J, Bohren M, Widmer M, Oladapo O, et al. Obstetric transition: the pathway towards ending preventable maternal deaths. BJOG. 2014;121(s1):1–4.

11. Mehl G, Labrique A. Prioritizing integrated mHealth strategies for universal health coverage. Science. 2014;345(6202):1284–7.

12. Labrique AB, Pereira S, Christian P, Murthy N, Bartlett L, Mehl G. Pregnancy registration systems can enhance health systems, increase accountability and reduce mortality. Reprod Health Matters. 2012;20(39):113–7.

13. Global health estimates 2015: deaths by cause, age, sex, by country and by region, 2000–2015. Geneva: World Health Organization; 2016.

© UNICEF/Paul

# 06 TRENDS IN MATERNAL MORTALITY CONCLUSIONS

The Sustainable Development Goals (SDGs) include a direct emphasis on reducing maternal mortality (SDG target 3.1) while also highlighting the importance of moving beyond the focus on survival, as expressed by SDG 3: Ensure healthy lives and promote wellbeing for all at all ages *(1)*. Despite the ambition to end preventable maternal deaths by 2030, the world will fall short of this target by more than 1 million lives with the current pace of progress. There is a continued urgent need for maternal health and survival to remain high on the global health and development agenda; the state of maternal health interacts with and reflects efforts to improve on the accessibility and quality of health care. The 2018 Declaration of Astana *(2)* repositioned primary health care as the most (cost) effective and inclusive means of delivering health services to achieve the SDGs *(3)*. When effectively linked with higher levels of care, primary health care is thereby considered the cornerstone for achieving universal health coverage (UHC), which only exists when all people receive the quality health services they need without suffering financial hardship *(4,5)*.

Unfortunately, the theory of this approach is not necessarily reflected in the daily reality of much of the world's population. During the MDG reporting era, hundreds of health financing schemes and programmes were initiated throughout low- and middle-income

countries to serve the public health needs of the population *(6)*. However, gaps still exist in coverage of maternal health, especially in the availability of comprehensive maternal health services, including emergency obstetric care, and adequate numbers of competent health-care providers, such as midwives *(6,7)*. Scratching below the surface of the admirable efforts to facilitate uptake of care and improve health outcomes shows that only about half of the financial schemes that emerged between 1990 and 2014 covered hospital services and maternal care *(6)*. From a behavioural and economics perspective, it is difficult for individuals and households to plan for low-probability events, such as a maternal health emergency. Furthermore, failing to prepare for such health emergencies will have greater consequences for the poor *(8,9)*. Financial implications aside, the ability to achieve UHC is also predicated on identifying the population in need of care. Countries are striving to register all births within their CRVS systems, but there remains a need to be able to (uniquely) identify individuals within a population.

Taking effective action to tackle the causes of maternal death is also critical to developing programmes that will be able to address health needs across the life course. This will require attention to shifting population dynamics and the increasing burden and impact of noncommunicable diseases in women of reproductive age. The need for states to establish mechanisms to provide health care must be qualified, in that health services that are unavailable, inaccessible or of poor quality will not support the achievement of UHC, as envisioned. Clearly, complex intricacies exist and the relevant stakeholders in this discourse include those within and beyond the health sector. Efforts to increase the provision of skilled and competent care to more women, before, during and after childbirth, must also be seen in the context of external forces including but not limited to climate change, migration and humanitarian crises *(3)* – not only because of the environmental risks presented, but also because of their contribution to health complications.

In consideration of the above, it must be noted that this report on the levels and trends of maternal mortality provides but one critical facet of information, which synthesizes and draws from the available data, to assess one aspect of global progress towards achieving global goals for improved health and sustainable development. In the context of efforts to achieve UHC, improving maternal health is critical to fulfilling the aspiration to reach SDG 3. One can only hope that the global community will not be indifferent to the shortfalls that are expected if we can't improve the current rate of reduction in maternal mortality. Ultimately, we need to expand horizons beyond a sole focus on mortality, to look at the broader aspects – country and regional situations and trends including health systems, UHC, quality of care, morbidity levels and socioeconomic determinants of women's empowerment and education – and ensure that appropriate action is taken to support family planning, healthy pregnancy and safe childbirth.

## References


1. Sustainable Development Goal 3. In: Sustainable Development Goals Knowledge Platform [website]. New York (NY): United Nations; 2019 (https://sustainabledevelopment.un.org/SDG3, accessed 4 September 2019).

2. Declaration of Astana. Geneva and New York (NY): World Health Organization and the United Nations Children's Fund (UNICEF), 2018 (https://www.who.int/docs/default-source/primary-health/declaration/gcphc-declaration.pdf, accessed 4 September 2019).

3. Binagwaho A, Ghebreyesus TA. Primary healthcare is cornerstone of universal health coverage. BMJ. 2019;365. doi:10.1136/bmj.l2391.

4. Arguing for universal health coverage. Geneva: World Health Organization; 2013 (https://www.who.int/health_financing/UHC_ENvs_BD.PDF, accessed 4 September 2019).

5. Xu K, Soucat A, Kutzin J, Brindley C, Dale E, Van de Maeleet N, et al. New perspectives on global health spending for universal health coverage. Geneva: World Health Organization; 2018 (WHO/HIS/HGF/HFWorkingPaper/18.2; https://apps.who.int/iris/bitstream/handle/10665/259632/WHO-HIS-HGF-HFWorkingPaper-17.10-eng.pdf, accessed 12 September 2019).

6. Vargas V, Ahmed S, Adams AM. Factors enabling comprehensive maternal health services in the benefits package of emerging financing schemes: a cross-sectional analysis from 1990 to 2014. PLoS One. 2018;13(9):e0201398. doi:10.1371/journal.pone.0201398.

7. The state of the world's midwifery 2014: a universal pathway: a woman's right to health. New York (NY): United Nations Population Fund; 2014 (https://www.unfpa.org/sowmy, accessed 13 September 2019).

8. Wagstaff A. Measuring financial protection in health. Policy Research Working Paper 4554. Washington (DC): The World Bank Development Research Group; 2008 (http://documents.worldbank.org/curated/en/157391468140940134/pdf/wps4554.pdf, accessed 4 September 2019).

9. Mullainathan S. Development economics through the lens of psychology. In: Annual World Bank Conference on Development Economics 2005: Lessons of Experience. Washington (DC) and New York (NY): World Bank and Oxford University Press 2005;45–70 (http://www.bjstrew.com/be/Mullainathan.pdf, accessed 4 September 2019).

# Annexes

## TRENDS IN MATERNAL MORTALITY

# ANNEX 1

## SUMMARY DESCRIPTION OF THE 2019 COUNTRY CONSULTATIONS

The development of global, regional and country-level estimates and trends in morbidity and mortality is one of the core functions of the World Health Organization (WHO). WHO is the custodian agency within the United Nations system that leads the development of updated maternal mortality estimates together with the United Nations Children's Fund (UNICEF), the United Nations Population Fund (UNFPA), the World Bank Group and the United Nations Population Division (UNPD), as members of the United Nations Maternal Mortality Estimation Inter-Agency Group (UN MMEIG).

In 2001, the WHO Executive Board endorsed a resolution (EB.107.R8) which included the proposal to "establish a technical consultation process bringing together personnel and perspectives from Member States in different WHO regions".[32] A key objective of this country consultation process is "to ensure that each Member State is consulted on the best data to be used" for international estimation and reporting purposes. Since the process is an integral step in the overall maternal mortality estimation strategy, as well as an SDG requirement to consult with national focal points[33], it is described here in brief.

The WHO country consultation process entails an exchange between WHO and technical focal person(s)/offices in each Member State, in addition to the territories Puerto Rico and the West Bank and Gaza Strip.[34] It is carried out after the development of preliminary estimates and prior to the publication of final estimates for the period of interest. During the consultation period, WHO invites technical focal person(s)/offices – who have been nominated to speak on behalf of their country about maternal mortality data – to review the UN MMEIG's input data sources, methods for estimation and the preliminary estimates. The focal person(s)/offices are encouraged to submit additional data that may not have been taken into account in the preliminary estimates.

The country consultation process for the 2019 round of maternal mortality estimates was initiated with an official communication from WHO to the countries on 9 May 2018. This letter informed them of the forthcoming exercise to estimate maternal mortality for the years 2000–2017 and requested the designation of an official technical focal person (typically within the national ministry of health and/or the central statistics office) to participate in the consultation. These designated officials and also the existing SDG national focal points subsequently, in May 2019, received the following items by email: (1) a copy of the official communication from WHO (CL.15.2018, dated 9 May 2018); (2) draft estimates and data sources; and (3) a summary of the methodology used. WHO headquarters and regional offices actively collaborated in identifying technical focal persons through their networks.

[32] Resolution of the Executive Board of the WHO: Health systems performance assessment (EB.107.R8: http://apps.who.int/gb/archive/pdf_files/EB107/eer8.pdf).

[33] National focal points for the SDGs are contact persons within national statistics offices who facilitate discussions with countries in relation to the reporting for SDGs. Report of the Inter-Agency and Expert Group on Sustainable Development Goal Indicators (E/CN.3/2018/2: https://unstats.un.org/unsd/statcom/49th-session/documents/2018-2-SDG-IAEG-E.pdf).

[34] Puerto Rico is an Associate Member, and the West Bank and Gaza Strip is a member in the regional committee for the WHO Eastern Mediterranean Region (EM/RC40/R.2: https://apps.who.int/iris/bitstream/handle/10665/121332/em_rc40_r2_en.pdf). The WHO governing bodies use the name "West Bank and Gaza Strip".

The formal consultation period ran from 15 May 2019 for four weeks, and the process was officially completed on 12 June 2019.

The table below provides a summary of the nominations of designated country WHO officials (technical focal persons for maternal mortality) and country SDG officials (SDG focal points), and numbers of countries providing feedback during the 2019 country consultations, by WHO region.

| WHO region | WHO technical focal persons (number of countries) | SDG focal points (number of countries) | Number of countries providing feedback during the country consultation |
|---|---|---|---|
| African Region | 22 | 23 | 12 |
| Region of the Americas | 25 | 16 | 19 |
| South-East Asia Region | 10 | 6 | 8 |
| European Region | 31 | 45 | 28 |
| Eastern Mediterranean Region | 20 | 11 | 11 |
| Western Pacific Region | 11 | 13 | 12 |
| Total | 119 | 114 | 90 |

During the consultation period, new data submitted by countries were reviewed by the UN MMEIG Secretariat and statisticians to determine whether they met the inclusion criteria of this global estimation exercise. Data were considered acceptable to use as new input if they were representative of the national population and referred to a specific time interval within the period from 1990 to 2017.

The inputs received during the 2019 country consultations were added to the input databases. The current estimates are based on 2975 records corresponding to 4123 country-years of information.

As in the previous country consultation, the new observations were from CRVS systems, specialized studies and household surveys.

However, an increase in the number of other new observations/data points, from various sources of data, shows that countries lacking functioning CRVS systems are increasingly investing in monitoring maternal mortality with empirical data from alternative sources, such as surveillance systems.

# ANNEX 2
## MEASURING MATERNAL MORTALITY

Definitions and measures of maternal mortality as used in this report have already been presented and described in Chapter 2. This annex provides further details on ICD coding and approaches to measuring maternal mortality.

Despite the standard definitions noted in Chapter 2, accurate identification of the causes of maternal deaths by differentiating the extent to which they are due to direct or indirect obstetric causes, or due to accidental or incidental events, is not always possible – particularly in settings where deliveries occur mostly at home, and/or where civil registration and vital statistics (CRVS) systems do not reliably include correct attribution of cause of death.

## Coding of maternal deaths

With the publication of ICD-10, WHO recommended adding a checkbox on death certificates for recording a woman's pregnancy status at the time of death or within 42 days or up to a year before death *(1)*. This helps to identify indirect maternal deaths and pregnancy-related deaths, but unfortunately it has not been implemented in many countries to date. Historically, for countries using ICD-10 coding for registered deaths, the United Nations Maternal Mortality Estimation Inter-Agency Group (UN MMEIG) counted all deaths coded to the maternal chapter (O codes) and A34 (maternal tetanus) as maternal deaths. As indicated in the ICD-11 (and previously in the ICD-10), only maternal deaths occurring up to 42 days postpartum are considered relevant for the purposes of international reporting and for the calculation of maternal mortality ratios and rates (i.e. excluding late maternal deaths).[35,36]

In 2012, WHO published *Application of ICD-10 to deaths during pregnancy, childbirth and the puerperium: ICD maternal mortality (ICD-MM)* to guide countries to reduce errors in coding maternal deaths and to improve the attribution of cause of maternal death (2). The ICD-MM is to be used together with the three ICD-10 volumes. For example, the ICD-MM clarifies that deaths among HIV-positive women who were pregnant, in labour or postpartum may be due to one of the following.

- Obstetric/maternal causes, such as haemorrhage or hypertensive disorders in pregnancy: These should be identified as direct maternal deaths.
- The interaction between HIV and pregnancy (i.e. aggravating effects of pregnancy on HIV): These should be identified as indirect maternal deaths, and they are referred to in this report as "HIV-related indirect maternal deaths". These deaths are coded in the ICD-10 to O98.7[37] ("HIV disease complicating pregnancy, childbirth and the puerperium"), and categorized

[35] ICD-11, Part 2, section 2.28.5.7: "International reporting of maternal mortality: For the purpose of the international reporting of maternal mortality, only those maternal deaths occurring before the end of the 42-day reference period should be included in the calculation of the various ratios and rates, although the recording of later deaths is useful for national analytical purposes" *(3)*.

[36] Late maternal deaths coded to O96 (late maternal deaths) and O97 (late maternal deaths due to sequalae of complications) are also of interest for national- and international-level analysis, but are not reported in this publication.

[37] Search for O98.7 in the current (2016) version of ICD-10: https://icd.who.int/browse10/2016/en.

in the ICD-MM as Group 7: non-obstetric complications. Before 2010, these should have been coded to Chapter 1 (Certain Infectious and Parasitic Disease) according to ICD-10 rule 5.8.3: "Note that when calculating maternal mortality rates, cases not coded to Chapter XV (O codes) should be included. These include those categories presented in the 'Exclusion Note' at the beginning of Chapter XV, provided that they meet the specifications outlined in Section 4.3.16 a) for indirect obstetric causes" *(4)*.

- AIDS: In these cases, the woman's pregnancy status is incidental to the course of her HIV infection and her death is a result of an HIV complication, as described by ICD-10 codes B20–24. These are not considered maternal deaths. Thus, proper reporting of the mutual influence of HIV or AIDS and pregnancy in Part 1 of the death certificate[38] will facilitate the identification and correct coding of these deaths.

## Approaches for measuring maternal mortality

Ideally, a country's data collection system for maternal mortality provides accurate data on mortality and the causes of death. However, in countries with poor quality data (e.g. incomplete CRVS systems or high rates of misclassification of cause of death), it is difficult to accurately measure levels of maternal mortality. First, it is challenging to identify maternal deaths precisely, as the deaths of women of reproductive age might not be recorded at all. Second, even if such deaths were recorded, the pregnancy status or cause of death may not have been known or recorded, and the deaths would therefore not have been reported as maternal deaths. Third, in most low- and middle-income country settings where medical certification of cause of death is not systematically implemented, accurate attribution of a female death as a maternal death remains difficult.

Even in countries where routine registration of deaths is in place, maternal deaths may be underreported due to misclassification of cause of death using ICD-10 coding, and identification of the true numbers of maternal deaths may require additional special investigations into the causes of death. A specific example of such an investigation is the confidential enquiry into maternal death (CEMD), a system first established in England and Wales in 1928 *(5,6,7)*. The United Kingdom and Ireland CEMD report for 2009–2012 identified 79% more maternal deaths than were reported in the routine CRVS system *(8)*. Other studies on the accuracy of the number of maternal deaths reported in CRVS systems have shown that the true number of maternal deaths could be twice as high as indicated by routine reports, or even more *(9, 10)*. A recent paper by Peterson et al. describes a Bayesian bivariate random walk model developed by the authors to estimate sensitivity and specificity of the reporting on maternal mortality in CRVS data and the fitting of the model to a global data set of CRVS and specialized (validation) study data (the searches included publications from 1990 to 2016) *(11)*.

These studies into the causes of death are diverse in terms of the definition of maternal mortality used, the sources considered (death certificates, other vital event certificates, medical records, questionnaires or autopsy reports) and the way maternal deaths are identified (record linkage or assessment from experts). In addition, the system of reporting causes of death to a civil registry differs from one country to another, depending on the death certificate forms, the type of certifiers and the coding practice. These studies have

[38] Available at: https://icd.who.int/icd11refguide/en/index.html#2.23.00AnnexesForMortalityCoding|international-form-of-medical-death-certificate|c2-23-1

estimated underreporting of maternal mortality due to misclassification in death registration data, ranging from 0.85 to 5.0, with a median value of 1.5 (i.e. a misclassification rate of 50%). Reporting errors in the registration of maternal deaths (i.e. incompleteness and/or misclassification of cause of death) were more common among *(12)*:

- early pregnancy deaths, including those not linked to a reportable birth outcome;
- deaths in the later postpartum period (i.e. after the first 7 days and up to 42 days postpartum; these were less likely to be reported as maternal deaths than early postpartum deaths);
- deaths at the extremes of maternal age (youngest/teenage [i.e. under age 20] and oldest/advanced maternal age [i.e. age 35 and over]);
- miscoding (in terms of ICD codes), most often seen in cases of deaths caused by:
  - cerebrovascular diseases
  - cardiovascular diseases.

Potential reasons cited for incompleteness (unregistered maternal deaths) and/or misclassification of cause of death include:

- inadequate understanding of the ICD rules
- death certificates completed without mention of pregnancy status
- desire to avoid litigation
- desire to suppress information (especially information about abortion-related deaths).

The definitions of misclassification and incompleteness of maternal death reporting are provided in Box 3.1 in Chapter 3.

In the absence of complete and accurate CRVS systems, MMR estimates are based on data from a variety of sources, including censuses, household surveys, reproductive-age mortality studies (RAMOS) and verbal autopsies. Each of these methods has limitations in estimating the true levels of maternal mortality. Brief descriptions of these methods together with their limitations are provided below.

## Methods, systems and tools for identifying and measuring maternal deaths

### a. Routine or regular data collection efforts

*Civil registration and vital statistics (CRVS) system*

A national CRVS system involves the routine registration of births and deaths (input), and the compilation of vital statistics (output). The record of each death should include the age and sex of the deceased, as well as the cause of death, based on a medical certificate completed by a physician. Ideally, maternal mortality data should be among the vital statistics that can be obtained through the CRVS system. However, even where CRVS coverage is complete nationally (i.e. full geographic coverage) and the causes of all registered deaths have been identified and reported based on standard medical certificates, in the absence of active case finding and review, maternal deaths may still be unregistered or misclassified *(9)*.

In some countries and territories with incomplete CRVS systems, specific effort is made to identify unregistered deaths. These efforts may be published under various labels or may exist as administrative processes to "clean" data. See subsection below: *Specialized studies to identify maternal deaths.* Sampled vital registration systems also exist in countries, such as India.[39] The basic

[39] Available at: http://censusindia.gov.in/vital_statistics/SRS/Sample_Registration_System.aspx

structure of these sample registration systems include a baseline survey and continuous enumeration of vital events with verification by verbal autopsy.

*Household surveys ( 13, 14, 15)*

Demographic and Health Surveys (DHS)[40] and Multiple Indicator Cluster Surveys (MICS)[41] use the direct "sisterhood" method to collection maternal mortality data using household surveys. This method obtains information by interviewing a representative sample of respondents about the survival of all their siblings (to determine the age of all siblings, how many are alive, how many are dead, age at death and year of death of those dead, and among sisters who reached reproductive age, how many died during pregnancy, delivery or within two months of pregnancy). This approach has the following limitations.

- It identifies pregnancy-related deaths, rather than maternal deaths (same as the original indirect sisterhood method).
- It produces estimates with wide confidence intervals, thereby diminishing opportunities for trend analysis (same as the indirect method).
- It provides a retrospective rather than a current maternal mortality estimate (referring to a period three to four years prior to the survey *( 15)*, which is better than 10–12 years in the past using the indirect sisterhood method).
- It requires a larger sample size and more questions than the original indirect variant of the method and the collection and analysis of the data are more complicated.

*Census ( 16, 17)*

A national census, with the addition of a limited number of questions about deaths to females of reproductive age, could support estimates of maternal mortality. This approach eliminates sampling errors (because all women are covered) and hence allows a more detailed breakdown of the results, including trend analysis, geographic subdivisions and social strata.

- This approach allows identification of deaths in the household in a relatively short reference period (1–2 years prior to the census), thereby providing recent maternal mortality estimates, but censuses are conducted at 10-year intervals, therefore limiting the monitoring of maternal mortality.
- It identifies pregnancy-related deaths (not maternal deaths); however, if combined with verbal autopsy (see below), maternal deaths could be identified.
- Training of census enumerators is crucial, since census activities collect information on a wide range of topics.
- Results must be adjusted for characteristics such as completeness of death and birth statistics and population structures, in order to arrive at reliable estimates.

### b. Specialized studies to identify maternal deaths

*Reproductive-age mortality studies ( RAMOS) ( 14, 18)*

This approach involves first identifying and then investigating and establishing the causes of all deaths of women of reproductive age in a defined area or population, by using multiple sources of data, such as CRVS systems, health-care facility records, burial records, and interviews with family members, community leaders, health-care providers (including physicians) and traditional birth attendants. The RAMOS approach has the following characteristics.

[40] https://dhsprogram.com/
[41] http://mics.unicef.org/

- Multiple and diverse sources of information must be used to identify deaths of women of reproductive age; no single source identifies all the deaths.
- Interviews with household members, health-care providers and reviews of facility records are used to classify the deaths as maternal or otherwise.
- If properly conducted, this approach provides a fairly complete estimation of maternal mortality in the absence of reliable CRVS systems with national coverage, and could provide subnational MMRs. However, inadequate identification of all deaths of women of reproductive age at the start of the process results in underestimation of maternal mortality levels.
- This approach can be complicated, time-consuming and expensive to undertake – particularly on a large scale.
- The number of live births used in the computation of MMR may not be accurate, especially in settings where most women deliver at home.

*Verbal autopsy (19–22)*

This approach is used to assign cause of death through interviews with family or community members, where medical certification of cause of death is not available (e.g. as part of the RAMOS method). Verbal autopsies may be conducted as part of a demographic surveillance system maintained by research institutions that collect records of births and deaths periodically among small populations (typically in a district). This approach may also be combined with household surveys or censuses (see above). In special versions, and in combination with software that helps to identify the diagnosis, verbal autopsy is suitable for routine use as an inexpensive method in populations where no other method of assessing the cause of death is in place. The following limitations characterize this approach.

- Misclassification of causes of deaths in women of reproductive age is not uncommon with this technique.
- It may fail to identify correctly a group of maternal deaths, particularly those occurring early in pregnancy (e.g. ectopic, abortion-related) and indirect causes of maternal death (e.g. malaria and HIV).
- The accuracy of the estimates depends on the extent of family members' knowledge of the events leading to the death, the skill of the interviewers, and the competence of physicians who do the diagnosis and coding. The latter two factors are largely overcome by the use of software.
- Detailed verbal autopsy for research purposes that aims to identify the cause of death of an individual requires physician assessment and long interviews. Such systems are expensive to maintain, and the findings cannot be extrapolated to obtain national MMRs. This limitation does not exist where simplified verbal autopsy is aiming to identify causes at a population level and where software helps to formulate the diagnoses.

*Confidential enquiries into maternal deaths (CEMD)*

CEMD is "a systematic multidisciplinary anonymous investigation of all or a representative sample of maternal deaths occurring at an area, regional (state) or national level which identifies the numbers, causes and avoidable or remediable factors associated with them" *(23)*. This approach can also involve efforts to ensure that suspected maternal deaths are reported from a defined catchment area, such as a health-care facility or a district. Case records from suspected maternal deaths are then reviewed by committee to examine the circumstances of the death and then the assigned cause of death is either confirmed or revised. In

some contexts, CEMD is intended to assess the response of the health system in each maternal death to inform programmatic changes. In other contexts, there may be an effort to search beyond deaths labelled as "suspected maternal deaths" and review the causes of death for all women of reproductive age, including deaths that have not yet been registered; in this way, CEMD can address both incompleteness and misclassification in the CRVS system. CEMD was developed in England and Wales *(24)*, where it is still used, and studies of CEMD have been conducted in a number of other countries, such as Australia, France, Ireland, Mexico and New Zealand *(12)*. Kazakhstan and South Africa both conducted CEMD studies, identifying 29% and 40% more maternal deaths, respectively, than were initially recorded in the CRVS system *(25,26)*.

### *Surveillance of maternal deaths*

Active surveillance for maternal mortality has been initiated in some settings where CRVS is incomplete or not fully functional. Surveillance may include active review of hospital registers, morgue records and police reports, as well as community outreach, with the intention of finding cases of unregistered deaths to women of reproductive age and then to classify their cause of death *(27)*.

Maternal death surveillance and response (MDSR) offers a method for obtaining more complete information on maternal deaths in "real time" and could thus contribute to better data on maternal mortality and stimulate more timely response and action to prevent future deaths *(28)*. In 2013, WHO and partners issued technical guidance on MDSR *(29)* – "a continuous action cycle" that builds on the maternal death review (MDR) approach. MDR, both community- and facility-based, was described by WHO in 2004 in Beyond the numbers: reviewing maternal deaths and complications to make pregnancy safer *(23)*. An effective MDSR system requires that maternal deaths be made a notifiable event. Notifications (of maternal deaths in health-care facilities and communities) would be followed by a review to assess contributing factors and avoidability – the results of these district-level reviews feed into national-level analysis, leading to recommendations for further action, and finally response (implementation of recommendations) *(29)*. In countries lacking national CRVS systems, MDSR can serve as "a building block for a comprehensive, national-level data collection system" *(12)*. The uptake and implementation of MDSR are being studied, with surveys every two years and there is optimism it will contribute to eliminating preventable maternal mortality *(30)*. Although MDSRs thus far fall short of being nationally representative, there are ongoing analyses to assess whether data collected at subnational level might eventually become usable as input for the UN MMEIG database, which is used to derive the estimates (using the estimation model) as described in this report.

## References


1. 2.17.2 Data source: the international death certificate. In: ICD-11 Reference guide, Part 2. Geneva: World Health Organization; 2019 (https://icd.who.int/icd11refguide/en/index.html#2.17.2DataSourceIntlDeathCertificate|data-source-the-international-death-certificate|c2-17-2, accessed 12 July 2019).

2. Application of ICD-10 to deaths during pregnancy, childbirth and the puerperium: ICD maternal mortality (ICD-MM). Geneva: World Health Organization; 2012 (https://www.who.int/reproductivehealth/publications/monitoring/9789241548458/en/, accessed 20 June 2019).

3. 2.28.5 Standards and reporting requirements related for maternal mortality. In: ICD-11 Reference guide, Part 2. Geneva: World Health Organization; 2019 (https://icd.who.int/icd11refguide/en/index.html#2.28.5StandardsMarternalMortaltiy|standards-and-reporting-requirements-related-for-maternal-mortality|c2-28-5, accessed 12 July 2019).

4. International statistical classification of diseases and related health problems, 10th revision. Volume 2: Instruction manual. Geneva; World Health Organization; 2010 (https://www.who.int/classifications/icd/ICD10Volume2_en_2010.pdf, accessed 10 June 2019).

5. Lewis G, editor. Why mothers die 2000–2002: the confidential enquiries into maternal deaths in the United Kingdom. London: RCOG Press; 2004.

6. Lewis G, editor. Saving mothers' lives: reviewing maternal deaths to make motherhood safer 2003–2005. The seventh report on confidential enquiries into maternal deaths in the United Kingdom. London: Confidential Enquiry into Maternal and Child Health (CEMACH); 2007.

7. Centre for Maternal and Child Enquiries (CMACE). Saving mothers' lives: reviewing maternal deaths to make motherhood safer: 2006–2008. The eighth report on confidential enquiries into maternal deaths in the United Kingdom. BJOG. 2011;118(Suppl.1):1–203. doi:10.1111/j.1471-0528.2010.02847.x.

8. Knight M, Kenyon S, Brocklehurst P, Neilson J, Shakespeare J, Kurinczuk JJ, editors (on behalf of MBRRACE-UK). Saving lives, improving mothers' care – lessons learned to inform future maternity care from the UK and Ireland Confidential Enquiries into Maternal Deaths and Morbidity 2009–2012. Oxford: National Perinatal Epidemiology Unit, University of Oxford; 2014.

9. Deneux-Tharaux C, Berg C, Bouvier-Colle MH, Gissler M, Harper M, Nannini A, et al. Underreporting of pregnancy-related mortality in the United States and Europe. Obstet Gynecol. 2005;106:684–92.

10. Atrash HK, Alexander S, Berg CJ. Maternal mortality in developed countries: not just a concern of the past. Obstet Gynecol. 1995;86(4 pt 2):700–5.

11. Peterson E, Chou D, Gemmill A, Moller AB, Say L, Alkema L. Estimating maternal mortality using vital registration data: a Bayesian hierarchical bivariate random walk model to estimate sensitivity and specificity of reporting for population-periods without validation data. 2019. https://arxiv.org/abs/1909.08578

12. World Health Organization (WHO), United Nations Children's Fund (UNICEF), United Nations Population Fund (UNFPA), World Bank Group, United Nations Population Division. Trends in maternal mortality: 1990 to 2015: estimates by WHO, UNICEF, UNFPA, World Bank Group and the United Nations Population Division. Geneva: World Health Organization; 2015 (https://www.who.int/reproductivehealth/publications/monitoring/maternal-mortality-2015/en/, accessed 4 September 2019).

13. Hill K, Arifeen SE, Koenig M, Al-Sabir A, Jamil K, Raggers H. How should we measure maternal mortality in the developing world? A comparison of household deaths and sibling history approaches. Bull World Health Organ. 2006;84(3):173–80.

14. Ahmed S, Li Q, Scrafford C, Pullum TW. An assessment of DHS maternal mortality data and estimates. DHS Methodological Reports No. 13. Rockville, MD: ICF International; 2014 (https://dhsprogram.com/pubs/pdf/MR13/MR13.pdf, accessed 25 July 2019).

15. The sisterhood method for estimating maternal mortality: guidance notes for potential users. Geneva: World Health Organization; 1997 (https://www.who.int/reproductivehealth/publications/monitoring/RHT_97_28/en/, accessed 25 July 2019).

16. Stanton C, Hobcraft J, Hill K, Kodjogbé N, Mapeta WT, Munene F Stanton C, et al. Every death counts: measurement of maternal mortality via a census. Bull World Health Organ. 2001;79:657–64.

17. WHO guidance for measuring maternal mortality from a census. Geneva: World Health Organization; 2013.

18. Stanton C, Abderrahim N, Hill K. DHS maternal mortality indicators: an assessment of data quality and implications for data use (DHS Analytical Report No. 4). Calverton (MD): Macro International; 1997 (https://dhsprogram.com/pubs/pdf/AR4/AR4.pdf, accessed 25 July 2019).

19. Chandramohan D, Rodrigues LC, Maude GH, Hayes RJ. The validity of verbal autopsies for assessing the causes of institutional maternal death. Stud Fam Plann. 1998;29:414–22.

20. Chandramohan D, Stetal P, Quigley M. Misclassification error in verbal autopsy: can it be adjusted? Int J Epidemiol. 2001;30:509–14.

21. Leitao J, Chandramohan D, Byass P, Jakob R, Bundhamcharoen K, Choprapawon C, et al. Revising the WHO verbal autopsy instrument to facilitate routine cause-of-death monitoring. Global Health Action. 2013;6:21518.

22. Riley ID, Hazard RH, Joshi R, Chowdhury HR, Lopez A. Monitoring progress in reducing maternal mortality using verbal autopsy methods in vital registration systems: what can we conclude about specific causes of maternal death? BMC Medicine. 2019;17:104. doi:10.1186/s12916-019-1343-4.

23. Beyond the numbers: reviewing maternal deaths and complications to make pregnancy safer. Geneva: World Health Organization; 2004 (https://www.who.int/maternal_child_adolescent/documents/9241591838/en/, accessed 4 September 2019).

24. Knight M, Kenyon S, Brocklehurst P, Neilson J, Shakespeare J, Kurinczuk JJ, editors (on behalf of MBRRACE-UK). Saving lives, improving mothers' care: lessons learned to inform future maternity care from the UK and Ireland Confidential Enquiries into Maternal Deaths and Morbidity 2009–2012. Oxford: National Perinatal Epidemiology Unit, University of Oxford; 2014 (https://www.npeu.ox.ac.uk/downloads/files/mbrrace-uk/reports/Saving%20Lives%20Improving%20Mothers%20Care%20report%202014%20Full.pdf, accessed 5 November 2015).

25. Findings of a confidential audit of maternal mortality rates in the Republic of Kazakhstan 2011–2013. Kazakhstan: Central Commission on Confidential Audit CCAC; 2014.42.

26. Dorrington RE, Bradshaw D, Laubscher R, Nannan N. Rapid Mortality Surveillance Report 2013. Cape Town: South African Medical Research Council; 2014.

27. McCaw-Binns A, Lindo JLM, Lewis-Bell, KN, Ashley DEC. Maternal mortality surveillance in Jamaica. Int J Gynecol Obstet. 2008;100(1):31–6. doi:10.1016/j.ijgo.2007.06.054.

28. Danel I, Graham WJ, Boerma T. Maternal death surveillance and response. Bull World Health Organ. 2011;89:779-a.

29. Maternal death surveillance and response: technical guidance. Information for action to prevent maternal death. Geneva: World Health Organization; 2013.

30. Time to respond: a report on the global implementation of maternal death surveillance and response (MDSR). Geneva: World Health Organization; 2016 (https://www.who.int/maternal_child_adolescent/documents/maternal_death_surveillance_implementation/en/, accessed 25 July 2019).

# ANNEX 3

## CALCULATION OF MATERNAL MORTALITY DURING CRISIS YEARS

### Crisis years and mortality shocks

The 1990–2016 life tables published by WHO in 2018 *(1)* account for "crises" due to natural disasters and conflict (as defined by the International statistical classification of diseases and related health problems [ICD], 10th revision *[2]*), because of the potential for substantial increases in death rates during the crisis-affected years, a phenomenon described as "mortality shocks". According to the life tables, "mortality shocks" include deaths whose underlying cause was due to a natural disaster or – in the case of war and conflict deaths – "an injury due to war, civil insurrection or organized conflict, whether or not that injury occurred during the time of war or after cessation of hostilities" *(1)*.

A crisis year for the purpose of estimated maternal mortality is defined in the following two ways (all years that meet either definition are included as crisis years):

- a year in which (a) there are at least 10 deaths attributable to mortality shocks among women of reproductive age (i.e. 15–49 years) and (b) these deaths constitute at least 10% of the total number of deaths to women aged 15–49 in that respective country-year (1) and in addition (c) in the five-year period surrounding the year, there are at most two additional crisis years; and
- a year identified by the United Nations Inter-agency Group for Child Mortality Estimation (UN IGME) as a crisis year for the estimation of child mortality *(3)* (this includes crises in potentially longer periods, i.e. for recent ongoing crises).

### Maternal mortality estimation

The approach taken in this round of maternal mortality estimation was to estimate the "crisis-free" proportion maternal (PM)[42] to maintain consistency across all countries.

The method for estimation of maternal deaths for countries with one or more crisis years is described below.

Any data points that overlap with the crisis period are recalculated to refer to the proportion of crisis-free maternal or pregnancy-related deaths among the total number of crisis-free deaths to women of reproductive age, referred to as "crisis-free observed PM"[43]. Pregnancy-related PMs are adjusted based on the assumption that the proportion of pregnancy-related deaths among the deaths attributable to mortality shocks is equal to the proportion of women in the population who are pregnant or postpartum at the time of the crisis. The proportion of pregnant women in the population is set equal to the general fertility rate, based on the

[42] PM = proportion of deaths among women of reproductive age that are due to maternal causes

[43] Although by definition PM refers strictly to maternal deaths (and the model is based on this definition), some observed PMs are based on the definition of pregnancy-related deaths (which includes but is not limited to maternal deaths; see definitions in Chapter 2).

assumption of a one-year period associated with a live birth *(4)*.

For each year, the MMEIG Bayesian maternal mortality estimation (BMat) model provides posterior samples of maternal deaths:

- The median of this sample constitutes the point estimate for the number of maternal deaths. The reported estimates of PM are the crisis-free PMs, the point estimate for the number of maternal deaths divided by the total number of crisis-free deaths among women of reproductive age.
- For non-crisis years, the 10th and 90th percentiles of the BMat samples for maternal deaths constitute the 80% uncertainty interval (UI). For crisis years, we include additional uncertainty by multiplying the samples of maternal deaths by values between 0.9 and 1.2.

This approach results in estimates of maternal mortality that are considered crisis-free within the larger envelope of all deaths among women of reproductive age, because deaths among pregnant women that are attributable to mortality shocks would be considered pregnancy-related deaths but not maternal deaths, according to the ICD definition. It is possible that crisis-related factors may contribute to maternal mortality but empirical evidence to distinguish maternal deaths from among pregnancy-related deaths in the context of mortality shocks is limited. To reflect the paucity of evidence on the effect of crisis on maternal mortality, UIs were widened. Future estimation exercises will continue to review the methods developed to account for natural disasters, conflict and other types of mortality shocks (e.g. disease pandemics).

## References


7. WHO methods and data sources for life tables 1990–2016. Global Health Estimates Technical Paper. Geneva: World Health Organization; 2018 (WHO/HIS/IER/GHE/2018.2; https://www.who.int/healthinfo/statistics/LT_method.pdf, accessed 5 July 2019).

8. International Statistical Classification of Diseases and Related Health Problems 10th Revision. Geneva: World Health Organization; 2016 (current version) (https://icd.who.int/browse10/2016/en#/, accessed 26 August 2019).

9. United Nations Inter-agency Group for Child Mortality Estimation (UN IGME). Levels & trends in child mortality: report 2018: estimates developed by the UN Inter-agency Group for Child Mortality Estimation. New York (NY): United Nations Children's Fund; 2018 (https://www.unicef.org/publications/index_103264.html, accessed 5 July 2019).

10. Wilmoth JR, Mizoguchi N, Oestergaard MZ, Say L, Mathers CD, Zureick-Brown S, et al. A new method for deriving global estimates of maternal mortality. Stat Politics Policy. 2012;3(2):2151-7509.1038.

# ANNEX 4

## METHODS USED TO DERIVE A COMPLETE SERIES OF ANNUAL ESTIMATES FOR EACH PREDICTOR VARIABLE

A complete series of annual estimates for each of the three predictor variables was obtained or constructed.

Gross domestic product (GDP) per capita measured in purchasing power parity (PPP) equivalent US dollars using 2011 as the baseline year were taken from the World Bank Group *(1)*. A five-year moving average was applied to this GDP series to smooth year-to-year GDP fluctuations *(1)*.

General fertility rate (GFR) estimates were computed from data on live births and the population size (number of women aged 15–49 years), from the UNPD's 2019 revision of *World population prospects (2)*.

Skilled birth attendant (SBA)[44] coverage data consist of time series derived using all available data from health surveys and countries' routine reporting mechanisms, which are compiled in a database jointly maintained by WHO and UNICEF *(3)*. This database is primarily compiled for SDG reporting purposes. Jointly, UNICEF and WHO are co-custodians of "SDG indicator 3.1.2: Skilled birth attendant" and collaborate actively in the compilation and harmonization of this database. As part of the regular consultations with countries by the custodians of the SDG indicator, UNICEF leads an annual process during which countries are consulted on each value and data source that goes into this database. Using this database as an input, annual series were estimated for countries with any value of SBA coverage less than 95% and with four or more observations, by fitting a regression model with time as the sole predictor for the logit (or log-odds) of SBA; such a model was estimated separately for each country. For all other countries, including those with no available SBA data, the SBA annual series were estimated using a multilevel model. In the multilevel model, logit (or log-odds) of observed SBA proportions for all countries were regressed against time. The model included region- and country-specific intercepts and slopes.

[44] The definition of this SBA coverage indicator was updated in a new joint statement (and full background document) in 2018 *(4)*, but the data used for the estimates presented in this present publication are based on application of the previous (2004) definition/joint statement *(5)*, which was still in effect through 2017.

### References


1. DataBank: World Development Indicators [website]. Washington (DC): The World Bank Group; 2019 (https://databank.worldbank.org/source/world-development-indicators, accessed 31 July 2019).
2. World population prospects: the 2019 revision. New York (NY): United Nations Population Division, Department of Economic and Social Affairs; 2019 (https://population.un.org/wpp/, accessed 18 June 2019).
3. World Health Organization (WHO), United Nations Children's Fund (UNICEF). WHO and UNICEF Joint Skilled Birth Attendant (SBA) database. Geneva: WHO; 2019.
4. Definition of skilled health personnel providing care during childbirth: the 2018 joint statement by WHO, UNFPA, UNICEF, ICM, ICN, FIGO, IPA. Geneva: World Health Organization; 2018 (https://www.who.int/reproductivehealth/publications/statement-competent-mnh-professionals/en/, accessed 18 June 2019).

5. Making pregnancy safer: the critical role of the skilled attendant: a joint statement by WHO, ICM and FIGO. Geneva: World Health Organization; 2004 (https://www.who.int/reproductivehealth/publications/maternal_perinatal_health/9241591692/en/, accessed 18 June 2019).

# ANNEX 5

## ESTIMATES OF MATERNAL MORTALITY RATIO (MMR, MATERNAL DEATHS PER 100 000 LIVE BIRTHS), NUMBER OF MATERNAL DEATHS, LIFETIME RISK, PERCENTAGE OF HIV-RELATED INDIRECT MATERNAL DEATHS AND PROPORTION OF DEATHS AMONG WOMEN OF REPRODUCTIVE AGE THAT ARE DUE TO MATERNAL CAUSES (PM), BY COUNTRY AND TERRITORY, 2017[a]

| Country and territory | MMR[b] point estimate and range of uncertainty interval (UI: 80%) | | | Number of maternal deaths[c] | Lifetime risk of maternal death[d] 1 in | % of HIV-related indirect maternal deaths[e] | PM point estimate and range of uncertainty interval (UI: 80%) | | |
|---|---|---|---|---|---|---|---|---|---|
| | Lower UI | MMR point estimate | Upper UI | | | | Lower UI | PM point estimate | Upper UI |
| Afghanistan | 427 | 638 | 1 010 | 7 700 | 33 | | 24 | 37 | 58 |
| Albania | 8 | 15 | 26 | 5 | 3 800 | | 0 | 1 | 1 |
| Algeria | 64 | 112 | 206 | 1 200 | 270 | | 6 | 10 | 18 |
| Angola | 167 | 241 | 346 | 3 000 | 69 | 3 | 10 | 14 | 20 |
| Antigua and Barbuda | 24 | 42 | 69 | 1 | 1 200 | | 1 | 2 | 3 |
| Argentina | 35 | 39 | 43 | 290 | 1 100 | 1 | 3 | 3 | 3 |
| Armenia | 21 | 26 | 32 | 11 | 2 000 | | 2 | 2 | 3 |
| Australia | 5 | 6 | 8 | 20 | 8 200 | | 1 | 1 | 1 |
| Austria | 4 | 5 | 7 | 4 | 13 500 | | 0 | 0 | 1 |
| Azerbaijan | 21 | 26 | 32 | 44 | 1 700 | | 2 | 2 | 3 |
| Bahamas | 48 | 70 | 110 | 4 | 820 | 25 | 1 | 2 | 3 |
| Bahrain | 10 | 14 | 21 | 3 | 3 000 | | 1 | 2 | 3 |
| Bangladesh | 131 | 173 | 234 | 5 100 | 250 | | 7 | 9 | 12 |
| Barbados | 17 | 27 | 39 | 1 | 2 400 | | 1 | 1 | 2 |
| Belarus | 1 | 2 | 4 | 3 | 23 800 | | 0 | 0 | 0 |
| Belgium | 4 | 5 | 7 | 6 | 11 200 | | 0 | 0 | 1 |
| Belize | 26 | 36 | 48 | 3 | 1 100 | | 1 | 2 | 2 |
| Benin | 291 | 397 | 570 | 1 600 | 49 | 1 | 13 | 17 | 25 |
| Bhutan | 127 | 183 | 292 | 24 | 250 | | 3 | 4 | 6 |
| Bolivia (Plurinational State of) | 113 | 155 | 213 | 380 | 220 | | 5 | 6 | 9 |
| Bosnia and Herzegovina | 5 | 10 | 16 | 3 | 8 200 | | 0 | 0 | 1 |
| Botswana | 124 | 144 | 170 | 81 | 220 | 15 | 3 | 4 | 4 |
| Brazil | 58 | 60 | 61 | 1 700 | 940 | 1 | 3 | 3 | 3 |

| Country and territory | MMR[b] point estimate and range of uncertainty interval (UI: 80%) | | | Number of maternal deaths[c] | Lifetime risk of maternal death[d] 1 in | % of HIV-related indirect maternal deaths[e] | PM point estimate and range of uncertainty interval (UI: 80%) | | |
|---|---|---|---|---|---|---|---|---|---|
| | Lower UI | MMR point estimate | Upper UI | | | | Lower UI | PM point estimate | Upper UI |
| Brunei Darussalam | 21 | 31 | 45 | 2 | 1 700 | | 1 | 2 | 3 |
| Bulgaria | 6 | 10 | 14 | 6 | 7 000 | | 0 | 0 | 1 |
| Burkina Faso | 220 | 320 | 454 | 2 400 | 57 | 1 | 9 | 13 | 19 |
| Burundi | 413 | 548 | 728 | 2 400 | 33 | | 16 | 21 | 27 |
| Cabo Verde | 45 | 58 | 75 | 6 | 670 | | 3 | 4 | 5 |
| Cambodia | 116 | 160 | 221 | 590 | 220 | 1 | 5 | 7 | 10 |
| Cameroon | 376 | 529 | 790 | 4 700 | 40 | 4 | 10 | 14 | 21 |
| Canada | 8 | 10 | 14 | 40 | 6 100 | | 1 | 1 | 1 |
| Central African Republic | 463 | 829 | 1 470 | 1 400 | 25 | 3 | 10 | 18 | 32 |
| Chad | 847 | 1 140 | 1 590 | 7 300 | 15 | | 25 | 34 | 48 |
| Chile | 11 | 13 | 14 | 29 | 4 600 | 7 | 1 | 1 | 1 |
| China | 22 | 29 | 35 | 4 900 | 2 100 | | 1 | 2 | 2 |
| Colombia | 71 | 83 | 98 | 610 | 630 | | 3 | 4 | 4 |
| Comoros | 167 | 273 | 435 | 72 | 83 | | 8 | 13 | 20 |
| Congo | 271 | 378 | 523 | 650 | 58 | 3 | 9 | 13 | 18 |
| Costa Rica | 24 | 27 | 31 | 19 | 1 900 | | 1 | 2 | 2 |
| Côte d'Ivoire | 426 | 617 | 896 | 5 400 | 34 | 2 | 9 | 13 | 19 |
| Croatia | 6 | 8 | 11 | 3 | 9 100 | | 0 | 1 | 1 |
| Cuba | 33 | 36 | 40 | 42 | 1 800 | | 2 | 2 | 2 |
| Cyprus | 4 | 6 | 10 | 1 | 11 000 | | 0 | 1 | 1 |
| Czechia | 2 | 3 | 5 | 4 | 17 900 | | 0 | 0 | 0 |
| Democratic People's Republic of Korea | 38 | 89 | 203 | 310 | 620 | | 1 | 3 | 7 |
| Democratic Republic of the Congo | 341 | 473 | 693 | 16 000 | 34 | 1 | 17 | 23 | 34 |
| Denmark | 3 | 4 | 5 | 2 | 16 200 | | 0 | 0 | 1 |
| Djibouti | 116 | 248 | 527 | 51 | 140 | 4 | 2 | 5 | 11 |
| Dominican Republic | 88 | 95 | 102 | 200 | 410 | 3 | 4 | 4 | 5 |
| Ecuador | 53 | 59 | 65 | 200 | 640 | 1 | 4 | 4 | 5 |
| Egypt | 27 | 37 | 47 | 960 | 730 | | 3 | 4 | 5 |
| El Salvador | 36 | 46 | 57 | 54 | 960 | 2 | 2 | 2 | 3 |
| Equatorial Guinea | 181 | 301 | 504 | 130 | 67 | 2 | 6 | 10 | 17 |
| Eritrea | 327 | 480 | 718 | 510 | 46 | 1 | 11 | 16 | 24 |
| Estonia | 5 | 9 | 13 | 1 | 6 900 | | 0 | 1 | 1 |
| Eswatini | 255 | 437 | 792 | 130 | 72 | 10 | 3 | 6 | 10 |
| Ethiopia | 298 | 401 | 573 | 14 000 | 55 | 1 | 14 | 19 | 27 |
| Fiji | 27 | 34 | 43 | 6 | 1 000 | | 1 | 2 | 2 |
| Finland | 2 | 3 | 4 | 2 | 20 900 | | 0 | 0 | 0 |
| France | 6 | 8 | 9 | 56 | 7 200 | 2 | 1 | 1 | 1 |

| Country and territory | MMR[b] point estimate and range of uncertainty interval (UI: 80%) | | | Number of maternal deaths[c] | Lifetime risk of maternal death[d] 1 in | % of HIV-related indirect maternal deaths[e] | PM point estimate and range of uncertainty interval (UI: 80%) | | |
|---|---|---|---|---|---|---|---|---|---|
| | Lower UI | MMR point estimate | Upper UI | | | | Lower UI | PM point estimate | Upper UI |
| Gabon | 165 | 252 | 407 | 170 | 93 | 4 | 7 | 11 | 17 |
| Gambia | 440 | 597 | 808 | 520 | 31 | 1 | 19 | 26 | 35 |
| Georgia | 21 | 25 | 29 | 14 | 1 900 | | 1 | 2 | 2 |
| Germany | 5 | 7 | 9 | 53 | 9 400 | | 0 | 0 | 1 |
| Ghana | 223 | 308 | 420 | 2 700 | 82 | 2 | 7 | 10 | 13 |
| Greece | 2 | 3 | 4 | 2 | 26 900 | | 0 | 0 | 0 |
| Grenada | 15 | 25 | 39 | 0 | 1700 | | 1 | 2 | 2 |
| Guatemala | 86 | 95 | 104 | 400 | 330 | 1 | 6 | 7 | 8 |
| Guinea | 437 | 576 | 779 | 2 600 | 35 | 1 | 15 | 20 | 27 |
| Guinea-Bissau | 457 | 667 | 995 | 440 | 32 | 2 | 16 | 24 | 35 |
| Guyana | 132 | 169 | 215 | 26 | 220 | | 4 | 5 | 6 |
| Haiti | 346 | 480 | 680 | 1 300 | 67 | 1 | 9 | 13 | 18 |
| Honduras | 55 | 65 | 76 | 130 | 560 | 1 | 3 | 3 | 3 |
| Hungary | 9 | 12 | 16 | 11 | 6 200 | | 0 | 1 | 1 |
| Iceland | 2 | 4 | 6 | 0 | 14 400 | | 0 | 1 | 1 |
| India | 117 | 145 | 177 | 35 000 | 290 | | 4 | 5 | 7 |
| Indonesia | 127 | 177 | 254 | 8 600 | 240 | 1 | 4 | 6 | 9 |
| Iran (Islamic Republic of) | 13 | 16 | 20 | 250 | 2 600 | 2 | 1 | 2 | 2 |
| Iraq | 53 | 79 | 113 | 870 | 320 | | 3 | 5 | 7 |
| Ireland | 3 | 5 | 7 | 3 | 11 300 | | 0 | 1 | 1 |
| Israel | 2 | 3 | 4 | 5 | 10 800 | 20 | 1 | 1 | 1 |
| Italy | 1 | 2 | 2 | 7 | 51 300 | 14 | 0 | 0 | 0 |
| Jamaica | 67 | 80 | 98 | 38 | 600 | 3 | 3 | 3 | 4 |
| Japan | 3 | 5 | 6 | 44 | 16 700 | | 0 | 0 | 0 |
| Jordan | 31 | 46 | 65 | 100 | 730 | | 3 | 4 | 6 |
| Kazakhstan | 8 | 10 | 12 | 37 | 3 500 | 3 | 0 | 1 | 1 |
| Kenya | 253 | 342 | 476 | 5 000 | 76 | 3 | 10 | 14 | 19 |
| Kiribati | 49 | 92 | 158 | 3 | 290 | | 3 | 5 | 8 |
| Kuwait | 8 | 12 | 17 | 7 | 4 200 | | 1 | 1 | 1 |
| Kyrgyzstan | 50 | 60 | 76 | 95 | 480 | | 4 | 5 | 7 |
| Lao People's Democratic Republic | 139 | 185 | 253 | 310 | 180 | | 6 | 7 | 10 |
| Latvia | 15 | 19 | 26 | 4 | 3 100 | | 1 | 1 | 1 |
| Lebanon | 22 | 29 | 40 | 34 | 1 600 | | 2 | 2 | 3 |
| Lesotho | 391 | 544 | 788 | 310 | 58 | 11 | 4 | 6 | 8 |
| Liberia | 481 | 661 | 943 | 1 000 | 32 | 2 | 19 | 26 | 38 |
| Lithuania | 5 | 8 | 12 | 2 | 7 500 | | 0 | 0 | 1 |
| Luxembourg | 3 | 5 | 8 | 0 | 14 300 | | 0 | 1 | 1 |

| Country and territory | MMR[b] point estimate and range of uncertainty interval (UI: 80%) | | | Number of maternal deaths[c] | Lifetime risk of maternal death[d] 1 in | % of HIV-related indirect maternal deaths[e] | PM point estimate and range of uncertainty interval (UI: 80%) | | |
|---|---|---|---|---|---|---|---|---|---|
| | Lower UI | MMR point estimate | Upper UI | | | | Lower UI | PM point estimate | Upper UI |
| Madagascar | 229 | 335 | 484 | 2 800 | 66 | | 11 | 16 | 23 |
| Malawi | 244 | 349 | 507 | 2 100 | 60 | 5 | 11 | 15 | 22 |
| Malaysia | 24 | 29 | 36 | 150 | 1 600 | 1 | 2 | 2 | 3 |
| Maldives | 35 | 53 | 84 | 4 | 840 | | 6 | 9 | 14 |
| Mali | 419 | 562 | 784 | 4 400 | 29 | 1 | 18 | 24 | 33 |
| Malta | 4 | 6 | 11 | 0 | 10 200 | | 0 | 1 | 1 |
| Mauritania | 528 | 766 | 1 140 | 1 100 | 28 | | 25 | 37 | 55 |
| Mauritius | 46 | 61 | 85 | 8 | 1 200 | | 2 | 2 | 3 |
| Mexico | 32 | 33 | 35 | 740 | 1 300 | 1 | 2 | 2 | 2 |
| Micronesia (Federated States of) | 40 | 88 | 193 | 2 | 370 | | 2 | 5 | 11 |
| Mongolia | 36 | 45 | 56 | 35 | 710 | | 3 | 3 | 4 |
| Montenegro | 3 | 6 | 10 | 0 | 9 900 | | 0 | 0 | 1 |
| Morocco | 54 | 70 | 91 | 480 | 560 | | 5 | 6 | 8 |
| Mozambique | 206 | 289 | 418 | 3 100 | 67 | 9 | 7 | 9 | 13 |
| Myanmar | 182 | 250 | 351 | 2 400 | 190 | | 5 | 7 | 10 |
| Namibia | 144 | 195 | 281 | 140 | 140 | 11 | 4 | 5 | 7 |
| Nepal | 135 | 186 | 267 | 1 100 | 230 | | 6 | 9 | 12 |
| Netherlands | 4 | 5 | 7 | 9 | 11 900 | | 0 | 0 | 1 |
| New Zealand | 7 | 9 | 11 | 5 | 6 100 | | 1 | 1 | 1 |
| Nicaragua | 77 | 98 | 127 | 130 | 380 | 1 | 5 | 6 | 8 |
| Niger | 368 | 509 | 724 | 5 100 | 27 | | 23 | 31 | 44 |
| Nigeria | 658 | 917 | 1 320 | 67 000 | 21 | 1 | 17 | 23 | 33 |
| Norway | 2 | 2 | 3 | 1 | 25 700 | | 0 | 0 | 0 |
| Oman | 16 | 19 | 22 | 17 | 1 600 | | 3 | 3 | 4 |
| Pakistan | 85 | 140 | 229 | 8 300 | 180 | | 6 | 10 | 17 |
| Panama | 45 | 52 | 59 | 41 | 750 | 2 | 3 | 4 | 4 |
| Papua New Guinea | 67 | 145 | 318 | 340 | 190 | 1 | 3 | 7 | 15 |
| Paraguay | 72 | 84 | 97 | 120 | 440 | 1 | 3 | 4 | 5 |
| Peru | 69 | 88 | 110 | 500 | 480 | | 4 | 5 | 6 |
| Philippines | 91 | 121 | 168 | 2 700 | 300 | | 4 | 6 | 8 |
| Poland | 2 | 2 | 3 | 8 | 30 300 | 13 | 0 | 0 | 0 |
| Portugal | 6 | 8 | 11 | 6 | 10 700 | | 0 | 0 | 1 |
| Puerto Rico | 16 | 21 | 29 | 5 | 4 000 | | 1 | 1 | 1 |
| Qatar | 6 | 9 | 14 | 2 | 5 000 | | 1 | 2 | 2 |
| Republic of Korea | 9 | 11 | 13 | 43 | 8 300 | | 1 | 1 | 1 |
| Republic of Moldova | 15 | 19 | 24 | 8 | 3 900 | | 1 | 1 | 1 |
| Republic of North Macedonia | 5 | 7 | 10 | 2 | 9 000 | | 0 | 0 | 1 |

| Country and territory | MMR[b] point estimate and range of uncertainty interval (UI: 80%) | | | Number of maternal deaths[c] | Lifetime risk of maternal death[d] 1 in | % of HIV-related indirect maternal deaths[e] | PM point estimate and range of uncertainty interval (UI: 80%) | | |
|---|---|---|---|---|---|---|---|---|---|
| | Lower UI | MMR point estimate | Upper UI | | | | Lower UI | PM point estimate | Upper UI |
| Romania | 14 | 19 | 25 | 36 | 3 600 | | 1 | 1 | 1 |
| Russian Federation | 13 | 17 | 23 | 320 | 3 100 | 15 | 0 | 1 | 1 |
| Rwanda | 184 | 248 | 347 | 960 | 94 | 2 | 9 | 12 | 17 |
| Saint Lucia | 71 | 117 | 197 | 3 | 580 | | 2 | 3 | 5 |
| Saint Vincent and the Grenadines | 44 | 68 | 100 | 1 | 750 | | 1 | 2 | 3 |
| Samoa | 20 | 43 | 97 | 2 | 590 | | 3 | 6 | 14 |
| Sao Tome and Principe | 73 | 130 | 217 | 9 | 170 | | 4 | 7 | 13 |
| Saudi Arabia | 10 | 17 | 30 | 100 | 2 300 | | 1 | 1 | 2 |
| Senegal | 237 | 315 | 434 | 1 700 | 65 | 1 | 16 | 21 | 29 |
| Serbia | 9 | 12 | 17 | 10 | 5 800 | | 1 | 1 | 1 |
| Seychelles | 26 | 53 | 109 | 1 | 790 | | 1 | 3 | 6 |
| Sierra Leone | 808 | 1 120 | 1 620 | 2 900 | 20 | | 15 | 21 | 30 |
| Singapore | 5 | 8 | 13 | 4 | 9 900 | | 0 | 1 | 1 |
| Slovakia | 4 | 5 | 7 | 3 | 12 600 | | 0 | 0 | 0 |
| Slovenia | 5 | 7 | 9 | 1 | 9 300 | | 0 | 1 | 1 |
| Solomon Islands | 70 | 104 | 157 | 22 | 200 | | 7 | 10 | 15 |
| Somalia | 385 | 829 | 1 590 | 5 100 | 20 | | 15 | 31 | 60 |
| South Africa | 96 | 119 | 153 | 1 400 | 330 | 21 | 2 | 2 | 3 |
| South Sudan | 789 | 1 150 | 1 710 | 4 500 | 18 | 2 | 18 | 26 | 38 |
| Spain | 3 | 4 | 5 | 14 | 21 500 | | 0 | 0 | 0 |
| Sri Lanka | 31 | 36 | 41 | 120 | 1 300 | | 2 | 2 | 3 |
| State of Libya | 30 | 72 | 164 | 92 | 590 | | 2 | 4 | 8 |
| Sudan | 207 | 295 | 408 | 3 900 | 75 | | 9 | 13 | 19 |
| Suriname | 96 | 120 | 144 | 13 | 330 | | 4 | 5 | 6 |
| Sweden | 3 | 4 | 6 | 5 | 12 600 | | 0 | 0 | 1 |
| Switzerland | 3 | 5 | 7 | 4 | 13 900 | | 0 | 1 | 1 |
| Syrian Arab Republic | 20 | 31 | 50 | 130 | 1 000 | | 2 | 3 | 4 |
| Tajikistan | 10 | 17 | 26 | 46 | 1 400 | 2 | 1 | 2 | 4 |
| Thailand | 32 | 37 | 44 | 270 | 1 900 | 6 | 1 | 1 | 1 |
| Timor-Leste | 102 | 142 | 192 | 52 | 170 | | 10 | 14 | 20 |
| Togo | 270 | 396 | 557 | 1 000 | 56 | 2 | 8 | 12 | 17 |
| Tonga | 24 | 52 | 116 | 1 | 540 | | 2 | 5 | 11 |
| Trinidad and Tobago | 50 | 67 | 90 | 12 | 840 | | 2 | 2 | 3 |
| Tunisia | 33 | 43 | 54 | 90 | 970 | | 3 | 4 | 4 |
| Turkey | 14 | 17 | 20 | 220 | 2 800 | | 1 | 1 | 1 |
| Turkmenistan | 5 | 7 | 10 | 10 | 4 400 | 20 | 0 | 0 | 1 |
| Uganda | 278 | 375 | 523 | 6 000 | 49 | 2 | 11 | 15 | 21 |
| Ukraine | 14 | 19 | 26 | 83 | 3 700 | 12 | 0 | 1 | 1 |

| Country and territory | MMR[b] point estimate and range of uncertainty interval (UI: 80%) | | | Number of maternal deaths[c] | Lifetime risk of maternal death[d] 1 in | % of HIV-related indirect maternal deaths[e] | PM point estimate and range of uncertainty interval (UI: 80%) | | |
|---|---|---|---|---|---|---|---|---|---|
| | Lower UI | MMR point estimate | Upper UI | | | | Lower UI | PM point estimate | Upper UI |
| United Arab Emirates | 2 | 3 | 5 | 3 | 17 900 | | 0 | 0 | 1 |
| United Kingdom of Great Britain and Northern Ireland | 6 | 7 | 8 | 52 | 8 400 | 2 | 0 | 1 | 1 |
| United Republic of Tanzania | 399 | 524 | 712 | 11 000 | 36 | 1 | 17 | 22 | 30 |
| United States of America | 17 | 19 | 21 | 720 | 3 000 | 1 | 1 | 1 | 1 |
| Uruguay | 14 | 17 | 21 | 8 | 2 900 | | 1 | 1 | 1 |
| Uzbekistan | 23 | 29 | 37 | 200 | 1 200 | 1 | 2 | 2 | 3 |
| Vanuatu | 33 | 72 | 161 | 6 | 330 | | 4 | 8 | 17 |
| Venezuela (Bolivarian Republic of) | 97 | 125 | 170 | 670 | 330 | 1 | 5 | 7 | 9 |
| Viet Nam | 32 | 43 | 61 | 700 | 1 100 | 1 | 2 | 3 | 5 |
| West Bank and Gaza Strip[f] | 23 | 27 | 32 | 39 | 880 | | 3 | 3 | 4 |
| Yemen | 109 | 164 | 235 | 1 400 | 150 | | 5 | 7 | 10 |
| Zambia | 159 | 213 | 289 | 1 300 | 93 | 7 | 6 | 8 | 10 |
| Zimbabwe | 360 | 458 | 577 | 2 100 | 55 | 6 | 7 | 9 | 12 |

PM: proportion of deaths among women of reproductive age (15–49 years) that are due to maternal causes; UI: uncertainty interval.

[a] Estimates have been computed to ensure comparability across countries, thus they are not necessarily the same as official statistics of the countries, which may use alternative rigorous methods. Countries included in all tables presented in this report (185 countries) are limited to WHO Member States with populations over 100 000, excluding those for which life tables were unavailable (Andorra, Cook Islands, Dominica, Marshall Islands, Monaco, Nauru, Niue, Palau, Saint Kitts and Nevis, San Marino, Tuvalu), plus two territories (Puerto Rico [an Associate Member], and the West Bank and Gaza Strip [a member in the regional committee for the WHO Eastern Mediterranean Region]).

[b] MMR estimates have been rounded according to the following scheme: < 100 rounded to nearest 1; 100–999 rounded to nearest 1; and ⩾ 1000 rounded to nearest 10.

[c] Numbers of maternal deaths have been rounded according to the following scheme: < 100 rounded to nearest 1; 100–999 rounded to nearest 10; 1000–9999 rounded to nearest 100; and ⩾ 10 000 rounded to nearest 1000.

[d] Life time risk has been rounded according to the following scheme: < 100 rounded to nearest 1; 100–999 rounded to nearest 10; and ⩾ 1000 rounded to nearest 100.

[e] Percentage of HIV-related indirect maternal deaths are presented only for countries with an HIV prevalence ⩾ 5% in 2017 *(1)*.

[f] UNICEF, UNPFA, World Bank Group and UNPD refer to this territory as the State of Palestine.

Reference

1. Life tables. In: Global Health Observatory (GHO) data [website]. Geneva: World Health Organization; 2019 (https://www.who.int/gho/mortality_burden_disease/life_tables/life_tables/en/, accessed 18 June 2019).

# ANNEX 6[1]

## ESTIMATES OF MATERNAL MORTALITY RATIO (MMR, MATERNAL DEATHS PER 100 000 LIVE BIRTHS), NUMBER OF MATERNAL DEATHS, AND LIFETIME RISK, BY WORLD HEALTH ORGANIZATION (WHO) REGION, 2017

| WHO region | MMR point estimate and range of uncertainty interval (UI: 80%) | | | Number of maternal deaths | Lifetime risk of maternal death: 1 in |
|---|---|---|---|---|---|
| | Lower UI | MMR point estimate | Upper UI | | |
| Africa | 480 | 525 | 629 | 19 2000 | 39 |
| Americas | 55 | 58 | 63 | 8 600 | 850 |
| South-East Asia | 132 | 152 | 180 | 53 000 | 280 |
| Europe | 12 | 13 | 14 | 1 400 | 4 300 |
| Eastern Mediterranean | 138 | 164 | 217 | 30 000 | 170 |
| Western Pacific | 36 | 41 | 49 | 9 800 | 1 400 |
| World | 199 | 211 | 243 | 295 000 | 190 |

WHO Member States in each WHO region can be found at:

African Region:
https://www.afro.who.int/countries

Region of the Americas:
https://www.paho.org/hq/index.php?option=com_wrapper&view=wrapper&Itemid=2005

South-East Asia Region:
http://www.searo.who.int/en/

European Region:
http://www.euro.who.int/en/countries

Eastern Mediterranean Region:
http://www.emro.who.int/countries.html

Western Pacific Region:
https://www.who.int/westernpacific/about/where-we-work

[1] For countries included, refer to note “a” for Annex 5, and web links for lists of WHO Member States provided in Annex 6.

# ANNEX 7[2]

## TRENDS IN ESTIMATES OF MATERNAL MORTALITY RATIO (MMR, MATERNAL DEATHS PER 100 000 LIVE BIRTHS), BY WHO REGION, 2000–2017

| WHO region | MMR point estimates | | | | | Overall reduction in MMR between 2000 and 2017 (%) | Average annual rate of reduction in MMR between 2000 and 2017 (%) |
|---|---|---|---|---|---|---|---|
| | 2000 | 2005 | 2010 | 2015 | 2017 | | |
| Africa | 857 | 735 | 615 | 548 | 525 | 38.7 | 2.9 |
| Americas | 73 | 68 | 64 | 60 | 58 | 20.9 | 1.4 |
| South-East Asia | 355 | 280 | 214 | 165 | 152 | 57.3 | 5.0 |
| Europe | 27 | 22 | 17 | 14 | 13 | 52.8 | 4.4 |
| Eastern Mediterranean | 330 | 275 | 220 | 175 | 164 | 50.3 | 4.1 |
| Western Pacific | 75 | 61 | 51 | 43 | 41 | 45.8 | 3.6 |
| World | 342 | 296 | 248 | 219 | 211 | 38.4 | 2.9 |

[2] For countries included, refer to note “a” for Annex 5, and web links for lists of WHO Member States provided in Annex 6.

# ANNEX 8[3]

## ESTIMATES OF MATERNAL MORTALITY RATIO (MMR, MATERNAL DEATHS PER 100 000 LIVE BIRTHS), NUMBER OF MATERNAL DEATHS, AND LIFETIME RISK, BY UNITED NATIONS CHILDREN'S FUND (UNICEF) REGION, 2017

| UNICEF region and subregion | MMR point estimate and range of uncertainty interval (UI: 80%) | | | Number of maternal deaths | Lifetime risk of maternal death: 1 in |
|---|---|---|---|---|---|
| | Lower UI | MMR point estimate | Upper UI | | |
| East Asia and the Pacific | 61 | 69 | 85 | 21 000 | 790 |
| Europe and Central Asia | 12 | 13 | 14 | 1 400 | 4 300 |
| Eastern Europe and Central Asia | 17 | 19 | 21 | 1 200 | 2 600 |
| Western Europe | 5 | 5 | 6 | 260 | 11 700 |
| Latin America and the Caribbean | 70 | 74 | 81 | 7 800 | 630 |
| Middle East and North Africa | 50 | 57 | 71 | 5 800 | 570 |
| North America | 16 | 18 | 20 | 760 | 3 100 |
| South Asia | 141 | 163 | 196 | 57 000 | 240 |
| Sub-Saharan Africa | 490 | 533 | 636 | 200 000 | 38 |
| Eastern and Southern Africa | 356 | 384 | 450 | 70 000 | 58 |
| West and Central Africa | 582 | 674 | 850 | 131 000 | 28 |
| Least developed countries[a] | 396 | 415 | 477 | 130 000 | 56 |
| World | 199 | 211 | 243 | 295 000 | 190 |

UI: uncertainty interval

Countries in each UNICEF region are listed at: https://www.unicef.org/where-we-work

[a] Afghanistan, Angola, Bangladesh, Benin, Bhutan, Burkina Faso, Burundi, Cambodia, Central African Republic, Chad, Comoros, Democratic Republic of the Congo, Djibouti, Equatorial Guinea, Eritrea, Ethiopia, Gambia, Guinea, Guinea-Bissau, Haiti, Kiribati, Lao People's Democratic Republic, Lesotho, Liberia, Madagascar, Malawi, Mali, Mauritania, Mozambique, Myanmar, Nepal, Niger, Rwanda, Sao Tome and Principe, Senegal, Sierra Leone, Solomon Islands, Somalia, South Sudan, Sudan, Timor-Leste, Togo, Tuvalu, Uganda, United Republic of Tanzania, Vanuatu, Yemen, Zambia.

[3] For countries included, refer to note "a" for Annex 5, and web links for lists of WHO Member States provided in Annex 6.

# ANNEX 9[4]

## TRENDS IN ESTIMATES OF MATERNAL MORTALITY RATIO (MMR, MATERNAL DEATHS PER 100 000 LIVE BIRTHS), BY UNICEF REGION, 2000–2017

| UNICEF region and subregion | MMR point estimates | | | | | Overall reduction[a] in MMR between 2000 and 2017 (%) | Average annual rate of reduction in MMR between 2000 and 2017 (%) |
|---|---|---|---|---|---|---|---|
| | 2000 | 2005 | 2010 | 2015 | 2017 | | |
| East Asia and the Pacific | 114 | 100 | 86 | 73 | 69 | 39.4 | 2.9 |
| Europe and Central Asia | 27 | 22 | 17 | 14 | 13 | 10.0 | 4.4 |
| Eastern Europe and Central Asia | 45 | 36 | 26 | 20 | 19 | 58.2 | 5.1 |
| Western Europe | 8 | 7 | 6 | 6 | 5 | 33.4 | 2.4 |
| Latin America and the Caribbean | 96 | 91 | 85 | 77 | 74 | 22.8 | 1.5 |
| Middle East and North Africa | 95 | 81 | 63 | 59 | 57 | 40.0 | 3.0 |
| North America | 12 | 13 | 14 | 17 | 18 | -52.2 | -2.5 |
| South Asia | 395 | 309 | 235 | 179 | 163 | 58.7 | 5.2 |
| Sub-Saharan Africa | 870 | 746 | 626 | 557 | 533 | 38.7 | 2.9 |
| Eastern and Southern Africa | 780 | 645 | 494 | 406 | 384 | 50.8 | 4.2 |
| West and Central Africa | 962 | 847 | 755 | 699 | 674 | 30.0 | 2.1 |
| Least developed countries[b] | 763 | 635 | 520 | 442 | 415 | 45.6 | 3.6 |
| World | 342 | 296 | 248 | 219 | 211 | 38.4 | 2.9 |

Countries in each UNICEF region are listed at: https://www.unicef.org/where-we-work

[a] Negative number indicates percentage increase in MMR.

[b] Afghanistan, Angola, Bangladesh, Benin, Bhutan, Burkina Faso, Burundi, Cambodia, Central African Republic, Chad, Comoros, Democratic Republic of the Congo, Djibouti, Equatorial Guinea, Eritrea, Ethiopia, Gambia, Guinea, Guinea-Bissau, Haiti, Kiribati, Lao People's Democratic Republic, Lesotho, Liberia, Madagascar, Malawi, Mali, Mauritania, Mozambique, Myanmar, Nepal, Niger, Rwanda, Sao Tome and Principe, Senegal, Sierra Leone, Solomon Islands, Somalia, South Sudan, Sudan, Timor-Leste, Togo, Tuvalu, Uganda, United Republic of Tanzania, Vanuatu, Yemen, Zambia.

[4] For countries included, refer to note "a" for Annex 5, and web links for lists of WHO Member States provided in Annex 6.

# ANNEX 10[5]

## ESTIMATES OF MATERNAL MORTALITY RATIO (MMR, MATERNAL DEATHS PER 100 000 LIVE BIRTHS), NUMBER OF MATERNAL DEATHS, AND LIFETIME RISK, BY UNITED NATIONS POPULATION FUND (UNFPA) REGION, 2017

| UNFPA region | MMR point estimate and range of uncertainty interval (UI: 80%) | | | Number of maternal deaths | Lifetime risk of maternal death: 1 in |
|---|---|---|---|---|---|
| | Lower UI | MMR point estimate | Upper UI | | |
| Arab States | 121 | 151 | 208 | 14 000 | 180 |
| Asia and the Pacific | 108 | 120 | 140 | 79 000 | 380 |
| East and Southern Africa | 361 | 391 | 463 | 77 000 | 54 |
| Eastern Europe and Central Asia | 18 | 20 | 22 | 800 | 2 300 |
| Latin America and the Caribbean | 70 | 74 | 81 | 7 800 | 630 |
| West and Central Africa | 606 | 717 | 917 | 114 000 | 27 |
| Non-UNFPA list[a] | 11 | 12 | 13 | 1 600 | 5 200 |
| World | 199 | 211 | 243 | 295 000 | 190 |

UI: uncertainty interval

Countries in each UNFPA region are listed at: https://www.unfpa.org/worldwide

[a] The countries in this category are not included among the countries listed in UNFPA regions (i.e. they do not have UNFPA country offices/programmes): Australia, Austria, Bahrain, Belgium, Brunei Darussalam, Bulgaria, Canada, Croatia, Cyprus, Czechia, Denmark, Estonia, Finland, France, Germany, Greece, Hungary, Iceland, Ireland, Israel, Italy, Japan, Kuwait, Latvia, Lithuania, Luxembourg, Malta, Montenegro, Netherlands, New Zealand, Norway, Poland, Portugal, Puerto Rico, Qatar, Republic of Korea, Romania, Russian Federation, Saudi Arabia, Seychelles, Singapore, Slovakia, Slovenia, Spain, Sweden, Switzerland, United Arab Emirates, United Kingdom of Great Britain and Northern Ireland, United States of America.

[5] For countries included, refer to note "a" for Annex 5, and web links for lists of WHO Member States provided in Annex 6.

# ANNEX 11[6]

## TRENDS IN ESTIMATES OF MATERNAL MORTALITY RATIO (MMR, MATERNAL DEATHS PER 100 000 LIVE BIRTHS), BY UNFPA REGION, 2000–2017

| UNFPA region | MMR point estimates | | | | | Overall reduction in MMR between 2000 and 2017 (%) | Average annual rate of reduction in MMR between 2000 and 2017 (%) |
|---|---|---|---|---|---|---|---|
| | 2000 | 2005 | 2010 | 2015 | 2017 | | |
| Arab States | 262 | 223 | 178 | 155 | 151 | 42.5 | 3.3 |
| Asia and the Pacific | 272 | 218 | 167 | 130 | 120 | 56.0 | 4.8 |
| East and Southern Africa | 773 | 639 | 494 | 413 | 391 | 49.4 | 4.0 |
| Eastern Europe and Central Asia | 42 | 34 | 26 | 21 | 20 | 52.0 | 4.3 |
| Latin America and the Caribbean | 96 | 91 | 85 | 77 | 74 | 22.8 | 1.5 |
| West and Central Africa | 1000 | 890 | 798 | 744 | 717 | 28.4 | 2.0 |
| Non-UNFPA list[a] | 16 | 14 | 12 | 12 | 12 | 26.4 | 1.8 |
| World | 342 | 296 | 248 | 219 | 211 | 38.4 | 2.9 |

[a] See note for previous table.

[6] For countries included, refer to note “a” for Annex 5, and web links for lists of WHO Member States provided in Annex 6.

# ANNEX 12[7]

## ESTIMATES OF MATERNAL MORTALITY RATIO (MMR, MATERNAL DEATHS PER 100 000 LIVE BIRTHS), NUMBER OF MATERNAL DEATHS, AND LIFETIME RISK, BY WORLD BANK GROUP REGION AND INCOME GROUP, 2017

| World Bank Group region and income group | MMR point estimate and range of uncertainty interval (UI: 80%) | | | Number of maternal deaths | Lifetime risk of maternal death: 1 in |
|---|---|---|---|---|---|
| | Lower UI | MMR point estimate | Upper UI | | |
| **Region** | | | | | |
| East Asia and Pacific | 61 | 69 | 85 | 21 000 | 790 |
| Europe and Central Asia | 12 | 13 | 14 | 1 400 | 4 300 |
| Latin America and the Caribbean | 70 | 74 | 81 | 7 800 | 630 |
| Middle East and North Africa | 50 | 57 | 71 | 5 800 | 570 |
| North America | 16 | 18 | 20 | 760 | 3 100 |
| South Asia | 141 | 163 | 196 | 57 000 | 240 |
| Sub-Saharan Africa | 490 | 534 | 636 | 200 000 | 38 |
| World | 199 | 211 | 243 | 295 000 | 190 |
| **Income group** | | | | | |
| Low income | 437 | 462 | 540 | 111 000 | 45 |
| Lower middle income | 226 | 254 | 307 | 166 000 | 140 |
| Upper middle income | 40 | 43 | 48 | 16 000 | 1 200 |
| High income | 10 | 11 | 12 | 1 400 | 5 400 |

UI: uncertainty interval.

Countries in each World Bank Group region are listed at: https://www.worldbank.org/en/where-we-work

Countries in each World Bank Group region and income group are listed at: https://datahelpdesk.worldbank.org/knowledgebase/articles/906519-world-bank-country-and-lending-groups

[7] For countries included, refer to note "a" for Annex 5, and web links for lists of WHO Member States provided in Annex 6.

# ANNEX 13[8]

## TRENDS IN ESTIMATES OF MATERNAL MORTALITY RATIO (MMR, MATERNAL DEATHS PER 100 000 LIVE BIRTHS), BY WORLD BANK GROUP REGION AND INCOME GROUP, 2000–2017

| World Bank Group region and income group | MMR point estimates | | | | | Overall reduction[a] in MMR between 2000 and 2017 (%) | Average annual rate of reduction in MMR between 2000 and 2017 (%) |
|---|---|---|---|---|---|---|---|
| | 2000 | 2005 | 2010 | 2015 | 2017 | | |
| **Region** | | | | | | | |
| East Asia and Pacific | 114 | 100 | 86 | 73 | 69 | 42.0 | 2.9 |
| Europe and Central Asia | 27 | 22 | 17 | 14 | 13 | 52.7 | 4.4 |
| Latin America and the Caribbean | 96 | 90 | 85 | 77 | 74 | 19.0 | 1.5 |
| Middle East and North Africa | 96 | 82 | 63 | 59 | 57 | 40.3 | 3.0 |
| North America | 12 | 13 | 14 | 17 | 18 | -52.2 | -2.5 |
| South Asia | 395 | 309 | 235 | 179 | 163 | 58.7 | 5.2 |
| Sub-Saharan Africa | 870 | 746 | 626 | 557 | 534 | 38.7 | 2.9 |
| World | 342 | 296 | 248 | 219 | 211 | 38.4 | 2.9 |
| **Income group** | | | | | | | |
| Low income | 833 | 696 | 573 | 491 | 462 | 45.0 | 3.5 |
| Lower middle income | 428 | 363 | 302 | 265 | 254 | 40.7 | 3.1 |
| Upper middle income | 69 | 61 | 51 | 45 | 43 | 37.6 | 2.8 |
| High income | 12 | 11 | 11 | 11 | 11 | 4.1 | 0.3 |

[a] Negative number indicates percentage increase in MMR.

[8] For countries included, refer to note “a” for Annex 5, and web links for lists of WHO Member States provided in Annex 6.

# ANNEX 14[9]

## ESTIMATES OF MATERNAL MORTALITY RATIO (MMR, MATERNAL DEATHS PER 100 000 LIVE BIRTHS), NUMBER OF MATERNAL DEATHS, AND LIFETIME RISK, BY UNITED NATIONS POPULATION DIVISION (UNPD) REGION AND SUBREGION, 2017

| UNPD region and subregion[a] | MMR point estimate and range of uncertainty interval (UI: 80%) | | | Number of maternal deaths | Lifetime risk of maternal death: 1 in |
|---|---|---|---|---|---|
| | Lower UI | MMR point estimate | Upper UI | | |
| Africa | 443 | 481 | 572 | 203 000 | 45 |
| Northern Africa | 91 | 112 | 145 | 6 700 | 260 |
| Sub-Saharan Africa | 498 | 542 | 649 | 196 000 | 37 |
| Asia | 100 | 110 | 129 | 82 000 | 410 |
| Central Asia | 21 | 24 | 28 | 390 | 1 400 |
| Eastern Asia | 22 | 28 | 35 | 5 300 | 2 200 |
| South-Eastern Asia | 115 | 137 | 173 | 16 000 | 320 |
| Southern Asia | 136 | 157 | 189 | 58 000 | 250 |
| Western Asia | 45 | 55 | 69 | 3 000 | 650 |
| Europe | 9 | 10 | 11 | 740 | 6 500 |
| Eastern Europe | 12 | 14 | 18 | 480 | 4 200 |
| Northern Europe | 5 | 6 | 7 | 72 | 9 300 |
| Southern Europe | 4 | 4 | 5 | 55 | 17 700 |
| Western Europe | 6 | 7 | 8 | 130 | 9 000 |
| Americas | 55 | 58 | 63 | 8 600 | 850 |
| Latin America and the Caribbean | 70 | 74 | 81 | 7 800 | 630 |
| Northern America | 16 | 18 | 20 | 760 | 3 100 |
| Oceania | 34 | 60 | 120 | 400 | 690 |
| Australia and New Zealand | 6 | 7 | 8 | 26 | 7 800 |
| Melanesia | 68 | 132 | 276 | 370 | 200 |
| Micronesia | 59 | 90 | 157 | 5 | 330 |
| Polynesia | 28 | 46 | 94 | 3 | 570 |
| Small island developing States | 178 | 210 | 277 | 2 600 | 190 |
| Least developed countries | 396 | 415 | 477 | 130 000 | 56 |
| Landlocked developing countries | 378 | 408 | 484 | 65 000 | 57 |
| Less developed regions[b] | 219 | 232 | 268 | 293 000 | 160 |
| More developed regions[c] | 11 | 12 | 13 | 1 600 | 5 200 |
| World | 199 | 211 | 243 | 295 000 | 190 |

[9] For countries included, refer to note "a" for Annex 5, and web links for lists of WHO Member States provided in Annex 6.

[a] The data are from the United Nations Statistics Division, a different division of the United Nations Department of Economic and Social Affairs (UN DESA).

Countries in each UNPD region are listed at: https://unstats.un.org/unsd/methodology/m49/ (select 'Geographic regions' or 'Other regions')

[b] Afghanistan, Algeria, Angola, Antigua and Barbuda, Argentina, Armenia, Azerbaijan, Bahamas, Bahrain, Bangladesh, Barbados, Belize, Benin, Bhutan, Bolivia (Plurinational State of), Botswana, Brazil, Brunei Darussalam, Burkina Faso, Burundi, Cabo Verde, Cambodia, Cameroon, Central African Republic, Chad, Chile, China, Colombia, Comoros, Congo, Costa Rica, Côte d'Ivoire, Cuba, Cyprus, Democratic People's Republic of Korea, Democratic Republic of the Congo, Djibouti, Dominican Republic, Ecuador, Egypt, El Salvador, Equatorial Guinea, Eritrea, Ethiopia, Eswatini, Fiji, Gabon, Gambia, Georgia, Ghana, Grenada, Guatemala, Guinea, Guinea-Bissau, Guyana, Haiti, Honduras, India, Indonesia, Iran (Islamic Republic of), Iraq, Israel, Jamaica, Jordan, Kazakhstan, Kenya, Kiribati, Kuwait, Kyrgyzstan, Lao People's Democratic Republic, Lebanon, Lesotho, Liberia, State of Libya, Madagascar, Malawi, Malaysia, Maldives, Mali, Mauritania, Mauritius, Mexico, Micronesia (Federated States of), Mongolia, Morocco, Mozambique, Myanmar, Namibia, Nepal, Nicaragua, Niger, Nigeria, Oman, Pakistan, Panama, Papua New Guinea, Paraguay, Peru, Philippines, Puerto Rico, Qatar, Republic of Korea, Rwanda, Saint Lucia, Saint Vincent and the Grenadines, Samoa, Sao Tome and Principe, Saudi Arabia, Senegal, Seychelles, Sierra Leone, Singapore, Solomon Islands, Somalia, South Africa, South Sudan, Sri Lanka, Sudan, Suriname, Syrian Arab Republic, Tajikistan, Thailand, Timor-Leste, Togo, Tonga, Trinidad and Tobago, Tunisia, Turkey, Turkmenistan, Uganda, United Arab Emirates, United Republic of Tanzania, Uruguay, Uzbekistan, Vanuatu, Venezuela (Bolivarian Republic of), Viet Nam, West Bank and Gaza Strip, Yemen, Zambia, Zimbabwe.

[c] Albania, Australia, Austria, Belarus, Belgium, Bosnia and Herzegovina, Bulgaria, Canada, Croatia, Czechia, Denmark, Estonia, Finland, France, Germany, Greece, Hungary, Iceland, Ireland, Italy, Japan, Latvia, Lithuania, Luxembourg, Malta, Montenegro, Netherlands, New Zealand, Norway, Poland, Portugal, Republic of Moldova, Republic of North Macedonia, Romania, Russian Federation, Serbia, Slovakia, Slovenia, Spain, Sweden, Switzerland, Ukraine, United Kingdom of Great Britain and Northern Ireland.

# ANNEX 15[10]

## TRENDS IN ESTIMATES OF MATERNAL MORTALITY RATIO (MMR, MATERNAL DEATHS PER 100 000 LIVE BIRTHS), BY UNPD REGION AND SUBREGION, 2000–2017

| UNPD region and subregion | MMR point estimate | | | | | Overall reduction[a] in MMR between 2000 and 2017 (%) | Average annual rate of reduction in MMR between 2000 and 2017 (%) |
|---|---|---|---|---|---|---|---|
| | 2000 | 2005 | 2010 | 2015 | 2017 | | |
| Africa | 788 | 678 | 565 | 501 | 481 | 39.0 | 2.9 |
| Northern Africa | 244 | 193 | 145 | 118 | 112 | 54.1 | 4.6 |
| Sub-Saharan Africa | 878 | 754 | 635 | 566 | 542 | 38.3 | 2.8 |
| Asia | 250 | 201 | 154 | 120 | 110 | 55.9 | 4.8 |
| Central Asia | 49 | 40 | 30 | 25 | 24 | 52.0 | 4.3 |
| Eastern Asia | 56 | 43 | 35 | 29 | 28 | 49.9 | 4.1 |
| South-Eastern Asia | 214 | 194 | 171 | 145 | 137 | 36.0 | 2.6 |
| Southern Asia | 384 | 301 | 228 | 172 | 157 | 59.2 | 5.3 |
| Western Asia | 81 | 78 | 58 | 56 | 55 | 32.4 | 2.3 |
| Europe | 20 | 17 | 13 | 10 | 10 | 53.4 | 4.5 |
| Eastern Europe | 40 | 31 | 20 | 16 | 14 | 64.0 | 6.0 |
| Northern Europe | 10 | 10 | 9 | 7 | 6 | 39.8 | 3.0 |
| Southern Europe | 7 | 6 | 5 | 5 | 4 | 36.8 | 2.7 |
| Western Europe | 9 | 8 | 7 | 6 | 7 | 23.5 | 1.6 |
| Americas | 73 | 68 | 64 | 60 | 58 | 20.8 | 1.4 |
| Latin America and the Caribbean | 96 | 90 | 85 | 77 | 74 | 22.6 | 1.5 |
| Northern America | 12 | 13 | 14 | 17 | 18 | -52.2 | -2.5 |
| Oceania | 106 | 84 | 69 | 62 | 60 | 43.0 | 3.3 |
| Australia and New Zealand | 8 | 6 | 6 | 7 | 7 | 11.0 | 0.7 |
| Melanesia | 230 | 185 | 155 | 138 | 132 | 42.4 | 3.2 |
| Micronesia | 146 | 126 | 111 | 96 | 90 | 38.1 | 2.8 |
| Polynesia | 84 | 70 | 58 | 48 | 46 | 45.0 | 3.5 |
| Small island developing States | 249 | 233 | 226 | 214 | 210 | 15.7 | 1.0 |
| Least developed countries | 763 | 635 | 520 | 442 | 415 | 45.6 | 3.6 |
| Landlocked developing countries | 788 | 666 | 525 | 435 | 408 | 48.2 | 3.9 |
| Less developed regions | 378 | 328 | 275 | 241 | 232 | 37.0 | 2.9 |
| More developed regions | 16 | 15 | 12 | 12 | 12 | 88.0 | 1.9 |
| World | 342 | 296 | 248 | 219 | 211 | 38.4 | 2.9 |

[a] Negative number indicates percentage increase in MMR.

[10] For countries included, refer to note “a” for Annex 5, and web links for lists of WHO Member States provided in Annex 6

# ANNEX 16[11]

## TRENDS IN ESTIMATES OF MATERNAL MORTALITY RATIO (MMR, MATERNAL DEATHS PER 100 000 LIVE BIRTHS), BY UNITED NATIONS SUSTAINABLE DEVELOPMENT GOAL (SDG) REGION, SUBREGION AND OTHER GROUPING, 2000–2017

| SDG region, subregion and other grouping | MMR point estimates | | | | | Overall reduction in MMR between 2000 and 2017 (%) | Average annual rate of reduction in MMR between 2000 and 2017 (%) |
|---|---|---|---|---|---|---|---|
| | 2000 | 2005 | 2010 | 2015 | 2017 | | |
| World | 342 | 296 | 248 | 219 | 211 | 38.4 | 2.9 |
| Sub-Saharan Africa | 878 | 754 | 635 | 566 | 542 | 38.3 | 2.8 |
| Eastern Africa[a] | 851 | 710 | 548 | 453 | 428 | 49.8 | 4.1 |
| Middle Africa[b] | 866 | 701 | 586 | 524 | 505 | 41.7 | 3.2 |
| Southern Africa[c] | 205 | 239 | 199 | 155 | 148 | 27.9 | 1.9 |
| Western Africa[d] | 993 | 885 | 796 | 743 | 716 | 27.9 | 1.9 |
| Northern Africa and Western Asia | 158 | 133 | 101 | 88 | 84 | 46.6 | 3.7 |
| Northern Africa[e] | 244 | 193 | 145 | 118 | 112 | 54.1 | 4.6 |
| Western Asia[f] | 81 | 78 | 58 | 56 | 55 | 32.4 | 2.3 |
| Central and Southern Asia | 375 | 293 | 220 | 166 | 151 | 59.7 | 5.3 |
| Central Asia[g] | 49 | 40 | 30 | 25 | 24 | 52.0 | 4.3 |
| Southern Asia[h] | 384 | 301 | 228 | 172 | 157 | 59.2 | 5.3 |
| Eastern and South-Eastern Asia | 114 | 100 | 86 | 73 | 69 | 39.3 | 2.9 |
| Eastern Asia[i] | 56 | 43 | 35 | 29 | 28 | 49.9 | 4.1 |
| South-Eastern Asia[j] | 214 | 194 | 171 | 145 | 137 | 36.0 | 2.6 |
| Latin America and the Caribbean | 96 | 90 | 85 | 77 | 74 | 22.6 | 1.5 |
| Caribbean[k] | 194 | 208 | 233 | 229 | 229 | -18.1 | -1.0 |
| Central America[l] | 75 | 70 | 62 | 50 | 47 | 38.1 | 2.8 |
| South America[m] | 95 | 88 | 80 | 74 | 71 | 25.1 | 1.7 |
| Oceania | 106 | 84 | 69 | 62 | 60 | 43.0 | 3.3 |
| Australia and New Zealand | 8 | 6 | 6 | 7 | 7 | 11.0 | 0.7 |
| Oceania (excl. Australia and New Zealand)[n] | 223 | 180 | 151 | 135 | 129 | 42.0 | 3.2 |
| Europe and Northern America | 17 | 16 | 13 | 12 | 12 | 27.5 | 1.9 |
| Europe | 20 | 17 | 13 | 10 | 10 | 53.4 | 4.5 |
| Eastern Europe[o] | 40 | 31 | 20 | 16 | 14 | 64.0 | 6.0 |

[11] For countries included, refer to note “a” for Annex 5, and web links for lists of WHO Member States provided in Annex 6.

## Annex 16 (continued)

| SDG region, subregion and other grouping | MMR point estimates | | | | | Overall change in MMR between 2000 and 2017 (%) | Average annual rate of reduction in MMR between 2000 and 2017 (%) |
|---|---|---|---|---|---|---|---|
| | 2000 | 2005 | 2010 | 2015 | 2017 | | |
| Northern Europe[p] | 10 | 10 | 9 | 7 | 6 | 39.8 | 3.0 |
| Southern Europe[q] | 7 | 6 | 5 | 5 | 4 | 36.8 | 2.7 |
| Western Europe[r] | 9 | 8 | 7 | 6 | 7 | 23.5 | 1.6 |
| Northern America[s] | 12 | 13 | 14 | 17 | 18 | -52.2 | -2.5 |
| Landlocked developing countries[t] | 788 | 666 | 525 | 435 | 408 | 48.2 | 3.9 |
| Least developed countries[u] | 763 | 635 | 520 | 442 | 415 | 45.6 | 3.6 |
| Small island developing States[v] | 249 | 233 | 226 | 214 | 210 | 15.7 | 1.0 |

Note: In the last two columns, negative numbers indicate increases instead of reductions.

[a] Burundi, Comoros, Djibouti, Eritrea, Ethiopia, Kenya, Madagascar, Malawi, Mauritius, Mozambique, Rwanda, Seychelles, Somalia, South Sudan, Uganda, United Republic of Tanzania, Zambia, Zimbabwe.

[b] Angola, Cameroon, Central African Republic, Chad, Congo, Democratic Republic of the Congo, Equatorial Guinea, Gabon, Sao Tome and Principe.

[c] Botswana, Eswatini, Lesotho, Namibia, South Africa.

[d] Benin, Burkina Faso, Cabo Verde, Côte d'Ivoire, Gambia, Ghana, Guinea, Guinea-Bissau, Liberia, Mali, Mauritania, Niger, Nigeria, Senegal, Sierra Leone, Togo.

[e] Algeria, Egypt, Morocco, State of Libya, Sudan, Tunisia.

[f] Armenia, Azerbaijan, Bahrain, Cyprus, Georgia, Iraq, Israel, Jordan, Kuwait, Lebanon, Oman, Qatar, Saudi Arabia, Syrian Arab Republic, Turkey, United Arab Emirates, West Bank and Gaza Strip, Yemen.

[g] Kazakhstan, Kyrgyzstan, Tajikistan, Turkmenistan, Uzbekistan.

[h] Afghanistan, Bangladesh, Bhutan, India, Iran (Islamic Republic of), Maldives, Nepal, Pakistan, Sri Lanka.

[i] China, Democratic People's Republic of Korea, Japan, Mongolia, Republic of Korea.

[j] Brunei Darussalam, Cambodia, Indonesia, Lao People's Democratic Republic, Malaysia, Myanmar, Philippines, Singapore, Thailand, Timor-Leste, Viet Nam.

[k] Antigua and Barbuda, Bahamas, Barbados, Cuba, Dominican Republic, Grenada, Haiti, Jamaica, Puerto Rico, Saint Lucia, Saint Vincent and the Grenadines, Trinidad and Tobago

[l] Belize, Costa Rica, El Salvador, Guatemala, Honduras, Mexico, Nicaragua, Panama.

[m] Argentina, Bolivia (Plurinational State of), Brazil, Chile, Colombia, Ecuador, Guyana, Paraguay, Peru, Suriname, Uruguay, Venezuela (Bolivarian Republic of)

[n] Fiji, Kiribati, Micronesia (Federated States of), Papua New Guinea, Samoa, Solomon Islands, Tonga, Vanuatu.

[o] Belarus, Bulgaria, Czechia, Hungary, Poland, Republic of Moldova, Romania, Russian Federation, Slovakia, Ukraine

[p] Denmark, Estonia, Finland, Iceland, Ireland, Latvia, Lithuania, Norway, Sweden, United Kingdom of Great Britain and Northern Ireland

[q] Albania, Bosnia and Herzegovina, Croatia, Greece, Italy, Malta, Montenegro, Portugal, Republic of North Macedonia, Serbia, Slovenia, Spain

[r] Austria, Belgium, France, Germany, Luxembourg, Netherlands, Switzerland

[s] Canada, United States of America.

[t] Afghanistan, Armenia, Azerbaijan, Bhutan, Bolivia (Plurinational State of), Botswana, Burkina Faso, Burundi, Central African Republic, Eswatini, Ethiopia, Kazakhstan, Kyrgyzstan, Lao People's Democratic Republic, Lesotho, Malawi, Mali, Mongolia, Nepal, Niger, Paraguay, Republic of Moldova, Republic of North Macedonia, Rwanda, South Sudan, Tajikistan, Turkmenistan, Uganda, Uzbekistan, Zambia, Zimbabwe.

[u] Afghanistan, Angola, Bangladesh, Benin, Bhutan, Burkina Faso, Burundi, Cambodia, Central African Republic, Chad, Comoros, Democratic Republic of the Congo, Djibouti, Eritrea, Ethiopia, Gambia, Guinea, Guinea-Bissau, Haiti, Kiribati, Lao People's Democratic Republic, Lesotho, Liberia, Madagascar, Malawi, Mali, Mauritania, Mozambique, Myanmar, Nepal, Niger, Rwanda, Sao Tome and Principe, Senegal, Sierra Leone, Solomon Islands, Somalia, South Sudan, Sudan, Timor-Leste, Togo, Uganda, United Republic of Tanzania, Vanuatu, Yemen, Zambia.

[v] Antigua and Barbuda, Bahamas, Barbados, Belize, Cabo Verde, Comoros, Cuba, Dominican Republic, Fiji, Grenada, Guinea-Bissau, Guyana, Haiti, Jamaica, Kiribati, Maldives, Mauritius, Micronesia (Federated States of), Papua New Guinea, Puerto Rico, Saint Lucia, Saint Vincent and the Grenadines, Samoa, Sao Tome and Principe, Seychelles, Singapore, Solomon Islands, Suriname, Timor-Leste, Tonga, Trinidad and Tobago, Vanuatu.

# ANNEX 17[12]

## TRENDS IN ESTIMATES OF MATERNAL MORTALITY RATIO (MMR, MATERNAL DEATHS PER 100 000 LIVE BIRTHS), BY COUNTRY AND TERRITORY, 2000–2017[a]

| Country and territory | MMR point estimates[b] | | | | | Overall reduction in MMR between 2000 and 2017[c] (%) | Average annual rate of reduction (ARR) point estimate and range of uncertainty interval on ARR between 2000 and 2017 (UI: 80%) (%) | | |
|---|---|---|---|---|---|---|---|---|---|
| | 2000 | 2005 | 2010 | 2015 | 2017 | | Lower UI | Average ARR point estimate[d] | Upper UI |
| Afghanistan | 1450 | 1140 | 954 | 701 | 638 | 56 | 1.4 | 4.8 | 7.3 |
| Albania | 23 | 22 | 21 | 15 | 15 | 35 | -0.1 | 2.5 | 5.7 |
| Algeria | 161 | 127 | 115 | 114 | 112 | 30 | -0.5 | 2.1 | 4.4 |
| Angola | 827 | 519 | 326 | 251 | 241 | 71 | 5.4 | 7.2 | 9.3 |
| Antigua and Barbuda | 44 | 40 | 44 | 43 | 42 | 5 | -1.8 | 0.2 | 2.4 |
| Argentina | 66 | 59 | 51 | 41 | 39 | 41 | 2.1 | 3.1 | 4.2 |
| Armenia | 43 | 35 | 32 | 28 | 26 | 40 | 1.5 | 3.0 | 4.3 |
| Australia | 7 | 5 | 5 | 6 | 6 | 14 | -1.4 | 0.2 | 1.7 |
| Austria | 6 | 6 | 5 | 5 | 5 | 17 | -0.5 | 1.6 | 3.1 |
| Azerbaijan | 47 | 42 | 31 | 27 | 26 | 45 | 2.2 | 3.5 | 4.9 |
| Bahamas | 75 | 77 | 78 | 74 | 70 | 7 | -2.4 | 0.4 | 2.6 |
| Bahrain | 27 | 19 | 18 | 15 | 14 | 48 | 1.6 | 3.6 | 5.4 |
| Bangladesh | 434 | 343 | 258 | 200 | 173 | 60 | 3.4 | 5.4 | 7.1 |
| Barbados | 50 | 42 | 36 | 31 | 27 | 46 | 1.9 | 3.7 | 6.0 |
| Belarus | 22 | 11 | 5 | 3 | 2 | 91 | 9.6 | 13.0 | 16.7 |
| Belgium | 8 | 7 | 6 | 5 | 5 | 38 | 1.0 | 2.5 | 4.1 |
| Belize | 89 | 70 | 54 | 43 | 36 | 60 | 3.7 | 5.3 | 7.5 |
| Benin | 520 | 500 | 464 | 421 | 397 | 24 | -0.4 | 1.6 | 3.2 |
| Bhutan | 423 | 310 | 247 | 203 | 183 | 57 | 2.1 | 4.9 | 7.0 |
| Bolivia (Plurinational State of) | 331 | 271 | 212 | 168 | 155 | 53 | 2.7 | 4.5 | 6.2 |
| Bosnia and Herzegovina | 17 | 13 | 11 | 10 | 10 | 41 | 1.3 | 3.3 | 6.3 |
| Botswana | 262 | 239 | 179 | 156 | 144 | 45 | 2.1 | 3.5 | 4.7 |
| Brazil | 69 | 71 | 65 | 63 | 60 | 13 | 0.7 | 0.9 | 1.1 |
| Brunei Darussalam | 28 | 29 | 28 | 30 | 31 | -11 | -2.5 | -0.7 | 1.6 |
| Bulgaria | 19 | 15 | 12 | 10 | 10 | 47 | 1.9 | 4.0 | 6.5 |

[12] For countries included, refer to note “a” for Annex 5, and web links for lists of WHO Member States provided in Annex 6

## Annex 17 (continued)

| Country and territory | MMR point estimates[a,b] | | | | | Overall reduction in MMR between 2000 and 2017[c] (%) | Average annual rate of reduction (ARR) point estimate and range of uncertainty interval on ARR between 2000 and 2017 (UI: 80%) (%) | | |
|---|---|---|---|---|---|---|---|---|---|
| | 2000 | 2005 | 2010 | 2015 | 2017 | | Lower UI | Average ARR point estimate[d] | Upper UI |
| Burkina Faso | 516 | 437 | 385 | 343 | 320 | 38 | 0.9 | 2.8 | 4.9 |
| Burundi | 1010 | 814 | 665 | 568 | 548 | 46 | 1.7 | 3.6 | 5.5 |
| Cabo Verde | 118 | 86 | 70 | 61 | 58 | 51 | 2.5 | 4.2 | 5.7 |
| Cambodia | 488 | 351 | 248 | 178 | 160 | 67 | 4.6 | 6.6 | 8.4 |
| Cameroon | 886 | 692 | 597 | 554 | 529 | 40 | 0.8 | 3.0 | 4.8 |
| Canada | 9 | 11 | 11 | 11 | 10 | -11 | -2.5 | -0.6 | 1.2 |
| Central African Republic | 1280 | 1200 | 1000 | 912 | 829 | 35 | 0.3 | 2.6 | 4.9 |
| Chad | 1420 | 1330 | 1240 | 1160 | 1140 | 20 | -0.7 | 1.3 | 2.9 |
| Chile | 31 | 25 | 20 | 14 | 13 | 58 | 4.3 | 5.4 | 6.7 |
| China | 59 | 44 | 36 | 30 | 29 | 51 | 2.9 | 4.2 | 6.0 |
| Colombia | 94 | 83 | 85 | 85 | 83 | 12 | -0.4 | 0.8 | 1.7 |
| Comoros | 444 | 404 | 341 | 285 | 273 | 39 | 0.8 | 2.9 | 4.9 |
| Congo | 739 | 677 | 506 | 416 | 378 | 49 | 2.0 | 3.9 | 5.7 |
| Costa Rica | 40 | 33 | 32 | 28 | 27 | 33 | 1.2 | 2.2 | 3.4 |
| Côte d'Ivoire | 704 | 704 | 701 | 658 | 617 | 12 | -1.2 | 0.8 | 2.7 |
| Croatia | 11 | 10 | 9 | 8 | 8 | 27 | 0.0 | 2.0 | 3.7 |
| Cuba | 46 | 41 | 41 | 38 | 36 | 22 | 0.6 | 1.4 | 2.2 |
| Cyprus | 14 | 12 | 8 | 7 | 6 | 57 | 2.9 | 4.9 | 7.0 |
| Czechia | 7 | 5 | 4 | 4 | 3 | 57 | 2.0 | 4.0 | 6.3 |
| Democratic People's Republic of Korea | 139 | 120 | 106 | 91 | 89 | 36 | 0.2 | 2.6 | 4.9 |
| Democratic Republic of the Congo | 760 | 627 | 542 | 490 | 473 | 38 | 0.1 | 2.8 | 4.7 |
| Denmark | 8 | 6 | 5 | 4 | 4 | 50 | 2.8 | 4.3 | 6.2 |
| Djibouti | 507 | 393 | 283 | 247 | 248 | 51 | 2.0 | 4.2 | 6.5 |
| Dominican Republic | 80 | 83 | 96 | 94 | 95 | -19 | -1.6 | -1.0 | -0.5 |
| Ecuador | 122 | 94 | 78 | 63 | 59 | 52 | 3.4 | 4.3 | 5.2 |
| Egypt | 64 | 52 | 45 | 39 | 37 | 42 | 1.7 | 3.2 | 5.4 |
| El Salvador | 73 | 62 | 54 | 48 | 46 | 37 | 1.3 | 2.7 | 4.3 |
| Equatorial Guinea | 454 | 344 | 308 | 296 | 301 | 34 | 0.3 | 2.4 | 4.5 |
| Eritrea | 1280 | 804 | 567 | 518 | 480 | 63 | 3.6 | 5.8 | 7.9 |
| Estonia | 29 | 18 | 11 | 10 | 9 | 69 | 5.0 | 7.1 | 9.6 |
| Eswatini | 521 | 532 | 450 | 435 | 437 | 16 | -1.6 | 1.0 | 3.0 |
| Ethiopia | 1030 | 865 | 597 | 446 | 401 | 61 | 3.0 | 5.5 | 7.4 |
| Fiji | 51 | 46 | 39 | 35 | 34 | 33 | 0.8 | 2.4 | 4.0 |
| Finland | 6 | 5 | 4 | 3 | 3 | 50 | 1.7 | 3.6 | 5.2 |

## Annex 17 (continued)

| Country and territory | MMR point estimates[a,b] | | | | | Overall reduction in MMR between 2000 and 2017[c] (%) | Average annual rate of reduction (ARR) point estimate and range of uncertainty interval on ARR between 2000 and 2017 (UI: 80%) (%) | | |
|---|---|---|---|---|---|---|---|---|---|
| | 2000 | 2005 | 2010 | 2015 | 2017 | | Lower UI | Average ARR point estimate[d] | Upper UI |
| France | 10 | 9 | 9 | 8 | 8 | 20 | 0.2 | 1.4 | 2.6 |
| Gabon | 380 | 348 | 314 | 261 | 252 | 34 | 0.1 | 2.4 | 4.3 |
| Gambia | 932 | 756 | 661 | 625 | 597 | 36 | 0.6 | 2.6 | 4.5 |
| Georgia | 31 | 39 | 32 | 27 | 25 | 19 | 0.1 | 1.3 | 2.5 |
| Germany | 7 | 6 | 6 | 5 | 7 | 0 | -1.3 | 0.2 | 1.8 |
| Ghana | 484 | 371 | 339 | 320 | 308 | 36 | 0.9 | 2.7 | 4.5 |
| Greece | 3 | 3 | 3 | 3 | 3 | 0 | -1.3 | 0.6 | 2.7 |
| Grenada | 38 | 33 | 29 | 25 | 25 | 34 | 0.4 | 2.4 | 4.5 |
| Guatemala | 161 | 142 | 129 | 103 | 95 | 41 | 2.5 | 3.1 | 3.7 |
| Guinea | 1020 | 920 | 747 | 699 | 576 | 44 | 1.6 | 3.4 | 4.9 |
| Guinea-Bissau | 1210 | 979 | 779 | 694 | 667 | 45 | 1.0 | 3.5 | 5.4 |
| Guyana | 231 | 223 | 179 | 172 | 169 | 27 | 0.4 | 1.8 | 3.3 |
| Haiti | 437 | 459 | 506 | 488 | 480 | -10 | -2.7 | -0.6 | 1.3 |
| Honduras | 85 | 77 | 74 | 67 | 65 | 24 | 0.4 | 1.6 | 2.7 |
| Hungary | 16 | 15 | 13 | 12 | 12 | 25 | -0.6 | 2.0 | 4.2 |
| Iceland | 6 | 5 | 5 | 4 | 4 | 33 | 0.7 | 2.7 | 4.9 |
| India | 370 | 286 | 210 | 158 | 145 | 61 | 4.2 | 5.5 | 7.0 |
| Indonesia | 272 | 252 | 228 | 192 | 177 | 35 | 0.5 | 2.5 | 4.3 |
| Iran (Islamic Republic of) | 48 | 34 | 22 | 17 | 16 | 67 | 5.0 | 6.3 | 8.0 |
| Iraq | 79 | 127 | 70 | 83 | 79 | 0 | -1.9 | 0.0 | 2.5 |
| Ireland | 7 | 7 | 6 | 6 | 5 | 29 | 0.0 | 2.5 | 4.3 |
| Israel | 7 | 5 | 4 | 3 | 3 | 57 | 3.4 | 4.9 | 6.5 |
| Italy | 4 | 3 | 2 | 2 | 2 | 50 | 3.3 | 5.1 | 6.9 |
| Jamaica | 77 | 80 | 79 | 78 | 80 | -4 | -1.5 | -0.2 | 0.9 |
| Japan | 9 | 7 | 6 | 5 | 5 | 44 | 2.1 | 3.8 | 5.7 |
| Jordan | 70 | 62 | 53 | 48 | 46 | 34 | 0.6 | 2.4 | 4.7 |
| Kazakhstan | 61 | 43 | 22 | 12 | 10 | 84 | 9.2 | 10.9 | 12.6 |
| Kenya | 708 | 618 | 432 | 353 | 342 | 52 | 2.4 | 4.3 | 5.9 |
| Kiribati | 136 | 119 | 112 | 97 | 92 | 32 | 0.1 | 2.3 | 4.7 |
| Kuwait | 10 | 10 | 10 | 11 | 12 | -20 | -2.8 | -0.7 | 1.2 |
| Kyrgyzstan | 79 | 82 | 79 | 66 | 60 | 24 | 0.0 | 1.6 | 2.8 |
| Lao People's Democratic Republic | 544 | 410 | 292 | 209 | 185 | 66 | 4.4 | 6.3 | 8.0 |
| Latvia | 34 | 30 | 26 | 23 | 19 | 44 | 1.6 | 3.5 | 5.0 |
| Lebanon | 28 | 24 | 23 | 29 | 29 | -4 | -2.9 | -0.4 | 1.6 |
| Lesotho | 614 | 679 | 594 | 574 | 544 | 11 | -1.6 | 0.7 | 2.5 |

## Annex 17 (continued)

| Country and territory | MMR point estimates[a,b] | | | | | Overall reduction in MMR between 2000 and 2017[c] (%) | Average annual rate of reduction (ARR) point estimate and range of uncertainty interval on ARR between 2000 and 2017 (UI: 80%) (%) | | |
|---|---|---|---|---|---|---|---|---|---|
| | 2000 | 2005 | 2010 | 2015 | 2017 | | Lower UI | Average ARR point estimate[d] | Upper UI |
| Liberia | 894 | 816 | 708 | 691 | 661 | 26 | -0.4 | 1.8 | 3.5 |
| Lithuania | 17 | 14 | 10 | 9 | 8 | 53 | 2.1 | 4.2 | 6.5 |
| Luxembourg | 10 | 9 | 8 | 5 | 5 | 50 | 2.4 | 4.5 | 6.3 |
| Madagascar | 559 | 526 | 453 | 363 | 335 | 40 | 1.0 | 3.0 | 5.0 |
| Malawi | 749 | 610 | 444 | 370 | 349 | 53 | 2.3 | 4.5 | 6.5 |
| Malaysia | 38 | 31 | 30 | 30 | 29 | 24 | 0.2 | 1.5 | 2.7 |
| Maldives | 125 | 75 | 67 | 54 | 53 | 58 | 2.1 | 5.1 | 7.3 |
| Mali | 836 | 691 | 660 | 620 | 562 | 33 | 0.3 | 2.3 | 3.9 |
| Malta | 9 | 8 | 8 | 7 | 6 | 33 | 0.1 | 2.3 | 4.4 |
| Mauritania | 834 | 826 | 824 | 785 | 766 | 8 | -2.0 | 0.5 | 2.6 |
| Mauritius | 59 | 53 | 66 | 73 | 61 | -3 | -2.8 | -0.2 | 1.9 |
| Mexico | 55 | 54 | 46 | 36 | 33 | 40 | 2.6 | 3.0 | 3.3 |
| Micronesia (Federated States of) | 154 | 133 | 110 | 95 | 88 | 43 | 1.0 | 3.3 | 5.6 |
| Mongolia | 155 | 98 | 66 | 47 | 45 | 71 | 5.8 | 7.3 | 8.8 |
| Montenegro | 12 | 9 | 7 | 6 | 6 | 50 | 2.1 | 4.3 | 6.9 |
| Morocco | 188 | 131 | 92 | 74 | 70 | 63 | 4.2 | 5.8 | 7.5 |
| Mozambique | 798 | 577 | 412 | 318 | 289 | 64 | 3.9 | 6.0 | 7.7 |
| Myanmar | 340 | 299 | 265 | 246 | 250 | 26 | -0.7 | 1.8 | 4.1 |
| Namibia | 348 | 346 | 266 | 217 | 195 | 44 | 1.4 | 3.4 | 4.9 |
| Nepal | 553 | 415 | 305 | 236 | 186 | 66 | 4.0 | 6.4 | 8.4 |
| Netherlands | 13 | 11 | 7 | 6 | 5 | 62 | 3.8 | 5.6 | 7.5 |
| New Zealand | 12 | 11 | 11 | 10 | 9 | 25 | 0.5 | 1.8 | 3.3 |
| Nicaragua | 162 | 131 | 112 | 101 | 98 | 40 | 1.2 | 3.0 | 4.5 |
| Niger | 813 | 755 | 663 | 555 | 509 | 37 | 0.8 | 2.7 | 4.5 |
| Nigeria | 1200 | 1080 | 978 | 931 | 917 | 24 | -0.8 | 1.6 | 3.5 |
| Norway | 6 | 5 | 4 | 3 | 2 | 67 | 3.4 | 5.3 | 7.8 |
| Oman | 20 | 19 | 18 | 19 | 19 | 5 | -1.0 | 0.3 | 1.6 |
| Pakistan | 286 | 237 | 191 | 154 | 140 | 51 | 2.0 | 4.2 | 6.4 |
| Panama | 91 | 88 | 79 | 58 | 52 | 43 | 2.1 | 3.3 | 4.7 |
| Papua New Guinea | 249 | 200 | 168 | 151 | 145 | 42 | 0.9 | 3.2 | 5.5 |
| Paraguay | 162 | 136 | 107 | 89 | 84 | 48 | 2.5 | 3.9 | 5.5 |
| Peru | 144 | 118 | 104 | 94 | 88 | 39 | 1.5 | 2.9 | 4.6 |
| Philippines | 160 | 156 | 144 | 127 | 121 | 24 | -0.3 | 1.7 | 3.3 |
| Poland | 7 | 4 | 3 | 2 | 2 | 71 | 4.5 | 6.6 | 8.9 |
| Portugal | 10 | 9 | 9 | 9 | 8 | 20 | -0.6 | 1.6 | 3.3 |

## Annex 17 (continued)

| Country and territory | MMR point estimates[a,b] | | | | | Overall reduction in MMR between 2000 and 2017[c] (%) | Average annual rate of reduction (ARR) point estimate and range of uncertainty interval on ARR between 2000 and 2017 (UI: 80%) (%) | | |
|---|---|---|---|---|---|---|---|---|---|
| | 2000 | 2005 | 2010 | 2015 | 2017 | | Lower UI | Average ARR point estimate[d] | Upper UI |
| Puerto Rico | 26 | 23 | 21 | 20 | 21 | 19 | -0.6 | 1.3 | 2.7 |
| Qatar | 14 | 12 | 10 | 9 | 9 | 36 | 0.5 | 2.6 | 4.5 |
| Republic of Korea | 17 | 15 | 15 | 12 | 11 | 35 | 1.4 | 2.4 | 3.6 |
| Republic of Moldova | 44 | 34 | 29 | 22 | 19 | 57 | 3.3 | 4.9 | 6.6 |
| Republic of North Macedonia | 13 | 10 | 8 | 8 | 7 | 46 | 1.7 | 3.5 | 5.8 |
| Romania | 54 | 35 | 27 | 21 | 19 | 65 | 4.3 | 6.3 | 8.3 |
| Russian Federation | 56 | 42 | 25 | 18 | 17 | 70 | 5.0 | 6.9 | 8.9 |
| Rwanda | 1160 | 643 | 373 | 275 | 248 | 79 | 7.0 | 9.1 | 10.7 |
| Saint Lucia | 86 | 83 | 109 | 115 | 117 | -36 | -4.7 | -1.8 | 0.8 |
| Saint Vincent and the Grenadines | 80 | 59 | 63 | 64 | 68 | 15 | -0.9 | 0.9 | 3.1 |
| Samoa | 88 | 72 | 58 | 45 | 43 | 51 | 1.7 | 4.2 | 6.6 |
| Sao Tome and Principe | 179 | 163 | 140 | 130 | 130 | 27 | -0.1 | 1.9 | 4.3 |
| Saudi Arabia | 24 | 22 | 19 | 17 | 17 | 29 | -0.2 | 2.1 | 4.5 |
| Senegal | 553 | 519 | 447 | 346 | 315 | 43 | 1.4 | 3.3 | 4.8 |
| Serbia | 13 | 12 | 12 | 13 | 12 | 8 | -2.0 | 0.6 | 2.9 |
| Seychelles | 53 | 55 | 55 | 54 | 53 | 0 | -2.4 | 0.0 | 2.4 |
| Sierra Leone | 2480 | 1760 | 1360 | 1180 | 1120 | 55 | 2.2 | 4.7 | 6.6 |
| Singapore | 13 | 13 | 10 | 9 | 8 | 38 | 0.4 | 2.9 | 5.3 |
| Slovakia | 8 | 7 | 6 | 6 | 5 | 38 | 0.6 | 2.3 | 4.0 |
| Slovenia | 12 | 10 | 8 | 7 | 7 | 42 | 1.6 | 3.3 | 5.0 |
| Solomon Islands | 245 | 188 | 141 | 112 | 104 | 58 | 3.0 | 5.0 | 7.0 |
| Somalia | 1210 | 1040 | 985 | 855 | 829 | 31 | 0.3 | 2.2 | 4.6 |
| South Africa | 160 | 201 | 171 | 125 | 119 | 26 | 0.1 | 1.7 | 3.0 |
| South Sudan | 1730 | 1480 | 1100 | 1110 | 1150 | 34 | 0.1 | 2.4 | 4.5 |
| Spain | 5 | 5 | 4 | 4 | 4 | 20 | 0.0 | 1.7 | 3.0 |
| Sri Lanka | 56 | 45 | 38 | 36 | 36 | 36 | 1.7 | 2.7 | 3.5 |
| State of Libya | 70 | 57 | 53 | 70 | 72 | -3 | -2.6 | -0.2 | 2.3 |
| Sudan | 667 | 529 | 408 | 320 | 295 | 56 | 2.7 | 4.8 | 7.1 |
| Suriname | 221 | 164 | 148 | 122 | 120 | 46 | 2.3 | 3.6 | 5.4 |
| Sweden | 5 | 5 | 4 | 4 | 4 | 20 | -0.2 | 1.5 | 2.9 |
| Switzerland | 7 | 7 | 6 | 5 | 5 | 29 | 0.4 | 2.6 | 4.2 |
| Syrian Arab Republic | 26 | 25 | 27 | 30 | 31 | -19 | -4.0 | -1.1 | 1.3 |
| Tajikistan | 53 | 32 | 23 | 18 | 17 | 68 | 4.3 | 6.8 | 9.5 |
| Thailand | 43 | 43 | 42 | 38 | 37 | 14 | -0.5 | 0.8 | 2.1 |
| Timor-Leste | 745 | 415 | 219 | 160 | 142 | 81 | 7.7 | 9.8 | 11.9 |

## Annex 17 (continued)

| Country and territory | MMR point estimates[a,b] | | | | | Overall reduction in MMR between 2000 and 2017[c] (%) | Average annual rate of reduction (ARR) point estimate and range of uncertainty interval on ARR between 2000 and 2017 (UI: 80%) (%) | | |
|---|---|---|---|---|---|---|---|---|---|
| | 2000 | 2005 | 2010 | 2015 | 2017 | | Lower UI | Average ARR point estimate[d] | Upper UI |
| Togo | 489 | 492 | 440 | 398 | 396 | 19 | -0.5 | 1.3 | 3.1 |
| Tonga | 77 | 66 | 57 | 54 | 52 | 32 | 0.0 | 2.3 | 4.6 |
| Trinidad and Tobago | 81 | 76 | 71 | 68 | 67 | 17 | -0.6 | 1.1 | 2.7 |
| Tunisia | 66 | 51 | 46 | 46 | 43 | 35 | 0.7 | 2.4 | 4.8 |
| Turkey | 42 | 33 | 24 | 19 | 17 | 60 | 3.6 | 5.3 | 7.5 |
| Turkmenistan | 29 | 18 | 10 | 8 | 7 | 76 | 5.9 | 8.2 | 10.5 |
| Uganda | 578 | 491 | 430 | 387 | 375 | 35 | 0.5 | 2.5 | 4.2 |
| Ukraine | 35 | 33 | 25 | 21 | 19 | 46 | 1.6 | 3.6 | 5.5 |
| United Arab Emirates | 6 | 5 | 4 | 3 | 3 | 50 | 1.9 | 4.0 | 6.9 |
| United Kingdom of Great Britain and Northern Ireland | 10 | 11 | 10 | 8 | 7 | 30 | 1.9 | 2.7 | 3.6 |
| United Republic of Tanzania | 854 | 721 | 644 | 556 | 524 | 39 | 0.9 | 2.9 | 4.4 |
| United States of America | 12 | 13 | 15 | 18 | 19 | -58 | -3.3 | -2.6 | -1.9 |
| Uruguay | 26 | 22 | 17 | 18 | 17 | 35 | 1.2 | 2.4 | 3.6 |
| Uzbekistan | 41 | 38 | 31 | 30 | 29 | 29 | 0.1 | 2.0 | 3.6 |
| Vanuatu | 140 | 113 | 92 | 76 | 72 | 49 | 1.6 | 4.0 | 6.1 |
| Venezuela (Bolivarian Republic of) | 119 | 113 | 117 | 115 | 125 | -5 | -2.2 | -0.3 | 1.3 |
| Viet Nam | 68 | 54 | 47 | 45 | 43 | 37 | 0.5 | 2.6 | 4.6 |
| West Bank and Gaza Strip[e] | 70 | 59 | 45 | 32 | 27 | 61 | 3.4 | 5.6 | 8.1 |
| Yemen | 301 | 242 | 192 | 169 | 164 | 46 | 1.7 | 3.6 | 6.1 |
| Zambia | 528 | 421 | 305 | 232 | 213 | 60 | 3.7 | 5.3 | 6.8 |
| Zimbabwe | 579 | 685 | 598 | 480 | 458 | 21 | 0.1 | 1.4 | 2.9 |

[a] Estimates have been computed to ensure comparability across countries, thus they are not necessarily the same as official statistics of the countries, which may use alternative rigorous methods.

[b] MMR estimates have been rounded according to the following scheme: < 100 rounded to nearest 1; 100–999 rounded to nearest 1; and ⩾ 1000 rounded to nearest 10; and all calculations are based on rounded numbers.

[c] Overall percentage change (reduction) for the whole period since the first year of the millennium (from 1 January 2000). Negative numbers indicate percentage increases in MMR.

[d] Average annual rate of reduction, for the whole period from the first year of the millennium (1 January 2000).

[e] UNICEF, UNPFA, World Bank Group and UNPD refer to this territory as the State of Palestine.