Trends in **Maternal Mortality: 1990 to 2015**

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

World Health Organization

unicef

UNFPA

WORLD BANK GROUP

UNITED NATIONS

Trends in maternal mortality: 1990 to 2015

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

WHO Library Cataloguing-in-Publication Data

Trends in maternal mortality: 1990 to 2015: estimates by WHO, UNICEF, UNFPA, World Bank Group and the United Nations Population Division.

1.Maternal Mortality - trends. 2.Maternal Welfare. 3.Data Collection - methods. 4.Models, Statistical. I.World Health Organization. II.World Bank. III.UNICEF. IV.United Nations Population Fund.

ISBN 978 92 4 156514 1 (NLM classification: WQ 16)

PRE-PUBLICATION VERSION

Contents

List of tables

List of annexes

Acknowledgments

The Maternal Mortality Estimation Inter-Agency Group (MMEIG), together with Leontine Alkema of the National University of Singapore, Singapore, and the University of Massachusetts Amherst, United States of America (USA), Sanqian Zhang of the National University of Singapore, Singapore, and Alison Gemmill of the University of California at Berkeley, USA, collaborated in developing these maternal mortality estimates.

The MMEIG consists of the following individuals, listed in alphabetical order: Mohamed Ali of the World Health Organization (WHO); Agbessi Amouzou of the United Nations Children's Fund (UNICEF); Ties Boerma of WHO; Liliana Caravajal of UNICEF; Doris Chou of WHO; Patrick Gerland of the United Nations Population Division (UNPD); Daniel Hogan of WHO; Victor Gaigbe-Togbe of the UNPD; Edilberto Loaiza of the United Nations Population Fund (UNFPA); Matthews Mathai of WHO; Colin Mathers of WHO; Samuel Mills of the World Bank Group; Holly Newby of UNICEF; Lale Say of WHO; Emi Suzuki of the World Bank Group; and Marleen Temmerman of WHO. Leontine Alkema is the lead adviser to the MMEIG.

Flavia Bustreo of WHO oversaw the overall work and process of developing the estimates.

An external technical advisory group (TAG) provided independent technical advice. The members of the TAG are: Saifuddin Ahmed of Johns Hopkins University, USA; David Braunholz, independent consultant, United Kingdom of Great Britain and Northern Ireland; Peter Byass of Umeå University, Sweden; Namuunda Mutombo of the African Population and Health Research Centre, Kenya; and Thomas Pullum of ICF Macro, USA.
We are also grateful to Jeffrey Eaton of Imperial College London, United Kingdom, Bilal Barakat of the Vienna Institute of Demography/International Institute for Applied Systems Analysis (IIASA), Austria, and Emily Peterson of the University of Massachusetts Amherst, USA, for discussion of the analyses.

The Department of Governing Bodies and External Relations of WHO, WHO country offices, UNFPA country offices and UNICEF country offices are all gratefully acknowledged for facilitating the country consultations.

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

Regional Office for Africa: Phanuel Habimana, Derege Kebede, Tigest Ketsela Mengestu, Peter Mbondji, Gisele Carole Wabo Nitcheu, Triphonie Nkurunziza, Leopold Ouedraogo

Regional Office for the Americas: Gerardo de Cosio, Patricia Lorena Ruiz Luna, Cuauhtemoc Ruiz Matus, Bremen De Mucio, Antonio Sanhueza, Suzanne Serruya

Regional Office for South East Asia: Mark Landry, Neena Raina, Sunil Senanayake, Arun Thapa

Regional Office for Europe: Gauden Galea, Gunta Lazdane, Ivo Rakovac, Claudia Elisabeth Stein

Regional Office for the Eastern Mediterranean: Mohamed Mahmoud Ali, Haifa Madi, Ramez Khairi Mahaini

Regional Office for the Western Pacific: Jun Gao, Susan P. Mercado, Mari Nagai, Teret Reginaldo, Howard Sobel.

In addition, Maria Barreix, Dmitri Botcheliouk, Lauri Jalanti and Karin Stein of WHO provided translation during the country consultations. Thanks to all focal points of governments who reviewed the preliminary estimates of maternal mortality ratios and provided valuable feedback.

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), the United States Agency for International Development (USAID) and the National University of Singapore.

This report was prepared by Leontine Alkema, Elena Broaddus, Doris Chou, Daniel Hogan, Colin Mathers, Ann-Beth Moller, Lale Say and Sanqian Zhang. Many thanks to Maria Barreix, Sara Cottler and Karin Stein for extensive work during the final preparation of the report.

Contact persons: Doris Chou (e-mail: choud@who.int) and Lale Say (e-mail: sayl@who.int), Department of Reproductive Health and Research, WHO.

Editing: Green Ink (www.greenink.co.uk)

Acronyms and abbreviations

AIHW	Australian Institute of Health and Welfare
ARR	annual rate of reduction (of MMR)
BMat	Bayesian maternal mortality estimation model
CEMD	Confidential Enquiry into Maternal Deaths
CMACE	Centre for Maternal and Child Enquiries
COIA	Commission on Information and Accountability
CRVS	civil registration and vital statistics
DHS	Demographic and Health Survey
EPMM	ending preventable maternal mortality
GDP	gross domestic product per capita based on PPP conversion[1]
GFR	general fertility rate
ICD-10	*International statistical classification of diseases and related health problems*, 10th edition
ICD-MM	*Application of ICD-10 to deaths during pregnancy, childbirth and the puerperium: ICD maternal mortality*
MDG	Millennium Development Goal
MDG 5	Improve maternal health
MDG 5A	Reduce by three quarters, between 1990 and 2015, the maternal mortality ratio
MICS	Multiple Indicator Cluster Survey
MMEIG	Maternal Mortality Estimation Inter-Agency Group
MMR	maternal mortality ratio (maternal deaths per 100 000 live births)
MMRate	maternal mortality rate (the number of maternal deaths divided by person-years lived by women of reproductive age)
PM	proportion of deaths among women of reproductive age that are due to maternal causes

[1] as used in this report.

PMMRC	Perinatal and Maternal Mortality Review Committee (New Zealand)
PPP	purchasing power parity
RAMOS	reproductive-age mortality study
SAB	skilled attendant(s) at birth
SDG	Sustainable Development Goal
SDG 3.1	By 2030, reduce the global maternal mortality ratio to less than 70 per 100 000 live births
TAG	technical advisory group
UI	uncertainty interval
UN	United Nations
UNAIDS	Joint United Nations Programme on HIV/AIDS
UNFPA	United Nations Population Fund
UNICEF	United Nations Children's Fund
UNPD	United Nations Population Division (in the Department of Economic and Social Affairs)
USA	United States of America
VR	vital registration (VR data come from CRVS systems)
WHO	World Health Organization

Executive summary

In 2000, the United Nations (UN) Member States pledged to work towards a series of Millennium Development Goals (MDGs), including the target of a three-quarters reduction in the 1990 maternal mortality ratio (MMR; maternal deaths per 100 000 live births), to be achieved by 2015. This target (MDG 5A) and that of achieving universal access to reproductive health (MDG 5B) together formed the two targets for MDG 5: Improve maternal health. In the five years counting down to the conclusion of the MDGs, a number of initiatives were established to galvanize efforts towards reducing maternal mortality. These included the UN Secretary-General's Global Strategy for Women's and Children's Health, which mobilized efforts towards achieving MDG 4 (Improve child health) as well as MDG 5, and the high-level Commission on Information and Accountability (COIA), which promoted "global reporting, oversight, and accountability on women's and children's health". Now, building on the momentum generated by MDG 5, the Sustainable Development Goals (SDGs) establish a transformative new agenda for maternal health towards ending preventable maternal mortality; target 3.1 of SDG 3 is to reduce the global MMR to less than 70 per 100 000 live births by 2030.

Planning and accountability for improving maternal health, and assessment of MDG 5 and SDG targets, require accurate and internationally comparable measures of maternal mortality. Countries have made notable progress in collecting data through civil registration systems, surveys, censuses and specialized studies over the past decade. Yet, many still lack comprehensive systems for capturing vital events data, and underreporting continues to pose a major challenge to data accuracy.

Given the challenges of obtaining accurate and standardized direct measures of maternal mortality, the Maternal Mortality Estimation Inter-Agency Group (MMEIG) – comprising the World Health Organization (WHO), the United Nations Children's Fund (UNICEF), the United Nations Population Fund (UNFPA), World Bank Group and the United Nations Population Division (UNPD) – partnered with a team at the University of Massachusetts Amherst, United States of America (USA), the National University of Singapore, Singapore, and the University of California at Berkeley, USA, to generate internationally comparable MMR estimates with independent advice from a technical advisory group that includes scientists and academics with experience in measuring maternal mortality.

The estimates for 1990 to 2015 presented in this report are the eighth in a series of analyses by the MMEIG to examine global, regional and country progress in reducing maternal mortality. To provide increasingly accurate maternal mortality estimates, the previous estimation methods have been refined to optimize use of country-level data and estimation of uncertainty around the estimates. The methodology used in this round by the MMEIG builds directly upon previous methods, but now provides estimates that are more informed by national data. It also supports more realistic assessments of uncertainty about those estimates, based on the quality of data used to produce them. The statistical code and full database used to produce the current estimates are publicly available online.[2]

[2] Available at: http://www.who.int/reproductivehealth/publications/monitoring/maternal-mortality-2015/en/

Globally, the MMR fell by nearly 44% over the past 25 years, to an estimated 216 (80% uncertainty interval [UI][3] 206 to 249) maternal deaths per 100 000 live births in 2015, from an MMR of 385 (UI 359 to 427) in 1990. The annual number of maternal deaths decreased by 43% from approximately 532 000 (UI 496 000 to 590 000) in 1990 to an estimated 303 000 (UI 291 000 to 349 000) in 2015. The approximate global lifetime risk of a maternal death fell considerably from 1 in 73 to 1 in 180.

Developing regions account for approximately 99% (302 000) of the global maternal deaths in 2015, with sub-Saharan Africa alone accounting for roughly 66% (201 000), followed by Southern Asia (66 000). Estimated MMR declined across all MDG regions[4] between 1990 and 2015, although the magnitude of the reduction differed substantially between regions. The greatest decline over that period was observed in Eastern Asia (72%). As of 2015, the two regions with highest MMR are sub-Saharan Africa (546; UI 511 to 652) and Oceania (187; UI 95 to 381).

At the country level, Nigeria and India are estimated to account for over one third of all maternal deaths worldwide in 2015, with an approximate 58 000 maternal deaths (19%) and 45 000 maternal deaths (15%), respectively. Sierra Leone is estimated to have the highest MMR at 1360 (UI 999 to 1980). Eighteen other countries, all in sub-Saharan Africa, are estimated to have very high MMR in 2015, with estimates ranging from 999 down to 500 deaths per 100 000 live births: Central African Republic (881; UI 508 to 1500), Chad (856; UI 560 to 1350), Nigeria (814; UI 596 to 1180), South Sudan (789; UI 523 to 1150), Somalia (732; UI 361 to 1390), Liberia (725; UI 527 to 1030), Burundi (712; UI 471 to 1050), Gambia (706; UI 484 to 1030), Democratic Republic of the Congo (693; UI 509 to 1010), Guinea (679; UI 504 to 927), Côte d'Ivoire (645; UI 458 to 909), Malawi (634; UI 422 to 1080), Mauritania (602; UI 399 to 984), Cameroon (596; UI 440 to 881), Mali (587; UI 448 to 823), Niger (553; UI 411 to 752), Guinea-Bissau (549; UI 273 to 1090) and Kenya (510; UI 344 to 754). The two countries with the highest estimated lifetime risk of maternal mortality are Sierra Leone with an approximate risk of 1 in 17, and Chad with an approximate risk of 1 in 18. The estimated lifetime risk of maternal mortality in high-income countries is 1 in 3300 in comparison with 1 in 41 in low-income countries.

Emergent humanitarian settings and situations of conflict, post-conflict and disaster significantly hinder the progress of maternal mortality reduction. In such situations, the breakdown of health systems can cause a dramatic rise in deaths due to complications that would be easily treatable under stable conditions. In countries designated as fragile states, the estimated lifetime risk of maternal mortality is 1 in 54.

Globally, approximately 1.6% (4700) of all maternal deaths are estimated to be AIDS-related indirect maternal deaths. In sub-Saharan Africa, 2.0% of all maternal deaths are estimated to be AIDS-related indirect maternal deaths, yielding an AIDS-related indirect MMR of 11 maternal deaths per 100 000 live births. In 2015 there are five countries where 10% or more of maternal deaths are estimated to be AIDS-related indirect maternal deaths: South Africa (32%), Swaziland (19%), Botswana (18%), Lesotho (13%) and Mozambique (11%).

---

[3] The uncertainty intervals (UI) computed for all the estimates refer to the 80% uncertainty intervals (10th and 90th percentiles of the posterior distributions). This was chosen as opposed to the more standard 95% intervals because of the substantial uncertainty inherent in maternal mortality outcomes.

[4] An explanation of the MDG regions is available at: http://mdgs.un.org/unsd/mdg/Host.aspx?Content=Data/RegionalGroupings.htm (a list of the MDG regions is also provided in the full report).

Nine countries that had MMR of more than 100 in 1990 are now categorized as having "achieved MDG 5A" based on MMR reduction point-estimates indicating a reduction of at least 75% between 1990 and 2015: Bhutan, Cambodia, Cabo Verde, the Islamic Republic of Iran, the Lao People's Democratic Republic, Maldives, Mongolia, Rwanda and Timor-Leste. Based on MMR reduction point-estimates and uncertainty intervals for the same period, an additional 39 countries are categorized as "making progress", 21 are categorized as having made "insufficient progress", and 26 are categorized as having made "no progress".

Achieving the SDG target of a global MMR below 70 will require reducing global MMR by an average of 7.5% each year between 2016 and 2030. This will require more than three times the 2.3% annual rate of reduction observed globally between 1990 and 2015.

Accurate measurement of maternal mortality levels remains an immense challenge, but the overall message is clear: hundreds of thousands of women are still dying due to complications of pregnancy and/or childbirth each year. Many of these deaths go uncounted. Working towards SDG 3.1 and ultimately towards ending preventable maternal mortality requires amplifying the efforts and progress catalysed by MDG 5. Among countries where maternal deaths remain high, efforts to save lives must be accelerated and must also be paired with country-driven efforts to accurately register births and deaths, including cause of death certification. Strengthening civil registration and vital statistics will support measurement efforts and help track progress towards reaching SDG 3.1. Among those countries with low overall maternal mortality, the next challenge is measuring and amending inequities among subpopulations. The new Global Strategy for Women's, Children's and Adolescents' Health will spearhead an enhanced global collaborative response aimed at ending all preventable maternal deaths.

1 Introduction

When the global commitment was first made in 2000 to achieve the Millennium Development Goals (MDGs), United Nations (UN) Member States pledged to work towards a three-quarters reduction in the 1990 maternal mortality ratio (MMR; maternal deaths per 100 000 live births) by 2015. This objective (MDG 5A), along with achieving universal access to reproductive health (MDG 5B), formed the two targets for MDG 5: Improve maternal health. In the years counting down to the conclusion of the MDGs, a number of initiatives were established to galvanize efforts towards reducing maternal mortality. These included the UN Secretary-General's Global Strategy for Women's and Children's Health, which mobilized efforts towards achieving MDG 4 (Improve child health) as well as MDG 5, and the high-level Commission on Information and Accountability (COIA), which promoted "global reporting, oversight, and accountability on women's and children's health" *(1, 2)*. To build upon the momentum generated by MDG 5, a transformative new agenda for maternal health has been laid out as part of the Sustainable Development Goals (SDGs): to reduce the global MMR to less than 70 per 100 000 live births by 2030 (SDG 3.1) *(3)*. The recent World Health Organization (WHO) publication, *Strategies toward ending preventable maternal mortality (EPMM),* establishes a supplementary national target that no country should have an MMR greater than 140 per 100 000 live births, and outlines a strategic framework for achieving these ambitious targets by 2030 *(4)*.

Planning and accountability for improving maternal health, and assessment of MDG 5 and SDG targets, require accurate and internationally comparable measures of maternal mortality. Many countries have made notable progress in collecting data through civil registration 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 civil registration systems prevents direct comparisons among indicators generated. The 2011 COIA recommendations emphasized the need for countries to establish civil registration systems for recording births, deaths and causes of death *(2)*. Insufficient progress has been made, as many countries still lack civil registration systems and where such systems do exist, underreporting continues to pose a major challenge to data accuracy *(5)*. Looking ahead, one cross-cutting action towards EPMM is to "improve metrics, measurement systems and data quality to ensure that all maternal and newborn deaths are counted" *(4)*.

Given the challenges of obtaining accurate and standardized direct measures of maternal mortality, the Maternal Mortality Estimation Inter-Agency Group (MMEIG) – comprising WHO, the United Nations Children's Fund (UNICEF), the United Nations Population Fund (UNFPA), the World Bank Group, and the UN Population Division (UNPD) of the Department of Economic and Social Affairs – has been working together with a team at the University of Massachusetts Amherst, United States of America (USA), the National University of Singapore, Singapore, and the University of California at Berkeley, USA, to generate internationally comparable MMR estimates. An independent technical advisory group (TAG), composed of demographers, epidemiologists and statisticians, provides technical advice. The estimates for 1990–2015 presented in this report are the eighth in a series of analyses by the MMEIG to examine the global, regional and country progress of maternal mortality *(6–11)*. 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 following the development of preliminary MMR estimates for the 1990–2015 period. Consultations aimed to: give countries the opportunity to

review the country estimates, data sources and methods; obtain additional primary data sources that may not have been previously reported or used in the analyses; and build mutual understanding of the strengths and weaknesses of available data and ensure broad ownership of the results. These consultations generated substantial 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 2015 country consultations.

This report presents global, regional and country-level estimates of trends in maternal mortality between 1990 and 2015. Chapter 2 describes in detail the methodology employed to generate the estimates. Chapter 3 provides the estimates and interpretation of the findings. Chapter 4 assesses performance in terms of MDG 5, discusses implications of the estimates for future efforts towards achieving SDG 3.1, and closes by underlining the importance of improved data quality for estimating maternal mortality. The annexes to this report present an overview of the definitions and common approaches for measuring maternal mortality, the sources of data for the country estimates, and MMR estimates for the different regional groupings for WHO, UNICEF, UNFPA, the World Bank Group and the UNPD.

2 Methodology for the 1990–2015 estimates of maternal mortality

The methodology employed by the Maternal Mortality Estimation Inter-Agency Group (MMEIG) in this round followed an improved approach that built directly on methods used to produce the 1990–2008, 1990–2010 and 1990–2013 maternal mortality estimates *(9–13)*. Estimates for this round were generated using a Bayesian approach, referred to as the Bayesian maternal mortality estimation model, or BMat model *(14, 15)*. This enhanced methodology uses the same core estimation method as in those previous rounds, but adds refinements to optimize the use of country-specific data sources. It provides estimates that are directly informed by country-specific data points, and uncertainty assessments that account for the varying levels of uncertainty associated with the different data points. There were two key methodological changes, described in section 2.1.

Combined with the updated global maternal mortality database, the BMat model provides the most up-to-date maternal mortality estimates yet for the entire 1990–2015 timespan. These results supersede all previously published estimates for years within that time period, and differences with previously published estimates should not be interpreted as representing time trends. The full database, country profiles and all model specification code used are available online.[5]

2.1 Methodological refinements

First, the improved model estimates data-driven trends for all countries with national data, better utilizing the substantial amount of data now available from recently established or strengthened civil registration systems, population-based surveys, specialized studies, surveillance studies and censuses. Given the historical scarcity of data, the previous iteration of the MMEIG model generated estimates for countries without well established civil registration and vital statistics (CRVS) systems from country-level covariate information (i.e. gross domestic product per capita based on purchasing power parity conversion [GDP], general fertility rate [GFR], and coverage of skilled attendants at birth [SAB]). The new model still incorporates these covariates, but the regression model has been modified to prioritize country-level data on maternal mortality, whenever available, to determine national trends in maternal mortality.

Second, the improved methodology gives data from higher quality sources more weight in the model so that they influence the final estimates more than data that are less precise or accurate. Final estimates convey information about the overall quality of all of the data contributing to them through the size of their uncertainty interval – those informed by higher quality data are more certain, and those informed by lower quality data are less certain.

Many of the key components of the estimation process, including data adjustments, covariates for informing estimates in settings with sparse data, and how AIDS-related indirect maternal deaths are estimated, remain very similar in the BMat model. In the future, as data quality and modelling

[5] Available at: http://www.who.int/reproductivehealth/publications/monitoring/maternal-mortality-2015/en/

methods improve, refinement of the methodology will continue. The following sections give an overview of all variables, data sources and statistical models involved in the estimations, and highlight the updated components.

2.2 Model input variables

Maternal mortality measures

Maternal mortality measures were obtained from country-specific data sources. Several data inputs on maternal mortality were included in the analysis: the absolute number of maternal deaths; the number of maternal deaths per 100 000 live births (i.e. the maternal mortality ratio or MMR); and the proportion of maternal deaths out of all deaths among women aged 15–49 years (PM).[6]

The PM was the primary input of analysis, because it is less affected by underreporting of all-cause deaths. In cases where only the MMR was reported, this was converted to a PM using the UN Population Division's estimates of live births for 2015 *(16)* and all-cause mortality among women of reproductive age from WHO life tables *(17)*. In some cases a reported PM also includes pregnancy-related deaths (i.e. accidental or incidental deaths not caused by the pregnancy) in the ratio, which requires adjustment. The absolute number of maternal deaths reported was used as the model input for a small subset of specialized studies that assessed the completeness of deaths recorded (including confidential enquiries and those studies which reported maternal deaths only). Details on the types of country-level maternal mortality data sources, the type of variable extracted from each, and the limitations of each type and consequent adjustments made are described in Box 1 and section 2.3. Types of data sources, variables extracted, and adjustments were similar to those made during the previous estimation round.

Covariates

To inform projection of trends across periods where data were sparse, or for countries with little or no data, the model included factors known to be associated with maternal mortality as predictor covariates. These predictor covariates were originally chosen by the MMEIG in 2010 from a broader list of potential predictor variables that fell into three groups: indicators of social and economic development (such as GDP, human development index and life expectancy), process variables (SAB, antenatal care, proportion of institutional births, etc.) and risk exposure (fertility level). The specific variables selected were: GDP, GFR and the proportion of births with SAB. Data for each of these variables were obtained respectively from: the World Bank Group *(18)*, the UNPD *(16)* and UNICEF *(19)*. Methods used to derive a complete series of annual estimates (1990–2015) for each covariate are described in detail in Annex 3. The most recent data from each source were used to update covariates; otherwise little changed from the previous estimation round.

Other model inputs

Estimating the MMR and other maternal mortality indicators required that country-year estimates for live births, and both all-cause deaths and deaths due to HIV/AIDS among women aged 15–49 years be included in the model. Sources for these data were the same as in the last round, but live

[6] More information on these measures and precise definitions for terms used are provided in Annex 2.

births were updated following the release of UNPD's *World population prospects: 2015 revision* in July 2015 *(16)*. WHO life tables provided all-cause mortality estimates *(17)*, and UNAIDS provided AIDS-related mortality estimates *(20)*. Details on the methodology used to produce these estimates are provided in the references cited after each (see Annex 4).

Box 1
Data source types, measures extracted from each, and sources of error

Data source type	Information used to construct maternal mortality estimates	Sources of systematic error accounted for in analysis	Sources of random error accounted for in analysis
CRVS	PM	• Underreporting of maternal deaths	• Stochastic errors due to the general rarity of maternal deaths
Specialized studies	Number of maternal deaths, PM or MMR	• None	• Stochastic errors due to the general rarity of maternal deaths
Other data sources reporting on pregnancy-related mortality (including surveys)	PM or MMR	• Underreporting of pregnancy-related deaths • Over-reporting of maternal deaths due to the inclusion of deaths which are accidental or incidental to pregnancy	• Sampling error • Error during data collection and data processing
Other data sources reporting on maternal mortality	Pregnancy-related PM or pregnancy-related MMR	• Underreporting of maternal deaths	• Error during data collection and data processing • Stochastic errors due to the general rarity of maternal deaths • Additional random error

CRVS: civil registration and vital statistics; MMR: maternal mortality ratio, i.e. maternal deaths per 100 000 live births; PM: the proportion of maternal deaths out of all deaths among women aged 15–49 years.

2.3 Country data on maternal mortality used for the 1990–2015 estimates

This section addresses the different sources of maternal mortality data obtained from countries, describing for each source: the types of measures extracted, the adjustments made to each and the sources of error. Detailed descriptions of each type of data source are provided in Annex 2. Box 1 summarizes the measures extracted from each data source and the sources of error, and Table 1 provides an overview of data availability by type and by country. Availability varies greatly; among the 183 countries covered in this analysis (i.e. all countries with a population higher than 100 000), 12 countries had no data available. Overall, 2608 records providing 3634[7] country-years of data on maternal mortality were included in this analysis.

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

Table 1. Availability of maternal mortality data records by source type and country for use in generating maternal mortality ratio estimates (MMR, maternal deaths per 100 000 live births) for 2015

Source type	# records	# country-years
A. CRVS	2025 years of reporting	2025
B. Specialized studies	224 studies	364
C. Other sources – reporting on maternal mortality	178 reports/studies	206
D. Other sources – reporting on pregnancy-related mortality	181 reports/studies	1038
All	**2608 records**	**3634**[a]

CRVS: civil registration and vital statistics.
[a] The sum of country-years of data has been rounded.

CRVS systems are the primary (and generally preferred) source of data on maternal mortality. However, many countries lack such a system, or have one that is not nationally representative. In such situations, other data sources can provide valuable information. These alternate data sources include specialized studies on maternal mortality, population-based surveys and miscellaneous studies.

All data on maternal mortality include a degree of uncertainty associated with the error in a particular data source. Some data are always (systematically) lower or higher than the true value of the variable being measured. For example, the numbers of deaths reported in CRVS records will be systematically lower than the true number, because there will always be deaths that go unreported. This is referred to as systematic error. Estimates of the amount of systematic error for a given data source were calculated based on past analyses that assessed the extent to which data from that source differed from the truth (as determined by rigorous specialized studies which looked to determine underreporting of maternal mortality, see Annex 4). Based on these assessments, adjustments were then applied to the data to account for systematic error and bring it closer to the "truth" using methods similar to the previous estimation round. These adjustments contribute uncertainty to the final estimates of maternal mortality, since no adjustment is based on perfect information. Data may also differ from the truth in a direction that is unpredictable. For example, human error when recording information and entering it into a database may cause data to deviate from the truth in either direction (higher or lower). This is referred to as random error, and it cannot be adjusted for but also adds uncertainty to the final maternal mortality estimates.

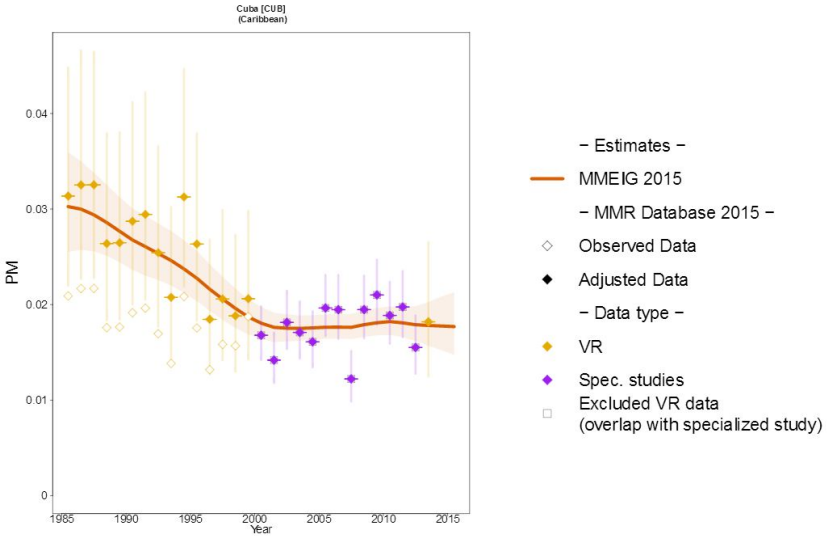
Uncertainty due to random error and uncertainty due to adjustments is communicated in the data's error variance. Generally speaking, inputs (usually PMs) from data sources with less random error and less uncertainty in systematic error (and corresponding adjustments) had smaller variances than inputs from data sources with more error. In turn, inputs with smaller variances carried greater weight in determining the final maternal mortality estimates. In this way, all data sources could be included, with higher quality data (containing less uncertainty) having a greater influence on estimated country-specific trends as compared to lower quality data.

Box 2 discusses the implications for the trend estimates of countries that have been improving the

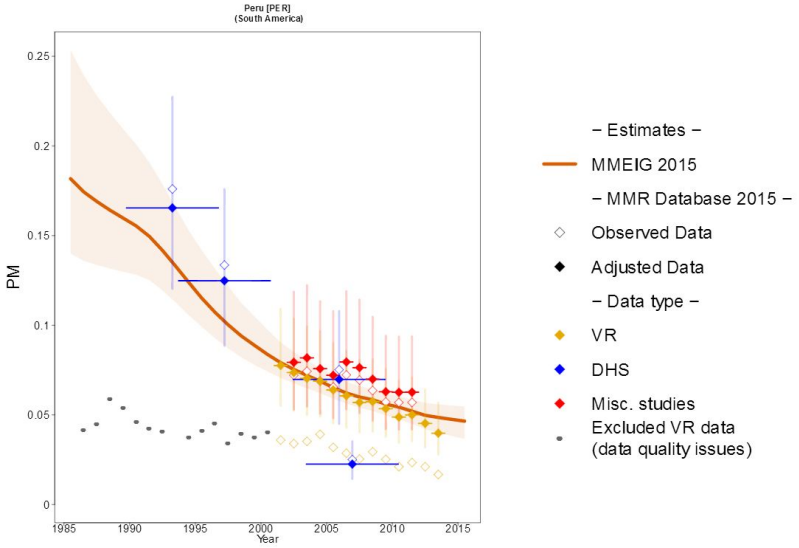
quality of their data over time. For more details on the data models and variance estimation, please see the paper by Alkema et al. *(15)*. The subsections below include discussion of sources of both systematic and random error for each type of data source, and how the model accounted for them.

Box 2
Estimating trends for countries with improving data quality

The MMR trend lines for Cuba, a country with consistently high-quality civil registration and vital statistics (CRVS) data, and Peru, a country with improving data, illustrate how data quality influences the estimates generated by the updated model:



Cuba has had a complete CRVS system established since before 1985 that consistently provides high-quality data for estimation of maternal mortality. As shown in the figure above, the estimated MMR trend line closely tracks the CRVS data points throughout the 1990–2015 time period. The shaded region around the trend line, which represents the 80% uncertainty interval (UI), remains roughly the same width throughout.



In contrast, Peru had little data of adequate quality available prior to 2000, but since 2000 has established a more

Box 2
Estimating trends for countries with improving data quality

robust CRVS system, and has conducted numerous additional studies. The estimated trend line is therefore influenced by covariate information prior to 2000, but tracks the data points from the high-quality data sources closely after 2000. Four DHS studies were conducted in Peru during the 1990–2015 period, and data points from these studies also influence the trend line. However, given the lower reliability of the data from these studies, they exert less influence (the line does not track them as closely) compared to the CRVS data points. Finally, the shaded region around the trend line narrows dramatically as time progresses. This represents the narrowing of the 80% UI as data quality improves and allows estimates to become more precise.

Like Peru, many countries have recently established CRVS systems, or have substantially improved the quality of data collected by their CRVS systems. The new model takes advantage of these new data, allowing these countries' trend lines to be more influenced by the data during the period after the system was established, and increasingly so as the quality improves.

Civil registration and vital statistics data

National CRVS systems are meant to record all births, deaths and causes of death within a country. The data retrieved from CRVS systems are referred to as vital registration (VR) data. For VR data, the observed proportion of maternal deaths among all deaths to women aged 15–49 was included as the data input. For VR country-years based on ICD-9, deaths coded to 630-676 were used and for those based upon ICD-10, deaths coded to codes O00-O95, O98-O99 and A34 were used (which include only those maternal deaths for which the timing corresponds to the definition of a maternal death)[8].

Under ideal circumstances, CRVS systems provide perfect data on the number of maternal deaths within a country. In reality, however, deaths often go unrecorded (resulting in incompleteness) or the causes of death are incorrectly recorded (resulting in misclassification) both of which contribute to underreporting of maternal deaths. The extent of underreporting determines a civil registration record's usability in the analysis. Usability is defined as the percentage of all deaths among women of reproductive age in the country-year for which a cause of death has been recorded. It is calculated by multiplying the system's completeness (proportion of all-cause deaths that were registered in the system) by the proportion of deaths registered in the system that were assigned a specific ICD cause (see Annex 5 for details on calculating usability). Additionally, the number of data-years available from a CRVS system in a given time period was used as a proxy for the data's reliability, with regular data reporting across years indicating a high-functioning system. Given these factors, each country-year of VR data was placed into one of three categories (type I, II or III) depending on its usability and the number of available years with data. Box 3 summarizes the criteria for each category. The category determined whether or not the record for that country-year of data was included in analysis, and if included, how it was adjusted to account for misclassification.

[8] A maternal death is defined 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 (from direct or indirect obstetric death), but not from accidental or incidental causes.

This method of categorizing each year of a country's VR data, rather than placing all of a country's data into the same category (as in the previous estimation round), takes into account changes in data quality over time. For example, if a country strengthens its CRVS system, data from years after the system improvement can be categorized as type I, even if data from earlier years were classified as type II. Annex 5 includes a table listing the calculated data usability for selected years of VR data, by country.

Box 3
Categorization of VR data retrieved from CRVS systems (country-year records) based on usability and availability

Category	Criteria
Type I	• Usability > 80% AND • Part of a continuous string of three or more country-year records with > 60% usability and no more than one year gap in between records
Type II	• Usability > 60% AND • Part of a continuous string of three or more country-year records with > 60% usability and no more than one year gap in between records
Type III	• Other data from registration and mortality reporting systems. For these data points, data quality cannot be assessed as the countries have not submitted data to the relevant WHO office.
Excluded	• Usability < 60% OR • Not part of a continuous string of three or more country-year records with > 60% usability and no more than one year gap in between records

Initial adjustment factors for all VR data (types I, II and III) were determined using procedures similar to those used in previous estimation rounds. For countries with type I data that have not conducted specialized studies (to assess the extent of systematic error in VR data; see next subsection for further information), the number of maternal deaths was multiplied by an adjustment factor of 1.5, as determined by a review of findings from 49 specialized studies, which was conducted in 2014 (the findings are summarized in Annex 4). However, for countries with type I data that have conducted at least one specialized study, the findings from the specialized study informed the adjustment factor applied to that country's VR data. Calculation of adjustment factors was based on the approach used in the last estimation round, and the methods are described in the paper by Alkema et al. *(15)*. Any civil registration records covering the same periods for which specialized study data were available were excluded to avoid double counting of the same information.

For countries with type II data, a similar procedure was used as described for countries with type I data to obtain initial estimates of adjustments factors for civil registration records (either 1.5 or values indicated by specialized studies). However, for type II and III data, the model set-up included the possibility of higher adjustment factors depending on data quality, with the possibility of estimating a larger adjustment factor decreasing as usability increases *(15)*. In addition to the systematic errors described above, and the uncertainty associated with those adjustments, the observed PMs obtained from civil registration records are subject to stochastic error, attributed to

maternal mortality being a generally rare event.

Specialized studies on maternal mortality

A number of countries reporting maternal deaths via CRVS systems also conducted specialized studies to determine if maternal deaths were underreported. While the methodology for these studies varies, any nationally representative study that documented corrections to data previously submitted to the WHO mortality database was considered a specialized study. These studies were used to inform maternal mortality estimates as well as VR data misclassification adjustment factors. Examples include those conducted in Guatemala and the United Kingdom, which reviewed a representative sample of the population using methods such as verbal autopsy to identify and correctly categorize causes of death; or studies such as those conducted in Australia, Mexico and the United Kingdom, which used the Confidential Enquiry system to review the classification and completeness of death reporting for deaths among women of reproductive age in a vital events database.

Information from specialized studies was summarized into an observed PM. The PM or MMR reported in the study was generally used, except for Confidential Enquiries or other specialized studies reporting on maternal deaths only, which addressed both potential underreporting of maternal deaths as well as the total deaths among women of reproductive age during the study time period; for those studies, the absolute number of maternal deaths observed was used directly as a model input. All data inputs from specialized studies were used to inform the modelled maternal mortality estimates, without further adjustments. The only studies excluded from analysis were those that did not report the total number of all-cause deaths among women of reproductive age or associated births within the study period, and for which that information was not available from the CRVS system.

Model inputs from specialized studies were assumed to have no systematic error. Sources of random error are the same as those for VR data.

Population-based surveys and other data sources

Examples of population-based surveys include the Demographic and Health Surveys (DHS), Multiple Indicator Cluster Surveys – Round 4 (MICS4), and Reproductive Health Surveys. Other data sources include censuses and surveillance systems.

Many surveys include questions inquiring whether deceased women of reproductive age died during pregnancy or shortly after. For example, DHS and MICS both use the direct "sisterhood" method in which they ask respondents about the survival of all of their siblings. Such surveys therefore collect data on pregnancy-related deaths, which are used to compute the pregnancy-related PM. Other studies obtain and report the PM, and some may report a pregnancy-related MMR rather than PM if information on births is collected and information on all causes of deaths among women of reproductive age is not collected.

Specialized studies indicate that there is some underreporting of maternal or pregnancy-related deaths in PMs derived from sources such as population-based surveys, censuses and surveillance studies, particularly since respondents may be unaware of the pregnancy status of their sisters or other women in the household. If no specific adjustments were reported, estimates for these data sources were revised to increase the number of maternal or pregnancy-related deaths by 10% to correct for underreporting. When pregnancy-related deaths were reported, the number was adjusted downward by 10% for sub-Saharan African countries and 15% in other low- and middle-

income countries to correct for inclusion of incidental and accidental deaths *(21)*. As in previous estimation rounds, for studies that excluded deaths due to accidents when calculating pregnancy-related PMs, the calculated PMs were taken and used as model inputs without any further adjustment.

In addition to the sources of systematic error discussed above, sources of random error for model inputs derived from surveys, censuses and other types of studies include sampling error and errors occurring during the data collection and data administration processes.

2.4 Statistical modelling to estimate 1990–2015 maternal mortality

Summary of methods

Limited data availability for many countries, and the limitations of the data that are available, mean that statistical models are needed for generating comparable estimates of maternal mortality across countries. The BMat model is flexible enough to account for differences in data availability and quality. Therefore, the same statistical model can now be used to generate estimates for all countries.

As in previous MMEIG estimation rounds, the MMR for each country-year is modelled as the sum of the AIDS-related indirect MMR and the non-AIDS-related MMR:

MMR = non-AIDS-related MMR + AIDS-related indirect MMR,

where non-AIDS-related maternal deaths refer to maternal deaths due to direct obstetric causes or to indirect causes other than HIV, while AIDS-related indirect maternal deaths are those AIDS-related deaths for which pregnancy was a substantial aggravating factor.

The estimation of the AIDS-related indirect MMR follows the same procedure as used in previous publications *(9–11)* and is described in detail in Annex 6.

The expected non-AIDS-related MMR for the year 1990, and expected changes in the non-AIDS-related MMR from 1990 to 2015, are obtained through the multilevel regression model that was used in previous estimation rounds (explained in more detail below in this subsection). However, this existing model was extended to enable it to capture country-specific data-driven trends. To do this, it now includes information from the data via a country-year-specific multiplier. The result of this approach is that in country-year periods where high-quality data exist, the data dominate (i.e. the estimates produced are closer to the data), and in cases where there are no data, the regression determines the level and trend of estimates. In between, both sources of information inform the estimate of a country's level and trend. For countries with high-quality VR data, the model tracks the data very closely, while providing some smoothing of the curve over time to remove stochastic fluctuations in the data.

In the new model, the non-AIDS-related MMR is estimated for all countries as follows:

Non-AIDS-related MMR(t) = expected non-AIDS-related MMR(t) x data-driven multiplier(t),

where "expected non-AIDS-related MMR(t)" is estimated from the multilevel regression model, and the "data-driven multiplier(t)" allows for differences in the rate of change in MMR implied by the "expected non-AIDS-related MMR" and country-year-specific data points. For example, if data suggested that the non-AIDS-related MMR decreased much faster in year t than expected based on covariates, the data-driven multiplier for that year is estimated to be greater than 1, allowing the

model to produce estimates that closely track country data. This data-driven multiplier is modelled with a flexible time series model, which fluctuates around 1, such that the covariates determine the estimated change when data are absent (for further details on the multiplier please see the technical paper *[15]*).

The extension of the non-AIDS-related MMR to allow for country-specific data trends was the main revision in the MMEIG model, as compared to the previous estimation approach. The second significant change to the model was the use of integrated data models to allow for uncertainty around data inputs to be incorporated into the estimates. For example, the PM from a DHS with a small sample size is assumed to be less precise than a PM from a DHS with a large sample size. As explained in section 2.3, this uncertainty is taken into account by the model when generating PM and thus MMR estimates; observations with smaller error variances are more informative of the true PM and thus will carry a greater weight in determining the estimates as compared to observations with larger error variances.

All analyses were conducted using JAGS 3·3·0 and R; both are open-source statistical software packages *(22, 23)*. Statistical code can be accessed online.[9]

Multilevel regression model

A multilevel regression model was used to obtain the expected number of non-AIDS-related maternal deaths for each country-year. The model predicts maternal mortality using three predictor variables described in section 2.2. The model can be described as follows:

$$\log(\mathrm{PM}_i^{\mathrm{na}}) = \alpha_i - \beta_1 \log(\mathrm{GDP}_i) + \beta_2 \log(\mathrm{GFR}_i) - \beta_3 \mathrm{SAB}_i$$

with random country intercepts modelled hierarchically within regions:

$$\alpha_i \sim \mathrm{N}(\alpha_{\mathrm{region}}, \sigma^2_{\mathrm{country}}),\ \alpha_r \sim \mathrm{N}(\alpha_{\mathrm{world}}, \sigma^2_{\mathrm{region}})$$

meaning country intercepts (α_i) are distributed normally with a country-specific variance ($\sigma^2_{\mathrm{country}}$) around random region intercepts (α_{region}), and random region intercepts (α_{region}) are distributed normally with a region-specific variance ($\sigma^2_{\mathrm{region}}$) around a world intercept (α_{world});

and:

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

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

SAB_i = skilled attendant at birth (as a proportion of total births).

For countries with data available on maternal mortality, the expected proportion of non-AIDS-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.

[9] Available at: http://www.who.int/reproductivehealth/publications/monitoring/maternal-mortality-2015/en

2.5 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 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 *[13]*) 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 *World population prospects: 2015 revision (16)*. The MMRate was used to calculate the adult lifetime risk of maternal mortality (i.e. the probability that a 15-year-old woman 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:

$$\text{Lifetime risk of maternal mortality} = (T_{15}\text{-}T_{50})/ \ell 15 \times MMRate,$$

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.

Regional maternal mortality estimates (according to the MDG, 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.

2.6 Uncertainty assessment

Accurately estimating maternal mortality proves challenging due to many countries' limited data availability, and due to quality issues affecting the data that are available. The improved model provides a more realistic assessment of uncertainty around the estimates based on the amount and quality of input data. It allows for greater precision when more and better data are available and indicates the extent of estimate uncertainty in cases where there the amount of data is insufficient or the data are from sources more susceptible to error. It should be noted, however, that the uncertainty assessment does not include the uncertainty in covariates or other model input variables other than maternal mortality data.

Model input data quality decreases with increasing systematic error and random error (discussed for

each data type in section 2.3), introducing uncertainty. This uncertainty is then carried through to the final estimates. Bayesian models allow for accurate assessment of the extent of uncertainty for a given estimated indicator by generating a posterior distribution of that indicator's potential values. A Markov Chain Monte Carlo (MCMC) algorithm was used to generate samples of the posterior distributions of all model parameters *(24)*. The sampling algorithm produced a set of trajectories of the MMR for each country, from which other indicators and aggregate outcomes were derived. This distribution is then used to compute a point-estimate and uncertainty interval (UI) for the indicator. In this case 80% UIs were calculated (rather than the standard 95%) because of the substantial uncertainty inherent in maternal mortality outcomes.

The extent of uncertainty about a particular estimate, indicated by the size of the 80% UI, is determined by the amount and quality of data used to produce that estimate. For a country with very accurate sources of maternal mortality data, the MMR can be estimated with greater precision, and the 80% UI will be smaller than for a country with little data, or with data from less reliable sources.

2.7 Model validation

The BMat model's predictive validity was assessed by cross-validation. This procedure involves removing a subset of records from the data set, re-fitting the model to that smaller data set, and then seeing how well the model's new estimates match the records that were removed (taking into account systematic errors). If the model's new estimates are similar to the dropped data, it provides evidence that the model can accurately predict the values of missing data, which is important because data on maternal mortality is very limited for many countries. Another variation was also run in which data from the most recent time period were dropped and then estimates were produced using the remaining data. Results from this validation process indicate that the model is robust and adequately calibrated to generate the estimates for global maternal mortality indicators.

Box 4
Accurately interpreting point-estimates and uncertainty intervals

All maternal mortality indicators derived from the 2015 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.[10] Both point-estimates and 80% UIs should be taken into account when assessing estimates.

For example:

The estimated 2015 global MMR is 216 (UI 207 to 249)

This means:

- The point-estimate is 216 and the 80% uncertainty interval ranges 207 to 249.
- There is a 50% chance that the true 2015 global MMR lies above 216, and a 50% chance that

[10] Available at: http://www.who.int/reproductivehealth/publications/monitoring/maternal-mortality-2015/en

Box 4
Accurately interpreting point-estimates and uncertainty intervals

the true value lies below 216.

- There is an 80% chance that the true 2015 global MMR lies between 207 and 249.
- There is still a 10% chance that the true 2015 global MMR lies above 249, and a 10% chance that the true value lies below 207.

Other accurate interpretations include:

- We are 90% certain that the true 2015 global MMR is at least 207.
- We are 90% certain that the true 2015 global MMR is 249 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.

3 Analysis and interpretation of the 2015 estimates

Globally, the maternal mortality ratio (MMR; number of maternal deaths per 100 000 live births) fell by approximately 44% over the past 25 years; this falls short of the Millennium Development Goal (MDG) target MDG 5A which called for a reduction of at least 75% in MMR. All MDG regions[11] of the world have experienced considerable reductions in maternal mortality. This section describes estimated MMRs, global maternal deaths, and adult lifetime risk of maternal mortality (i.e. the probability that a 15-year-old woman will die eventually from a maternal cause). It then examines trends in these indicators since 1990.

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 (see Box 4, Chapter 2). Uncertainty intervals (UI) are therefore given after all MMR point-estimates and MMR reduction point-estimates below.

3.1 Maternal mortality estimates for 2015

An estimated 303 000 maternal deaths will occur globally in 2015, yielding an overall MMR of 216 (UI 207 to 249) maternal deaths per 100 000 live births for the 183 countries and territories covered in this analysis (i.e. all those with a population higher than 100 000) (see Table 2). The global lifetime risk of maternal mortality is approximately 1 in 180 for 2015. Table 2 provides point-estimates of global and regional maternal mortality indicators, and the range of uncertainty for each MMR point-estimate. For the purpose of categorization, MMR is considered to be high if it is 300–499, very high if it is 500–999 and extremely high if it is ≥ 1000 maternal deaths per 100 000 live births.

[11] An explanation of the MDG regions is available at: http://mdgs.un.org/unsd/mdg/Host.aspx?Content=Data/REgionalGroupings.htm (a list of the MDG regions is also provided in the full report).

Table 2. Estimates of maternal mortality ratio (MMR, maternal deaths per 100 000 live births), number of maternal deaths, and lifetime risk, by United Nations Millennium Development Goal (MDG) region, 2015

MDG region	MMR[a]	Range of MMR uncertainty (80% UI)		Number of maternal deaths[b]	Lifetime risk of maternal death, 1 in:[c]
		Lower estimate	Upper estimate		
World	216	207	249	303 000	180
Developed regions[d]	12	11	14	1 700	4 900
Developing regions	239	229	275	302 000	150
Northern Africa[e]	70	56	92	3 100	450
Sub-Saharan Africa[f]	546	511	652	201 000	36
Eastern Asia[g]	27	23	33	4 800	2 300
Eastern Asia excluding China	43	24	86	378	1 500
Southern Asia[h]	176	153	216	66 000	210
Southern Asia excluding India	180	147	249	21 000	190
South-eastern Asia[i]	110	95	142	13 000	380
Western Asia[j]	91	73	125	4 700	360
Caucasus and Central Asia[k]	33	27	45	610	1 100
Latin America and the Caribbean	67	64	77	7 300	670
Latin America[l]	60	57	66	6 600	760
Caribbean[m]	175	130	265	1 300	250
Oceania[n]	187	95	381	500	150

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. Albania, Australia, Austria, Belarus, Belgium, Bosnia and Herzegovina, Bulgaria, Canada, Croatia, Cyprus, Czech Republic, Denmark, Estonia, Finland, France, Germany, Greece, Hungary, Iceland, Ireland, Israel, Italy, Japan, Latvia, Lithuania, Luxembourg, Malta, Montenegro, Netherlands, New Zealand, Norway, Poland, Portugal, Republic of Moldova, Romania, Russian Federation, Serbia, Slovakia, Slovenia, Spain, Sweden, Switzerland, The former Yugoslav Republic of Macedonia, Ukraine, United Kingdom, United States of America.

e. Algeria, Egypt, Libya, Morocco, Tunisia.

f. Angola, Benin, Botswana, Burkina Faso, Burundi, Cameroon, Cabo Verde, Central African Republic, Chad, Comoros, Congo, Côte d'Ivoire, Democratic Republic of the Congo, Djibouti, Equatorial Guinea, Eritrea, 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, Sierra Leone, Somalia, South Africa, South Sudan, Sudan, Swaziland, Togo, Uganda, United Republic of Tanzania, Zambia, Zimbabwe.

g. China, Democratic People's Republic of Korea, Mongolia, Republic of Korea.

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

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

j. Bahrain, Iraq, Jordan, Kuwait, Lebanon, Occupied Palestinian Territory, Oman, Qatar, Saudi Arabia, Syrian Arab Republic, Turkey, United Arab Emirates, Yemen.

k. Armenia, Azerbaijan, Georgia, Kazakhstan, Kyrgyzstan, Tajikistan, Turkmenistan, Uzbekistan.

l. Argentina, Belize, Bolivia (Plurinational State of), Brazil, Chile, Colombia, Costa Rica, Ecuador, El Salvador, Guatemala, Guyana, Honduras, Mexico, Nicaragua, Panama, Paraguay, Peru, Suriname, Uruguay, Venezuela (Bolivarian Republic of).

m. Bahamas, Barbados, Cuba, Dominican Republic, Grenada, Haiti, Jamaica, Puerto Rico, Saint Lucia, Saint Vincent and the Grenadines, Trinidad and Tobago.

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

Regional estimates

The overall MMR in developing regions is 239 (UI 229 to 275), which is roughly 20 times higher than that of developed regions, where it is just 12 (UI 11 to 14) (see Table 2). Sub-Saharan Africa has a very high MMR[12] with a point-estimate of 546 (UI 511 to 652). Three regions – Oceania (187; UI 95 to 381), Southern Asia (176; UI 153 to 216) and South-eastern Asia (110; UI 95 to 142) – have moderate MMR. The remaining five regions have low MMR.

Developing regions account for approximately 99% (302 000) of the estimated global maternal deaths in 2015, with sub-Saharan Africa alone accounting for roughly 66% (201 000), followed by Southern Asia (66 000). Among the developing regions, the fewest maternal deaths (an estimated 500) occurred in Oceania.

The lifetime risk of maternal mortality is estimated at 1 in 36 in sub-Saharan Africa, contrasting sharply with approximately 1 in 4900 in developed countries. Developing regions with the lowest lifetime risk are Eastern Asia (1 in 2300) and Caucasus and Central Asia (1 in 1100).

Table 3 shows the number of maternal deaths, MMR and percentage of AIDS-related indirect maternal deaths by MDG region in 2015. Annex 7 provides the percentage of AIDS-related indirect maternal deaths by country, for countries with an HIV prevalence of 5% or more among adults aged

[12] Extremely high MMR (maternal deaths per 100 000 live births) 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.

15–49 years between 1990 and 2015. Sub-Saharan Africa accounts for the largest proportion (85%) of the nearly 4700 AIDS-related indirect maternal deaths globally in 2015. The proportion of AIDS-related indirect maternal deaths in sub-Saharan Africa is 2.0%, yielding an AIDS-related indirect MMR for sub-Saharan Africa of 11 maternal deaths per 100 000 live births. Without HIV, the MMR for sub-Saharan Africa in 2015 would be 535 maternal deaths per 100 000 live births. Two other regions are estimated to have had more than 100 maternal deaths attributed to HIV in 2015: Southern Asia (310) and South-eastern Asia (150).

Table 3. Estimates of maternal mortality ratio (MMR, maternal deaths per 100 000 live births), number of maternal deaths and AIDS-related indirect maternal deaths, by United Nations Millennium Development Goal (MDG) region, 2015

MDG region	MMR[a]	Number of maternal deaths[b]	AIDS-related indirect MMR[c]	Number of AIDS-related indirect maternal deaths	Percentage of AIDS-related indirect maternal deaths
World	216	303 000	3	4 700	1.6
Developed regions[d]	12	1 700	1	87	5.1
Developing regions	239	302 000	4	4 600	1.5
Northern Africa[e]	70	3 100	0	10	0.3
Sub-Saharan Africa[f]	546	201 000	11	4 000	2.0
Eastern Asia[g]	27	4 800	0	43	0.9
Eastern Asia excluding China	43	378	0	0	0.0
Southern Asia[h]	176	66 000	1	310	0.5
Southern Asia excluding India	180	21 000	0	25	0.1
South-eastern Asia[i]	110	13 000	1	150	1.2
Western Asia[j]	91	4 700	0	5	0.1
Caucasus and Central Asia[k]	33	610	0	8	1.3

MDG region	MMR[a]	Number of maternal deaths[b]	AIDS-related indirect MMR[c]	Number of AIDS-related indirect maternal deaths	Percentage of AIDS-related indirect maternal deaths
Latin America and the Caribbean	67	7 300	1	71	0.9
Latin Americai[l]	60	6 000	1	51	0.9
Caribbean[m]	175	1 300	3	20	1.5
Oceania[n]	187	500	1	3	0.6

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), AIDS-related deaths (including AIDS-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.

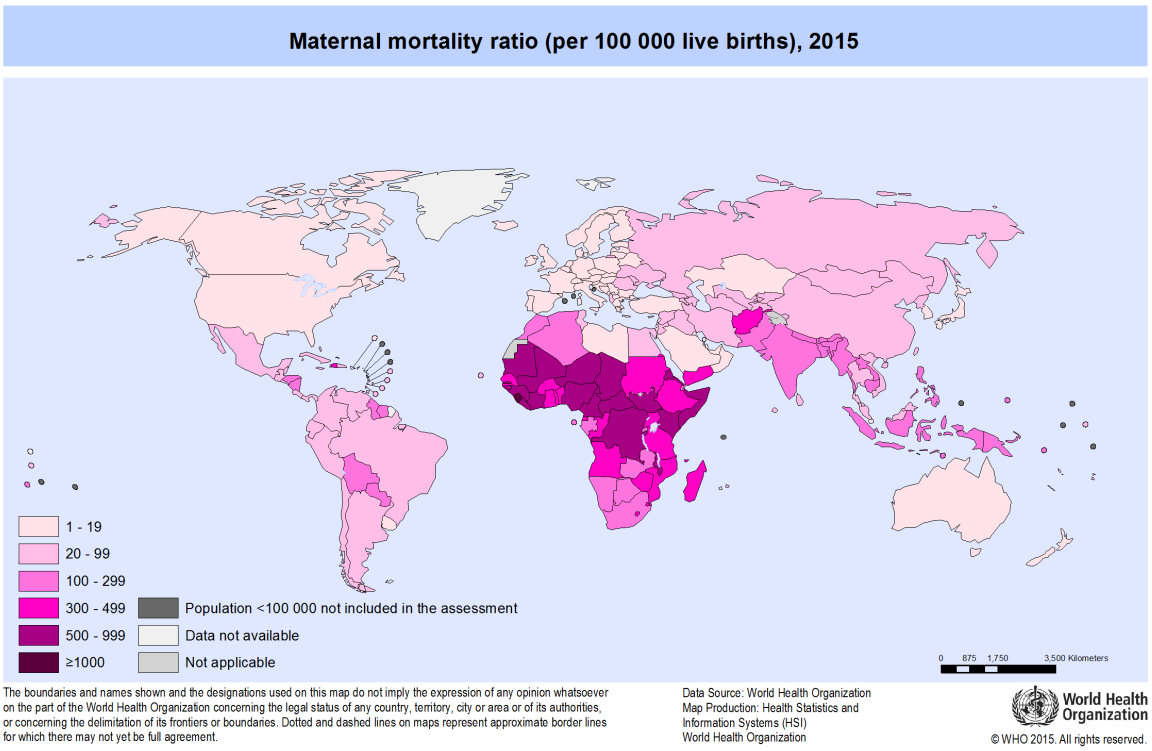
d–n see footnotes for Table 2.

Annexes 8, 9, 10, 11, 12, 13, 14, 15, 16 and 17 present the MMR point-estimates, range of uncertainty, numbers of maternal deaths and lifetime risk for WHO, UNICEF, UNFPA, World Bank Group and UNPD regions, respectively.

Country-level estimates

Annex 7 provides each country's 2015 maternal mortality indicator point-estimates, and MMR uncertainty intervals. Figure 1 displays a map with all countries shaded according to MMR levels.

Figure 1. Maternal mortality ratio (MMR, maternal deaths per 100 000 live births), 2015



Sierra Leone is estimated to have the highest MMR at 1360 (UI 999 to 1980) deaths per 100 000 live births in 2015. Eighteen other countries, all in sub-Saharan Africa, are estimated to have very high MMR in 2015, with estimates ranging from 999 down to 500: Central African Republic (882; UI 508 to 1500), Chad (856; UI 560 to 1350), Nigeria (814; UI 596 to 1180), South Sudan (789; UI 523 to 1150), Somalia (732; UI 361 to 1390), Liberia (725; UI 527 to 1030), Burundi (712; UI 471 to 1050), Gambia (706; UI 484 to 1030), Democratic Republic of the Congo (693; UI 509 to 1010), Guinea (679; UI 504 to 927), Côte d'Ivoire (645; UI 458 to 909), Malawi (634; UI 422 to 1080), Mauritania (602; UI 399 to 984), Cameroon (596; UI 440 to 881), Mali (587; UI 448 to 823), Niger (553; UI 411 to 752), Guinea-Bissau (549; UI 273 to 1090) and Kenya (510; UI 344 to 754). Only two countries in sub-Saharan Africa – Mauritius (53; UI 38 to 77) and Cabo Verde (42; UI 20 to 95) – have low MMR. Three countries outside the sub-Saharan African region have high MMR: Afghanistan (396; UI 253 to 620), Yemen (385; UI 274 to 582) and Haiti (359; UI 236 to 601).

Nigeria and India account for over one third of all global maternal deaths in 2015, with an approximate 58 000 (UI 42 000 to 84 000) maternal deaths (19%) and 45 000 (UI 36 000 to 56 000) maternal deaths (15%), respectively. Ten countries account for nearly 59% of global maternal deaths. In addition to Nigeria and India, they are (in descending order of numbers of maternal deaths): Democratic Republic of the Congo (22 000; UI 16 000 to 33 000), Ethiopia (11 000; UI 7900 to 18 000), Pakistan (9700; UI 6100 to 15 000), United Republic of Tanzania (8200; UI 5800 to 12 000), Kenya (8000; UI 5400 to 12 000), Indonesia (6400; UI 4700 to 9000), Uganda (5700; UI 4100 to 8200) and Bangladesh (5500; UI 3900 to 8800).

Regarding lifetime risk of maternal mortality, the two countries with the highest estimates are

Sierra Leone with an approximate lifetime risk of 1 in 17, and Chad with an approximate lifetime risk of 1 in 18. The estimated risk in high-income countries is 1 in 3300 in comparison with 1 in 41 in low-income countries.

Annex 7 presents the percentage of AIDS-related indirect maternal deaths by country for countries with an HIV prevalence of at least 5.0% among adults aged 15–49 years, between 1990 and 2015. Although at a regional level the overall proportions of AIDS-related indirect maternal deaths are relatively small, for countries with high HIV prevalence they are substantial. In 2015, there are five countries where 10% or more of maternal deaths are estimated to be AIDS-related indirect maternal deaths: South Africa (32%), Swaziland (19%), Botswana (18%), Lesotho (13%) and Mozambique (11%).

3.2 Trends in MMR from 1990 to 2015

An estimated global total of 13.6 million women have died in the 25 years between 1990 and 2015 due to maternal causes. Over the course of that time, however, the world has made steady progress in reducing maternal mortality. The global MMR has fallen by 44% (UI 33.1% to 47.5%), from the 1990 level of 385 (UI 359 to 427) to the 2015 level of 216 (UI 207 to 249). This translates to a decrease of over 43% in the estimated annual number of maternal deaths, from 532 000 (UI 496 000 to 590 000) in 1990 to 303 000 (UI 291 000 to 349000) in 2015, and a more than halving of the approximate global lifetime risk of a maternal death from 1 in 73 to 1 in 180. Worldwide, MMR declined by an average of 3.0% (UI 2.1% to 3.4%) per year between 2005 and 2015, more than doubling the estimated average annual decline of 1.2% (UI 0.5% to 2.0%) between 1990 and 2000. Table 4 compares estimates of MMR and numbers of maternal deaths at the global and regional levels for 1990 and 2015.

Table 4. Comparison of maternal mortality ratio (MMR, maternal deaths per 100 000 live births) and number of maternal deaths, by United Nations Millennium Development Goal (MDG) region, 1990 and 2015

MDG region	1990		2015		% change in MMR between 1990 and 2015[c]	Average annual % change in MMR between 1990 and 2015	Average annual % change in MMR between 1990 and 2000	Average annual % change in MMR between 2000 and 2015
	MMR[a]	Maternal deaths[b]	MMR	Maternal deaths				
World	385	532 000	216	303 000	44	2.3	1.2	3.0
Developed regions[d]	23	3 500	12	1 700	48	2.6	3.3	2.2
Developing regions	430	529 000	239	302 000	44	2.4	1.3	3.1
Northern Africa[e]	171	6 400	70	3 100	59	3.6	4.1	3.2
Sub-Saharan Africa[f]	987	223 000	546	201 000	45	2.4	1.5	2.9
Eastern Asia[g]	95	26 000	27	4 800	72	5.0	4.8	5.0
Eastern Asia excluding China	51	590	43	380	16	0.7	–3.0	3.1
Southern Asia[h]	538	210 000	176	66 000	67	4.5	3.6	5.1
Southern Asia excluding India	495	57 800	180	21 000	64	4.1	2.5	5.1
South-eastern Asia[i]	320	39 000	110	13 000	66	4.3	4.7	4.0
Western Asia[j]	160	6 700	91	4 700	43	2.2	2.7	1.9
Caucasus and Central Asia[k]	69	1 300	33	610	52	3.0	3.1	2.9
Latin America and the	135	16 000	67	7 300	50	2.8	3.1	2.6

MDG region	1990		2015		% change in MMR between 1990 and 2015[c]	Average annual % change in MMR between 1990 and 2015	Average annual % change in MMR between 1990 and 2000	Average annual % change in MMR between 2000 and 2015
	MMR[a]	Maternal deaths[b]	MMR	Maternal deaths				
Caribbean								
Latin America[l]	124	14 000	60	6 000	52	2.9	3.1	2.8
Caribbean[m]	276	2 300	175	1 300	37	1.8	2.5	1.4
Oceania[n]	391	780	187	500	52	3.0	2.9	3.0

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. Overall change.

d–n see footnote in Table 2.

Regional estimates

Estimated MMR declined across all MDG regions between 1990 and 2015, although the magnitude of the reduction differed substantially between regions (Annex 18). When interpreting change in MMR, one should take into consideration that it is easier to reduce MMR when levels are high than when they are low. The highest decline between 1990 and 2015 was observed in Eastern Asia (72%), followed by Southern Asia (67%), South-eastern Asia (66%), Northern Africa (59%), Caucasus and Central Asia (52%), Oceania (52%), Latin America and the Caribbean (50%), sub-Saharan Africa (45%) and Western Asia (43%). The decline in developed regions was 48%.

In the developing regions, the annual rate of MMR reduction was 1.3% (UI 0.6% to 2.0%) between 1990 and 2000, and progress accelerated to an annual rate of 3.1% (UI 2.2% to 3.5%) between 2000 and 2015. Overall, this translates to an estimated 2.4% (UI 1.7% to 2.7%) average yearly reduction over the past 25 years. Eastern Asia experienced the highest estimated annual rate of decline with an average yearly MMR decrease of 5.0% (UI 4.0% to 6.0%) between 1990 and 2015. The lowest estimated annual rate of decline occurred in Western Asia, where MMR decreased by 2.2% (UI 0.8% to 3.4%) per year during the same period.

In 1990 there were approximately 1500 AIDS-related indirect maternal deaths in sub-Saharan Africa. Following the trend of the epidemic, these AIDS-related indirect maternal deaths increased in number until 2005 when there were an estimated 12 370 AIDS-related indirect maternal deaths, before decline to an estimated 4700 in 2015.

Annexes 8, 10, 12, 14 and 16 present the MMR trends, reduction in MMR between 1990 and 2015, range of uncertainty for reduction estimates, and average annual change in MMR between 1990 and 2015 for WHO, UNICEF, UNFPA, World Bank Group and UNPD regions, respectively.

Country estimates

Annex 19 provides information on MMR trends from 1990 to 2015 for each country. Assessments of national-level progress towards achieving MDG 5A[13] (see categories explained in Box 5) were conducted for those 95 countries that started the evaluation period in 1990 with the highest MMR (100 or greater). This cut-off was chosen in order to focus the assessment of progress on those countries with the greatest maternal mortality burden, and due to the difficulty of reducing MMR further in countries where levels were already relatively low in 1990. Of these 95 countries, results strongly[14] indicate that 58 experienced a decline in MMR between 1990 and 2015. For the remaining 26 countries, it cannot be confidently concluded whether MMR increased or decreased, however point-estimates suggest that 22 of them likely experienced a decrease and 4 likely experienced an increase.

Point-estimates indicate that nine countries achieved at least a 75% reduction in MMR over the 25-year period, meaning that they achieved MDG 5A. These countries are: Maldives (90% reduction in MMR), Bhutan (84%), Cambodia (84%), Cabo Verde (84%), the Islamic Republic of Iran (80%), Timor-Leste (80%), the Lao People's Democratic Republic (78%), Rwanda (78%) and Mongolia (76%).

3.3 Comparison with previous maternal mortality estimates

The results described in this report are the most accurate maternal mortality estimates yet for all years in the 1990–2015 period. Therefore, these 2015 estimates should be used for the interpretation of trends in MMR from 1990 to 2015, rather than extrapolating estimates from previously published estimates. As explained in Chapter 2, these estimates were generated using an improved approach that built directly upon the methods used to produce previously published estimates. In addition to the refined model, updated data and a larger overall global database informed the 2015 estimates, as compared to those previously published. Notably, the publication of new population-based studies from the Democratic Republic of the Congo, Nigeria and, to a lesser extent, Sierra Leone all indicated much higher MMR than was previously estimated for those counties. Given the large populations in the Democratic Republic of the Congo and Nigeria, this has impacted the global-level estimates. The updated methodology adds refinements that allow country-level data to drive estimates as much as possible (rather than the covariates GDP, fertility rate and skilled attendants at birth coverage), and ensure that higher quality data influences estimates more than lower quality data.

[13] Reduce by three quarters, between 1990 and 2015, the maternal mortality ratio.

[14] With a confidence level of ≥ 90%.

4 Assessing progress and setting a trajectory towards ending preventable maternal mortality

4.1 Millennium Development Goal (MDG) 5 outcomes

With the aim of improving maternal health, MDG 5 established a target of reducing the 1990 global maternal mortality ratio (MMR) by 75% by 2015 (MDG 5A). Assessing country-level progress towards this target requires examining estimated reductions, while also taking into consideration the range of uncertainty around those estimates. For example, Nigeria's estimated MMR reduction between 1990 and 2015 is 39.6%, but the 80% uncertainty interval (UI) for that point-estimate spans zero (–5% to 56.3%), which implies that there is a greater than 10% chance that no reduction in Nigeria's MMR has occurred. There is, therefore, not enough reliable information on maternal mortality in Nigeria to conclude with confidence that the country has made any progress towards the MDG 5A target. Due to this need to consider estimation uncertainty when evaluating progress, the 95 countries with an MMR above 100[15] in 1990 have been categorized based on both MMR reduction point-estimates and 80% UI. Box 5 lists the categories and describes the criteria used to assign countries to categories. Countries were placed into the highest category for which they met the criteria.

Box 5
Categorization of countries based on evidence for progress in reducing the MMR between 1990 and 2015

Category	Criteria
Achieved MDG 5A	• MMR reduction point-estimate of ≥ 75%
Making progress	• MMR reduction point-estimate of ≥ 50% *AND* • ≥ 90% probability of an MMR reduction of ≥ 25%
Insufficient progress	• MMR reduction point-estimate of ≥ 25% *AND* • ≥ 90% probability of an MMR reduction of ≥ 0%
No progress	• MMR reduction point-estimate of < 25% *OR* • a 90% probability that there has been no reduction in MMR, or there has been an increase in MMR

Among those 95 countries, the 9 countries with an estimated MMR reduction between 1990 and 2015 of 75% or more have achieved MDG 5A – they have been placed in the first category. The second category, those countries that are making progress, includes 39 countries with an estimated MMR reduction of 50% or more, and at least a 90% chance that the true reduction was above 25%. The third category, countries making insufficient progress, comprises 21 countries with an

[15] The MMR cut-off of 100 maternal deaths per 100 000 live births was chosen in order to focus the assessment of progress on countries that started with a relatively high level of maternal mortality in 1990, and due to the difficulty of reducing MMR further in countries where levels were already relatively low (< 100) in 1990.

estimated MMR reduction of 25% or more, and at least a 90% chance that the true reduction was above zero. The fourth and final category includes 26 countries that have made no progress; they have an estimated MMR reduction of less than 25%, or a greater than 10% chance that no reduction has occurred at all. Given the variability of maternal mortality reporting methods and data quality, these categories provide the best possible assessment of likely performance on the MDG 5A target. Annex 18 displays category labels for all 95 countries.

The nine countries which are considered to have achieved MDG 5A based on point-estimates are: Bhutan, Cambodia, Cabo Verde, the Islamic Republic of Iran, the Lao People's Democratic Republic, Maldives, Mongolia, Rwanda and Timor-Leste. Yet, among these countries there is substantial variation in the level of certainty of this achievement. As indicated by uncertainty intervals (only Cambodia and Maldives have a greater than 90% likelihood of having a true MMR reduction of 75% or more. For the other seven, a 10% or greater chance of not having achieved the target persists. The consideration of uncertainty regarding rates of reduction is intended to demonstrate the need for more rigorous data collection. Differences in the sizes of UIs are due to differences in the quality of data used to inform estimates. For example, the Islamic Republic of Iran and Maldives had substantial maternal mortality data from civil registration and vital statistics (CRVS) systems and surveillance studies available for inclusion in the estimation model, while others, such as Cabo Verde, Lao People's Democratic Republic and Timor-Leste, had little to no country-level data.

While no MDG region achieved the target of reducing maternal mortality by 75% (see Table 4), all demonstrated substantial progress, particularly after announcement of the MDGs in 2000 – the estimated global 2000–2015 annual reduction rate of 3% was significantly increased in comparison to the 1990–2000 rate of 1.2%. This acceleration of progress reflects a widespread escalation of efforts to reduce maternal mortality, stimulated by MDG 5. Maternal mortality has proved to be a valuable indicator both for tracking development progress and for spurring action to improve maternal health.

4.2 Looking towards the future

The Sustainable Development Goals (SDGs) now call for an acceleration of current progress in order to achieve a global MMR of 70 maternal deaths per 100 000 live births, or less, by 2030, working towards a vision of ending all preventable maternal mortality. Achieving this global goal will require countries to reduce their MMR by at least 7.5% each year between 2016 and 2030. Based on their point-estimates for average annual reduction, three countries with an MMR greater than 100 nearly reached or exceeded this reduction rate between 2000 and 2015: Cambodia (7.4%; UI 5.4% to 9.5%), Rwanda (8.4%; UI 6.5% to 10.6%) and Timor-Leste (7.8%; UI 5.7% to 10.2 %). The recent success of these countries in rapidly reducing maternal mortality demonstrates that this goal is achievable.

Global targets for 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 no country should have an MMR higher than 140 deaths per 100 000 live births (twice the global target) *(4)*.

While differing contexts make issuing prescribed reduction strategies impossible, examining the strategies employed by successful countries can illuminate routes that other countries may find useful. However, the 30 countries with the highest MMRs in 2015 will have to achieve substantially higher annual rates of reduction to attain MMRs below 140 in 2030.

Projections indicate that accomplishing this target will result in over 60% fewer deaths in 2030 than the estimated number in 2015, and will save a cumulative 2.5 million women's lives between 2016 and 2030, as compared to a situation in which current reduction trajectories remain unchanged *(14)*.

Strategies for success and challenges to address

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. Box 6 describes several key strategies used by countries that have demonstrated success in improving maternal survival. These strategies are situated within a recently developed strategic framework for policy and programme planning that is informed by the guiding principles of: (1) empowering women, girls and communities, (2) protecting and supporting the mother–baby dyad, (3) ensuring country ownership, leadership and supportive legal, technical and financial frameworks, and (4) applying 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 *(4)*.

Box 6
Strategies driving success in reducing maternal mortality

WHO's recently published *Strategies towards ending preventable maternal mortality (EPMM)* establishes a strategic framework that specifies five objectives *(4)*. Below, for each of these objectives, examples are presented of strategies implemented by countries that have made significant reductions in maternal mortality:

1. Addressing inequities in access to and quality of sexual, reproductive, maternal and newborn health care

- Ethiopia trained women's association members in strategies for addressing social and structural barriers to sexual, reproductive, maternal and newborn health, and also trained health managers on gender mainstreaming in their areas of work *(25)*.
- Viet Nam developed sexual and reproductive health services specifically for adolescents and youths *(25)*.

2. Ensuring universal health coverage for comprehensive sexual, reproductive, maternal and newborn health care

- Rwanda used a community-based health insurance scheme to ensure vulnerable populations' access to maternal and child health services *(26)*.
- Bangladesh expanded access to maternity services in new, private-sector health-care facilities *(27)*.

3. Addressing all causes of maternal mortality, reproductive and maternal morbidities, and related disabilities

- Nepal expanded access to modern family planning methods, and increased school attendance and literacy rates among women and girls *(28)*.
- The Maldives strengthened emergency obstetric care, including basic care and comprehensive emergency obstetric care throughout the country's health system *(29)*.

4. Strengthening heath systems to respond to the needs and priorities of women and girls

- Indonesia invested in the training of midwives and the creation of dedicated, village-level delivery points for maternal health services *(30)*.
- Cambodia invested in transport infrastructure and construction of health-care facilities staffed with an expanded cadre of trained midwives throughout the country, including maternity waiting houses and extended delivery rooms *(31)*.

5. Ensuring accountability to improve quality of care and equity

- Mongolia introduced procedures at the facility, provincial and ministerial levels to ensure maternal deaths were reported within a 24-hour period and transmitted to the Ministry of Health for review *(32)*.
- India developed guidelines for maternal death audits and near-miss analyses *(25)*.

Examining countries that experienced little to no reduction in maternal mortality since 1990 reveals several prevalent factors that impede progress. Among the 27 countries categorized as likely having made "no progress", 23 are particularly impacted by the HIV epidemic. Despite the recent positive influence of antiretroviral medications on AIDS-related indirect maternal mortality, overall the epidemic poses immense challenges to maternal mortality reduction due to the strain it places on

health systems and infrastructure, in addition to its direct health impacts. Emergent humanitarian settings and situations of conflict, post-conflict and disaster also significantly hinder progress. Indeed, 76% of high maternal mortality countries (those with MMR ≥ 300) are defined as fragile states *(33)*. In such situations, the breakdown of health systems can cause a dramatic rise in deaths due to complications that would be easily treatable under stable conditions. At the peak of the 2014–2015 Ebola virus disease outbreak in Liberia, for example, maternal health service utilization dropped precipitously and common obstetric complications went untreated out of fear of disease transmission *(34)*. Compounding the tragedy of lives lost in crisis settings, many of these deaths go unrecorded. Settings where the needs are greatest are also those with the least evidence and analysis. In countries designated as fragile states, the estimated lifetime risk of maternal mortality is 1 in 54.

Many of the most vulnerable populations are not represented in the current global data. Moreover, even within countries with good overall progress indicators, the optimistic numbers often mask extreme disparities. Australia, for example, determined through a specialized study that the MMR among Aboriginal and Torres Strait Islander women was over twice that of non-indigenous women. Marginalized subpopulations often lack representation in the data, and disparities may not be evident without disaggregating data. This lack of accurate 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" *(35)*. Late maternal mortality refers to maternal deaths that occur more than 42 days but less than one year after termination of pregnancy. As health systems improve and are better able to manage immediate childbirth complications, deaths within the first 48 hours of delivery may be averted, but the proportion of morbidity and mortality caused by late maternal sequelae or late maternal complications can also increase. This trend has been observed in several countries, such as Mexico where late maternal deaths account for up to 15% of overall maternal mortality *(36)*. Further analyses of this subset of deaths is warranted. Monitoring all maternal deaths thus proves increasingly important for ensuring accurate documentation to detect shifting dynamics in maternal health.

Need for improved measurement and data

Impressive efforts to establish and improve CRVS systems or implement alternative methods of rigorously recording maternal deaths have been made in recent years. Box 7 provides examples of several methods countries are using to dramatically improve data collection. The high-quality data generated even prompted the use for this report of a refined estimation methodology, one that fully utilizes country-level data to produce a more accurate and realistic picture of global maternal mortality trends than ever before.

Box 7
Tools for improving data collection

Confidential Enquiry into Maternal Deaths (CEMD)

Within established civil registration and vital statistics (CRVS) systems, CEMD facilitates investigation of and correction for underreporting of maternal deaths due to misclassification. Developed in England and Wales and conducted continuously there since 1952 *(37)*, CEMD involves having multiple experts review all potential maternal mortality cases in detail, assessing the accuracy of classifications applied as well as examining the circumstances of the death. It thus also helps to identify areas for action to prevent future deaths. Kazakhstan and South Africa both recently conducted CEMD studies, identifying 29% and 40% more maternal deaths, respectively, than were initially recorded in the CRVS system.

Maternal Death Surveillance and Response (MDSR)

At the health-care facility level, MDSR systems promote a continuous action cycle for monitoring of maternal deaths, identifying trends in and causes of maternal mortality, and acting to prevent future deaths *(38)*. Information generated by MDSR can be communicated upwards from facilities, to be aggregated at the regional and national levels. Where national CRVS systems have not yet been established, MDSR serves as a building block for a comprehensive, national-level data collection system. Countries that have recently established, strengthened or expanded MDSR systems include Cameroon, the Democratic Republic of the Congo, India, Morocco, Nigeria and Togo *(25)*.

Digital innovations

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 frontline health workers to national health systems can simultaneously improve health-care service delivery, strengthen accountability, and generate real-time data *(39)*. 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 health management and vital events statistical systems *(40)*. One example is the Open Smart Register Platform, or OpenSRP *(41)*. Pilot tests of OpenSRP and similar digital tools are under way in Bangladesh, India, Indonesia, Pakistan and South Africa.

Yet, while the estimates presented in this report provide valuable policy and programme planning guidance, they cannot change the fact that many women who die from maternal causes still go uncounted. Taking effective action to prevent future maternal deaths requires knowing who has died and why they died. Respect for human rights and human life necessitates improved record-keeping so that all births, deaths and causes of death are officially accounted for. For these reasons, improving metrics, measurement systems and data quality is a crucial cross-cutting action for all strategies aimed at ensuring maternal survival *(4)*.

The broad uncertainty intervals associated with the estimates presented throughout this report directly reflect the critical need for better data on maternal mortality. 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 underreporting 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 are critical for implementing strategies to address inequities and accelerate progress towards maternal mortality reduction. Populations requiring particular attention include refugees and groups that face discrimination or stigma. Better data on the maternal mortality burden among adolescent girls is also needed; maternal causes rank second among causes of death for girls aged 15–19 *(42)*. 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.

4.3 A call to action

The announcement of MDG 5 in 2000 attracted intense scrutiny of the shamefully high numbers of women dying from maternal causes. It initiated an unprecedented and ongoing global conversation about how maternal mortality should be measured, what strategies could be employed to save lives, and how the progress of these reduction efforts would be assessed. Accurate measurement of maternal mortality levels remains an immense challenge, but the overall message is clear: hundreds of thousands of women are still dying during childbirth or from pregnancy-related causes each year.

The goal of ending preventable maternal mortality is a call to action across all regions of the globe, developed and developing, including areas where substantial progress has already been made. Among countries where maternal death counts remain high, the challenge is clear. Efforts to save lives must be accelerated and must also be paired with country-driven efforts to accurately count lives and record deaths. Among those countries with low overall maternal mortality indicators, the next challenge is measuring and amending inequities among subpopulations. Across varying settings, strategies must be both context-specific and thoroughly grounded in a human rights approach. With rapid acceleration of the efforts and progress catalysed by MDG 5, ending preventable maternal mortality on a global level can be achieved by 2030.

References

1. Ki-Moon B. Global strategy for women's and children's health. New York (NY): United Nations; 2010.

2. Keeping promises, measuring results: commission on information and accountability for women's and children's health. Geneva: World Health Organization; 2011.

3. 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; 2015 (A/RES/70/1; http://www.un.org/ga/search/view_doc.asp?symbol=A/RES/70/1, accessed 5 November 2015).

4. 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).

5. Every woman, every child: from commitments to action: the first report of the independent Expert Review Group (iERG) on Information and Accountability for Women's and Children's Health. Geneva: World Health Organization; 2012 (www.who.int/woman_child_accountability/ierg/reports/2012/IERG_report_low_resolution.pdf, accessed 5 November 2015).

6. World Health Organization (WHO), 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 5 November 2015).

7. AbouZahr C, Wardlaw T, Hill K. Maternal mortality in 1995: estimates developed by WHO UNICEF UNFPA. Geneva: World Health Organization; 2001.

8. AbouZahr C, Wardlaw TM, Hill K, Choi Y. 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).

9. World Health Organization (WHO), United Nations Children's Fund (UNICEF), United Nations Population Fund (UNFPA) and The World Bank. Trends in maternal mortality: 1990 to 2008. Estimates developed by WHO, UNICEF, UNFPA and The World Bank. Geneva: WHO; 2010 (http://apps.who.int/iris/bitstream/10665/44423/1/9789241500265_eng.pdf, accessed 5 November 2015).

10. World Health Organization (WHO), United Nations Children's Fund (UNICEF), United Nations Population Fund (UNFPA), The 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 5 November 2015).

11. World Health Organization (WHO), United Nations Children's Fund (UNICEF), United Nations Population Fund (UNFPA), The 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 5 November

2015).

12. Wilmoth J, Mizoguchi N, Oestergaard M, Say L, Mathers C, Zureick-Brown S, et al. Levels and trends of maternal mortality in the world: the development of new estimates by the United Nations. Technical report (submitted to the WHO, UNICEF, UNFPA, and The World Bank). 2010 (http://www.who.int/reproductivehealth/publications/monitoring/MMR_technical_report.pdf, accessed 12 November 2015).

13. 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. Stat Politics Policy. 2012;3(2):1-38.

14. Alkema L, Chou D, Hogan D, Zhang S, Moller A, Gemmill A, et al. National, regional, and global levels and trends in maternal mortality between 1990 and 2015 with scenario-based projections to 2030: a systematic analysis by the United Nations Maternal Mortality Estimation Inter-Agency Group. Lancet. 2015 (in press).

15. Alkema L, Zhang S, Chou D, Gemmill A, Moller A, Ma Fat D, et al. A Beyesian approach to the global estimation of maternal mortality. 2015 (submitted for peer review; http://arxiv.org/abs/1511.03330).

16. World population prospects: the 2015 revision. New York (NY): United Nations, Department of Economic and Social Affairs, Population Division; 2015 (http://esa.un.org/unpd/wpp/, accessed 9 November 2015).

17. Life tables for WHO Member States 1990–2012. Geneva: World Health Organization; 2014.

18. Data Catalog. Washington (DC): The World Bank; 2013.

19. UNICEF Data: Monitoring the Situation of Children and Women [website]. New York (NY): United Nations Children's Fund; 2015 (http://data.unicef.org/, accessed 5 November 2015).

20. Global report: UNAIDS report on the global AIDS epidemic 2013. Geneva: Joint United Nations Programme on HIV/AIDS; 2013.

21. Mortality and burden of disease estimates for WHO Member States in 2008. Geneva: World Health Organization; 2011.

22. Plummer M, editor. JAGS: a program for analysis of Bayesian graphical models using Gibbs sampling. In: Proceedings of the 3rd international workshop on distributed statistical computing. Vienna: Technische Universität Wien; 2003.

23. R Core Team. R: A language and environment for statistical computing. Vienna: R Foundation for Statistical Computing; 2013 (http://www.R-project.org, accessed 15 September 2015).

24. Gelman A, Hill J. Data analysis using regression and multilevel/hierarchical models. Cambridge University Press; 2006.

25. H4+ Partnership. The H4+ partnership: joint country support to improve women's and children's health: progress report. Geneva: World Health Organization; 2015.

26. Worley H. Rwanda's success in improving maternal health 2015. In: Population Reference Bureau (PRB) Publications [website]. Washington (DC): PRB; 2015 (http://www.prb.org/Publications/Articles/2015/rwanda-maternal-health.aspx, accessed 5

November 2015).

27. El Arifeen S, Hill K, Ahsan KZ, Jamil K, Nahar Q, Streatfield PK. Maternal mortality in Bangladesh: a Countdown to 2015 country case study. Lancet. 2014;384(9951):1366-74.

28. Nepal Ministry of Health and Population Nepal, Partnership for Maternal, Newborn & Child Health, World Health Organization (WHO), World Bank and Alliance for Health Policy and Systems Research. Success factors for women's and children's health: Nepal. Geneva: WHO; 2015 (http://www.who.int/pmnch/knowledge/publications/nepal_country_report.pdf, accessed 5 November 2015).

29. Maternal and Perinatal Morbidity and Mortality Review Committee. Maternal deaths in the Maldives: 2009-2011. The Maldives Government; 2011.

30. Van Lerberghe W, Matthews Z, Achadi E, Ancona C, Campbell J, Channon A, et al. Country experience with strengthening of health systems and deployment of midwives in countries with high maternal mortality. Lancet. 2014;384(9949):1215-25.

31. Cambodia reduces maternal mortality. In: WHO in the Western Pacific [website]. Manila: World Health Organization Western Pacific Regional Office; 2015 (http://www.wpro.who.int/about/administration_structure/dhs/story_cambodia_reduces_maternal_mortality/en/, accessed 5 November 2015).

32. Yadamsuren B, Merialdi M, Davaadorj I, Requejo JH, Betrán AP, Ahmad A, et al. Tracking maternal mortality declines in Mongolia between 1992 and 2007: the importance of collaboration. Bull World Health Organ. 2010;88(3):192-8.

33. Organisation for Economic Co-operation and Development (OECD). States of fragility 2015: Meeting post-2015 ambitions. Paris: OECD Publishing; 2015.

34. Iyengar P, Kerber K, Howe CJ, Dahn B. Services for mothers and newborns during the Ebola outbreak in Liberia: the need for improvement in emergencies. PLoS currents. 2014;7.

35. 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.

36. Búsqueda Intencionada de Muertes Maternas en México. Informe 2011. Mexico; Secretaría de Salud México; 2013.

37. Knight M, Kenyon S, Brocklehurst P, Neilson J, Shakespeare J, Kurinczuk J, 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).

38. MDSR Working Group (Canadian Network for Maternal, Newborn & Child Health, International Federation of Gynecology and Obstetrics, International Stillbirth Alliance, Department for International Development UK, United Nations Population Fund, United States Centers for Disease Control and Prevention and the World Health Organization. Maternal death surveillance and response: technical guidance information for action to prevent maternal death. Geneva: World Health Organization; 2013 (https://www.unfpa.org/sites/default/files/pub-pdf/Maternal_Death_Surveillance_and_Response_o.

pdf, accessed 5 November 2015).

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

40. 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.

41. Open Smart Register Platform (OpenSRP) [website]. 2015 (www.smartregister.org, accessed 5 November 2015).

42. Health for the world's adolescents: a second chance in the second decade. Geneva: World Health Organization; 2014.

Annexes

Annex 1. Summary of the country consultations 2015

The generation of global, regional and country-level estimates and trends in morbidity and mortality is one of the core functions of WHO, which is the agency within the UN system that leads the production of updated maternal mortality estimates. In 2001, the WHO Executive Board endorsed a resolution (EB.107.R8) seeking to "establish a technical consultation process bringing together personnel and perspectives from Member States in different WHO regions". A key objective of this consultation process is "to ensure that each Member State is consulted on the best data to be used". Since the process is an integral step in the overall estimation strategy, it is described here in brief.

The country consultation process entails an exchange between WHO and technical focal person(s) in each country. It is carried out prior to the publication of estimates. During the consultation period, WHO invites focal person(s) to review input data sources, methods for estimation and the preliminary estimates. Focal person(s) are encouraged to submit additional data that may not have been taken into account in the preliminary estimates.

The country consultation process for the 2015 round of maternal mortality estimates was initiated with an official communication from WHO to all Member States on 25 August 2014. This letter informed Member States of the forthcoming exercise to estimate maternal mortality and requested the designation of an official contact (typically within the national health ministry and/or the central statistics office) to participate in the consultation. The designated officials received the following items by email: (1) a copy of the official communication; (2) draft estimates and data sources; and (3) a summary of the methodology used. WHO regional offices actively collaborated in identifying focal persons through their networks.

The formal consultation process was officially completed by 24 July 2015. Of the 183 Member States included in the analysis, WHO received nominations of designated officials from 125 – Regional Office for Africa (17), Regional Office for the Americas (24), Regional Office for South-East Asia (6), Regional Office for Europe (39), Regional Office for the Eastern Mediterranean (19), Regional Office for the Western Pacific (20) – and received feedback, comments or data from 60 Member States. During the consultation period, new data submitted by countries were reviewed to determine whether they met the study's inclusion criteria. 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 1985 to 2015.

As a result of the country consultation and updated vital registration data, 234 new or modified entries were included. Thus, the current estimates are based on 2608 observations corresponding to 3634 country-years of information in 171 countries.

As in the previous country consultation, the new observations were from civil registration systems and surveys; however, an increase in number of other new observations shows that countries lacking functioning civil registration systems are increasingly investing in monitoring maternal mortality with empirical data from alternative sources.

Annex 2. Measuring maternal mortality

Concepts and definitions

In the *International statistical classification of diseases and related health problems*, 10th revision (ICD-10),[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 the site of the pregnancy, from any cause related to or aggravated by the pregnancy or its management (from direct or indirect obstetric death), but not from accidental or incidental causes.

This definition allows identification of maternal deaths, based on their causes, as either direct or indirect. Direct maternal deaths are those resulting from obstetric complications of the pregnant state (i.e. pregnancy, delivery and postpartum), interventions, omissions, incorrect treatment, or a chain of events resulting from any of the above. Deaths due to, for example, obstetric haemorrhage or hypertensive disorders in pregnancy, or those due to complications of anaesthesia or caesarean section are classified as direct maternal deaths. Indirect maternal deaths are those resulting from previously existing diseases, or from diseases that developed during pregnancy and that were not due to direct obstetric causes but aggravated by physiological effects of pregnancy. For example, deaths due to aggravation of an existing cardiac or renal disease are considered indirect maternal deaths.

The concept of death during pregnancy, childbirth and the puerperium is included in the ICD-10 and is defined as any death temporal to pregnancy, childbirth or the postpartum period, even if it is due to accidental or incidental causes (this was formerly referred to as "pregnancy-related death", see Box 1). This alternative definition allows measurement of deaths that are related to pregnancy, even though they do not strictly conform to the standard "maternal death" concept, in settings where accurate information about causes of death based on medical certificates is unavailable.

For instance, in population-based surveys, respondents provide information on the pregnancy status of a reproductive-aged sibling at the time of death, but no further information is elicited on the cause of death. These surveys – for example, the Demographic and Health Surveys and Multiple Indicator Cluster Surveys – therefore, usually provide measures of pregnancy-related deaths rather than maternal deaths.

Further, complications of pregnancy or childbirth can lead to death beyond the six weeks 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 to delay death beyond 42 days postpartum. Despite being caused by pregnancy-related events, these deaths do not count as maternal deaths in routine civil registration systems. Specific codes for "late maternal deaths" are included in the ICD-10 (O96 and O97) to capture delayed maternal deaths occurring between six weeks and one year postpartum (see Box A2.1). Some countries, particularly those with more developed civil registration systems, use this definition.

---

[1] International statistical classification of diseases and related health problems, tenth revision. Vol. 2: Instruction manual. Geneva: World Health Organization; 2010.

Box A2.1 Definitions related to maternal death in ICD-10
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 (from direct or indirect obstetric death), but not from accidental or incidental causes.
Pregnancy-related death The death of a woman while pregnant or within 42 days of termination of pregnancy, irrespective of the cause of death.
Late maternal death The death of a woman from direct or indirect obstetric causes, more than 42 days, but less than one year after termination of pregnancy.

Coding of maternal deaths

Despite the standard definitions noted above, accurate identification of the causes of maternal deaths is not always possible. It can be a challenge for medical certifiers to correctly attribute cause of death to direct or indirect maternal causes, or to accidental or incidental events, particularly in settings where most deliveries occur at home. While several countries apply the ICD-10 in civil registration systems, the identification and classification of causes of death during pregnancy, childbirth and the puerperium remain inconsistent across countries.

With the publication of the ICD-10, WHO recommended adding a checkbox on the death certificate for recording a woman's pregnancy status at the time of death.[2] This was to help identify indirect maternal deaths, but it has not been implemented in many countries. For countries using ICD-10 coding for registered deaths, all deaths coded to the maternal chapter (O codes) and maternal tetanus (A34) are counted as maternal deaths.

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.[3] The ICD-MM is to be used together with the three ICD-10 volumes. For example, the ICD-MM clarifies that the coding of maternal deaths among HIV-positive women may be due to one of the following.

- *Obstetric causes*: Such as haemorrhage or hypertensive disorders in pregnancy – these should be identified as direct maternal deaths.
- *The interaction between human immunodeficiency virus (HIV) and pregnancy*: In these cases, there is an aggravating effect of pregnancy on HIV and the interaction between pregnancy

[2] International statistical classification of diseases and related health problems, tenth revision. Vol. 2: Instruction manual. Geneva: World Health Organization; 2010.

[3] Application of ICD-10 to deaths during pregnancy, childbirth and the puerperium: ICD maternal mortality (ICD-MM). Geneva: World Health Organization; 2012.

and HIV is the underlying cause of death. These deaths are considered as indirect maternal deaths. In this report, they are referred to as "AIDS-related indirect maternal deaths", and in the ICD those deaths are coded to O98.7 and categorized in Group 7 (non-obstetric complications) in the ICD-MM.

- *Acquired immunodeficiency syndrome* (*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 will facilitate the coding and identification of these deaths.

Measures of maternal mortality

The extent of maternal mortality in a population is essentially the combination of two factors:

(i) The risk of death in a single pregnancy or a single live birth.

(ii) The fertility level (i.e. the number of pregnancies or births that are experienced by women of reproductive age).

The MMR is defined as the number of maternal deaths during a given time period per 100 000 live births during the same time period. It depicts the risk of maternal death relative to the number of live births and essentially captures (i) above.

By contrast, the maternal mortality rate (MMRate) is defined as the number of maternal deaths in a population divided by the number of women aged 15–49 years (or woman-years lived at ages 15–49 years). The MMRate captures both the risk of maternal death per pregnancy or per total birth (live birth or stillbirth), and the level of fertility in the population. In addition to the MMR and the MMRate, it is possible to calculate the adult lifetime risk of maternal mortality for women in the population (see Box A2). An alternative measure of maternal mortality, the proportion of maternal deaths among deaths of women of reproductive age (PM), is calculated as the number of maternal deaths divided by the total deaths among women aged 15–49 years.

Box A2.2 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.
Maternal mortality rate (MMRate) Number of maternal deaths divided by person-years lived by women of reproductive age.[4]

[4] 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. Stat Politics Policy. 2012;3(2):1–38.

Box A2.2 Statistical measures of maternal mortality
Adult lifetime risk of maternal death The probability that a 15-year-old woman will die eventually from a maternal cause.
The proportion of maternal deaths among deaths of women of reproductive age (PM) The number of maternal deaths in a given time period divided by the total deaths among women aged 15–49 years.

Approaches for measuring maternal mortality

Ideally, civil registration systems with good attribution of cause of death provide accurate data on the level of maternal mortality and the causes of maternal deaths. In countries with incomplete civil registration systems, 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 and the deaths would therefore not have been reported as maternal deaths. Third, in most developing-country settings where medical certification of cause of death does not exist, accurate attribution of a female death as a maternal death is difficult.

Even in developed countries where routine registration of deaths is in place, maternal deaths may be underreported due to misclassification of 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 Deaths (CEMD), a system established in England and Wales in 1928.[5,6,7] The most recent report of the CEMD (for 2009–2011) identified 79% more maternal deaths than were reported in the routine civil registration system.[8] Other studies on the accuracy of the number of maternal deaths reported in civil registration 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] Annex 6 summarizes the results of a

[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 (CEMAH); 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 2009–12. Oxford: National Perinatal Epidemiology Unit, University of Oxford; 2014.

[9] Deneux-Tharaux C 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

literature review (updated January 2014) for such studies where misclassification on coding in civil registration could be identified.

These studies 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 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%).

Underreporting of maternal deaths was more common among:

- early pregnancy deaths, including those not linked to a reportable birth outcome;
- deaths in the later postpartum period (these were less likely to be reported than early postpartum deaths);
- deaths at extremes of maternal age (youngest and oldest);
- miscoding by the ICD-9 or ICD-10, most often seen in cases of deaths caused by:
    - cerebrovascular diseases;
    - cardiovascular diseases.

Potential reasons cited for underreporting and/or misclassification include:

- inadequate understanding of the ICD rules (either ICD-9 or ICD-10);
- death certificates completed without mention of pregnancy status;
- desire to avoid litigation;
- desire to suppress information (especially as related to abortion deaths).

The definitions of misclassification, incompleteness and underreporting of maternal deaths are shown in Box A2.3.

Box A2.3
Definitions of misclassification, incompleteness and underreporting

Misclassification

Refers to incorrect coding in civil registration, due either to error in the medical certification of cause of death or error in applying the correct code.

Incompleteness

Refers to incomplete death registration. Includes both the identification of individual deaths in each country and the national coverage of the register.

Gynecol. 1995;86(4 pt 2):700–5.

Box A2.3
Definitions of misclassification, incompleteness and underreporting

Underreporting

Is a combination of misclassification and incompleteness.

In the absence of complete and accurate civil registration 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 shown in Box A2.4.

Box A2.4
Approaches to measuring maternal mortality

Civil registration system[8,9,11]

This approach involves routine registration of births and deaths. Ideally, maternal mortality statistics should be obtained through civil registration data. However, even where coverage is complete and the causes of all deaths are identified based on standard medical certificates, in the absence of active case finding, maternal deaths may be missed or misclassified; and therefore confidential enquiries are used to identify the extent of misclassification and underreporting.

Household surveys[12,13]

Demographic and Health Surveys (DHS) and Multiple Indicator Cluster Surveys – Round 4 (MICS) use the direct "sisterhood" method using household survey data. 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.
- It produces estimates with wide confidence intervals, thereby diminishing opportunities for trend analysis.
- It provides a retrospective rather than a current maternal mortality estimate (referring to a

[11] 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 2009–12. Oxford: National Perinatal Epidemiology Unit, University of Oxford; 2014.

[12] Hill K et al. How should we measure maternal mortality in the developing world? A comparison of household deaths and sibling history approaches. Bull World Health Organ. 2006;84:173–80.

[13] 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.

Box A2.4
Approaches to measuring maternal mortality

period approximately five years prior to the survey); the analysis is more complicated.

Census[14,15]

A national census, with the addition of a limited number of questions, could produce 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), thereby providing recent maternal mortality estimates, but is conducted at 10-year intervals and therefore limits monitoring of maternal mortality.
- It identifies pregnancy-related deaths (not maternal deaths); however, if combined with verbal autopsy, maternal deaths could be identified.
- Training of enumerators is crucial, since census activities collect information on a range of other topics unrelated to maternal deaths.
- Results must be adjusted for characteristics such as completeness of death and birth statistics and population structures, in order to arrive at reliable estimates.

Reproductive-age mortality studies (RAMOS)[11,12]

This approach involves identifying and investigating the causes of all deaths of women of reproductive age in a defined area or population, by using multiple sources of data (e.g. interviews of family members, civil registrations, health-care facility records, burial records, traditional birth attendants), and has the following characteristics.

- 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 and 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 routine registration systems) and could provide subnational MMRs. However, inadequate identification of all deaths of reproductive-aged women 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 may not be accurate, especially in settings where most women deliver at home.

[14] Stanton C et al. Every death counts: measurement of maternal mortality via a census. Bull World Health Organ. 2001;79:657–64.

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

Box A2.4
Approaches to measuring maternal mortality

Verbal autopsy[16,17,18]

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. 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. 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).
- 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.

[16] Chandramohan D et al. The validity of verbal autopsies for assessing the causes of institutional maternal death. Stud Fam Plann. 1998;29:414–22.

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

[18] Leitao J et al. Revising the WHO verbal autopsy instrument to facilitate routine cause-of-death monitoring. Global Health Action. 2013;6:21518.

Annex 3. Methods used to derive a complete series of annual estimates for each covariate, 1985–2015

A complete series of annual estimates for each of the three covariates was obtained or constructed between 1985 and 2015.

GDP per capita measured in purchasing power parity (PPP) equivalent dollars using 2011 as the baseline year were taken from World Bank Group[19] with estimates from other sources (e.g. IMF, OECD, WHO National Health Accounts and the Institute for Health Metrics and Evaluation) used to inform trends in instances with missing country-years in the World Bank Group data set. A five-year moving average was applied to this GDP series to smooth year-to-year GDP fluctuations.

General fertility rate (GFR) estimates were calculated using annual series of live births and the populations of women aged 15–49 years, which were constructed using estimates from UNPD.[20]

Skilled attendant at birth (SAB) coverage estimates consist of time series derived using data from household surveys and other sources, obtained from a database maintained by UNICEF.[21] Although other sources of SAB data were consulted, only the UNICEF data were used because they adhere strictly to the indicator's definition.[22] For countries with any value of SAB less than 95% and with four or more observations, annual series were estimated by fitting a regression model with time as the sole predictor for the logit (log-odds) of SAB; such a model was estimated separately for each country. For all other countries, including those with no available SAB data, the SAB annual series were estimated using a multilevel model. In the multilevel model, logit (or log-odds) of observed SAB proportions for all countries were regressed against time. The model included region- and country-specific intercepts and slopes.

[19] GDP per capita measured in purchasing power parity (PPP) equivalent dollars, reported as constant 2011 international dollars, based on estimates published by World Bank Group. International Comparison Program database. Washington (DC): World Bank Group; 2014.

[20] World population prospects: the 2015 revision. New York: United Nations, Department of Economic and Social Affairs, Population Division; 2015.

[21] UNICEF Data: Monitoring the Situation of Children and Women [website]. New York: United Nations Children's Fund; 2015 (http://data.unicef.org/).

[22] Making pregnancy safer: the critical role of the skilled attendant: a joint statement by WHO, ICM and FIGO. Geneva: World Health Organization; 2014.

Annex 4. Adjustment factor to account for misclassification of maternal deaths in civil registration, literature review of reports and articles

Country	Period/year	Adjustment factor
Australia[a]	1994–1996	1.23
Australia[b]	1997–1999	1.80
Australia[c]	2000–2002	1.97
Australia[d]	2003–2005	2.03
Austria[e]	1980–1998	1.61
Brazil[f]	2002	1.40
Canada[g]	1988–1992	1.69
Canada[h]	1997–2000	1.52
Denmark[i]	1985–1994	1.94
Denmark[j]	2002–2006	1.04
Finland[k]	1987–1994	0.94
France[l]	Dec 1988 to March 1989	2.38
France[m]	1999	1.29
France[n]	2001–2006	1.21
France[o]	2007–2009	1.21
Guatemala[p]	1989	1.84
Guatemala[p]	1996–1998	1.84
Guatemala[q]	2000	1.88
Guatemala[r]	2007	1.73
Ireland[s]	2009–2011	3.40
Japan[t]	2005	1.35
Mexico[u]	2008	0.99
Netherlands[v]	1983–1992	1.34
Netherlands[x]	1993–2005	1.48
New Zealand[y]	2006	1.11
New Zealand[z]	2007	0.85
New Zealand[aa]	2008	1.00

Country	Period/year	Adjustment factor
New Zealand[bb]	2009	0.92
New Zealand[cc]	2010	1.00
Portugal[dd]	2001–2007	2.04
Serbia[ee]	2007–2010	1.86
Singapore[ff]	1990–1999	1.79
Slovenia[gg]	2003–2005	5.00
South Africa[hh]	1999–2001	0.98
South Africa[ii]	2002–2004	1.16
South Africa[ii]	2005–2007	0.90
Sweden[jj]	1997–2005	1.33
Sweden[kk]	1988–2007	1.68
United Kingdom[ll]	1988–1990	1.39
United Kingdom[ll]	1991–1993	1.52
United Kingdom[ll]	1994–1996	1.64
United Kingdom[ll]	1997–1999	1.77
United Kingdom[ll]	2000–2002	1.80
United Kingdom[ll]	2003–2005	1.86
United Kingdom[ll]	2006–2008	1.60
United States[mm]	1991–1997	1.48
United States[nn]	1995–1997	1.54
United States[oo]	1999–2002	1.59
United States[oo]	2003–2005	1.41
Median		1.5

[a] AIHW, NHMRC. Report on maternal deaths in Australia 1994–96. Cat. no. PER 17. Canberra: AIHW; 2001 ().

[b] Slaytor EK, Sullivan EA, King JF. Maternal deaths in Australia 1997–1999. Cat. No. PER 24. Sydney: AIHW National Perinatal Statistics Unit; 2004 (Maternal Deaths Series, No. 1).

[c] Sullivan EA, King JF, editors. Maternal deaths in Australia 2000–2002. Cat. no. PER 32. Sydney: AIHW National Perinatal Statistics Unit; 2006 (Maternal Deaths Series, No. 2).

[d] Sullivan EA, Hall B, King JF. Maternal deaths in Australia 2003–2005. Cat. no. PER 42. Sydney: AIHW National Perinatal Statistics Unit; 2007 (Maternal Deaths Series, No. 3).

[e] Johnson S, Bonello MR, Li Z, Hilder L, Sullivan EA. Maternal deaths in Australia 2006–2010. Cat. no. PER 61. Canberra: AIHW; 2014 (Maternal Deaths Series, No. 4).

[f] Brasil Ministério da Saúde, Secretaria de Atenção à Saúde, Departamento de Ações Programáticas Estratégicas. Estudo da mortalidade de mulheres de 10 a 49 anos, com ênfase na mortalidade materna: relatório final. Brasilia: Ministério da Saúde, Secretaria de Atenção à Saúde, Departamento de Ações Programáticas Estratégicas, Editora do Ministério da Saúde; 2006.

[g] Turner LA et al. Underreporting of maternal mortality in Canada: a question of definition. Chronic Dis Can. 2002;23:22–30.

[h] Health Canada. Special report on maternal mortality and severe morbidity in Canada – enhanced surveillance: the path to prevention. Ottawa: Minister of Public Works and Government Services Canada; 2004.

[i] Andersen BR et al. Maternal mortality in Denmark 1985–1994. Eur J Obstet Gynecol Reprod Biol. 2009;42:124–8.

[j] Bødker B et al. Maternal deaths in Denmark 2002–2006. Acta Obstet Gynecol Scand. 2009;88:556–62.

[k] Gissler M et al. Pregnancy-associated deaths in Finland 1987–1994 definition problems and benefits of record linkage. Acta Obstet Gynecol Scand. 1997;76(7):651–7.

[l] Bouvier-Colle MH et al. Reasons for the underreporting of maternal mortality in France, as indicated by a survey of all deaths among women of childbearing age. Int J Epidemiol. 1991;20:717–21.

[m] Bouvier-Colle MH et al. Estimation de la mortalité maternelle en France : une nouvelle méthode. J Gynecol Obstet Biol Reprod. 2004;33(5):421–9.

[n] Rapport du Comité national d'experts sur la mortalité maternelle (CNEMM) 2001–2006. Saint-Maurice: Institut de veille sanitaire; 2010.

[o] Rapport du comité national d'experts sur la mortalité maternelle (CNEMM). Enquête nationale confidentielle sur les morts maternelles France, 2007–2009 Inserm, France: Institut national de la santé et de la recherche médicale; 2013.

[p] Schieber B, Stanton C. Estimación de la mortalidad materna en Guatemala período 1996–1998. Guatemala; 2000.

[q] Línea basal de mortalidad materna para el año 2000. Informe final. Guatemala: Ministerio de Salud Pública y Asistencia Social; 2003.

[r] Estudio nacional de mortalidad materna. Informe final. Guatemala: Secretaría de Planificación y Programación de la Presidencia Ministerio de Salud Pública y Asistencia Social; 2011.

[s] Confidential Maternal Death Enquiry in Ireland, report for triennium 2009–2011. Cork: Maternal Death Enquiry; 2012.

[t] Health Sciences Research Grant. Analysis and recommendations of the causes of maternal mortality and infant mortality. Tomoaki I, principal investigator. Research Report 2006–2008. Osaka: Department of Perinatology, National Cardiovascular Center; 2009 [in Japanese].
Hidaka A et al. [Causes and ratio of maternal mortality, and its reliability]. Sanfujinkachiryou [Treatment in obstetrics and gynaecology]. 2009;99(1):85–95 [in Japanese].

[u] Búsqueda intencionada de muertes maternas en México. Informe 2008. Mexico, DF: Dirección General de Información en Salud, Secretaría de Salud; 2010.

[v] Schuitemaker N et al. Confidential enquiry into maternal deaths in the Netherlands 1983–1992. Eur J Obstet Gynecol Reprod Biol. 1998;79(1):57–62.

[x] Schutte J et al. Rise in maternal mortality in the Netherlands. BJOG. 2010;117(4):399–406.

[y] PMMRC. Perinatal and maternal mortality in New Zealand 2006: second report to the Minister of Health. Wellington: Ministry of Health; 2009.

[z] PMMRC. Perinatal and maternal mortality in New Zealand 2007: third report to the Minister of Health July 2008 to June 2009. Wellington: Ministry of Health; 2009.

[aa] PMMRC. Perinatal and maternal mortality in New Zealand 2008: fourth report to the Minister of Health July 2009 to June 2010. Wellington: Ministry of Health; 2010.

[bb] PMMRC. Fifth annual report of the Perinatal and Maternal Mortality Review Committee: reporting mortality 2009. Wellington: Health Quality and Safety Commission; 2011.

[cc] PMMRC. Sixth annual report of the Perinatal and Maternal Mortality Review Committee: reporting mortality 2010. Wellington: Health Quality and Safety Commission; 2012.

[dd] Gomes MC, Ventura MT, Nunes RS. How many maternal deaths are there in Portugal? J Matern Fetal Neonatal Med. 2012;25(10):1975–9.

[ee] Krstic M et al. Maternal deaths – methodology for cases registration and reporting. Belgrade; 2008 [unpublished paper].

[ff] Lau G. Are maternal deaths on the ascent in Singapore? A review of maternal mortality as reflected by coronial casework from 1990 to 1999. Ann Acad Med Singapore. 2002;31(3):261–75.

[gg] Kralj E, Mihevc-Ponikvar B, Premru-Sršenc T, Balažica J. Maternal mortality in Slovenia: case report and the method of identifying pregnancy-associated deaths. Forensic Sci Int Suppl Ser. 2009;1(1):52–7.

[hh] Moodley J. Saving mothers: 1999–2001. S Afr Med J. 2003;93(5):364–6.

[ii] Saving mothers 2008–2010: fifth report on the confidential enquiries into maternal deaths in South Africa. Comprehensive report. South Africa: Department of Health, National Committee on Confidential Enquires into Maternal Deaths; 2012.

[jj] Grunewald C et al. Modradodligheten underskattad i Sverige. Lakartidningen. 2008;34(105):2250–3.

[kk] Esscher A et al., Maternal mortality in Sweden 1988–2007: more deaths than officially reported. Acta Obstet Gynecol Scand. 2012;92:40–6.

[ll] 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.

[mm] Berg CJ et al. Pregnancy-related mortality in the United States, 1991–1997. Obstet Gynecol. 2003;101(2):289–96.

[nn] MacKay AP et al. An assessment of pregnancy-related mortality in the United States. Paediatr Perinat Epidemiol. 2005;19(3):206–14.

[oo] MacKay AP et al. Changes in pregnancy mortality ascertainment United States, 1999–2005. Obstet Gynecol. 2011;118:104–10.

Annex 5. Usability assessment of civil registration data for selected years (1990, 1995, 2000, 2005, 2010 and latest available year)

Assessment of civil registration data (VR data) quality – usability

National civil registration and vital statistics (CRVS) systems are meant to record all births, deaths and causes of death within a country. The data retrieved from CRVS systems are referred to as vital registration (VR) data.

For the VR data, the usability, referred to as ($G_{c,t}$) for country c in year t, was defined as the proportion of all deaths to women of reproductive ages in the country-year for which causes have been assessed in the VR data set. Essentially, ($G_{c,t}$) is the product of the completeness of the VR data and the percentage of deaths with a well-defined cause:

$$G_{c,t} = G_{c,t}^{(complete)} \times (1 - G_{c,t}^{(ill)})$$

where $G_{c,t}^{(complete)}$ refers to the completeness of the VR, and $G_{c,t}^{(ill)}$ refers to the proportion of VR deaths with ill-defined causes (as reported).

The completeness is assessed by comparing the total number of deaths among women of reproductive age recorded in the VR database (WHO Mortality Database)[23] to the WHO estimate of the total number of deaths among women of reproductive age,[24] i.e.:

$$G_{c,t}^{(complete)} = \text{VR total deaths / WHO total deaths}$$

with $G_{c,t}^{(complete)} = 1$ if the VR total deaths exceeds the WHO estimate of total deaths.

Based on the assessment of data quality and data source, VR data are grouped into three categories. These categories affect how much uncertainty is assumed to surround each data point obtained from the VR system. The categories are as follows.

- Type I: good quality VR data with usability > 80%.
- Type II: VR data from a string of decent VR data with usability between 60% and 80%.
- Type III: other data from registration and mortality reporting systems. For these data points, data quality cannot be assessed as the countries have not submitted data to the relevant WHO office.

Please refer to Table A5.1 for the usability assessment by country for selected years.

[23] WHO Mortality Database (http://www.who.int/healthinfo/mortality_data/en/).

[24] Life tables for WHO Member States 1990–2012. Geneva: World Health Organization; 2014.

Table A5.1. Usability assessment of civil registration data for selected years (1990, 1995, 2000, 2005, 2010 and latest available year)

Country	1990	1995	2000	2005	2010	Latest available year
Albania	NA	56	49	55		42 (2009)
Argentina	96	97	94	94	94	95 (2013)
Armenia	67	86	91		84	82 (2012)
Australia	99	96	98	98		98 (2011)
Austria	99	100	100	100	98	97 (2014)
Azerbaijan	60	64	80			87 (2007)
Bahamas		99	84	92	82	99 (2012)
Bahrain			98	94	93	94 (2013)
Barbados	83	100	98	98	100	100 (2012)
Belarus	99	98	98			98 (2011)
Belgium	94	96	98	97	95	94 (2012)
Belize	83	85	98	100	99	100 (2013)
Bolivia (Plurinational State of)			15			21 (2003)
Bosnia and Herzegovina	88					91 (2011)
Brazil	69	72	75	81	83	92 (2013)
Brunei Darussalam			88	97	83	97 (2012)
Bulgaria	97	98	96	96	94	93 (2014)
Cabo Verde						97 (2012)
Canada	92	97	97	97	93	93 (2011)
Chile	97	98	98	98	98	98 (2013)
Colombia	85	82	84	83	81	82 (2012)
Costa Rica	89	90	91	91	90	87 (2013)

Country	1990	1995	2000	2005	2010	Latest available year
Croatia	95	88	99	98	99	99 (2014)
Cuba	99	99	99	99	98	98 (2013)
Cyprus			37	65		71 (2012)
Czech Republic	100	99	99	98	97	91 (2013)
Denmark	96	94	98	97	93	87 (2012)
Dominican Republic	44	44	45	48	48	65 (2012)
Ecuador	72	74	75	76	78	72 (2013)
Egypt			80	82	91	91 (2013)
El Salvador	61	63	65	65	64	55 (2012)
Estonia	99	99	99	98	98	99 (2012)
Fiji				99		100 (2012)
Finland	98	99	99	97	96	98 (2013)
France	93	94	92	91	90	90 (2011)
Georgia	96	89	78	87	49	73 (2014)
Germany	93	95	93	94	93	93 (2013)
Greece	96	94	95	98	96	96 (2012)
Grenada	91	87	92	100	98	96 (2013)
Guatemala	76	78	85	93	81	76 (2013)
Guyana	81	84		85	73	65 (2011)
Honduras	54				14	15 (2013)
Hungary	100	100	99	99	100	97 (2014)
Iceland	93	92	97	93	95	93 (2012)
Ireland	98	99	99	99	99	
Israel	98	96	98	93		100 (2009)

Country	1990	1995	2000	2005	2010	Latest available year
Italy	98	98	98		98	97 (2012)
Jamaica	48		53	63	73	77 (2011)
Japan	99	99	98	97	97	88 (2013)
Jordan					50	49 (2011)
Kazakhstan	86	887	82	83	85	86 (2012)
Kiribati		61	56			53 (2001)
Kuwait		85	99	98	99	99 (2013)
Kyrgyzstan	82	80	85	89	89	82 (2013)
Latvia	98	100	98	99	99	99 (2012)
Lithuania	100	99	99	97	96	92 (2012)
Luxembourg	96	90	94	89	94	98 (2013)
Malaysia			85	81		85 (2008)
Maldives			51	63	71	77 (2011)
Malta	74	87	89	91	79	97 (2012)
Mauritius	96	96	97	99	100	99 (2013)
Mexico	96	92	90	93	94	88 (2013)
Montenegro			84	92		86 (2009)
Morocco					16	15 (2012)
Netherlands	93	94	93	95	95	94 (2013)
New Zealand	99	100	100	99	100	99 (2011)
Nicaragua	62		63	63	64	66 (2013)
Norway	98	97	97	97	95	89 (2013)
Oman					56	
Panama			79	83	75	81 (2013)

Country	1990	1995	2000	2005	2010	Latest available year
Paraguay		75	74	77	79	76 (2013)
Peru	43	48	55	62	61	63 (2013)
Philippines		83	85			88 (2008)
Poland	95	94	94	93	93	88 (2013)
Portugal	89	89	85		88	80 (2013)
Puerto Rico	99	100	99	99	95	89 (2013)
Qatar		98	86		71	65 (2012)
Republic of Korea	85	95	96	97	96	96 (2012)
Republic of Moldova	100	100	89	97	100	99 (2013)
Romania	100	97	99	95	93	83 (2012)
Russian Federation	98	97	95	95	96	96 (2011)
Saint Lucia	98	94	85	87	95	100 (2012)
Saint Vincent and the Grenadines	97	100	83	79	93	98 (2013)
Saudi Arabia						42 (2012)
Serbia			67	69	71	66 (2013)
Singapore	86	85	82	78	74	74 (2014)
Slovakia	NA	99	98	96	95	91 (2014)
Slovenia	97	95	96	95	97	
South Africa	NA	70	88	87	83	67 (2013)
Spain	99	99	97	97	95	91 (2013)
Sri Lanka			72			79 (2006)
Suriname	92	69	72	75	96	94 (2012)
Sweden	99	99	99	98	94	97 (2013)
Switzerland	97	95	95	96	95	91 (2012)

Country	1990	1995	2000	2005	2010	Latest available year
Syria					90	
Tajikistan	64	64	65	67		
Thailand	67	82	77	75		80 (2006)
The former Yugoslav Republic of Macedonia	NA	88	91	89	90	
Trinidad and Tobago	99	98	98	99		99 (2009)
Tunisia						24 (2013)
Turkey					40	45 (2013)
Turkmenistan	74	79				53 (2013)
Ukraine	99	98	97	98	98	96 (2012)
United Arab Emirates				79	53	
United Kingdom	100	99		99	98	97 (2013)
United States of America	95	96	96	97	96	98 (2013)
Uruguay	95	95	93	91	89	94 (2013)
Uzbekistan	88	89	88	90		
Venezuela (Bolivarian Republic of)	89		89	89	94	96 (2012)
Zimbabwe	36					

Annex 6. Estimation of AIDS-related indirect maternal deaths

In this estimation process, the full model has two parts, the first part to separately estimate maternal deaths not related to AIDS (discussed in section 2.4 of the main report) and the second part to estimate AIDS-related indirect maternal deaths. AIDS-related indirect maternal deaths refer to HIV-positive women who have died because of the aggravating effect of pregnancy on HIV; where the interaction between pregnancy and HIV becomes the underlying cause of death, these are counted as indirect maternal deaths. It is important to note that direct maternal deaths among HIV-positive women are not estimated separately but are rather included within the first part of the model.

Thus, the final PM estimates are the result of adding the results of this two-part model: the estimated number of non-AIDS-related maternal deaths and the estimated number of AIDS-related indirect maternal deaths:

$$PM = (1 - a)PM^{na} + aPM^{a} \quad \text{(A6.1)}$$

where PM^{na} is the proportion of non-AIDS-related maternal deaths among all non-AIDS-related deaths (women aged 15–49 years); PM^{a} is the proportion of AIDS-related indirect maternal deaths among all AIDS-related deaths (women aged 15–49 years); and a is the proportion of AIDS-related deaths among all deaths (women aged 15–49 years).

This appendix describes the second part of the two-part model, that is, the estimation of AIDS-related indirect maternal deaths, PM^{a}. The sources of data for estimating the fraction of AIDS-related indirect maternal deaths are the UNAIDS 2013 estimates of AIDS-related deaths[25] and the total number of deaths estimated by WHO from its life tables. The approach used to estimate the proportion of AIDS-related deaths that qualify as indirect maternal deaths, PM^{a}, is the product of two quantities:

$$PM^{a} = \upsilon u \quad \text{(A6.2)}$$

where υ is the proportion of AIDS deaths in women aged 15–49 years that occur during pregnancy or the childbirth period, computed as follows:

$$\upsilon = \frac{ckGFR}{1 + c(k-1)GFR} \quad \text{(A6.3)}$$

u is the fraction of AIDS-related deaths among pregnant women that qualify as maternal because of some causal relationship with the pregnancy, delivery or postpartum period; GFR is the general fertility rate; c is the average woman-years lived in the maternal risk period per live birth (set equal to 1 year, including the 9 month gestation, plus 42 days postpartum, and an additional 1.5 months to account for pregnancies not ending in a live birth); k is the relative risk of dying from AIDS for a pregnant versus non-pregnant woman.

In the 2013 estimates, updated values for k and u were used, in light of new data from the network for Analyzing Longitudinal Population-based HIV/AIDS data on Africa (ALPHA).[26] Based on the

[25] According to the Joint United Nations Programme on HIV/AIDS (UNAIDS), AIDS-related deaths (including AIDS-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.

[26] Zaba B 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 Analyzing Longitudinal Population-based HIV/AIDS data on Africa (ALPHA). Lancet. 2013;381(9879):1763–71. doi:10.1016/S0140-6736(13)60803-X.

findings in the paper and further exploration of the data, both *k* and *u* were set equal to 0.3. The uncertainty distributions for both parameters were updated as well, the standard deviation for *k* was set to 0.1 and for *u*, a uniform distribution with outcomes between 0.1 and 0.5 was used.

Annex 7. Estimates of maternal mortality ratio (MMR, maternal deaths per 100 000 live births), number of maternal deaths, lifetime risk and percentage of AIDS-related indirect maternal deaths, 2015[a]

Country	MMR[b]	Range of MMR uncertainty (UI 80%)		Number of maternal deaths[c]	Lifetime risk of maternal death: 1 in[d]	% of AIDS-related indirect maternal deaths[e]	PM	Range of PM uncertainty	
		Lower estimate	Upper estimate					Lower estimate	Upper estimate
Afghanistan	396	253	620	4 300	52	–	17.7	11.3	27.7
Albania	29	16	46	11	1 900	–	1.3	0.7	2.1
Algeria	140	82	244	1 300	240	–	8.0	4.7	14.0
Angola	477	221	988	5 400	32	–	18.3	8.5	37.8
Argentina	52	44	63	390	790	–	3.8	3.2	4.6
Armenia	25	21	31	10	2 300	–	1.4	1.1	1.7
Australia	6	5	7	19	8 700	–	0.6	0.5	0.8
Austria	4	3	5	3	18 200	–	0.3	0.2	0.4
Azerbaijan	25	17	35	48	1 600	–	2.0	1.3	2.7
Bahamas	80	53	124	5	660	–	3.8	2.5	5.9
Bahrain	15	12	19	3	3 000	–	1.9	1.5	2.4
Bangladesh	176	125	280	5 500	240	–	8.6	6.1	13.6
Barbados	27	19	37	1	2 100	–	1.5	1.0	2.0
Belarus	4	3	6	5	13 800	–	0.2	0.1	0.2
Belgium	7	5	10	9	8 000	–	0.5	0.4	0.7
Belize	28	20	36	2	1 300	–	2.7	2.0	3.5
Benin	405	279	633	1 600	51	–	14.8	10.2	23.1
Bhutan	148	101	241	20	310	–	3.6	2.4	5.8
Bolivia (Pluri-national State of)	206	140	351	520	160	–	7.9	5.4	13.4
Bosnia and Herzegovina	11	7	17	4	6 800	–	0.7	0.4	1.0
Botswana	129	102	172	72	270	18	3.1	2.5	4.2
Brazil	44	36	54	1 300	1 200	–	2.0	1.6	2.5
Brunei Darussalam	23	15	30	2	2 300	–	1.7	1.2	2.3
Bulgaria	11	8	14	7	6 200	–	0.4	0.3	0.6
Burkina Faso	371	257	509	2 700	48	–	14.2	9.8	19.5
Burundi	712	471	1 050	1 350	23	–	27.0	17.9	39.8
Cabo Verde	42	20	95	5	900	–	5.0	2.3	11.2
Cambodia	161	117	213	590	210	–	6.4	4.7	8.5
Cameroon	596	440	881	5 100	35	–	15.2	11.2	22.5
Canada[f]	7	5	9	27	8 800	–	0.5	0.4	0.7
Central African Republic	882	508	1 500	1 400	27	–	15.0	8.7	25.6
Chad	856	560	1 350	5 400	18	–	28.3	18.5	44.5
Chile	22	18	26	52	2 600	–	1.8	1.5	2.2
China	27	22	32	4 400	2 400	–	1.3	1.1	1.6

Country	MMR[b]	Range of MMR uncertainty (UI 80%)		Number of maternal deaths[c]	Lifetime risk of maternal death: 1 in[d]	% of AIDS-related indirect maternal deaths[e]	PM	Range of PM uncertainty	
		Lower estimate	Upper estimate					Lower estimate	Upper estimate
Colombia	64	56	81	480	800	–	3.8	3.3	4.7
Comoros	335	207	536	88	66	–	13.4	8.3	21.3
Congo	442	300	638	740	45	–	12.8	8.7	18.4
Costa Rica	25	20	29	18	2 100	–	1.8	1.4	2.1
Côte d'Ivoire	645	458	909	5 400	32	–	13.4	9.5	18.9
Croatia	8	6	11	3	7 900	–	0.6	0.4	0.7
Cuba	39	33	47	45	1 800	–	1.8	1.5	2.1
Cyprus	7	4	12	1	9 400	–	0.8	0.4	1.4
Czech Republic	4	3	6	5	14 800	–	0.3	0.2	0.4
Democratic People's Republic of Korea	82	37	190	300	660	–	2.8	1.3	6.5
Democratic Republic of the Congo	693	509	1 010	22 000	24	–	22.3	16.4	32.5
Denmark	6	5	9	4	9 500	–	0.5	0.4	0.7
Djibouti	229	111	482	50	140	–	5.4	2.6	11.3
Dominican Republic	92	77	111	200	400	–	3.7	3.1	4.5
Ecuador	64	57	71	210	580	–	4.4	3.9	4.9
Egypt	33	26	39	820	810	–	3.5	2.8	4.1
El Salvador	54	40	69	57	890	–	1.9	1.4	2.4
Equatorial Guinea	342	207	542	100	61	5.6	8.8	5.3	13.9
Eritrea	501	332	750	880	43	–	20.5	13.6	30.6
Estonia	9	6	14	1	6 300	–	0.5	0.3	0.7
Ethiopia	353	247	567	11 000	64	–	16.7	11.7	26.8
Fiji	30	23	41	5	1 200	–	1.5	1.1	2.0
Finland	3	2	3	2	21 700	–	0.2	0.2	0.3
France	8	7	10	66	6 100	–	0.7	0.6	0.9
Gabon	291	197	442	150	85	–	8.6	5.8	13.1
Gambia	706	484	1 030	590	24	–	31.1	21.4	45.5
Georgia	36	28	47	19	1 500	–	2.3	1.8	3.0
Germany	6	5	8	42	11 700	–	0.4	0.3	0.5
Ghana	319	216	458	2 800	74	–	11.3	7.6	16.2
Greece	3	2	4	3	23 700	–	0.2	0.2	0.3
Grenada	27	19	42	1	1 500	–	1.7	1.2	2.7
Guatemala	88	77	100	380	330	–	5.3	4.7	6.0
Guinea	679	504	927	3 100	29	–	23.3	17.3	31.8
Guinea-Bissau	549	273	1 090	370	38	–	13.3	6.6	26.3
Guyana	229	184	301	34	170	–	4.7	3.8	6.2
Haiti	359	236	601	950	90	–	10.1	6.6	16.9
Honduras	129	99	166	220	300	–	5.7	4.4	7.3
Hungary	17	12	22	15	4 400	–	0.7	0.5	0.9
Iceland	3	2	6	0	14 600	–	0.4	0.2	0.7

Country	MMR[b]	Range of MMR uncertainty (UI 80%)		Number of maternal deaths[c]	Lifetime risk of maternal death: 1 in[d]	% of AIDS-related indirect maternal deaths[e]	PM	Range of PM uncertainty	
		Lower estimate	Upper estimate					Lower estimate	Upper estimate
India	174	139	217	45 000	220	–	6.2	5.0	7.7
Indonesia	126	93	179	6 400	320	–	6.3	4.6	8.9
Iran (Islamic Republic of)	25	21	31	340	2 000	–	1.5	1.2	1.8
Iraq	50	35	69	620	420	–	6.2	4.3	8.5
Ireland	8	6	11	5	6 100	–	0.8	0.6	1.2
Israel	5	4	6	9	6 200	–	1.2	0.9	1.4
Italy	4	3	5	18	21 970	–	0.3	0.2	0.4
Jamaica	89	70	115	43	520	–	3.8	3.0	4.9
Japan	5	4	7	56	13 400	–	0.4	0.3	0.5
Jordan	58	44	75	110	490	–	5.2	4.0	6.8
Kazakhstan	12	10	15	45	3 000	–	0.6	0.4	0.7
Kenya	510	344	754	8 000	42	2.3	17.4	11.7	25.7
Kiribati	90	51	152	3	300	–	6.6	3.8	11.2
Kuwait	4	3	6	3	10 300	–	0.9	0.7	1.2
Kyrgyzstan	76	59	96	120	390	–	5.2	4.1	6.5
Lao People's Democratic Republic	197	136	307	350	150	–	10.3	7.1	16.1
Latvia	18	13	26	4	3 500	–	0.7	0.5	1.0
Lebanon	15	10	22	13	3 700	–	1.8	1.3	2.8
Lesotho	487	310	871	300	61	12.8	5.9	3.8	10.6
Liberia	725	527	1 030	1 100	28	–	31.5	22.9	44.9
Libya	9	6	15	12	4 200	–	0.7	0.5	1.2
Lithuania	10	7	14	3	6 300	–	0.4	0.3	0.5
Luxembourg	10	7	16	1	6 500	–	0.8	0.6	1.4
Madagascar	353	256	484	2 900	60	–	16.4	11.9	22.5
Malawi	634	422	1 080	4 200	29	2.9	22.3	14.9	38.1
Malaysia	40	32	53	200	1 200	–	2.8	2.3	3.7
Maldives	68	45	108	5	600	–	11.4	7.6	18.2
Mali	587	448	823	4 400	27	–	25.2	19.2	35.3
Malta	9	6	15	0	8 300	–	0.8	0.5	1.4
Mauritania	602	399	984	810	36	–	27.4	18.2	44.8
Mauritius	53	38	77	7	1 300	–	2.2	1.5	3.1
Mexico	38	34	42	890	1 100	–	2.5	2.2	2.8
Micronesia	100	46	211	2	310	–	5.4	2.5	11.5
Mongolia	44	35	55	30	800	–	2.3	1.8	2.9
Montenegro	7	4	12	1	8 300	–	0.4	0.2	0.7
Morocco	121	93	142	850	320	–	6.3	4.8	7.4
Mozambique	489	360	686	5 300	40	10.7	9.5	7.0	13.4
Myanmar	178	121	284	1 700	260	–	3.9	2.6	6.2
Namibia	265	172	423	190	100	4.3	11.1	7.2	17.8
Nepal	258	176	425	1 500	150	–	9.8	6.7	16.2
Netherlands	7	5	9	12	8 700	–	0.6	0.4	0.7
New Zealand	11	9	14	7	4 500	–	0.9	0.7	1.1
Nicaragua	150	115	196	180	270	–	8.5	6.5	11.1
Niger	553	411	752	5 400	23	–	34.3	25.5	46.6

Country	MMR[b]	Range of MMR uncertainty (UI 80%)		Number of maternal deaths[c]	Lifetime risk of maternal death: 1 in[d]	% of AIDS-related indirect maternal deaths[e]	PM	Range of PM uncertainty	
		Lower estimate	Upper estimate					Lower estimate	Upper estimate
Nigeria	814	596	1 180	58 000	22	–	25.6	18.7	37.0
Norway	5	4	6	3	11 500	–	0.5	0.4	0.6
Occupied Palestinian Territory[g]	45	21	99	69	490	–	6.1	2.8	13.2
Oman	17	13	24	14	1 900	–	2.8	2.0	3.9
Pakistan	178	111	283	9 700	140	–	10.9	6.8	17.3
Panama	94	77	121	71	420	–	6.3	5.1	8.0
Papua New Guinea	215	98	457	460	120	–	7.4	3.4	15.8
Paraguay	132	107	163	190	270	–	9.3	7.6	11.6
Peru	68	54	80	420	570	–	4.7	3.7	5.5
Philippines	114	87	175	2 700	280	–	6.3	4.8	9.7
Poland	3	2	4	12	22 100	–	0.2	0.1	0.3
Portugal	10	9	13	8	8 200	–	0.5	0.4	0.6
Puerto Rico	14	10	18	6	4 300	–	0.8	0.6	1.0
Qatar	13	9	19	3	3 500	–	2.6	1.8	3.9
Republic of Korea	11	9	13	50	7 200	–	0.7	0.6	0.9
Republic of Moldova	23	19	28	10	3 200	–	1.0	0.8	1.3
Romania	31	22	44	56	2 300	–	1.1	0.8	1.5
Russian Federation	25	18	33	450	2 300	–	0.7	0.5	1.0
Rwanda	290	208	389	1 100	85	–	11.4	8.2	15.3
Saint Lucia	48	32	72	1	1 100	–	2.7	1.8	4.0
Saint Vincent and the Grenadines	45	34	63	1	1 100	–	2.0	1.5	2.8
Samoa	51	24	115	2	500	–	6.2	2.9	13.8
Sao Tome and Principe	156	83	268	10	140	–	8.0	4.2	13.7
Saudi Arabia	12	7	20	72	3 100	–	1.6	0.9	2.7
Senegal	315	214	468	1 800	61	–	16.3	11.1	24.2
Serbia	17	12	24	15	3 900	–	0.8	0.6	1.1
Sierra Leone	1 360	999	1 980	3 100	17	–	21.0	15.4	30.6
Singapore	10	6	17	5	8 200	–	0.8	0.5	1.2
Slovakia	6	4	7	3	12 100	–	0.3	0.3	0.4
Slovenia	9	6	14	2	7 000	–	0.8	0.5	1.2
Solomon Islands	114	75	175	19	220	–	6.6	4.4	10.1
Somalia	732	361	13 900	3 400	22	–	27.6	13.6	52.5
South Africa	138	124	154	1 500	300	32.1	1.7	1.5	1.8
South Sudan	789	523	1 150	3 500	26	–	22.7	15.1	33.1
Spain	5	4	6	21	14 700	–	0.4	0.3	0.5
Sri Lanka	30	26	38	98	1 580	–	1.9	1.7	2.4
Sudan	311	214	433	4 100	72	–	12.5	8.6	17.4
Suriname	155	110	220	15	270	–	7.4	5.2	10.4

Country	MMR[b]	Range of MMR uncertainty (UI 80%)		Number of maternal deaths[c]	Lifetime risk of maternal death: 1 in[d]	% of AIDS-related indirect maternal deaths[e]	PM	Range of PM uncertainty	
		Lower estimate	Upper estimate					Lower estimate	Upper estimate
Swaziland	389	251	627	150	76	18.6	4.2	2.7	6.7
Sweden	4	3	5	5	12 900	–	0.5	0.4	0.6
Switzerland	5	4	7	4	12 400	–	0.5	0.4	0.7
Syrian Arab Republic	68	48	97	300	400	–	6.7	4.7	9.6
Tajikistan	32	19	51	82	790	–	2.9	1.7	4.6
Thailand	20	14	32	140	3 600	–	0.6	0.4	0.9
The former Yugoslav Republic of Macedonia	8	5	10	2	8 500	–	0.5	0.3	0.6
Timor-Leste	215	150	300	94	82	–	21.8	15.3	30.4
Togo	368	255	518	940	58	–	10.7	7.4	15.1
Tonga	124	57	270	3	230	–	5.2	2.4	11.3
Trinidad and Tobago	63	49	80	12	860	–	2.1	1.6	2.7
Tunisia	62	42	92	130	710	–	5.0	3.4	7.4
Turkey	16	12	21	210	3 000	–	0.9	0.7	1.2
Turkmenistan	42	20	73	47	940	–	1.3	0.6	2.3
Uganda	343	247	493	5 700	47	3.1	13.4	9.7	19.3
Ukraine	24	19	32	120	2 600	–	0.7	0.5	0.9
United Arab Emirates	6	3	11	6	7 900	–	0.7	0.4	1.4
United Kingdom	9	8	11	74	5 800	–	0.8	0.6	0.9
United Republic of Tanzania	398	281	570	8 200	45	2.4	18.4	13.0	26.3
United States of America	14	12	16	550	3 800	–	0.8	0.7	0.9
Uruguay	15	11	19	7	3 300	–	0.9	0.7	1.2
Uzbekistan	36	20	65	240	1 000	–	2.2	1.2	4.0
Vanuatu	78	36	169	5	360	–	6.8	3.1	14.7
Venezuela (Bolivarian Republic of)	95	77	124	570	420	–	6.3	5.1	8.2
Viet Nam	54	41	74	860	870	–	4.0	3.0	5.5
Yemen	385	274	582	3 300	60	–	17.4	12.3	26.2
Zambia	224	162	306	1 400	79	9.4	8.3	6.0	11.3
Zimbabwe	443	363	563	2 400	52	4.7	13.2	10.8	16.7

PM: proportion of deaths among women of reproductive age 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.

[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 AIDS-related indirect maternal deaths are presented only for countries with an HIV prevalence ≥5.0% in 2014 (*How AIDS changed everything. MDG 6: 15 years, 15 lessons of hope from the AIDS response*. UNAIDS; 2015).

[f] Vital registration data were available for analysis only up to 2011. Recent hospital surveillance data for Canada excluding Quebec indicate a decline of maternal deaths per 100 000 deliveries from 8.8 in 2007/2008–2008/2009 to 5.1 in 2011/2012. Some 98% of deliveries in Canada occur in hospitals.

[g] Refers to a territory.

Annex 8. Estimates of maternal mortality ratio (MMR, maternal deaths per 100 000 live births), number of maternal deaths, and lifetime risk by WHO region, 2015

WHO region	MMR	Range of MMR uncertainty		Number of maternal deaths	Lifetime risk of maternal death: 1 in
		Lower estimate	Upper estimate		
Africa	542	506	650	195 000	37
Americas	52	49	59	7 900	920
South-East Asia	164	141	199	61 000	240
Europe	16	15	19	1 800	3 400
Eastern Mediterranean	166	142	216	28 000	170
Western Pacific	41	37	50	9 800	1 400
World	216	207	249	303 000	180

Annex 9. Trends in estimates of maternal mortality ratio (MMR, maternal deaths per 100 000 live births), by WHO region, 1990–2015

WHO region	MMR						% change in MMR between 1990 and 2015	Average annual % change in MMR between 1990 and 2015
	1990	1995	2000	2005	2010	2015		
Africa	965	914	840	712	620	542	44	2.3
Americas	102	89	76	67	62	52	49	2.7
South-East Asia	525	438	352	268	206	164	69	4.7
Europe	44	42	33	26	19	16	64	4.0
Eastern Mediterranean	362	340	304	250	199	166	54	3.1
Western Pacific	114	89	75	63	50	41	64	4.1
World	385	369	341	288	246	216	44	2.3

Annex 10. Estimates of maternal mortality ratio (MMR, maternal deaths per 100 000 live births), number of maternal deaths, and lifetime risk by UNICEF region, 2015

Region	MMR	Range of MMR uncertainty		Number of maternal deaths	Lifetime risk of maternal death: 1 in
		Lower estimate	Upper estimate		
Sub-Saharan Africa	546	511	652	201 000	36
Eastern and Southern Africa	417	387	512	70 000	51
West and Central Africa	679	599	849	127 000	27
Middle East and North Africa	110	95	137	12 000	280
South Asia	182	157	223	66 000	200
East Asia and the Pacific	62	56	76	18 000	880
Latin America and Caribbean	68	64	77	7 300	670
Central and Eastern Europe and the Commonwealth of Independent States	25	22	30	1 500	2 000
Least developed countries	436	207	514	135 000	52
World	216	207	249	303 000	180

Annex 11. Trends in estimates of maternal mortality ratio (MMR, maternal deaths per 100 000 live births), by UNICEF region, 1990–2015

UNICEF region	MMR						% change in MMR between 1990 and 2015	Average annual % change in MMR between 1990 and 2015
	1990	1995	2000	2005	2010	2015		
Sub-Saharan Africa	987	928	846	717	624	546	45	2.4
Eastern and Southern Africa	926	858	755	636	509	417	55	3.2
West and Central Africa	1070	1020	956	814	749	679	37	1.8
Middle East and North Africa	221	198	170	145	122	110	50	2.8
South Asia	558	476	388	296	228	182	67	4.5
East Asia and the Pacific	165	134	118	98	78	62	62	3.9
Latin America and Caribbean	135	117	99	88	81	68	49	2.8
Central and Eastern Europe and the Commonwealth of Independent States	69	71	56	43	29	25	64	4.2
Least developed countries	903	832	732	614	519	436	52	2.9
World	385	369	341	288	246	216	44	2.3

Annex 12. Estimates of maternal mortality ratio (MMR, maternal deaths per 100 000 live births), number of maternal deaths, and lifetime risk by UNFPA region, 2015

UNFPA region	MMR	Range of MMR uncertainty		Number of maternal deaths	Lifetime risk of maternal death: 1 in:
		Lower estimate	Upper estimate		
Arab States	162	138	212	15 000	170
Asia and the Pacific	127	114	151	84 000	350
Eastern and Southern Africa	407	377	501	66 000	52
Eastern Europe and Central Asia	25	22	30	1 490	2 000
Latin America and the Caribbean	68	64	77	7 290	670
West and Central Africa	679	599	849	127 000	27
Non-UNFPA list	9	9	10	1 200	6 300
World	216	207	249	303 000	180

Annex 13. Trends in estimates of maternal mortality ratio (MMR, maternal deaths per 100 000 live births), by UNFPA region, 1990–2015

UNFPA region	MMR						% change in MMR between 1990 and 2015	Average annual % change in MMR between 1990 and 2015
	1990	1995	2000	2005	2010	2015		
Arab States	306	285	250	216	181	162	47	2.5
Asia and the Pacific	353	316	271	209	160	127	64	4.1
Eastern and Southern Africa	918	848	746	627	500	407	56	3.3
Eastern Europe and Central Asia	70	71	56	44	29	25	64	4.2
Latin America and the Caribbean	135	117	99	88	81	68	49	2.8
West and Central Africa	1070	1020	956	814	749	679	37	1.8
Non-UNFPA list	14	13	11	11	10	9	36	1.6
World	385	369	341	288	246	216	44	2.3

Annex 14. 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, 2015

World Bank Group region and income group	MMR	Range of MMR uncertainty		Number of maternal deaths	Lifetime risk of maternal death: 1 in:
		Lower estimate	Upper estimate		
Low income	495	468	586	113 000	41
Middle income	185	170	221	188 000	220
Lower middle income	253	229	305	169 000	130
Upper middle income	55	47	73	19 000	970
Low and middle income	242	232	279	300 000	150
East Asia and Pacific	63	57	77	18000	860
Europe and Central Asia	25	22	30	1000	1900
Latin America and the Caribbean	69	65	79	6200	670
Middle East and North Africa	90	78	116	7800	350
South Asia	182	157	223	66000	200
Sub-Saharan Africa	547	512	653	201000	36
High income	17	16	19	2800	3300
World	216	207	249	303 000	180

Annex 15. Trends in estimates of maternal mortality ratio (MMR, maternal deaths per 100 000 live births), by World Bank Group region and income group, 1990–2015

World Bank Group region and income group	MMR						% change in MMR between 1990 and 2015	Average annual % change in MMR between 1990 and 2015
	1990	1995	2000	2005	2010	2015		
Low income	1020	944	839	705	593	495	51	2.9
Middle income	356	330	299	248	210	185	48	2.6
Lower middle income	532	470	411	337	287	253	52	3.0
Upper middle income	117	101	88	75	64	55	53	3.0
Low and middle income	435	416	383	324	276	242	44	2.3
East Asia and Pacific	168	137	120	100	79	63	63	3.9
Europe and Central Asia	71	67	55	43	29	25	65	4.3
Latin America and the Caribbean	138	120	101	90	83	69	50	2.8
Middle East and North Africa	181	152	125	110	99	90	50	2.8
South Asia	558	476	388	296	228	182	67	4.5
Sub-Saharan Africa	987	928	846	717	625	547	45	2.4
High income	27	26	22	20	19	17	37	1.9
World	385	369	341	288	246	216	44	2.3

Annex 16. Estimates of maternal mortality ratio (MMR, maternal deaths per 100 000 live births), number of maternal deaths, and lifetime risk by UNPD region, 2015

UNPD region	MMR	Range of MMR uncertainty		Number of maternal deaths	Lifetime risk of maternal death: 1 in:
		Lower estimate	Upper estimate		
Africa	495	464	590	204 000	42
Sub-Saharan Africa	555	518	664	197 000	35
Asia	119	108	141	90 000	370
Europe	13	11	15	1 000	4 800
Latin America and the Caribbean	67	64	77	7 300	670
Northern America	13	11	15	580	4 100
Oceania	82	44	163	530	510
More Developed Regions	12	11	14	1 700	4 900
Less Developed Regions	238	157	210	302 000	150
Least developed countries	436	418	514	135 000	52
Less developed regions, excluding least developed countries	174	157	210	167 000	230
World	216	207	249	303 000	180

Annex 17. Trends in estimates of maternal mortality ratio (MMR, maternal deaths per 100 000 live births), by UNPD region, 1990–2015

Region	MMR						% change in MMR between 1990 and 2015	Average annual % change in MMR between 1990 and 2015
	1990	1995	2000	2005	2010	2015		
Africa	870	834	770	654	565	495	43	2.3
Sub-Saharan Africa	996	939	858	728	635	555	44	2.3
Asia	329	293	251	195	149	119	64	4.1
Europe	31	30	21	17	14	13	58	3.6
Latin America and the Caribbean	135	117	99	88	81	67	50	2.8
Northern America	11	11	12	13	14	13	–18	–0.6
Oceania	159	138	134	108	91	82	48	2.7
More Developed Regions	23	22	17	15	13	12	48	2.6
Less Developed Regions	430	409	377	319	272	238	45	2.4
Least developed countries	903	832	732	614	519	436	52	2.9
Less developed regions, excluding least developed countries	328	303	276	230	196	174	47	2.5
World	385	369	341	288	246	216	44	2.3

Annex 18. Trends in estimates of maternal mortality ratio (MMR, maternal deaths per 100 000 live births), by United Nations Millennium Development Goal region (indicated in bold) and other grouping, 1990–2015

MDG region	MMR						% change in MMR between 1990 and 2015	Average annual % change in MMR between 1990 and 2015
	1990	1995	2000	2005	2010	2015		
World	385	369	341	288	246	216	44	2.3
Developed regions[a]	23	22	17	15	13	12	48	2.6
Developing regions	430	409	377	319	273	239	44	2.4
Africa	870	834	770	654	565	495	43	2.3
Northern Africa[b]	171	141	113	95	82	70	59	3.6
Sub-Saharan Africa	987	928	846	717	624	546	45	2.4
Eastern Africa[c]	995	906	790	659	521	424	57	3.4
Middle Africa[d]	958	978	911	799	748	650	32	1.6
Southern Africa[e]	161	115	144	171	189	167	–4	–0.2
Western Africa[f]	1120	1050	974	812	734	675	40	2.0
Asia	341	303	259	201	154	123	64	4.1
Eastern Asia[g]	95	71	59	48	36	27	72	5.0
Eastern Asia excluding China	51	51	68	57	52	43	16	0.7
Southern Asia[h]	538	461	377	288	221	176	67	4.5
Southern Asia excluding India	495	438	384	306	235	180	64	4.1
South-eastern Asia[i]	320	241	201	166	136	110	66	4.3
Western Asia[j]	160	141	122	110	96	91	43	2.2
Caucasus and Central Asia[k]	69	68	50	46	37	33	52	3.0
Latin America and the Caribbean	135	117	99	88	81	67	50	2.8
Latin America[l]	124	107	91	80	74	60	52	2.9

MDG region	MMR						% change in MMR between 1990 and 2015	Average annual % change in MMR between 1990 and 2015
	1990	1995	2000	2005	2010	2015		
Caribbean[m]	276	257	214	198	180	175	37	1.8
Oceania[n]	391	320	292	239	206	187	52	3.0

[a] Albania, Australia, Austria, Belarus, Belgium, Bosnia and Herzegovina, Bulgaria, Canada, Croatia, Cyprus, Czech Republic, Denmark, Estonia, Finland, France, Germany, Greece, Hungary, Iceland, Ireland, Israel, Italy, Japan, Latvia, Lithuania, Luxembourg, Malta, Montenegro, Netherlands, New Zealand, Norway, Poland, Portugal, Republic of Moldova, Romania, Russian Federation, Serbia, Slovakia, Slovenia, Spain, Sweden, Switzerland, the former Yugoslav Republic of Macedonia, Ukraine, United Kingdom, United States of America.

[b] Algeria, Egypt, Libya, Morocco, Tunisia.

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

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

[e] Botswana, Lesotho, Namibia, South Africa, Swaziland.

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

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

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

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

[j] Bahrain, Iraq, Jordan, Kuwait, Lebanon, Occupied Palestinian Territory, Oman, Qatar, Saudi Arabia, Syrian Arab Republic, Turkey, United Arab Emirates, Yemen.

[k] Armenia, Azerbaijan, Georgia, Kazakhstan, Kyrgyzstan, Tajikistan, Turkmenistan, Uzbekistan.

[l] Argentina, Belize, Bolivia (Plurinational State of), Brazil, Chile, Colombia, Costa Rica, Ecuador, El Salvador, Guatemala, Guyana, Honduras, Mexico, Nicaragua, Panama, Paraguay, Peru, Suriname, Uruguay, Venezuela (Bolivarian Republic of).

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

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

Annex 19. Trends in estimates of maternal mortality ratio (MMR, maternal deaths per 100 000 live births), by country, 1990–2015

Country[a]	MMR[b]						% change in MMR between 1990 and 2015[c]	Average annual % change in MMR between 1990 and 2015	Range of uncertainty on annual % change in MMR (80% UI)		Progress towards MDG 5A[d]
	1990	1995	2000	2005	2010	2015			Lower estimate	Upper estimate	
Afghanistan	1340	1270	1100	821	584	396	70.4	4.9	3.0	6.4	Making progress
Albania	71	53	43	30	30	29	59.2	3.7	1.6	6.2	NA
Algeria	216	192	170	148	147	140	35.2	1.8	–0.8	3.5	No progress
Angola	1160	1150	924	705	561	477	58.9	3.5	1.5	5.5	Making progress
Argentina	72	63	60	58	58	52	27.8	1.3	0.3	2.0	NA
Armenia	58	50	40	40	33	25	56.9	3.3	2.4	4.2	NA
Australia	8	8	9	7	6	6	25.0	1.3	0.1	2.0	NA
Austria	8	6	5	5	4	4	50.0	2.9	2.0	4.2	NA
Azerbaijan	64	86	48	34	27	25	60.9	3.8	2.3	5.4	NA
Bahamas	46	49	61	74	85	80	–73.9	–2.2	–4.4	–0.1	NA
Bahrain	26	22	21	20	16	15	42.3	2.1	0.7	3.2	NA
Bangladesh	569	479	399	319	242	176	69.1	4.7	2.5	6.1	Making progress
Barbados	58	49	48	40	33	27	53.4	3.0	1.8	4.8	NA
Belarus	33	33	26	13	5	4	87.9	8.1	6.4	9.6	NA
Belgium	9	10	9	8	8	7	22.2	0.8	–0.8	1.9	NA
Belize	54	55	53	52	37	28	48.1	2.7	1.6	4.0	NA
Benin	576	550	572	502	446	405	29.7	1.4	–0.6	2.8	No progress
Bhutan	945	636	423	308	204	148	84.3	7.4	5.0	9.1	Achieved
Bolivia (Plurinational State of)	425	390	334	305	253	206	51.5	2.9	0.5	4.5	Insufficient progress
Bosnia and Herzegovina	28	22	17	14	13	11	60.7	3.6	2.1	5.4	NA
Botswana	243	238	311	276	169	129	46.9	2.5	0.1	4.2	Insufficient progress
Brazil	104	84	66	67	65	44	57.7	3.5	2.5	4.5	Making progress
Brunei Darussalam	35	33	31	30	27	23	34.3	1.8	0.3	3.7	NA
Bulgaria	25	24	21	15	11	11	56.0	3.3	2.0	4.6	NA
Burkina Faso	727	636	547	468	417	371	49.0	2.7	1.3	4.4	Insufficient progress
Burundi	1220	1210	954	863	808	712	41.6	2.2	0.6	3.7	Insufficient progress
Cabo Verde	256	150	83	54	51	42	83.6	7.2	5.2	9.2	Achieved
Cambodia	1020	730	484	315	202	161	84.2	7.4	5.6	8.9	Achieved
Cameroon	728	749	750	729	676	596	18.1	0.8	–1.0	2.0	No progress
Canada[e]	7	9	9	9	8	7	0.0	0.3	–0.9	1.6	NA

Country[a]	MMR[b]						% change in MMR between 1990 and 2015[c]	Average annual % change in MMR between 1990 and 2015	Range of uncertainty on annual % change in MMR (80% UI)		Progress towards MDG 5A[d]
	1990	1995	2000	2005	2010	2015			Lower estimate	Upper estimate	
Central African Republic	1290	1300	1200	1060	909	882	31.6	1.5	–0.4	3.4	No progress
Chad	1450	1430	1370	1170	1040	856	41.0	2.1	0.2	3.7	Insufficient progress
Chile	57	41	31	27	26	22	61.4	3.8	3.0	4.7	NA
China	97	72	58	48	35	27	72.2	5.2	4.2	6.3	NA
Colombia	118	105	97	80	72	64	45.8	2.4	1.0	3.3	Insufficient progress
Comoros	635	563	499	436	388	335	47.2	2.6	1.0	4.2	Insufficient progress
Congo	603	634	653	596	509	442	26.7	1.2	–0.3	2.7	No progress
Costa Rica	43	44	38	31	29	25	41.9	2.2	1.5	3.1	NA
Côte d'Ivoire	745	711	671	742	717	645	13.4	0.6	–0.7	1.9	No progress
Croatia	10	12	11	11	10	8	20.0	0.6	–0.8	1.9	NA
Cuba	58	55	43	41	44	39	32.8	1.6	0.7	2.5	NA
Cyprus	16	17	15	12	8	7	56.3	3.3	1.7	5.4	NA
Czech Republic	14	10	7	6	5	4	71.4	4.8	3.3	6.4	NA
Democratic People's Republic of Korea	75	81	128	105	97	82	–9.3	–0.4	–2.3	1.6	NA
Democratic Republic of the Congo	879	914	874	787	794	693	21.2	1.0	–1.1	2.4	No progress
Denmark	11	11	9	8	7	6	38.8	2.0	0.6	2.9	NA
Djibouti	517	452	401	341	275	229	55.7	3.3	1.4	5.1	Making progress
Dominican Republic	198	198	79	64	75	92	53.5	3.1	1.3	4.7	Making progress
Ecuador	185	131	103	74	75	64	65.4	4.3	3.6	5.0	Making progress
Egypt	106	83	63	52	40	33	68.9	4.7	3.8	5.9	Making progress
El Salvador	157	118	84	68	59	54	65.5	4.3	3.0	5.7	Making progress
Equatorial Guinea	1310	1050	702	483	379	342	73.9	5.4	3.6	7.0	Making progress
Eritrea	1590	1100	733	619	579	501	68.5	4.6	3.0	6.0	Making progress
Estonia	42	43	26	15	8	9	78.6	6.1	4.3	7.9	NA
Ethiopia	1250	1080	897	743	523	353	71.8	5.0	2.7	6.5	Making progress
Fiji	63	51	42	39	34	30	52.2	3.0	1.6	5.0	NA
Finland	6	5	5	4	3	3	50.0	3.3	2.1	5.1	NA
France	15	15	12	10	9	8	46.7	2.2	1.2	3.4	NA
Gabon	422	405	405	370	322	291	31.0	1.5	–0.5	2.9	No progress
Gambia	1030	977	887	807	753	706	31.5	1.5	–0.4	2.9	No progress
Georgia	34	35	37	37	40	36	–5.9	–0.2	–1.4	1.0	NA

Country[a]	MMR[b]						% change in MMR between 1990 and 2015[c]	Average annual % change in MMR between 1990 and 2015	Range of uncertainty on annual % change in MMR (80% UI)		Progress towards MDG 5A[d]
	1990	1995	2000	2005	2010	2015			Lower estimate	Upper estimate	
Germany	11	9	8	7	7	6	45.5	2.3	1.5	3.2	NA
Ghana	634	532	467	376	325	319	49.7	2.7	1.3	4.4	Insufficient progress
Greece	5	4	4	3	3	3	40.0	1.8	0.6	3.3	NA
Grenada	41	37	29	25	27	27	34.1	1.7	–0.4	3.0	NA
Guatemala	205	173	178	120	109	88	57.1	3.4	2.8	4.0	Making progress
Guinea	1040	964	976	831	720	679	34.7	1.7	0.2	2.9	Insufficient progress
Guinea-Bissau	907	780	800	714	570	549	39.5	2.0	0.2	3.8	Insufficient progress
Guyana	171	205	210	232	241	229	–33.9	–1.2	–2.6	–0.3	No progress
Haiti	625	544	505	459	389	359	42.6	2.2	–0.2	3.8	No progress
Honduras	272	166	133	150	155	129	52.6	3.0	2.0	4.1	Making progress
Hungary	24	20	15	14	15	17	29.2	1.5	0.2	2.7	NA
Iceland	7	6	5	4	4	3	57.1	2.6	1.1	4.8	NA
India	556	471	374	280	215	174	68.7	4.6	3.5	5.7	Making progress
Indonesia	446	326	265	212	165	126	71.7	5.0	3.4	6.3	Making progress
Iran (Islamic Republic of)	123	80	51	34	27	25	79.7	6.4	5.3	7.8	Achieved
Iraq	107	87	63	54	51	50	53.3	3.1	1.5	5.2	Making progress
Ireland	11	10	9	8	7	8	27.3	1.5	–0.1	2.4	NA
Israel	11	10	8	7	6	5	54.5	3.0	2.1	3.9	NA
Italy	8	7	5	4	4	4	50.0	3.0	1.8	4.4	NA
Jamaica	79	81	89	92	93	89	–12.7	–0.4	–1.9	0.8	NA
Japan	14	11	10	7	6	5	64.3	3.6	2.6	4.8	NA
Jordan	110	93	77	62	59	58	47.3	2.6	1.2	4.1	Insufficient progress
Kazakhstan	78	92	65	44	20	12	84.6	7.5	6.5	8.5	NA
Kenya	687	698	759	728	605	510	25.8	1.2	–0.5	2.8	No progress
Kiribati	234	207	166	135	109	90	61.5	3.8	2.0	6.0	Making progress
Kuwait	7	9	7	6	5	4	42.9	2.0	0.4	3.0	NA
Kyrgyzstan	80	92	74	85	84	76	5.0	0.2	–0.9	1.3	NA
Lao People's Democratic Republic	905	695	546	418	294	197	78.2	6.1	3.9	7.7	Achieved
Latvia	48	54	30	22	19	18	62.5	3.9	2.3	5.4	NA
Lebanon	74	54	42	27	19	15	79.7	6.4	4.6	7.8	NA
Lesotho	629	525	649	746	587	487	22.5	1.0	–1.9	2.9	No progress
Liberia	1500	1800	1270	1020	811	725	51.7	2.9	0.8	4.2	Insufficient progress
Libya	39	25	17	11	9	9	76.9	5.7	2.8	8.8	NA

Country[a]	MMR[b]						% change in MMR between 1990 and 2015[c]	Average annual % change in MMR between 1990 and 2015	Range of uncertainty on annual % change in MMR (80% UI)		Progress towards MDG 5A[d]
	1990	1995	2000	2005	2010	2015			Lower estimate	Upper estimate	
Lithuania	29	28	16	12	9	10	65.5	4.3	2.8	5.8	NA
Luxembourg	12	13	13	13	11	10	16.7	0.8	–1.6	2.6	NA
Madagascar	778	644	536	508	436	353	54.6	3.2	1.8	4.5	Making progress
Malawi	957	953	890	648	629	634	33.8	1.6	–0.7	3.3	No progress
Malaysia	79	68	58	52	48	40	49.4	2.7	0.8	3.9	NA
Maldives	677	340	163	101	87	68	90.0	9.2	6.2	11.6	Achieved
Mali	1010	911	834	714	630	587	41.9	2.2	0.6	3.2	Insufficient progress
Malta	13	14	15	13	11	9	30.8	1.6	–0.9	3.3	NA
Mauritania	859	824	813	750	723	602	29.9	1.4	–1.2	3.2	No progress
Mauritius	81	60	40	39	59	53	34.6	1.6	0.1	3.1	NA
Mexico	90	85	77	54	45	38	57.8	3.4	3.0	3.9	NA
Micronesia (Federated States of)	183	166	153	134	115	100	45.4	2.4	0.4	4.4	Insufficient progress
Mongolia	186	205	161	95	63	44	76.3	5.8	4.4	7.1	Achieved
Montenegro	10	12	11	9	8	7	30.0	1.3	–0.5	3.9	NA
Morocco	317	257	221	190	153	121	61.8	3.8	2.7	5.1	Making progress
Mozambique	1390	1150	915	762	619	489	64.8	4.2	2.5	5.5	Making progress
Myanmar	453	376	308	248	205	178	60.7	3.7	1.6	5.3	Making progress
Namibia	338	320	352	390	319	265	21.6	1.0	–1.3	3.1	No progress
Nepal	901	660	548	444	349	258	71.4	5.0	2.6	6.8	Making progress
Netherlands	12	13	14	11	8	7	41.7	2.0	1.1	3.3	NA
New Zealand	18	15	12	14	13	11	38.9	1.9	0.8	2.9	NA
Nicaragua	173	212	202	190	166	150	13.3	0.6	–0.7	1.9	No progress
Niger	873	828	794	723	657	553	36.7	1.8	0.4	3.0	Insufficient progress
Nigeria	1350	1250	1170	946	867	814	39.7	2.0	–0.2	3.3	No progress
Norway	7	7	7	7	6	5	28.6	1.5	0.3	2.5	NA
Occupied Palestinian Territoryf	118	96	72	62	54	45	61.9	3.8	1.8	5.8	Making progress
Oman	30	20	20	20	18	17	43.2	2.3	0.6	3.8	NA
Pakistan	431	363	306	249	211	178	58.7	3.5	1.8	5.1	Making progress
Panama	102	94	82	87	101	94	7.8	0.3	–1.0	1.4	No progress
Papua New Guinea	470	377	342	277	238	215	54.3	3.1	1.1	5.3	Insufficient progress
Paraguay	150	147	158	159	139	132	12.0	0.5	–0.7	1.6	No progress
Peru	251	206	140	114	92	68	72.9	5.2	4.2	6.7	Making progress

Country[a]	MMR[b]						% change in MMR between 1990 and 2015[c]	Average annual % change in MMR between 1990 and 2015	Range of uncertainty on annual % change in MMR (80% UI)		Progress towards MDG 5A[d]
	1990	1995	2000	2005	2010	2015			Lower estimate	Upper estimate	
Philippines	152	122	124	127	129	114	25.0	1.1	–0.8	2.4	No progress
Poland	17	13	8	6	4	3	82.4	6.8	5.4	8.2	NA
Portugal	17	15	13	12	11	10	41.2	2.1	1.1	2.9	NA
Puerto Rico	26	25	22	19	16	14	46.2	2.4	1.5	3.9	NA
Qatar	29	28	24	21	16	13	55.2	3.3	0.8	4.9	NA
Republic of Korea	21	19	16	14	15	11	47.6	2.6	1.8	3.5	NA
Republic of Moldova	51	66	49	39	34	23	54.9	3.2	2.3	4.2	NA
Romania	124	77	51	33	30	31	75.0	5.5	4.0	6.9	Making progress
Russian Federation	63	82	57	42	29	25	60.3	3.8	2.5	5.1	NA
Rwanda	1300	1260	1020	567	381	290	77.7	6.0	4.5	7.5	Achieved
Saint Lucia	45	43	54	67	54	48	–6.7	–0.2	–2.1	1.6	NA
Saint Vincent and the Grenadines	58	81	74	50	50	45	22.4	1.1	–0.5	2.4	NA
Samoa	156	119	93	77	64	51	67.3	4.4	2.4	6.3	Making progress
Sao Tome and Principe	330	263	222	181	162	156	52.7	3.0	1.2	5.4	Making progress
Saudi Arabia	46	33	23	18	14	12	73.9	5.5	3.7	7.5	NA
Senegal	540	509	488	427	375	315	41.7	2.2	0.7	3.6	Insufficient progress
Serbia	14	15	17	15	16	17	–21.4	–0.8	–2.8	0.9	NA
Sierra Leone	2630	2900	2650	1990	1630	1360	48.3	2.6	0.5	4.0	Insufficient progress
Singapore	12	13	18	16	11	10	16.7	0.8	–1.4	2.9	NA
Slovakia	11	9	8	7	6	6	45.5	2.8	1.8	4.0	NA
Slovenia	12	12	12	11	9	9	25.0	1.2	–1.0	2.6	NA
Solomon Islands	364	273	214	164	136	114	68.7	4.6	3.1	6.4	Making progress
Somalia	1210	1190	1080	939	820	732	39.5	2.0	0.3	3.9	Insufficient progress
South Africa	108	62	85	112	154	138	–27.8	–1.0	–2.5	0.6	No progress
South Sudan	1730	1530	1310	1090	876	789	54.4	3.1	1.4	4.7	Making progress
Spain	6	6	5	5	5	5	16.7	1.0	–0.1	1.8	NA
Sri Lanka	75	70	57	43	35	30	60.0	3.6	2.6	4.5	NA
Sudan	744	648	544	440	349	311	58.2	3.5	2.0	5.4	Making progress
Suriname	127	177	259	223	169	155	–22.0	–0.8	–2.4	0.8	No progress
Swaziland	635	537	586	595	436	389	38.7	2.0	–0.1	3.4	No progress
Sweden	8	6	5	5	4	4	50.0	2.5	1.2	3.3	NA
Switzerland	8	8	7	7	6	5	37.5	1.8	0.3	2.8	NA
Syrian Arab Republic	123	89	73	58	49	68	44.7	2.4	0.3	3.9	Insufficient progress

Country[a]	MMR[b]						% change in MMR between 1990 and 2015[c]	Average annual % change in MMR between 1990 and 2015	Range of uncertainty on annual % change in MMR (80% UI)		Progress towards MDG 5A[d]
	1990	1995	2000	2005	2010	2015			Lower estimate	Upper estimate	
Tajikistan	107	129	68	46	35	32	70.1	4.8	2.9	7.0	Making progress
Thailand	40	23	25	26	23	20	50.0	2.7	0.8	4.3	NA
The former Yugoslav Republic of Macedonia	14	13	12	10	8	8	42.9	2.4	1.2	4.1	NA
Timor-Leste	1080	897	694	506	317	215	80.1	6.5	4.8	8.0	Achieved
Togo	568	563	491	427	393	368	35.2	1.7	0.5	3.2	Insufficient progress
Tonga	75	100	97	114	130	124	–65.3	–2.0	–4.0	0.0	NA
Trinidad and Tobago	90	77	62	62	65	63	30.0	1.5	0.5	2.5	NA
Tunisia	131	112	84	74	67	62	52.7	3.0	1.4	4.3	Making progress
Turkey	97	86	79	57	23	16	83.5	7.2	5.2	9.1	NA
Turkmenistan	82	74	59	53	46	42	48.8	2.7	0.4	5.8	NA
Uganda	687	684	620	504	420	343	50.1	2.8	1.3	4.1	Making progress
Ukraine	46	52	34	30	26	24	47.8	2.6	1.4	3.7	NA
United Arab Emirates	17	12	8	6	6	6	64.7	4.1	2.2	6.8	NA
United Kingdom	10	11	12	12	10	9	10.0	0.4	–0.3	1.2	NA
United Republic of Tanzania	997	961	842	687	514	398	60.1	3.7	2.2	5.0	Making progress
United States of America	12	12	12	13	14	14	–16.7	–0.6	–1.4	0.1	NA
Uruguay	37	36	31	26	19	15	59.5	3.7	2.4	5.1	NA
Uzbekistan	54	32	34	42	39	36	33.3	1.6	–0.8	4.0	NA
Vanuatu	225	184	144	116	94	78	65.3	4.2	2.3	6.2	Making progress
Venezuela	94	90	90	93	99	95	–1.1	–0.1	–1.3	0.9	NA
Viet Nam	139	107	81	61	58	54	61.2	3.8	1.6	5.2	Making progress
Yemen	547	498	440	428	416	385	29.6	1.4	–0.8	3.0	No progress
Zambia	577	596	541	372	262	224	61.2	3.8	2.6	5.2	Making progress
Zimbabwe	440	449	590	629	446	443	–0.7	0.0	–1.4	0.9	No progress

MDG: Millennium Development Goal; NA: data not available; 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.

[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] Percentage change in MMR is based on rounded numbers.

[d] Progress towards MDG 5A (i.e. to reduce MMR by 75% between 1990 and 2015) was assessed for the 95 countries with an MMR higher than 100 in 1990. See section 4.1 and Box 5 for additional details in the full report: World Health Organization (WHO), United Nations Children's Fund (UNICEF), United Nations Population Fund (UNFPA), World Bank Group, United Nations Population Division (UNPD). Trends in maternal mortality: 1990 to 2015. Geneva: WHO; 2015 (available from: http://www.who.int/reproductivehealth/publications/monitoring/maternal-mortality-2015/en/).

[e] Vital registration data were available for analysis only up to 2011. Recent hospital surveillance data for Canada (excluding Quebec) indicate a decline of maternal deaths per 100 000 deliveries from 8.8 in 2007/2008–2008/2009 to 5.1 in 2011/2012; some 98% of deliveries in Canada occur in hospitals.

[f] Refers to a territory.

For more information, please contact:
Department of Reproductive Health and Research
World Health Organization
Avenue Appia 20, CH-1211 Geneva 27, Switzerland
Email: reproductivehealth@who.int
http://www.who.int/reproductivehealth