Trends in
Maternal Mortality: 1990 to 2010

WHO, UNICEF, UNFPA and The World Bank estimates

World Health Organization

unicef

UNFPA

The World Bank

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Contents

TABLES

ANNEXES AND APPENDICES

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Abbreviations

AIHW	Australian Institute of Health and Welfare
CEMD	Confidential Enquiry into Maternal Deaths
CEMACH	Confidential Enquiry into Maternal and Child Health
CMACE	Centre for Maternal and Child Enquiries
DHS	Demographic and Health Surveys
GDP	gross domestic product per capita based on purchasing power parity conversion
GFR	gross 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*
IHME	Institute of Health Metrics and Evaluation
MDG	Millennium Development Goal
MICS4	Multiple Indicator Cluster Surveys – Round 4
MMEIG	Maternal Mortality Inter-Agency Group
MMR	maternal mortality ratio
MMRate	maternal mortality rate
PM	the proportion of maternal deaths among deaths of women of reproductive age
PMMRC	Perinatal and Maternal Mortality Review Committee (New Zealand)
PPP	purchasing power parity
RAMOS	reproductive-age mortality study
SAB	presence of a skilled attendant at birth as a proportion of total births
TAG	technical advisory group
UN	United Nations
UNAIDS	Joint United Nations Programme on HIV/AIDS
UNFPA	United Nations Population Fund
UNGASS	United Nations General Assembly Special Session
UNICEF	United Nations Children's Fund
UNPD	United Nations Population Division
USA	United States of America
WHO	World Health Organization

Executive summary

The high-level Commission on Information and Accountability for Women's and Children's Health included among its 10 recommendations one that is specific to improving measurement of maternal (and child) deaths. This recommendation requires that "by 2015, all countries have taken significant steps to establish a system for registration of births, deaths and causes of death, and have well-functioning health information systems that combine data from facilities, administrative sources and surveys". Considering that only a third of countries are characterized as having a complete civil registration system with good attribution of cause of death, it is imperative that countries with incomplete civil registration systems take steps to strengthen those systems. This will tremendously improve the estimation of maternal mortality and monitoring of the Millennium Development Goal (MDG) 5: *Improve maternal health*. The two targets for assessing MDG 5 are reducing the maternal mortality ratio (MMR) by three quarters between 1990 and 2015, and achieving universal access to reproductive health by 2015.

The estimates on maternal mortality presented in this report are the sixth in a series of exercises by the United Nations agencies. For the second time, the Maternal Mortality Estimation Inter-Agency Group (MMEIG), comprising the World Health Organization (WHO), United Nations Children's Fund (UNICEF), United Nations Population Fund (UNFPA), the United Nations Population Division, and The World Bank, together with a team at the University of California at Berkeley, United States of America have been working together to generate internationally comparable MMR estimates. A technical advisory group (TAG) provides independent technical advice to MMEIG. Based on the achievement from the last round, newly available data collected by MMEIG and obtained during country consultation were incorporated, and trend estimates from 1990 to 2010 were generated.

Globally, an estimated 287 000 maternal deaths occurred in 2010, a decline of 47% from levels in 1990. Sub-Saharan Africa (56%) and Southern Asia (29%) accounted for 85% of the global burden (245 000 maternal deaths) in 2010. At the country level, two countries account for a third of global maternal deaths: India at 19% (56 000) and Nigeria at 14% (40 000). The global MMR in 2010 was 210 maternal deaths per 100 000 live births, down from 400 maternal deaths per 100 000 live births in 1990. The MMR in developing regions (240) was 15 times higher than in developed regions (16). Sub-Saharan Africa had the highest MMR at 500 maternal deaths per 100 000 live births, while Eastern Asia had the lowest among MDG developing regions, at 37 maternal deaths per 100 000 live births. The MMRs of the remaining MDG developing regions, in descending order of maternal deaths per 100 000 live births are Southern Asia (220), Oceania (200), South-eastern Asia (150), Latin America and the Caribbean (80), Northern Africa (78), Western Asia (71) and the Caucasus and Central Asia (46).

A total of 40 countries had high MMR (defined as MMR ≥300 maternal deaths per 100 000 live births) in 2010. Of these countries, Chad and Somalia had extremely high MMRs (≥1000 maternal deaths per 100 000 live births) at 1100 and 1000, respectively. The other eight highest MMR countries were: Sierra Leone (890), the Central African Republic (890), Burundi (800), Guinea-Bissau (790), Liberia (770), the Sudan (730), Cameroon (690) and Nigeria (630). Although most sub-Saharan African countries had high MMR, Mauritius (60), Sao Tome and Principe (70) and Cape Verde (79) had low MMR (defined as 20–99 maternal

deaths per 100 000 live births), while Botswana (160), Djibouti (200), Namibia (200), Gabon (230), Equatorial Guinea (240), Eritrea (240) and Madagascar (240) had moderate MMR (defined as 100–299 maternal deaths per 100 000 live births). Only four countries outside the sub-Saharan African region had high MMR: the Lao People's Democratic Republic (470), Afghanistan (460), Haiti (350) and Timor-Leste (300).

Sub-Saharan Africa had the largest proportion of maternal deaths attributed to HIV at 10%, while the Caribbean had the second largest at 6%. Of the 19 000 maternal deaths due to HIV/AIDS worldwide, 17 000 (91%) are in sub-Saharan Africa, while 920 (5%) occurred in Southern Asia. Further, for some countries in Southern Africa, such as Botswana, Lesotho, Namibia, South Africa and Swaziland, MMR increased from the year 1990 to 2000, mainly as a result of the HIV epidemic; in these countries, the MMR is now declining as antiretroviral therapy is becoming increasingly available.

The fifth MDG aims to improve maternal health, with a target of reducing the MMR by 75% between 1990 and 2015. The percentage reductions for the 10 countries that have already achieved MDG 5 by 2010 are: Estonia (95%), Maldives (93%), Belarus (88%), Romania (84%), Bhutan (82%), Equatorial Guinea (81%), Islamic Republic of Iran (81%), Lithuania (78%), Nepal (78%) and Viet Nam (76%). For the remaining countries, one way to gauge progress is to examine whether they have had the expected average annual decline of 5.5% in the MMR from 1990 to 2010. Among countries with MMR ≥100 in 1990, nine countries are "on track", in addition to those mentioned above: Eritrea (6.3%), Oman (6.2%), Egypt (6%), Timor-Leste (6%), Bangladesh (5.9%), China (5.9%), Lao People's Democratic Republic (5.9%), Syrian Arab Republic (5.9%) and Cambodia (5.8%). Further, Poland (6.1%) and Turkey (5.8%) have experienced average annual declines of more than 5.5% but because the MMR in 1990 was <100 maternal deaths per 100 000 live births, they are not categorized as being on track. Moreover, 51 countries are "making progress". Conversely, 14 countries have made "insufficient progress", and 11 are characterized as having made "no progress" and are likely to miss the MDG target unless accelerated interventions are put in place.

1 Introduction

One of the eight Millennium Development Goals (MDGs) that has made some progress, albeit slow, is MDG 5: *Improve maternal health*. The two targets for assessing MDG 5 are reducing the maternal mortality ratio (MMR) by three quarters between 1990 and 2015, and achieving universal access to reproductive health by 2015. The United Nations (UN) Secretary-General has launched the *Global strategy for women's and children's health*, to mobilize commitments by governments, civil society organizations and development partners to accelerate progress towards MDGs 4 and 5 (*1*). Subsequently, the high-level Commission on Information and Accountability for Women's and Children's Health was established to "determine the most effective international institutional arrangements for global reporting, oversight and accountability on women's and children's health" (*2*). Additional political support for reducing maternal mortality, especially in countries with significant HIV epidemics, has come in the form of the *Global plan towards the elimination of new HIV infections among children by 2015 and keeping their mothers alive*, which aims to reduce by half maternal deaths among HIV-positive women (*3*).

An important challenge is that a majority of countries still lack a complete civil registration system with good attribution of cause of death, making it challenging to assess accurately the extent of progress towards MDG 5. Accordingly, 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), the United Nations Population Division (UNPD) and The World Bank, together with a team at the University of California at Berkeley, United States of America, have been working together to generate internationally comparable MMR estimates. A technical advisory group (TAG) provides independent technical advice. The estimates for 2010 presented in this report are the sixth in a series of exercises by the MMEIG to examine the likely global health implications of maternal mortality (*4–8*). The methods, as well as the data sources for the estimation of MMR, have improved over time.

Consultations with countries were carried out following the development of the MMR estimates. The purposes of the consultations were primarily: to give countries the opportunity to review the country estimates, data sources and methods; to obtain additional primary data sources that may not have been previously reported or used; and to build mutual understanding of the strengths and weaknesses of available data and ensure broad ownership of the results. Appendix 17 presents a summary of the 2012 country consultations.

This report presents the global, regional and country estimates of maternal mortality in 2010, as well as trends from 1990 to 2010. Chapter 2 provides an overview of the definitions and approaches for measuring maternal mortality. Chapter 3 is a detailed description of the methodology employed in generating the estimates and a brief comparison with alternative approaches for estimating the global burden of maternal mortality. Chapter 4 presents the estimates and interpretation of the findings. Chapter 5 assesses the progress towards MDG 5 and the importance of improved data quality for estimating maternal mortality. The annexes and appendices present the sources of data for the country estimates, as well as MMR estimates for the different regional groupings for UNFPA, UNICEF, the United Nations Population Division, WHO and The World Bank.

2 Measuring maternal mortality

2.1 Concepts and definitions

In the *International statistical classification of diseases and related health problems*, 10th revision (ICD-10) (*9*), WHO defines maternal death as:

The death of a woman while pregnant or within 42 days of termination of pregnancy, irrespective of the duration and site of the pregnancy, from any cause related to or aggravated by the pregnancy or its management but not from 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 (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 deaths based on medical certificates is unavailable.

Box 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 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 1 year after termination of pregnancy.

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, therefore, usually provide measures of pregnancy-related deaths rather than maternal deaths.

Further, complications of pregnancy or childbirth can lead to death beyond the 6 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), in order to capture delayed maternal deaths occurring between 6 weeks and 1 year postpartum (see Box 1). Some countries, particularly those with more developed civil registration systems, use this definition.

This report aims to achieve a globally consistent set of estimates of maternal deaths in line with the ICD-10 definition of "maternal death", which does not include "late maternal death" nor does it include accidental or incidental deaths classified as "pregnancy related", although the various ways the data are collected do not always allow the above definition to be followed.

2.2 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 attribute correctly cause of death to direct or indirect maternal causes, or to accidental or incidental events, particularly in settings where deliveries mostly 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 (9). 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) were counted as maternal deaths.

In 2012, WHO published the *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 (*10*). 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:

Obstetric causes: such as haemorrhage or hypertensive disorders in pregnancy – these should be identified as direct maternal deaths.

The interaction between HIV and pregnancy: in these cases, there is an aggravating effect of pregnancy on HIV and the interaction between pregnancy 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 are those deaths coded to O98.7 and categorized in Group 7 (non-obstetric complications) in the ICD-MM.

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.[1] These are not considered maternal deaths. In this report, they are referred to as AIDS 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; and (ii) the fertility level, that is, the number of pregnancies or births that are experienced by women of reproductive age. The MMR is defined as the number of maternal deaths in a population divided by the number of live births. 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 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 2). An alternate 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 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 in a given period per 100 000 women of reproductive age during the same time period.

Adult lifetime risk of maternal death

The probability that a 15-year-old women 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.

1 The deaths referred to in this document as AIDS deaths are referred to as AIDS-related deaths in Joint United Nations Programme on HIV/AIDS (UNAIDS) publications. These deaths include the estimated number of deaths related to HIV infection, including deaths that occur before reaching the clinical stage classified as AIDS.

2.3 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 measure accurately the 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 (Appendix 1). A specific example of such an investigation is the Confidential Enquiry into Maternal Deaths (CEMD), a system established in England and Wales in 1928 (*11*). The most recent report of the CEMD (for 2006–2008) identified 60% more maternal deaths than were reported in the routine civil registration system (*12*). 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 (*13*, *14*). Appendix 1 summarizes the results of a literature review for such studies where misclassification on coding in civil registration could be identified.

These studies are diverse, depending on 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 3.3, with a median value of 1.5.

Underreporting of maternal deaths was more common among the following:

- early pregnancy deaths, including those not linked to 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/misclassification include the following:

- 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 3.

Box 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.

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 4.

Box 4
Approaches to measuring maternal mortality

Civil registration system (*14,15*)

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 (*16, 17*)

Demographic and Health Surveys (DHS) and Multiple Indicator Cluster Surveys – Round 4 (MICS) employ 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 period approximately 5 years prior to the survey);
- the analysis is more complicated.

Census (*18*)

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.
- The 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 such characteristics as completeness of death and birth statistics and population structures, in order to arrive at reliable estimates.

Cont'd

Box 4
Approaches to measuring maternal mortality

Reproductive-age mortality studies (RAMOS) (*17, 19*)

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

- Multiple and varied 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.

Verbal autopsy (*6, 20–22*)

This approach is used to assign cause of death through interviews with family or community members, where medical certification of cause of death is not available. 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 methodological 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.
- A 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 diagnosis.

3 Methodology for the 1990–2010 estimates of maternal mortality

The methodology employed in this round was similar to the 2008 exercise but with updated data. A description of sources of data is presented next, followed by the methods used depending on the data source. The main differences between the 2010 and 2008 methodology are highlighted.

3.1 Sources of country data used for the 1990–2010 estimates

By February 2012, the most recent data related to maternal mortality and its covariates were made available during the country consultation process or obtained through databases maintained by UNAIDS, UNICEF, UNPD, WHO, The World Bank and the Center for International Comparisons at the University of Pennsylvania, USA. As the trend from 1990 to 2010 is estimated, the time reference of the data gathered starts from 1985, in order to cover fully the period around 1990. Deaths due to AIDS were obtained from UNAIDS (unpublished tables from the Global Report: UNAIDS Report on the Global AIDS Epidemic 2010. New York, UNAIDS, 2010), deaths among women aged 15–49 years from WHO life tables (*23*); live births from UNPD (*24*); the presence of a skilled attendant at birth as a proportion of total births (SAB) from UNICEF (*25*); and gross domestic product per capita (GDP), measured in purchasing power parity (PPP), from The World Bank (*26*, *27*), Penn World Tables (*28*) and WHO (unpublished data, health systems and information). These agencies revise their estimates on a regular basis, to take into account new data and improved methods.

Maternal mortality data from civil registration were extracted primarily from the WHO mortality database for the years 1985 onwards. For civil registration data using the ICD-9, deaths from chapter X *Complication of pregnancy, childbirth and the puerperium* (codes 630–676) were included. For civil registration data using the ICD-10, the chapter XV *Pregnancy, childbirth and the puerperium* codes (O00–O99) plus maternal tetanus (A34) were extracted in order to match the ICD-9, which does not specifically identify late maternal deaths. To maintain comparability between these data sets, maternal deaths coded as late maternal deaths (ICD-10 O96, O97) were not excluded in the total numbers of maternal deaths. These late maternal deaths accounted globally for only 1–2% of the deaths coded with the ICD-10.

Periodic population-based surveys (such as DHS and MICS4) and censuses have collected information on maternal deaths using the direct sisterhood method or recent deaths in the household, reported in the 12 or 24 months prior to the data collection. Studies have shown that reported deaths in the household surveys may lead to biased estimates of levels of maternal mortality (*29, 30*). Two alternative measures of maternal mortality can typically be extracted from surveys. The first, the MMR, incorporates information on maternal deaths and live births, but tends to be systematically biased downward due to underreporting of maternal deaths. The second, the PM, reflects the ratio of maternal deaths to total female deaths and, because both numerator and denominator tend to be biased in the same direction and to a similar degree, the PM is relatively unbiased. For this reason, the PM is the preferred measure of maternal mortality from surveys when both the MMR and PM are available. The observed PM from sisterhood data was age-standardized by imposing the age distribution of women in the sample population at the time of survey (rather than the age

distribution implied by retrospective reports of sisters' lives). If only the MMR was available from a data source, the MMR was converted into a PM using estimates of all-cause deaths of women aged 15–49 years, derived from WHO life tables, and live births data from UNPD.

A total of 181 countries and territories were included in this study, representing 99.9% of global births; countries and territories with populations under 100 000 have not been included. Maternal mortality data available from countries varied in terms of the source and type, and countries were classified accordingly into three groups (Table 1, and Appendices 2–4). In total, the database of observed MMR and PM includes 3200 country-years of data, of which 2125 country-years are derived from vital registration data, 895 from survey-based sisterhood data, and the remainder from surveillance systems (87), other household surveys (31), censuses (19), RAMOS (16), sample registration systems (14) and other sources (13). Observation intervals refer to 1985 or later. Only national-level studies were included in the database, except those considered deficient in terms of data quality or lacking the necessary information.

Table 1. Sources of maternal mortality data used in generating the 2010 maternal mortality ratio estimates

Group	Source of maternal mortality data	Number of countries/ territories	% of countries/ territories in each category	% of births in 181 countries/ territories covered
A	Civil registration characterized as complete, with good attribution of cause of death[a]	65	35.9	15.7
B	Countries lacking good complete registration data but where other types of data are available	89	49.2	80.3
C	No national data on maternal mortality	27	14.9	4.0
	Total	181	100.0	100.0

[a] Bahamas, Belgium, Iceland, Malta, Saint Lucia and Saint Vincent and the Grenadines (0.1% of global births), the statistical model was used because the scarce number of maternal mortality events resulted in erratic trends.

3.2 Methods used to estimate maternal mortality ratio in 1990–2010 according to data source

Two broad strategies were followed to develop the maternal mortality estimates for 181 countries and territories. For most of the 65 countries with complete and reliable vital registration information, as defined below (Group A), these data were used directly for computing estimates of MMR. For countries in Groups B and C, a two-part multilevel regression model was developed using national-level data from civil registration, surveys, surveillance systems, censuses, RAMOS, sample registration systems and others. For six

countries in Group A (Bahamas, Belgium, Iceland, Malta, Saint Lucia and Saint Vincent, and the Grenadines), which have good-quality data from the civil registration systems but very few numbers of maternal deaths for the target periods (1990, 1995, 2000, 2005 and 2010), the same multilevel regression model was used to generate estimates for all time periods.

The steps taken for estimating maternal mortality with these strategies are summarized below. A technical report of the methodology (*31*), data sets including input data sets for each country by type of data source, and the statistical analysis code used to prepare these estimates, are made available at the WHO web site: www.who.int/reproductivehealth/publications/monitoring/9789241503631 and Maternal Mortality Estimates (MME) Info: www.maternalmortalitydata.org.

Estimation of maternal mortality ratio from civil registration data (Group A)

As noted above, mortality data from vital registration were extracted from the WHO mortality database. These data were used directly to estimate maternal mortality for most of the 65 countries that met the following criteria (see Appendix 2 for the list of countries):

- earliest year of data available is 1995 or before;
- latest year of data available is 2005 or later;
- data were available for more than half of the full range of years, from the first year available to the last year available for each country;
- estimated completeness of death registration of at least 85% for almost all years, with no more than two exceptional years per country;
- deaths coded to ill-defined causes (i.e. R codes in ICD-10) did not exceed 20% for almost all years, with no more than two exceptional years per country.

For countries whose death registration data met the above criteria, MMR estimates were calculated directly after adjusting the numbers of maternal deaths for completeness and misclassification. Completeness refers to the extent of death registration, while misclassification refers to incorrect coding in civil registration systems. In assessing completeness, deaths of unknown age were distributed over the age range in proportion to the number of reported deaths where the age was known. Completeness was then assessed and adjusted by methods described by Mathers and co-workers in 2005 (*32*).To further adjust for underreporting of maternal deaths due to potential misclassification, the numbers of maternal deaths were multiplied by a factor of 1.5, or by a country-specific factor where appropriate evidence is available. The default factor of 1.5 was chosen because it is the median of values ranging from 0.85 to 3.3, derived from studies (Appendix 1).

Having adjusted the numbers of maternal deaths for misclassification and completeness, the maternal mortality estimates were computed as follows: for the target years $t = 1990$, 1995, 2000 and 2005, the number of maternal deaths and the corresponding live births were pooled for the 5-year periods, i.e. years $t - 2$ to $t + 2$ (*34*). The pooled maternal deaths were divided by the pooled live births. Data for the last target period, 2007–2010, were used for the country's direct estimate.

As inputs for the regression model described below, the PM from all civil registration data (including those not in Group A) were computed as follows: for the target years $t = 1990$,

1995, 2000 and 2005, the number of maternal deaths adjusted for misclassification and the corresponding number of deaths of women aged 15 to 49 years were pooled for the 5-year periods, i.e. years $t - 2$ to $t + 2$. The pooled maternal deaths were divided by the pooled deaths of women aged 15–49 years. The last target period 2007–2010 was not used as an input observation in the model because it does not refer to the target year 2010 in the same fashion as previous target years (i.e. 5-year averages).[2]

Estimation of maternal mortality ratio using a statistical model (Groups B and C)

For the majority of countries with limited or no reliable maternal mortality data, the multilevel regression model as developed in the 2008 round of MMR estimates (*4*) was used to derive estimates and projections of maternal mortality with updated information in maternal mortality and in covariates. The model permits an integrated comparison of trends over the full interval, from 1990 to 2010, for 5-year intervals centred on 1990, 1995, 2000, 2005 and 2010. The full model includes two parts: the first part is a multilevel linear regression model that predicts the PM due to direct obstetric causes or to indirect causes other than AIDS for which pregnancy was a substantial aggravating factor; the second part estimates the proportion of AIDS deaths that qualify as indirect maternal deaths out of the total number of AIDS deaths among women aged 15–49 years. The three selected predictor variables in the regression model are: the GDP, the general fertility rate (GFR) and the SAB. These predictor variables were chosen from a broader list of potential predictor variables that fell into three groups: (i) indicators of social and economic development (such as GDP, human development index, and female life expectancy at birth); (ii) process variables (SAB, proportions receiving antenatal care, proportion of institutional births, etc.); and (iii) risk exposure as a function of fertility (GFR or the total fertility rate).

Annual series of predictor variable time series

A complete series of annual estimates for each of the three covariates was obtained or constructed between 1985 and 2010. Weighted averages of annual values were then computed for time intervals corresponding to each of the PM or MMR observations, using an algorithm described elsewhere (*30*).

- *GDP per capita measured in PPP* or equivalent international dollars using 2005 as the base year (derived from The World Bank (*25*, *26*), Penn world tables (*27*) and WHO (unpublished data, health systems and information). Where a complete series was unavailable, annual estimates were obtained using linear interpolation between two observations, and assuming constant values before the first observation and after the last data point.
- *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 (*32*).
- *SAB* data consist of time series derived using data from household surveys and other sources, obtained from a database maintained by UNICEF. Although other sources of SAB data were consulted, only the UNICEF data were used because they adhere strictly to the indicator's definition (*26*). Annual series were estimated by fitting a linear logit (linear

2 For Serbia, in order to take into account the fact that Kosovo is not included in data after 1998, the MMR derived from the PM was used.

log-odds) of SAB with time as the sole covariate; such a model was estimated separately for each country. When a country had only one observation, it was assumed that the SAB proportion remained constant over time. For some countries where the model did not fit well (including the Democratic People's Republic of Korea, Djibouti, Fiji, Guyana, Montenegro, New Zealand, the Republic of Korea and Thailand), annual values were interpolated using the same approach as with the 1-year GDP estimates.

Adjustments to the input data

Prior to being used in the regression model, several adjustment factors were applied to all maternal mortality observations, to take into account the likely underidentification of maternal deaths due to unreported abortion-related deaths or other causes.

Deaths from civil registration were adjusted upwards (by a factor of 1.5 by default as noted earlier) for misclassification and then divided by the number of deaths of women aged 15–49 years to derive the PM. These deaths were adjusted by a country-specific misclassification factor or a default factor of 1.5 (see Appendix 1). Observed deaths from other sources (e.g. surveys, surveillance systems, censuses, RAMOS, sample registration system and others) were adjusted upwards by a factor of 1.1.

In addition, in order to improve the comparability of data inputs in terms of the definition, as some referred to maternal deaths and others to pregnancy-related deaths, pregnancy-related deaths were adjusted down by removing a fraction of deaths that were assumed to be pregnancy related but not maternal (i.e. accidental or incidental deaths). Although the true fraction is typically unknown, an examination of studies that collected information on both maternal and pregnancy-related mortality showed average fractions of about 10–15%. The numbers of pregnancy-related deaths were therefore adjusted downwards by 10% for countries in sub-Saharan Africa and, because data on injury-related deaths suggest higher risks outside of sub-Saharan Africa, maternal deaths were adjusted downwards by 15% (*34*).

Multilevel regression model

Multilevel models offer a statistically well-grounded means of representing country data about levels and trends of maternal mortality within a global model that can also be used for predicting out-of-sample values (*35*). A multilevel linear regression model was used for deriving non-AIDS MMR estimates for 122 countries (all Group B and C countries as well as six Group A countries as explained previously), using available observations of PM from Group A and B countries. A range of models were compared and the preferred model was chosen by assessing the statistical goodness of fit, the within-sample predictive accuracy and the plausibility of estimates out-of-sample. Goodness of fit was measured using deviance scores derived from standard log-likelihood calculations. The predictive accuracy of each model was evaluated by repeatedly holding out a portion of the data, fitting the model to the remaining subset of data and then comparing model predictions against the data that had been held out.

The model was fitted with three selected covariates (GDP, GFR and SAB) and random intercept effects for countries and regions. It can be described as follows:

$$\log(PM_i^{na}) = \beta_0 + \beta_1 \log(GDP_i) + \beta_2 \log(GFR_i) + \beta_3 SAB_i + \alpha^{c}_{j[i]} + \alpha^{R}_{K[i]} + \varepsilon_i$$

where the following are associated with each observation *i*, within country *j*, within region *k*:

PM_i^{na} = proportion of maternal among non-AIDS deaths in women aged 15–49 years

GDP_i = gross domestic product per capita (in 2005 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)

$\alpha^{c}_{j[i]}$ = variable intercept component for country *j*

$\alpha^{R}_{K[i]}$ = variable intercept component for region *k*

ε_i = error.

The model was estimated using the "lme4" package (*36*) in R statistical software (*37*).

Only non-AIDS-related maternal deaths are included in the dependent variable of the regression model, PM^{na}. The adjustment to the PM to remove AIDS deaths by 10% (for countries in sub-Saharan Africa) or 15% (for countries outside of sub-Saharan Africa) as described above, minimizes the influence of the HIV epidemic on observed PM values, by removing AIDS deaths from both the numerator and the denominator.

Weights were not used in the model to adjust for differential uncertainty of observations. However, the weights of civil registration observations were implicitly reduced by a factor of five because these observations were collapsed into 5-year time periods, and each such observation received a weight of one in the regression model. This approach was adopted to avoid giving excessive weight to vital registration data, which tend to come from countries where maternal mortality levels are low. Most other data sources (a single survey, census, special study, etc.) yielded a single observation that also refers to a multiple-year time period; such observations also received a weight of one in the regression model. Some surveys, however, yielded more than one data point for multiple time periods; in such cases all of the various observations were included in the model but with a combined weight of one.

To predict PM using the model, country covariate data and relevant country and regional effects were used. To estimate the multilevel regression model, countries were grouped into regions according to the global categories used by the UN Statistics Division. For countries with data available on maternal mortality, predictions of non-AIDS PM were based on country and regional random effects, whereas for countries with no available data, predictions used regional random effects only.

After a final adjustment to add back the AIDS-related indirect maternal deaths to the PM (see below), the final PM values were 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 estimated from WHO death rates (*23*) and UNPD population estimates (*33*), and *B* is the number of live births from UNPD population estimates (*33*).

Estimation of AIDS-related indirect maternal deaths

For countries with high HIV prevalence, HIV has become a leading cause of death during pregnancy and the postpartum period. There is also some evidence from community studies that HIV-positive women have a higher risk of maternal death, although this may be offset by lower fertility (*38–40*). If HIV is prevalent, then there will also be more AIDS deaths[3] among pregnant women that were incidental to pregnancy. It is thus important to address the issue of incidental and indirect maternal deaths among HIV-positive women, in estimating maternal mortality for these countries.

The dependent variable of the regression model described above includes only direct maternal deaths but excludes all AIDS deaths from "pregnancy-related" observations (even AIDS deaths that could properly be termed "indirect maternal", in the sense that the pregnancy was a substantial aggravating factor for a death caused primarily by HIV infection). Thus, the regression model was used to estimate the number of maternal deaths not primarily due to HIV infection, and then the estimated number of AIDS-related indirect maternal deaths was added back to obtain the total number of maternal deaths (see Appendix 5 for details).

Uncertainty of estimates

In this report, estimates of maternal mortality are presented along with upper and lower limits designed to depict the uncertainty of those estimates. The intervals are the product of a detailed probabilistic evaluation of the uncertainty attributable to the various components of the estimation process. The components of uncertainty can be divided into two groups: variability within the regression model (internal sources) and variability due to assumptions or calculations outside the model (external sources). Estimates of the total uncertainty reflect a combination of these various sources.

The internal component quantifies inferential uncertainty including variability in all elements of the multilevel regression model for deriving best estimates for individual countries (Groups B and C) and stochastic variability of estimates derived for countries with good civil registration data (Group A). Another internal component, predictive uncertainty associated with individual data points, was not included in the evaluation. The external component, on the other hand, includes uncertainty regarding assumptions about key parameters that are inputs into the estimation process (e.g. adjustment factors applied to observed data), as well as uncertainty about data inputs used for calculations that occur outside the regression model (e.g. estimated births, deaths and fraction of AIDS deaths).

For estimates computed directly from civil registration data, the level of uncertainty includes both an external component, i.e. variability due to inputs and assumptions, and an internal component of stochastic uncertainty related to random variation of maternal deaths recorded in civil registration.

3 The deaths referred to in this document as AIDS deaths are AIDS-related deaths in UNAIDS publications. These deaths include the estimated number of deaths related to HIV infection, including deaths that occur before reaching the clinical stage classified as AIDS.

To obtain the uncertainty intervals presented here, simulations of values using probability distributions were performed to depict internal and external components of variability. For the internal component, the regression model was estimated and simulations of parameter coefficients were performed. Using the simulated results, the distribution of the dependent variable was approximated in order to quantify the inferential uncertainty computed using "lme4" in the R Statistical Package (*36*, *37*). For the external component, the probability distribution was assumed after considering a range of plausible alternatives and assessing the sensitivity of final estimates to choices within that range. It is worth noting that the uncertainty due to the external component is relatively small compared to the internal component; thus, the uncertainty due to choices of adjustment factors and unknown parameters appears rather small compared with the variability of observed data points around predictions of the regression model.

Using the distributions of the simulated estimates, 95% uncertainty intervals were derived from the 2.5th and 97.5th percentiles. Further details on estimating uncertainty levels can be found in Wilmoth et al. (2012) (*31*), or on the WHO web site: www.who.int/reproductivehealth/publications/monitoring/9789241503631

3.3 Computation of adult lifetime risk of maternal mortality

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 survival to adulthood. Information presented here includes a synthetic estimate of *adult lifetime risk of maternal mortality*, corresponding to the probability of a 15-year-old woman eventually dying from a maternal cause, assuming she is subjected throughout her lifetime to the age-specific risks of maternal death observed for a given population in a given year.

The adult lifetime risk of maternal mortality can be derived using either the MMR or the MMRate. However, a precise estimate of lifetime risk requires knowledge of how the MMR or the MMRate changes within the reproductive lifespan of women. Although such information is not generally available, it can be assumed that neither the MMR nor the MMRate is constant over the reproductive lifespan. Because this assumption is more realistic for the MMRate than for the MMR, the adult lifetime risk was calculated using the MMRate as shown in Box 5. This formula yields an estimate of the adult lifetime risk that takes into account competing causes of death. The 2010 country estimates of lifetime risk of maternal mortality are shown in Annex 1, while the regional estimates are presented in Table 2 and in Appendices 7, 9, 11, 13 and 15.

Box 5
Formula for estimating adult lifetime risk of maternal mortality

$$\text{Adult lifetime risk of maternal mortality} = \frac{T_{15} - T_{50}}{\ell_{15}} \times \text{MMRate}$$

Where ℓ_{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 ℓ_{15}, T_{15} and T_{50} are life-table quantities for the female population during the period in question.

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 region, 2010

Region	MMR[a]	Range of MMR uncertainty		Number of maternal deaths[a]	Lifetime risk of maternal death,[a] 1 in:
		Lower estimate	Upper estimate		
World	210	170	300	287 000	180
Developed regions[b]	16	14	18	2200	3800
Developing regions	240	190	330	284 000	150
Northern Africa[c]	78	52	120	2800	470
Sub-Saharan Africa[d]	500	400	750	162 000	39
Eastern Asia[e]	37	24	58	6400	1700
Eastern Asia excluding China	45	27	85	400	1500
Southern Asia[f]	220	150	310	83 000	160
Southern Asia excluding India	240	160	380	28 000	140
South-eastern Asia[g]	150	100	220	17 000	290
Western Asia[h]	71	48	110	3500	430
Caucasus and Central Asia[i]	46	37	62	750	850
Latin America and the Caribbean	80	68	99	8800	520
Latin America[j]	72	61	88	7400	580
Caribbean[k]	190	140	290	1400	220
Oceania[l]	200	98	430	520	130

[a] The MMR, number of maternal deaths, and lifetime risk have been rounded according to the following scheme: <100, no rounding; 100–999, rounded to nearest 10; 1000–9999, rounded to nearest 100; and >10 000, rounded to nearest 1000.

[b] 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 of Great Britain and Northern Ireland, United States of America.

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

[d] Angola, Benin, Botswana, Burkina Faso, Burundi, Cameroon, Cape 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, Seychelles, Sierra Leone, Somalia, South Africa, Sudan, Swaziland, Togo, Uganda, United Republic of Tanzania, Zambia, Zimbabwe.

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

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

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

[h] Bahrain, Iraq, Jordan, Kuwait, Lebanon, Oman, Qatar, Saudi Arabia, Syrian Arab Republic, Turkey, United Arab Emirates, West Bank and Gaza Strip (territory), Yemen.

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

[j] 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).

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

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

3.4 Global and regional estimates

Global and regional maternal mortality estimates (according to the MDG, UNFPA, UNICEF, UNPD, WHO and World Bank 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 adult 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.

3.5 Differences between the 2010 methodology and 2008

Generally, the methods used for the 2010 maternal mortality estimation were similar to those for 2008 (*4*). The main differences were related to data availability and countries included in the exercise:

- The 2010 round draws from an expanding global database of empirical observations consisting of 3200 country-years of data compared to 2842 country-years of data in the 2008 round, a 13% increase.
- Estimates of total female deaths in the reproductive age group for WHO Member States were revised from those used in the 2008 revision (*4*) to take into account new evidence and data on levels of adult mortality. This is a regular updating process carried out by WHO, with revised estimates published annually in the World Health Statistics. These revisions have resulted in revisions to MMRs estimated for a number of Member States, in some cases for countries where the survey data available for maternal deaths have not changed.
- The total number of countries included in this exercise was 181 (as compared to 172 in the previous round). The population cut-off for countries included in this round was 100 000. For the previous round it was 250 000.

3.6 Similarities and differences to other maternal mortality estimates

The Institute of Health Metrics and Evaluation (IHME) at the University of Washington in Seattle, USA, published a set of maternal mortality estimates to track MDG 5 trends in 2010 for 181 countries (*41*), and an update of those estimates in 2011 for 187 countries (*42*). The period of assessment for the latter is from 1990 to 2011, with country and regional/income group estimates published for 1990, 2000 and 2011. There are similarities and differences in the 2011 IHME study and this analysis by MMEIG in the sources of data, treatment of AIDS deaths, adjustments for completeness and misclassification, model specifications and predictor variables, and uncertainty analysis as follows.

- ***Data sources:***
  - Both MMEIG and IHME compile and assess the quality of all available empirical data – mainly civil registration, household survey, census and surveillance system – relevant to the estimation of maternal mortality. Common data sources are also used, including 2010 estimates from UNAIDS and population denominators and live births from UNPD's World Population Prospects 2010. However, the MMEIG estimates used only nationally representative data, while the IHME study used subnational data in some cases.

  - Regarding the coding of maternal deaths data from civil registration, MMEIG includes the full Chapter 15 of the ICD-10, and clarifies the HIV status of female deaths using O98.7 as well as codes B20–24, whereas IHME uses ICD-0 codes O00–O95 and O98–O99 (indirect obstetric causes), and all HIV deaths occurring among pregnant women.

- ***Predictor variables:***
  - MMEIG uses GDP, GFR and SAB, while IHME includes total fertility rate, GDP, HIV prevalence, neonatal mortality rate and female education. The sources of data for these covariates may differ.
- ***Addressing AIDS deaths:***
  - Both MMEIG and IHME applied a separate model for estimating AIDS-related indirect maternal deaths but the parameter assumptions differed. MMEIG includes only half of the AIDS deaths during pregnancy in the estimation ($u = 0.5$, see Appendix 5 for details) but IHME includes all of them ($u = 1$).
- ***Number of female deaths at ages 15–49 years:***
  - MMEIG derives these from life tables created using the modified logit model life-table system (*23*), whereas IHME derives levels of adult female mortality from life tables created by IHME (*43*). Both entities estimate PM as the dependent variable and apply the estimated PM to the total number of deaths in women of reproductive age. Thus, with the same PM estimates, there may still be differences in the estimation of number of deaths of women of reproductive age.
- ***Model specification and predictor variables:***
  - MMEIG used a two-part parametric model while IHME used a statistical model that is an ensemble of individual component models.
  - Both MMEIG and IHME explore possible statistical models before deciding on a best-performing statistical model to prepare mortality estimates. Both MMEIG and IHME use out-of-sample predictive measures for most of these evaluations.
- ***Process for collecting and reviewing new data***
  - MMEIG engaged countries in a formal country consultation process. During the consultation period, WHO interacts with government-nominated focal persons who review input data sources, methods for estimation and the preliminary estimates. Further, additional data are obtained and mutual understanding of the strengths and weaknesses of available data is enhanced. IHME held two regional workshops with countries, reviewed published reports, and had correspondence with some countries to gather new data observations.

4 Analysis and interpretation of the 2010 estimates

Globally, maternal mortality has fallen by 47% between 1990 and 2010. This means that the overall aim of MDG 5 (a 75% reduction) is very unlikely to be achieved by 2015, unless there are remarkable further reductions from 2011 to 2015. Nevertheless, apart from Southern Africa, substantial reductions in maternal deaths have been achieved in all regions of the world.

4.1 Maternal mortality estimates for 2010

This chapter presents the estimates of MMR and related indicators, including the number of maternal deaths and the lifetime risk of maternal death. Table 2 displays these estimates, the range of uncertainty of MMR estimates, the number of maternal deaths and the lifetime risk by the MDG regional groupings (*44*), while Annex 1 shows the same information by country. The range of uncertainty suggests that although a point estimate is presented, the true MMR could be somewhere between the lower and upper uncertainty limits.

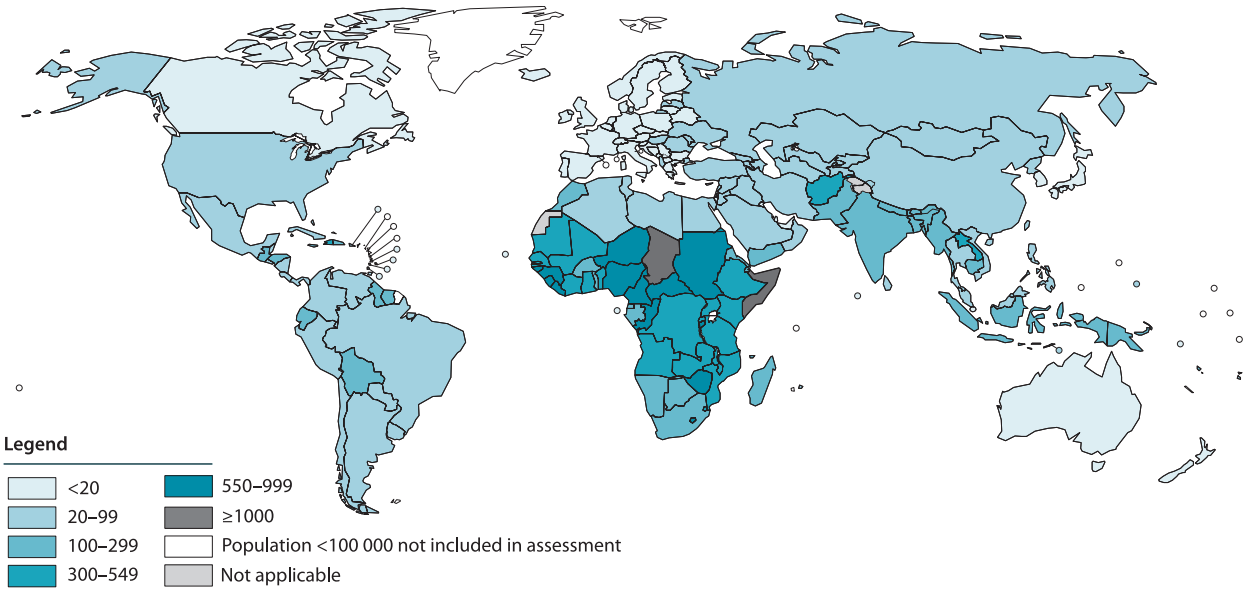
Globally, there were an estimated 287 000 maternal deaths in 2010, yielding a MMR of 210 maternal deaths per 100 000 live births among the 181 countries that were covered in this study. The range of uncertainty indicates that the true total number of maternal deaths could plausibly be as low as 230 000 and as high as 398 000. Similarly, the global MMR plausibly ranges from 170 to 300 maternal deaths per 100 000 live births. Further, the global adult lifetime risk of maternal mortality (i.e. the probability that a 15-year-old woman will die eventually from a maternal cause) is 1 in 180.

Developing countries account for 99% (284 000) of the global maternal deaths (Table 2), the majority of which are in sub-Saharan Africa (162 000) and Southern Asia (83 000). These two regions accounted for 85% of global burden, with sub-Saharan Africa alone accounting for 56%. The MMR in developing regions (240) was 15 times higher than in developed regions (16) (see Figure 1). Sub-Saharan Africa had the highest MMR at 500 maternal deaths per 100 000 live births, while Eastern Asia had the lowest among MDG developing regions at 37 maternal deaths per 100 000 live births. The MMR of the remaining MDG developing regions in descending order are Southern Asia (220), Oceania (200), South-eastern Asia (150), Latin America and the Caribbean (80), Northern Africa (78), Western Asia (71), and Caucasus and Central Asia (46). The adult lifetime risk of maternal mortality in women from sub-Saharan Africa was the highest at 1 in 39, in contrast to 1 in 130 in Oceania, 1 in 160 in Southern Asia, 1 in 290 in South-eastern Asia and 1 in 3800 among women in developed countries.

At the country level, two countries account for one third of global maternal deaths: India at 19% (56 000) of all global maternal deaths, followed by Nigeria at 14% (40 000). Additionally, the following seven countries account for 3% to 5% of global maternal deaths each: Democratic Republic of the Congo (15 000), Pakistan (12 000), Sudan (10 000), Indonesia (9600), Ethiopia (9000), United Republic of Tanzania (8500) and Bangladesh (7200). Together with Afghanistan (6400), these 10 countries comprised 60% of the global maternal deaths reported in 2010.

MMR is considered to be high if it is ≥300 maternal deaths per 100 000 live births and extremely high if it is ≥1000 maternal deaths per 100 000 live births. As shown in Annexes 1 and 2 and in Figure 1, 40 countries had high MMR in 2010. Of these countries, only Chad and Somalia had extremely high MMRs at 1100 and 1000, respectively. The other eight highest

Figure 1. Map with countries by category according to their maternal mortality ratio (MMR, death per 100 000 live births), 2010



The boundaries and names shown and the designations used on this map do not imply the expression of any opinion whatsoever on the part of the WHO concerning the legal status of any country, territory, city or area or of its authorities, or concerning the delimitation of its frontiers or boundaries. Dotted lines and dashed lines on maps represent approximate border lines for which there may not yet be full agreement.

MMR countries were: Central African Republic (890), Sierra Leone (890), Burundi (800), Guinea-Bissau (790), Liberia (770), Sudan (730), Cameroon (690) and Nigeria (630). Although most sub-Saharan African countries had high MMR, Mauritius (60), Sao Tome and Principe (70) and Cape Verde (79) had low MMR (defined as 20–99 maternal deaths per 100 000 live births), while Botswana (160), Djibouti (200), Namibia (200), Gabon (230), Equatorial Guinea (240), Eritrea (240) and Madagascar (240) had moderate MMR (defined as 100–299 maternal deaths per 100 000 live births). Only four countries outside the sub-Saharan African region had high MMR: Lao People's Democratic Republic (470), Afghanistan (460), Haiti (350), and Timor-Leste (300).

Of all the 181 countries and territories covered in this analysis, Chad and Somalia also had the highest adult lifetime risk of maternal mortality at 1 in 15 and 1 in 16, respectively. In sharp contrast, the estimated adult lifetime maternal mortality risks in Greece, Singapore, Estonia, and Italy are more than 1 in 20 000.

Appendices 7, 9, 11, 13 and 15 present the MMR, range of uncertainty, number of maternal deaths and adult lifetime risk for WHO, UNICEF, UNFPA, World Bank and UNPD regions, respectively.

Table 3 shows the number of maternal deaths, MMR and percentage of maternal deaths attributed to HIV by MDG region, while Annex 1 presents percentage of AIDS-related indirect maternal deaths by country for countries with an HIV prevalence ≥ 5.0% (among adults 15–49 years) between 1990 and 2009. Of the estimated 19 000 maternal deaths attributed to HIV worldwide, 17 000 (89%) are in sub-Saharan Africa. Southern Asia is a distant second with <1000 deaths. A large proportion of maternal deaths are attributed to HIV in both sub-Saharan Africa (10.4%) and the Caribbean (5.9%). Without HIV, the MMR

for sub-Saharan Africa would be 450 maternal deaths per 100 000 live births instead of 500. Eighteen countries have a proportion of maternal deaths attributed to HIV of 20% or more: Swaziland (67.3), South Africa (59.9), Namibia (59.4), Botswana (56.4), Lesotho (41.5), Zimbabwe (38.8), Ukraine (31.7), Zambia (30.7), Malawi (29.3), Mozambique (26.8), the Bahamas (26), Gabon (25.8), Uganda (25), Thailand (21.9), Equatorial Guinea (21.8), Kenya (20.2), the Russian Federation (20.2) and Djibouti (20). Of these 18 countries, 14 are in sub-Saharan Africa, with the exception of Ukraine, the Bahamas, Thailand and the Russian Federation.

Table 3. Estimates of maternal mortality ratio (MMR, maternal deaths per 100 000 live births), number of maternal deaths and maternal deaths attributed to HIV/AIDS, by United Nations Millennium Development Goal region, 2010

Region	MMR[a]	Number of maternal deaths[a]	HIV-attributed MMR	Number of AIDS-related indirect maternal deaths attributed to HIV[a]	Percentage of AIDS-related indirect maternal deaths[a]
World	210	287 000	14	19 000	6.5
Developed regions[b]	16	2200	2	220	10.0
Developing regions	240	284 000	15	18 000	6.4
Northern Africa[c]	78	2800	0	9	0.3
Sub-Saharan Africa[d]	500	162 000	52	17 000	10.4
Eastern Asia[e]	37	6400	0	69	1.1
Eastern Asia excluding China	45	400	0	0	0.1
Southern Asia[f]	220	83 000	2	920	1.1
Southern Asia excluding India	240	28 000	1	68	0.2
South-eastern Asia[g]	150	17 000	2	230	1.4
Western Asia[h]	71	3500	0	1	0
Caucasus and Central Asia[i]	46	750	1	9	1.2
Latin America and the Caribbean	80	8800	2	260	3.0
Latin America[j]	72	7400	2	180	2.4
Caribbean[k]	190	1400	11	84	5.9
Oceania[l]	200	520	5	14	2.6

[a] The MMR have been rounded according to the following scheme: <100, no rounding; 100–999, rounded to nearest 10; and >1000, rounded to nearest 100. The numbers of maternal deaths have been rounded as follows: <100, no rounding; 100–999, rounded to nearest 10; 1000–9999, rounded to nearest 100; and >10 000, rounded to nearest 1000. Percentages have been calculated on unrounded estimates.

[b–l] See footnotes in Table 2.

4.2 Trends in MMR from 1990 to 2010

Globally, the total number of maternal deaths decreased by from 543 000 in 1990 to 287 000 in 2010 (Table 4). Likewise, global MMR declined from 400 maternal deaths per 100 000 live births in 1990 to 210 in 2010. The latter represents an average annual decline of 3.1%. All MDG regions experienced a decline in MMR between 1990 and 2010, with the highest reduction in the 20-year period in Eastern Asia (69%) followed by Northern Africa (66%), Southern Asia (64%), Sub-Saharan Africa (41%), Latin America and the Caribbean (41%), Oceania (38%) and finally Caucasus and Central Asia (35%). Although the latter region experienced the lowest decline, its already low MMR of 71 maternal deaths per 100 000 live births in 1990 made it more challenging to achieve the same decline as another region with a higher 1990 MMR value. 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. Like Table 4, Appendices 6, 8, 10, 12, 14 and 16 present similar tables by MDG (and other grouping) for WHO, UNICEF, UNFPA, World Bank and UNPD regions, respectively. Despite an initial increase in maternal mortality in regions highly affected by HIV (Southern Africa) between 1990 and 2005, there is evidence of declines between 2005 and 2010 (see Appendix 6).

Of the 181 countries and territories that were covered in this analysis, between 1990 and 2010, 155 countries experienced total MMR percentage declines, while 26 countries had an increase (Annex 2). Notably, 10 countries have already experienced 75% reduction in MMR between 1990 and 2010, much earlier than the target year of 2015. These countries are: Estonia (95%), Maldives (93%), Belarus (88%), Romania (84%), Bhutan (82%), Equatorial Guinea (81%), Iran (Islamic Republic of) (81%), Lithuania (78%), Nepal (78%) and Viet Nam (76%). Further, for some countries in Southern Africa such as Botswana, Lesotho, Namibia, South Africa and Swaziland, MMR increased from the year 1990 to 2000, mainly as result of the HIV epidemic, and then the MMR started to decline when antiretroviral therapy became more available (*45*).

Table 4. Comparison of 1990 and 2010 maternal mortality ratio (MMR, maternal deaths per 100 000 live births) and number of maternal deaths, by United Nations Millennium Development Goal region

Region	1990[a]		2010[a]		% change in MMR between 1990 and 2010[a]	Average annual % change in MMR between 1990 and 2010[a]
	MMR	Maternal deaths	MMR	Maternal deaths		
World	400	543 000	210	287 000	–47	–3.1
Developed regions[b]	26	4000	16	2200	–39	–2.5
Developing regions	440	539 000	240	284 000	–47	–3.1
Northern Africa[c]	230	8500	78	2800	–66	–5.3
Sub-Saharan Africa[d]	850	192 000	500	162 000	–41	–2.6
Eastern Asia[e]	120	30 000	37	6400	–69	–5.7
Eastern Asia excluding China	53	610	45	400	–15	–0.8
Southern Asia[f]	590	233 000	220	83 000	–64	–4.9
Southern Asia excluding India	590	70 000	240	28 000	–59	–4.4
South-eastern Asia[g]	410	50 000	150	17 000	–63	–4.9
Western Asia[h]	170	7000	71	3500	–57	–4.2
Caucasus and Central Asia[i]	71	1400	46	750	–35	–2.1
Latin America and the Caribbean	140	16 000	80	8800	–41	–2.6
Latin America[j]	130	14 000	72	7400	–43	–2.8
Caribbean[k]	280	2300	190	1400	–30	–1.8
Oceania[l]	320	630	200	520	–38	–2.4

[a] MMR estimates have been rounded according to the following scheme: <100, no rounding; 100–999, rounded to nearest 10; and >1000, rounded to nearest 100. The numbers of maternal deaths have been rounded as follows: <1000, rounded to nearest 10; 1000–9999, rounded to nearest 100; and >10 000, rounded to nearest 1000. Negative values for % change indicate a decreasing MMR from 1990 to 2010, while positive values indicate an increasing MMR. Percentages have been calculated using unrounded estimates.

[b–l] See footnotes in Table 2.

4.3 Issues to consider in using the 2010 maternal mortality estimates

As explained in Section 3.5, the methodology employed for the 2010 round of estimates is similar to that for the 2008 estimates. However, given that the global database used in 2010 increased in country-years of data by 13% and the number of countries increased from 172 to 181, the 2010 estimates should be used for the interpretation of trends in MMR from 1990 to 2010, rather than extrapolating estimates from the 2008 values.

5 Is the fifth Millennium Development Goal achievable?

The fifth MDG aims to improve maternal health, with a target of reducing the MMR by 75% between 1990 and 2015. As noted in Section 4.2, the 10 countries that had achieved MDG 5 by 2010 are: Estonia (95%), Maldives (93%), Belarus (88%), Romania (84%), Bhutan (82%), Equatorial Guinea (81%), Islamic Republic of Iran (81%), Lithuania (78%), Nepal (78%) and Viet Nam (76%). For the remaining countries, one way to gauge progress is to examine if they have had the expected average annual decline of 5.5% in the MMR from 1990 to 2010. Accordingly, countries with MMR ≥100 in 1990 have been categorized as "on track", "making progress", "insufficient progress" or "no progress" in improving maternal health. A country is considered to be "on track" if the average annual percentage decline between 1990 and 2010 is 5.5% or more. If the annual decline in MMR is between 2% and 5.5%, the country is considered to be "making progress". Countries with an annual decline of less than 2% are considered to have made "insufficient progress" and countries with rising MMR have been categorized as making "no progress". Given the difficulty in reducing MMR further for countries that had low MMR (<100) in 1990, those countries have not been categorized.

Worldwide, an average annual decline of 3.1% was observed, which indicates "making progress". However, the breakdown by MDG region gives a different picture (Table 4). Eastern Asia is on track with 5.7% average annual decline, while Northern Africa nearly made the target at 5.3%. The Caucasus and Central Asia region had the lowest average annual decline but the MMR was already low at 71 maternal deaths per 100 000 live births.

In addition to the 10 countries mentioned above that have already achieved MDG 5, nine countries are "on track", meaning they have shown an average annual percentage decline of 5.5% or more in MMR between 1990 and 2010 (Annex 2). These nine countries are: Eritrea (6.3%), Oman (6.2%), Egypt (6.0%), Timor-Leste (6.0%), Bangladesh (5.9%), China (5.9%), Lao People's Democratic Republic (5.9%), the Syrian Arab Republic (5.9%) and Cambodia (5.8%). Further, Poland (6.1%) and Turkey (5.8%) have experienced an average annual decline of more than 5.5% but because the MMR in 1990 was <100, they are not categorized as being on track. Moreover, 51 countries are "making progress". In contrast, 14 countries have made "insufficient progress", and 11 are characterized as having made "no progress" and are likely to miss the MDG target unless accelerated interventions are put in place.

5.1 Potential reasons for declining maternal mortality

Several factors could account for global, regional and country decline in maternal mortality between 1990 and 2010. In addition to improvement in health systems, other factors outside the health sector such as increased female education and increased physical accessibility to health facilities could be contributory factors. Given different country contexts, it is not possible to fully explain why some countries had steeper declines than others, or why some made no progress.

The Millennium Development Goals report of 2011 indicates that the other MDG 5 indicators have also shown some improvement in the past two decades (see Figure 2). The proportion of deliveries attended by skilled health personnel in developing regions rose from 55% in 1990 to 65% in 2009 (*46*). Similarly, the proportion of women who were attended to by skilled health-care personnel at least once during pregnancy increased from 64% to 81%, while the

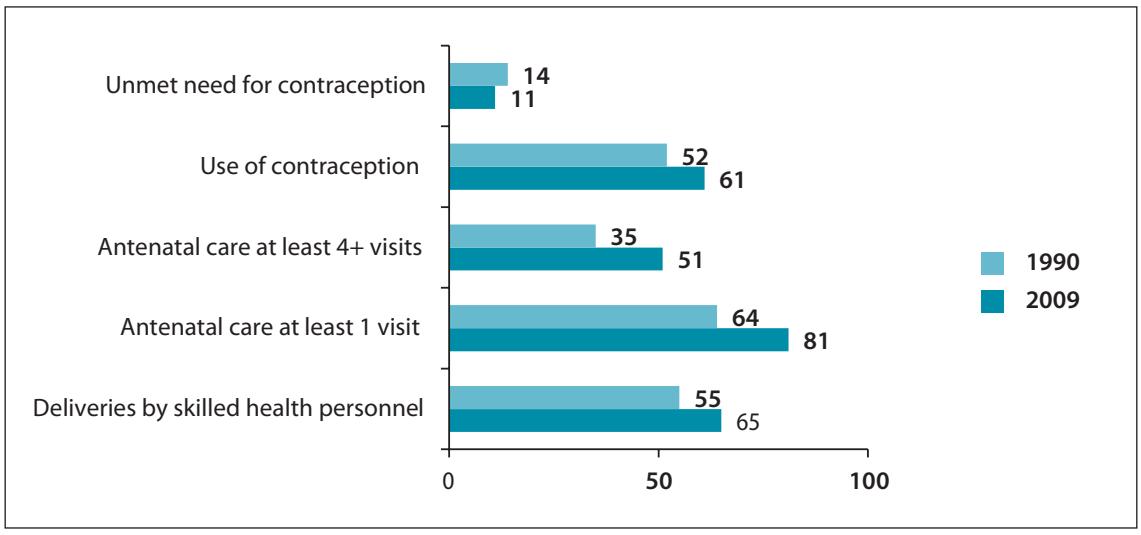
proportion of women aged 15–49 years who use any method of contraception also increased from 52% to 61%. More recently, the rapid roll-out of antiretroviral therapy in sub-Saharan Africa to HIV-positive women, from <10% in 2000 to 55% in 2010, improves the chances of surviving the additional demands of pregnancy in immunocompromised health (*45*). Improvement in the coverage of these health-care interventions over the past two decades may have contributed to improved outcomes. However, disparities exist, within and across regions. For example, Eastern Asia, which experienced the greatest MMR decline, has a contraceptive prevalence rate of 84% as opposed to only 22% in sub-Saharan Africa, the region with one of the lowest MMR declines. Efforts to improve maternal health and reduce maternal deaths should be focused on addressing inequalities across and within countries.

As noted earlier regarding MMR trends, five countries (Botswana, Lesotho, Namibia, South Africa and Swaziland) in Southern Africa had increased MMR from 1990 to 2000, partly as attributed to the HIV epidemic. The increased availability of antiretroviral therapy in the 2000s has contributed to the recent decrease in MMR in some of these countries. Indeed, all these five countries have attained the 2001 UN General Assembly Special Session (UNGASS) goal of providing antiretroviral drugs for preventing mother-to-child transmission to 80% of pregnant women living with HIV (*45*).

In September 2010, the UN Secretary-General launched the *Global strategy for women's and children's health*, to mobilize commitments by governments, civil society organizations and development partners to accelerate progress towards MDGs 4 and 5 (*1*). The strategy identifies the following elements as key pillars to achieve MDGs 4 and 5: (i) country-led health plans; (ii) a comprehensive, integrated package of essential interventions and services; (iii) integrated care; (iv) health-systems strengthening; (v) health workforce capacity building; and (vi) coordinated research and innovation.

Following the launch of the global strategy, a high-level Commission on Information and Accountability for Women's and Children's Health was established to "determine the most effective international institutional arrangements for global reporting, oversight and accountability on women's and children's health". The commission launched its report in

Figure 2. Reproductive health indicators in developing regions, 1990 and 2009 (percentage)



For contraception, data were available for 1990–2008.
Source: United Nations. *The Millennium Development Goals report 2011*, (*46*).

May 2011 and included, among its 10 recommendations one that is specific to improving measurement of maternal (and child) deaths. This recommendation requires that "by 2015, all countries have taken significant steps to establish a system for registration of births, deaths and causes of death, and have well-functioning health information systems that combine data from facilities, administrative sources and surveys" (*2*). Considering that only a third of countries are characterized as having complete civil registration system with good attribution of cause of death (Appendix 2), it is imperative that countries with deficient civil registration data take steps to strengthen them. This will tremendously improve the estimation of maternal mortality and monitoring of MDG 5.

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Annex 1. 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, 2010

Country	MMR[a]	Range of MMR uncertainty		Number of maternal deaths[a]	Lifetime risk of maternal death[a]: 1 in:	% of AIDS-related indirect maternal deaths[b]	PM[c] (%)	Group[d]
		Lower estimate	Upper estimate					
Afghanistan	460	250	850	6400	32		27.5	B
Albania	27	17	43	11	2200		1.1	B
Algeria	97	50	180	690	430		5.8	B
Angola	450	210	1000	3600	39		13.1	C
Argentina	77	67	87	530	560		5.2	A
Armenia	30	20	46	14	1700		1.5	B
Australia	7	4	12	19	8100		0.6	A
Austria	4	3	7	3	18 200		0.3	A
Azerbaijan	43	27	67	79	1000		2.0	B
Bahamas	47	28	75	2	1100		1.3	A
Bahrain	20	12	32	5	1800		2.1	B
Bangladesh	240	140	410	7200	170		5.7	B
Barbados	51	19	140	2	1300		1.3	A
Belarus	4	3	5	5	16 300		0.1	A
Belgium	8	5	12	9	7500		0.5	A
Belize	53	33	88	4	610		3.2	A
Benin	350	220	600	1200	53		13.3	B
Bhutan	180	95	320	27	210		5.6	B
Bolivia (Plurinational State of)	190	130	290	510	140		9.2	B
Bosnia and Herzegovina	8	5	14	2	11 400		0.3	B
Botswana	160	81	260	75	220	56.4	2.4	B
Brazil	56	36	85	1700	910		2.5	B
Brunei Darussalam	24	15	40	2	1900		1.9	B
Bulgaria	11	8	15	9	5900		0.4	A
Burkina Faso	300	190	520	2100	55		15.6	B
Burundi	800	370	1800	2200	31	6.7	13.1	C
Cambodia	250	160	390	790	150		6.5	B
Cameroon	690	430	1200	4900	31	10.1	12.5	B
Canada	12	9	16	46	5200		0.8	A
Cape Verde	79	33	190	8	480		4.7	C
Central African Republic	890	530	1700	1400	26	10.9	13.2	B
Chad	1100	640	2000	5300	15		28.0	B
Chile	25	21	29	61	2200		1.9	A
China	37	23	58	6000	1700		1.5	B
Colombia	92	80	100	840	430		6.5	A
Comoros	280	120	680	79	67		13.7	C
Congo	560	320	1100	800	39	8.2	12.4	B
Costa Rica	40	31	50	29	1300		3.2	A

Country	MMR[a]	Range of MMR uncertainty		Number of maternal deaths[a]	Lifetime risk of maternal death[a]: 1 in:	% of AIDS-related indirect maternal deaths[b]	PM[c] (%)	Group[d]
		Lower estimate	Upper estimate					
Côte d'Ivoire	400	260	680	2700	53	17.4	9.4	B
Croatia	17	10	29	7	4100		1.0	A
Cuba	73	60	87	84	1000		2.9	A
Cyprus	10	4	23	<2	6300		1.0	C
Czech Republic	5	4	8	6	12 100		0.4	A
Democratic People's Republic of Korea	81	36	180	280	670		2.5	C
Democratic Republic of the Congo	540	300	1100	15 000	30		18.4	B
Denmark	12	7	23	8	4500		0.8	A
Djibouti	200	100	410	51	140		4.8	C
Dominican Republic	150	100	210	320	240		5.9	B
Ecuador	110	62	180	320	350		6.4	B
Egypt	66	40	100	1200	490		5.2	B
El Salvador	81	55	120	100	490		3.6	B
Equatorial Guinea	240	120	510	61	88	21.8	5.1	C
Eritrea	240	130	460	460	86		15.3	B
Estonia	2	1	4	<2	25 100		0.1	A
Ethiopia	350	210	630	9000	67		12.1	B
Fiji	26	15	48	5	1400		1.1	B
Finland	5	3	8	3	12 200		0.3	A
France	8	7	10	67	6200		0.6	A
Gabon	230	130	390	94	130	25.8	5.2	B
Gambia	360	170	820	230	56		14.4	C
Georgia	67	43	110	35	960		2.1	B
Germany	7	6	9	51	10 600		0.4	A
Ghana	350	210	630	2700	68		11.3	B
Greece	3	2	5	3	25 500		0.2	A
Grenada	24	15	38	<2	1700		1.3	B
Guatemala	120	110	140	550	190		8.7	A
Guinea	610	380	1100	2400	30		19.9	B
Guinea-Bissau	790	370	1900	460	25		18.1	C
Guyana	280	180	430	38	150		5.9	B
Haiti	350	210	610	940	83		10.2	B
Honduras	100	64	160	210	270		6.9	B
Hungary	21	15	31	21	3300		0.8	A
Iceland	5	3	9	<2	8900		0.6	A
India	200	140	310	56 000	170		7.4	B
Indonesia	220	130	350	9600	210		5.5	B
Iran (Islamic Republic of)	21	15	30	270	2400		1.3	B
Iraq	63	34	120	710	310		6.0	B
Ireland	6	3	12	4	8100		0.5	A

Country	MMR[a]	Range of MMR uncertainty		Number of maternal deaths[a]	Lifetime risk of maternal death[a]: 1 in:	% of AIDS-related indirect maternal deaths[b]	PM[c] (%)	Group[d]
		Lower estimate	Upper estimate					
Israel	7	5	10	10	5100		1.2	A
Italy	4	3	5	20	20 300		0.3	A
Jamaica	110	77	170	57	370		4.1	B
Japan	5	5	6	59	13 100		0.4	A
Jordan	63	37	110	96	470		5.5	B
Kazakhstan	51	44	58	170	770		1.6	A
Kenya	360	230	590	5500	55	20.2	10.2	B
Kuwait	14	8	23	6	2900		1.6	A
Kyrgyzstan	71	44	110	91	480		3.3	B
Lao People's Democratic Republic	470	260	840	670	74		11.7	B
Latvia	34	22	55	8	2000		1	A
Lebanon	25	14	45	16	2100		1.4	B
Lesotho	620	370	970	370	53	41.5	4.7	B
Liberia	770	430	1500	1200	24		25.5	B
Libya	58	25	130	83	620		4.2	C
Lithuania	8	5	12	3	9400		0.2	A
Luxembourg	20	4	93	<2	3200		1.5	A
Madagascar	240	160	400	1800	81		17.8	B
Malawi	460	290	710	3000	36	29.3	11.1	B
Malaysia	29	12	64	170	1300		2.4	C
Maldives	60	35	99	3	870		6.1	B
Mali	540	350	930	3800	28		21.7	B
Malta	8	5	14	<2	8900		0.7	A
Mauritania	510	280	990	590	44		17.1	B
Mauritius	60	39	91	10	1000		2.4	A
Mexico	50	44	56	1100	790		3.6	A
Micronesia (Federated States of)	100	44	230	3	290		5.3	C
Mongolia	63	27	140	40	600		3.2	C
Montenegro	8	5	14	<2	7400		0.4	B
Morocco	100	62	170	650	400		7.7	B
Mozambique	490	300	850	4300	43	26.8	7.7	B
Myanmar	200	120	330	1600	250		4.3	B
Namibia	200	100	320	120	160	59.4	3.0	B
Nepal	170	100	290	1200	190		7.9	B
Netherlands	6	4	7	11	10 500		0.4	A
New Zealand	15	9	26	10	3300		1.2	A
Nicaragua	95	54	170	130	350		6.7	B
Niger	590	360	1100	4500	23		31.2	B
Nigeria	630	370	1200	40 000	29		16.1	B
Norway	7	4	12	4	7900		0.6	A
Oman	32	19	51	16	1200		3.0	B

Country	MMR[a]	Range of MMR uncertainty		Number of maternal deaths[a]	Lifetime risk of maternal death[a]: 1 in:	% of AIDS-related indirect maternal deaths[b]	PM[c] (%)	Group[d]
		Lower estimate	Upper estimate					
Pakistan	260	150	500	12000	110		11.4	B
Panama	92	75	110	65	410		6.3	A
Papua New Guinea	230	100	510	480	110		9.2	C
Paraguay	99	60	160	160	310		8.4	B
Peru	67	42	110	400	570		4.3	B
Philippines	99	66	140	2300	300		6.3	B
Poland	5	4	6	19	14 400		0.2	A
Portugal	8	5	11	8	9200		0.4	A
Puerto Rico	20	13	31	10	2800		1.1	B
Qatar	7	3	16	<2	5400		1.4	C
Republic of Korea	16	13	19	76	4800		0.8	A
Republic of Moldova	41	32	55	18	1500		1.2	A
Romania	27	23	32	60	2600		1.1	A
Russian Federation	34	26	42	550	2000		0.7	A
Rwanda	340	200	590	1500	54	3.5	15.2	B
Saint Lucia	35	22	54	<2	1400		2.0	A
Saint Vincent and the Grenadines	48	30	78	<2	940		2.3	A
Samoa	100	47	230	5	260		5.7	C
Sao Tome and Principe	70	38	140	4	330		9.8	B
Saudi Arabia	24	13	45	140	1400		2.0	B
Senegal	370	230	640	1700	54		15.6	B
Serbia	12	9	17	14	4900		0.6	A
Sierra Leone	890	510	1700	2000	23		19.9	B
Singapore	3	2	7	2	25 300		0.3	A
Slovakia	6	4	10	3	12 200		0.3	A
Slovenia	12	5	30	2	5900		0.8	A
Solomon Islands	93	41	220	16	240		9.5	C
Somalia	1000	460	2400	4200	16		30.5	C
South Africa	300	150	500	3200	140	59.9	2.3	B
Spain	6	4	7	27	12 000		0.4	A
Sri Lanka	35	25	49	130	1200		2.4	B
Sudan	730	380	1400	10 000	31		22.7	B
Suriname	130	89	190	13	320		5.2	A
Swaziland	320	160	670	110	95	67.3	3.1	B
Sweden	4	2	7	4	14 100		0.4	A
Switzerland	8	4	15	6	9500		0.6	A
Syrian Arab Republic	70	41	110	330	460		6.7	B
Tajikistan	65	29	150	130	430		5.1	C
Thailand	48	33	70	400	1400		1.0	B
The former Yugoslav Republic of Macedonia	10	3	31	2	6300		0.5	A
Timor-Leste	300	160	560	130	55		30.4	C

Country	MMR[a]	Range of MMR uncertainty		Number of maternal deaths[a]	Lifetime risk of maternal death[a]: 1 in:	% of AIDS-related indirect maternal deaths[b]	PM[c] (%)	Group[d]
		Lower estimate	Upper estimate					
Togo	300	180	530	580	80		8.3	B
Tonga	110	50	260	3	230		5.2	C
Trinidad and Tobago	46	26	84	9	1300		1.6	A
Tunisia	56	29	110	100	860		4.3	B
Turkey	20	13	32	260	2200		1.7	B
Turkmenistan	67	29	150	73	590		2.0	C
Uganda	310	200	500	4700	49	25	9.7	B
Ukraine	32	24	43	160	2200		0.7	A
United Arab Emirates	12	5	27	11	4000		1.3	C
United Kingdom	12	10	14	92	4600		0.9	A
United Republic of Tanzania	460	190	740	8500	38	18	12.2	B
United States of America	21	18	23	880	2400		1.1	A
Uruguay	29	21	39	15	1600		1.7	A
Uzbekistan	28	23	34	160	1400		1.5	A
Vanuatu	110	46	240	8	230		7.0	C
Venezuela (Bolivarian Republic of)	92	78	110	550	410		6.2	A
Viet Nam	59	27	130	860	870		2.6	C
West Bank and Gaza Strip[e]	64	28	150	85	330		7.2	C
Yemen	200	110	370	1900	90		15.7	B
Zambia	440	220	790	2600	37	30.7	9.1	B
Zimbabwe	570	320	920	2200	52	38.8	5.5	B

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.

[a] The MMR and lifetime risk have been rounded according to the following scheme: <100, no rounding; 100–999, rounded to nearest 10; and >1000, rounded to nearest 100. The numbers of maternal deaths have been rounded as follows: <100, no rounding; 100–999, rounded to nearest 10; 1000–9999, rounded to nearest 100; and >10 000, rounded to nearest 1000.

[b] Percentage of AIDS-related maternal deaths are presented only for countries with an HIV prevalence ≥ 5.0% (among adults 15–49 years) between 1990 and 2009.

[c] Proportion of maternal deaths among deaths of women of reproductive age (PM).

[d] Group A indicates country estimates based on good civil registration data; Group B indicates modelled country estimates using available national data; and Group C indicates modelled country estimates where no good-quality national data are available on maternal mortality.

[e] Refers to a territory.

Annex 2. Trends in estimates of maternal mortality ratio (MMR, maternal deaths per 100 000 live births) by 5-year intervals, 1990–2010, by country

Country	MMR[a]					% change in MMR between 1990 and 2010	Average annual % change in MMR between 1990 and 2010[b]	Range of uncertainty on annual % change in MMR		Progress towards improving maternal health[c]
	1990	1995	2000	2005	2010			Lower estimate	Upper estimate	
Afghanistan	1300	1300	1000	710	460	–65	–5.1	–5.7	–4.5	making progress
Albania	48	43	39	31	27	–44	–2.9	–3.6	–2.2	
Algeria	220	180	140	110	97	–56	–4.0	–4.8	–3.4	making progress
Angola	1200	1200	890	650	450	–62	–4.7	–9.5	0.3	making progress
Argentina	71	60	63	69	77	9	0.4	0	0.7	
Armenia	46	47	38	34	30	–35	–2.1	–2.6	–1.7	
Australia	10	13	9	7	7	–24	–1.4	–3.8	1.1	
Austria	10	7	5	5	4	–59	–4.4	–7.1	–1.6	
Azerbaijan	56	81	65	52	43	–23	–1.3	–2.3	–0.3	
Bahamas	52	56	56	47	47	–9	–0.4	–1.3	0.8	
Bahrain	23	21	22	21	20	–13	–0.7	–1.3	–0.2	
Bangladesh	800	560	400	330	240	–70	–5.9	–6.6	–5.3	on track
Barbados	120	39	49	41	51	–56	–4.0	–9.6	1.8	making progress
Belarus	37	28	31	20	4	–88	–10.2	–11.3	–9.1	
Belgium	10	10	9	8	8	–26	–1.5	–1.7	–1.3	
Belize	71	32	100	77	53	–25	–1.4	–4.7	2.2	
Benin	770	660	530	430	350	–55	–3.9	–4.6	–3.3	making progress
Bhutan	1000	670	430	270	180	–82	–8.3	–9.6	–7.0	on track
Bolivia (Plurinational State of)	450	360	280	240	190	–57	–4.1	–4.8	–3.6	making progress

Country	MMR[a]					% change in MMR between 1990 and 2010	Average annual % change in MMR between 1990 and 2010[b]	Range of uncertainty on annual % change in MMR		Progress towards improving maternal health[c]
	1990	1995	2000	2005	2010			Lower estimate	Upper estimate	
Bosnia and Herzegovina	18	14	10	9	8	–56	–4.0	–4.8	–3.2	
Botswana	140	210	350	330	160	14	0.7	–2.3	4.5	no progress
Brazil	120	96	81	67	56	–51	–3.5	–4.1	–3.1	making progress
Brunei Darussalam	29	25	24	25	24	–16	–0.9	–1.6	–0.2	
Bulgaria	24	23	28	13	11	–53	–3.7	–5.3	–2.1	
Burkina Faso	700	560	450	370	300	–57	–4.1	–4.5	–3.9	making progress
Burundi	1100	1100	1000	910	800	–26	–1.5	–6.6	3.8	insufficient progress
Cambodia	830	750	510	340	250	–70	–5.8	–7.1	–4.7	on track
Cameroon	670	720	730	720	690	3	0.2	–0.4	0.9	no progress
Canada	6	7	7	11	12	101	3.6	2.0	5.2	
Cape Verde	200	200	170	110	79	–61	–4.7	–9.8	0.6	making progress
Central African Republic	930	1000	1000	1000	890	–4	–0.2	–0.7	0.5	insufficient progress
Chad	920	1000	1100	1100	1100	15	0.7	0.4	1.0	no progress
Chile	56	40	29	26	25	–56	–4.0	–4.7	–3.3	
China	120	84	61	45	37	–70	–5.9	–6.6	–5.1	on track
Colombia	170	130	130	100	92	–45	–2.9	–3.2	–2.7	making progress
Comoros	440	380	340	310	280	–36	–2.2	–7.4	3.3	making progress
Congo	420	480	540	550	560	33	1.5	1.2	1.7	no progress
Costa Rica	38	45	47	50	40	4	0.2	–1.0	1.4	
Côte d'Ivoire	710	660	590	510	400	–43	–2.8	–3.8	–1.5	making progress
Croatia	8	14	11	14	17	102	3.6	0.4	6.7	

Country	MMR[a]					% change in MMR between 1990 and 2010	Average annual % change in MMR between 1990 and 2010[b]	Range of uncertainty on annual % change in MMR		Progress towards improving maternal health[c]
	1990	1995	2000	2005	2010			Lower estimate	Upper estimate	
Cuba	63	61	63	67	73	16	0.7	0	1.5	
Cyprus	17	17	15	12	10	–42	–2.7	–8.0	3.1	
Czech Republic	15	9	7	7	5	–65	–5.1	–7.1	–3.1	
Democratic People's Republic of Korea	97	140	120	85	81	–16	–0.9	–6.0	4.6	
Democratic Republic of the Congo	930	870	770	660	540	–42	–2.7	–4.0	–1.4	making progress
Denmark	13	19	8	7	12	–3	–0.1	–3.6	3.3	
Djibouti	290	290	290	220	200	–31	–1.9	–6.9	3.3	insufficient progress
Dominican Republic	220	170	130	130	150	–32	–1.9	–2.5	–1.4	insufficient progress
Ecuador	180	150	130	110	110	–42	–2.7	–3.2	–2.3	making progress
Egypt	230	150	100	78	66	–71	–6	–6.9	–5.2	on track
El Salvador	150	130	110	94	81	–46	–3.1	–3.8	–2.4	making progress
Equatorial Guinea	1200	1000	450	270	240	–81	–7.9	–12.8	–2.9	on track
Eritrea	880	550	390	300	240	–73	–6.3	–7.0	–5.6	on track
Estonia	48	46	28	23	2	–95	–14	–16.8	–11.1	
Ethiopia	950	880	700	510	350	–64	–4.9	–5.5	–4.4	making progress
Fiji	32	33	31	29	26	–18	–1.0	–1.4	–0.6	
Finland	7	5	5	6	5	–30	–1.7	–5.1	1.8	
France	13	13	10	8	8	–35	–2.1	–3.0	–1.1	
Gabon	270	260	270	260	230	–15	–0.8	–2.2	1.2	insufficient progress
Gambia	700	650	520	430	360	–50	–3.4	–8.2	2.0	making progress

Country	MMR[a]					% change in MMR between 1990 and 2010	Average annual % change in MMR between 1990 and 2010[b]	Range of uncertainty on annual % change in MMR		Progress towards improving maternal health[c]
	1990	1995	2000	2005	2010			Lower estimate	Upper estimate	
Georgia	63	75	58	61	67	7	0.3	–0.1	0.8	
Germany	13	9	7	7	7	–43	–2.8	–3.6	–1.9	
Ghana	580	590	550	440	350	–40	–2.6	–3.0	–1.9	making progress
Greece	6	2	5	3	3	–55	–3.9	–7.0	–0.6	
Grenada	34	32	27	25	24	–30	–1.8	–2.5	–1.1	
Guatemala	160	160	130	120	120	–27	–1.5	–2.0	–1.1	insufficient progress
Guinea	1200	1100	970	800	610	–50	–3.4	–4.0	–2.9	making progress
Guinea-Bissau	1100	1000	970	890	790	–29	–1.7	–6.9	3.8	insufficient progress
Guyana	180	170	220	280	280	51	2.1	1.4	2.6	no progress
Haiti	620	550	460	410	350	–43	–2.7	–3.3	–2.1	making progress
Honduras	220	180	160	130	100	–52	–3.7	–4.3	–3.1	making progress
Hungary	23	23	10	10	21	–5	–0.3	–2.2	1.7	
Iceland	8	7	7	6	5	–30	–1.8	–2.0	–1.6	
India	600	480	390	280	200	–66	–5.2	–5.7	–4.7	making progress
Indonesia	600	420	340	270	220	–63	–4.9	–5.9	–4.0	making progress
Iran (Islamic Republic of)	120	72	48	30	21	–81	–8.1	–9.1	–7.2	on track
Iraq	89	84	78	74	63	–29	–1.7	–2.5	–0.9	
Ireland	6	4	6	2	6	–12	–0.6	–4.7	3.7	
Israel	12	10	9	7	7	–44	–2.8	–4.8	–0.8	
Italy	10	6	4	5	4	–65	–5.2	–6.7	–3.6	
Jamaica	59	62	83	89	110	92	3.3	2.3	3.9	

Country	MMR[a]					% change in MMR between 1990 and 2010	Average annual % change in MMR between 1990 and 2010[b]	Range of uncertainty on annual % change in MMR		Progress towards improving maternal health[c]
	1990	1995	2000	2005	2010			Lower estimate	Upper estimate	
Japan	12	9	10	7	5	–56	–4.0	–4.6	–3.3	
Jordan	110	88	79	72	63	–42	–2.7	–3.3	–2.2	making progress
Kazakhstan	92	90	70	50	51	–44	–2.9	–3.4	–2.4	
Kenya	400	460	490	450	360	–9	–0.5	–1.4	0.9	insufficient progress
Kuwait	11	10	9	8	14	24	1.1	–3.4	5.5	
Kyrgyzstan	73	98	82	77	71	–3	–0.2	–0.7	0.3	
Lao People's Democratic Republic	1600	1200	870	650	470	–70	–5.9	–6.7	–5.1	on track
Latvia	57	58	43	21	34	–40	–2.5	–4.9	0	
Lebanon	52	46	38	31	25	–52	–3.6	–4.4	–2.9	
Lesotho	520	540	690	720	620	19	0.9	–1.4	4.5	no progress
Liberia	1200	1900	1300	1100	770	–38	–2.4	–2.9	–1.8	making progress
Libya	99	76	67	61	58	–42	–2.7	–7.5	2.9	
Lithuania	34	21	21	11	8	–78	–7.2	–9.6	–5.0	
Luxembourg	6	11	11	17	20	222	6.0	–3.5	17.2	
Madagascar	640	550	400	310	240	–62	–4.7	–5.2	–4.2	making progress
Malawi	1100	1000	840	630	460	–59	–4.4	–5.6	–2.4	making progress
Malaysia	53	44	39	34	29	–45	–3.0	–8.1	2.2	
Maldives	830	390	190	94	60	–93	–12.3	–13.6	–11.2	on track
Mali	1100	930	740	620	540	–51	–3.5	–3.9	–3.2	making progress
Malta	14	13	12	10	8	–42	–2.7	–3.2	–2.2	
Mauritania	760	690	630	560	510	–33	–2.0	–2.6	–1.5	making progress

Country	MMR[a]					% change in MMR between 1990 and 2010	Average annual % change in MMR between 1990 and 2010[b]	Range of uncertainty on annual % change in MMR		Progress towards improving maternal health[c]
	1990	1995	2000	2005	2010			Lower estimate	Upper estimate	
Mauritius	68	66	28	32	60	–12	–0.6	–2.9	1.8	
Mexico	92	85	82	54	50	–45	–3.0	–3.2	–2.8	
Micronesia (Federated States of)	140	130	130	110	100	–28	–1.6	–6.8	4.3	insufficient progress
Mongolia	120	110	96	84	63	–49	–3.4	–8.4	2.2	making progress
Montenegro	8	10	11	9	8	–6	–0.3	–0.5	0	
Morocco	300	230	170	130	100	–65	–5.1	–6.0	–4.3	making progress
Mozambique	910	800	710	630	490	–46	–3.1	–4.4	–1.0	making progress
Myanmar	520	380	300	230	200	–62	–4.8	–5.4	–4.2	making progress
Namibia	200	200	280	310	200	2	0.1	–3.5	4.0	no progress
Nepal	770	550	360	250	170	–78	–7.3	–8.0	–6.7	on track
Netherlands	10	12	13	8	6	–44	–2.9	–4.4	–1.3	
New Zealand	18	13	12	15	15	–15	–0.8	–3.6	2.3	
Nicaragua	170	150	130	110	95	–44	–2.9	–3.5	–2.3	making progress
Niger	1200	1100	870	720	590	–52	–3.6	–3.7	–3.4	making progress
Nigeria	1100	1000	970	820	630	–41	–2.6	–3.0	–2.0	making progress
Norway	9	4	8	9	7	–26	–1.5	–4.5	1.7	
Oman	110	74	51	39	32	–72	–6.2	–7.3	–5.2	on track
Pakistan	490	440	380	310	260	–46	–3	–3.6	–2.5	making progress
Panama	100	110	110	100	92	–9	–0.5	–1.4	0.4	insufficient progress
Papua New Guinea	390	330	310	270	230	–41	–2.6	–7.8	2.5	making progress
Paraguay	120	120	110	110	99	–16	–0.9	–1.3	–0.5	insufficient progress

Country	MMR[a]					% change in MMR between 1990 and 2010	Average annual % change in MMR between 1990 and 2010[b]	Range of uncertainty on annual % change in MMR		Progress towards improving maternal health[c]
	1990	1995	2000	2005	2010			Lower estimate	Upper estimate	
Peru	200	170	120	90	67	–66	–5.2	–6.0	–4.5	making progress
Philippines	170	140	120	110	99	–43	–2.8	–3.1	–2.5	making progress
Poland	17	14	8	5	5	–72	–6.1	–7.2	–5.0	
Portugal	15	10	8	8	8	–48	–3.2	–5.2	–1.1	
Puerto Rico	33	35	26	22	20	–40	–2.5	–2.8	–2.2	
Qatar	15	13	11	9	7	–53	–3.7	–9.1	1.4	
Republic of Korea	18	18	19	17	16	–9	–0.5	–1.2	0.2	
Republic of Moldova	62	60	39	25	41	–33	–2	–3.3	–0.5	
Romania	170	72	52	30	27	–84	–8.8	–9.4	–8.2	on track
Russian Federation	74	72	57	37	34	–55	–3.9	–4.8	–2.7	
Rwanda	910	1000	840	550	340	–63	–4.9	–5.7	–4.0	making progress
Saint Lucia	64	55	46	40	35	–46	–3	–3.8	–2.3	
Saint Vincent and the Grenadines	59	87	88	64	48	–18	–1	–1.6	–0.5	
Samoa	260	180	150	120	100	–60	–4.5	–9.5	0.8	making progress
Sao Tome and Principe	150	120	110	87	70	–54	–3.8	–4.2	–3.5	making progress
Saudi Arabia	44	33	27	25	24	–45	–3	–3.7	–2.3	
Senegal	670	590	500	430	370	–45	–3	–3.4	–2.6	making progress
Serbia	23	25	12	10	12	–46	–3	–5.7	–0.5	
Sierra Leone	1300	1300	1300	1000	890	–30	–1.8	–1.9	–1.6	insufficient progress
Singapore	6	6	15	9	3	–40	–2.5	–5.9	1.0	
Slovakia	15	10	13	6	6	–58	–4.3	–6.7	–1.7	

Country	MMR[a]					% change in MMR between 1990 and 2010	Average annual % change in MMR between 1990 and 2010[b]	Range of uncertainty on annual % change in MMR		Progress towards improving maternal health[c]
	1990	1995	2000	2005	2010			Lower estimate	Upper estimate	
Slovenia	11	13	12	14	12	7	0.4	–4.7	5.7	
Solomon Islands	150	120	120	110	93	–36	–2.2	–7.4	3.4	making progress
Somalia	890	970	1000	1000	1000	15	0.7	–4.5	6.3	no progress
South Africa	250	260	330	360	300	21	0.9	–2.6	6.4	no progress
Spain	7	4	5	6	6	–16	–0.9	–2.2	0.6	
Sri Lanka	85	74	58	44	35	–59	–4.3	–4.7	–4.0	
Sudan	1000	930	870	800	730	–27	–1.6	–2.2	–0.9	insufficient progress
Suriname	84	39	130	110	130	55	2.2	0	4.5	
Swaziland	300	290	360	420	320	7	0.3	–4.3	6.4	no progress
Sweden	6	5	5	4	4	–32	–1.9	–4.6	1.2	
Switzerland	7	6	6	6	8	16	0.7	–3.0	4.8	
Syrian Arab Republic	240	160	120	89	70	–70	–5.9	–6.5	–5.3	on track
Tajikistan	94	160	120	79	65	–31	–1.8	–6.9	3.5	
Thailand	54	54	66	54	48	–11	–0.6	–1.7	1.1	
The former Yugoslav Republic of Macedonia	16	14	15	10	10	–37	–2.3	–8.2	4.2	
Timor-Leste	1000	880	610	410	300	–71	–6	–6.2	–5.9	on track
Togo	620	540	440	370	300	–51	–3.5	–4.5	–2.4	making progress
Tonga	67	86	87	100	110	70	2.7	–2.6	8.3	
Trinidad and Tobago	86	90	59	59	46	–47	–3.1	–6.0	–0.1	
Tunisia	130	110	84	68	56	–57	–4.1	–4.8	–3.6	making progress
Turkey	67	51	39	28	20	–69	–5.8	–6.2	–5.4	

Country	MMR[a]					% change in MMR between 1990 and 2010	Average annual % change in MMR between 1990 and 2010[b]	Range of uncertainty on annual % change in MMR		Progress towards improving maternal health[c]
	1990	1995	2000	2005	2010			Lower estimate	Upper estimate	
Turkmenistan	82	94	91	76	67	–18	–1	–6.2	4.8	
Uganda	600	590	530	420	310	–47	–3.2	–3.9	–2.1	making progress
Ukraine	49	45	35	25	32	–34	–2	–3.6	–0.1	
United Arab Emirates	24	16	14	13	12	–49	–3.3	–8.2	2.1	
United Kingdom	10	10	12	13	12	23	1.1	0.3	1.8	
United Republic of Tanzania	870	840	730	610	460	–47	–3.2	–3.8	–2.0	making progress
United States of America	12	12	14	18	21	65	2.5	2.3	2.8	
Uruguay	39	35	35	31	29	–26	–1.5	–3.2	0.3	
Uzbekistan	59	36	33	32	28	–53	–3.7	–4.4	–2.9	
Vanuatu	220	180	120	110	110	–52	–3.6	–8.9	1.4	making progress
Venezuela (Bolivarian Republic of)	94	98	91	94	92	–2	–0.1	–0.6	0.4	
Viet Nam	240	160	100	74	59	–76	–6.9	–12.0	–2.0	on track
West Bank and Gaza Strip[d]	90	72	64	67	64	–29	–1.7	–7.0	3.9	
Yemen	610	520	380	270	200	–67	–5.3	–6.0	–4.8	making progress
Zambia	470	530	540	500	440	–7	–0.4	–1.0	0.6	insufficient progress
Zimbabwe	450	540	640	690	570	28	1.2	–0.5	4.2	no progress

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.

[a] MMR estimates have been rounded according to the following scheme: <100, no rounding; 100–999, rounded to nearest 10; and >1000, rounded to nearest 100.

[b] Negative values indicate a decreasing MMR from 1990 to 2010, while positive values indicate an increasing MMR. The average annual per cent change is estimated by:

$$\left[\left(\frac{\text{MMR}\,2010}{\text{MMR}\,1990}\right)^{\frac{1}{2010-1990}} - 1\right] \times 100$$

[c] For countries with MMR ≥100 in 1990, they are categorized as "on track" if MMR has had 5.5% or more average annual decline; "making progress" if MMR has had 2% to 5.5% average annual decline; "insufficient progress" if MMR has had less than 2% average annual decline; and "no progress" if MMR has had an average annual increase. Countries with MMR <100 in 1990 are not categorized.

[d] Refers to a territory.

Annex 3. Countries with 40% or more decrease in the maternal mortality ratio (maternal deaths per 100 000 live births) from 1990 to 2010

Country	% change in MMR between 1990 and 2010[a]
Estonia	–95
Maldives	–93
Belarus	–88
Romania	–84
Bhutan	–82
Equatorial Guinea	–81
Iran (Islamic Republic of)	–81
Lithuania	–78
Nepal	–78
Viet Nam	–76
Eritrea	–73
Oman	–72
Poland	–72
Egypt	–71
Timor-Leste	–71
Bangladesh	–70
China	–70
Cambodia	–70
Lao People's Democratic Republic	–70
Syrian Arab Republic	–70
Turkey	–69
Yemen	–67
India	–66
Peru	–66
Afghanistan	–65
Czech Republic	–65
Italy	–65
Morocco	–65
Ethiopia	–64
Indonesia	–63
Rwanda	–63
Angola	–62
Madagascar	–62
Myanmar	–62
Cape Verde	–61
Samoa	–60
Austria	–59
Sri Lanka	–59

Country	% change in MMR between 1990 and 2010[a]
Malawi	–59
Slovakia	–58
Burkina Faso	–57
Bolivia (Plurinational State of)	–57
Tunisia	–57
Bosnia and Herzegovina	–56
Barbados	–56
Chile	–56
Algeria	–56
Japan	–56
Benin	–55
Greece	–55
Russian Federation	–55
Sao Tome and Principe	–54
Bulgaria	–53
Qatar	–53
Uzbekistan	–53
Honduras	–52
Lebanon	–52
Niger	–52
Vanuatu	–52
Brazil	–51
Mali	–51
Togo	–51
Guinea	–50
Gambia	–50
United Arab Emirates	–49
Mongolia	–49
Portugal	–48
Trinidad and Tobago	–47
United Republic of Tanzania	–47
Uganda	–47
Saint Lucia	–46
Mozambique	–46
Pakistan	–46

Country	% change in MMR between 1990 and 2010[a]
El Salvador	–46
Serbia	–46
Colombia	–45
Mexico	–45
Malaysia	–45
Saudi Arabia	–45
Senegal	–45
Albania	–44
Israel	–44
Kazakhstan	–44
Nicaragua	–44
Netherlands	–44
Côte d'Ivoire	–43
Germany	–43
Haiti	–43
Philippines	–43
Democratic Republic of the Congo	–42
Cyprus	–42
Ecuador	–42
Jordan	–42
Libya	–42
Malta	–42
Nigeria	–41
Papua New Guinea	–41
Ghana	–40
Latvia	–40
Puerto Rico	–40
Singapore	–40

[a] Percentages have been rounded to whole numbers.

Appendix 1. Adjustment factor to account for misclassification of maternal deaths in civil registration, literature review of reports and articles

Country	Period/year	Adjustment factor	Additional maternal deaths with adjustment factor (%)
Australia[a]	1994–1996	1.23	23
Australia[b]	1997–1999	1.80	80
Australia[c]	2000–2002	1.97	97
Australia[d]	2003–2005	2.03	103
Austria[e]	1980–1998	1.61	61
Brazil (capital cities)[f]	2002	1.40	40
Canada[g]	1988–1992	1.60	60
Canada[h]	1997–2000	1.52	52
China (Taiwan)[i]	1984–1987	1.58	58
Denmark[j]	1985–1994	1.94	94
Denmark[k]	2002–2006	3.30	230
El Salvador[l]	June 2005–May 2006	3.20	220
Finland[m]	1987–1994	1.03	3
France[n]	1999	1.24	24
France[o]	2001–2006	1.21	21
Georgia[p]	2006	2.00	100
Germany (Bavaria)[q]	1983–2000	1.02	2
Japan[r]	2005	1.35	35
Mexico[s]	2008	1.10	10
Netherlands[t]	1983–1992	1.34	34
Netherlands[u]	1993–2005	1.49	49
New Zealand[v]	2006	1.11	11
New Zealand[x]	2007	0.85	–15
Serbia[y]	2007–2010	1.86	86
Sweden[z]	1997–2005	1.33	33
Switzerland[aa]	1985–1996	1.25	25
United Kingdom[bb]	1988–1990	1.39	39
United Kingdom[bb]	1991–1993	1.52	52
United Kingdom[bb]	1994–1996	1.64	64
United Kingdom[bb]	1997–1999	1.82	82
United Kingdom[cc]	2000–2002	1.66	66
United Kingdom[bb]	2003–2005	1.74	74
United Kingdom[dd]	2006–2008	1.60	60
United States of America[ee]	1991–1997	1.48	48
United States of America[ff]	1995–1997	1.59	59
United States of America (Maryland)[gg]	2001–2008	1.02	2
United States of America (Maryland)[hh]	1993–2000	1.61	61
United States of America[jj]	1999–2002	1.50	50
United States of America[jj]	2003–2005	1.10	10
Median		**1.5**	

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[b] AIHW. *Maternal Deaths in Australia 1997–1999*. Canberra, 2004.

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Appendix 2. Sixty-five countries with civil registration data characterized as complete, with good attribution of cause of death

Argentina	Guatemala	Republic of Moldova
Australia	Hungary	Romania
Austria	Iceland	Russian Federation
Bahamas	Ireland	Saint Lucia
Barbados	Israel	Saint Vincent and the Grenadines
Belarus	Italy	Serbia
Belgium	Japan	Singapore
Belize	Kazakhstan	Slovakia
Bulgaria	Kuwait	Slovenia
Canada	Latvia	Spain
Chile	Lithuania	Suriname
Colombia	Luxembourg	Sweden
Costa Rica	Malta	Switzerland
Croatia	Mauritius	The former Yugoslav Republic of Macedonia
Cuba	Mexico	Trinidad and Tobago
Czech Republic	Netherlands	Ukraine
Denmark	New Zealand	United Kingdom
Estonia	Norway	United States of America
Finland	Panama	Uruguay
France	Poland	Uzbekistan
Germany	Portugal	Venezuela (Bolivarian Republic of)
Greece	Republic of Korea	

Appendix 3. Eighty-nine countries lacking good complete civil registration data but where other sources of national data are available

Afghanistan	Gabon	Nepal
Albania	Georgia	Nicaragua
Algeria	Ghana	Niger
Armenia	Grenada	Nigeria
Azerbaijan	Guinea	Oman
Bahrain	Guyana	Pakistan
Bangladesh	Haiti	Paraguay
Benin	Honduras	Peru
Bhutan	India	Philippines
Bolivia (Plurinational State of)	Indonesia	Puerto Rico
Bosnia and Herzegovina	Iran (Islamic Republic of)	Rwanda
Botswana	Iraq	Sao Tome and Principe
Brazil	Jamaica	Saudi Arabia
Brunei Darussalam	Jordan	Senegal
Burkina Faso	Kenya	Sierra Leone
Cambodia	Kyrgyzstan	South Africa
Cameroon	Lao People's Democratic Republic	Sri Lanka
Central African Republic	Lebanon	Sudan
Chad	Lesotho	Swaziland
China	Liberia	Syrian Arab Republic
Congo	Madagascar	Thailand
Côte d'Ivoire	Malawi	Togo
Democratic Republic of the Congo	Maldives	Tunisia
Dominican Republic	Mali	Turkey
Ecuador	Mauritania	Uganda
Egypt	Montenegro	United Republic of Tanzania
El Salvador	Morocco	Yemen
Eritrea	Mozambique	Zambia
Ethiopia	Myanmar	Zimbabwe
Fiji	Namibia	

Appendix 4. Twenty-seven countries with no national data on maternal mortality[a]

Angola	Guinea-Bissau	Somalia
Burundi	Libya	Tajikistan
Cape Verde	Malaysia	Timor-Leste
Comoros	Micronesia	Tonga
Cyprus	Mongolia	Turkmenistan
Democratic People's Republic of Korea	Papua New Guinea	United Arab Emirates
Djibouti	Qatar	Vanuatu
Equatorial Guinea	Samoa	Viet Nam
Gambia	Solomon Islands	West Bank and Gaza Strip (territory)

[a] Countries where no good-quality national data are available on maternal mortality.

Appendix 5. Estimation of maternal deaths due to HIV

In this estimation process, the full model has two parts, the first part to separately estimate maternal deaths not related to AIDS (discussed in Chapter 3) and the second part to estimate AIDS-related maternal deaths. AIDS-related 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:

$$PM = (1 - a)\,PM^{na} + a\,PM^{a} \qquad (A1)$$

where:

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

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

a is the proportion of AIDS 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 indirect maternal AIDS-related deaths, PM^{a}. The sources of data for estimating the fraction of AIDS-related indirect maternal deaths are the UNAIDS 2010 estimates of AIDS-related deaths[1] and the total number of deaths estimated by WHO from its life tables. The approach used to estimate the proportion of AIDS deaths that qualify as indirect maternal deaths, PM^{a}, is the product of two quantities:

$$PM^{a} = \upsilon u \qquad (A2)$$

where:

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

$$\upsilon = \frac{ck\,GFR}{1 + c\,(k-1)\,GFR} \qquad (A3)$$

u is the fraction of AIDS 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.

The value of k was also difficult to estimate directly from available empirical data, and instead a statistical analysis of deviance scores indicated that values below 0.6 had close to optimal goodness of fit. The value that was closest to optimal was 0.3; however, given the lack of direct evidence, it was decided to accept

1 The deaths referred to in this document as AIDS deaths are referred to as AIDS-related deaths in UNAIDS publications. These deaths include the estimated number of deaths related to HIV infection, including deaths that occur before reaching the clinical stage classified as AIDS.

a less extreme assumption and set $k = 0.4$, suggesting that, among all women, pregnant women are 60% less likely to die from AIDS than non-pregnant women. For HIV-positive women who have high viral load, the conditions of pregnancy may increase the risk of AIDS mortality, suggesting that k might be greater than one. However, since women with high viral loads are much less likely to become pregnant[2], the relative risk of an AIDS death for a pregnant versus a non-pregnant woman is likely less than one.

In choosing the specific value for u, it was necessary to take into account the lack of empirical evidence of u and how this fraction likely varies over time and space. Applying the reasoning that two extreme possibilities can be dismissed with confidence – that either zero or all of the deaths are related to HIV– we assumed that the correct value overall lies somewhere in between the two extremes. The single, constant value of $u = 0.5$ was selected, which, as the middle value, furthermore minimizes the expected error that is implied by any symmetrical probability distribution of uncertainty (over the interval of zero to one). Using this value estimates that exactly one half of the 37 000 deaths HIV-positive pregnant women were AIDS-related indirect maternal deaths.

2 Chen W, Walker N. Fertility of HIV-infected women: insights from demographic and health surveys. *Sexually Transmitted Infections*, 2010, 86(Suppl. 2):ii22–ii27.

Appendix 6. Trends in estimates of maternal mortality ratio (MMR, maternal deaths per 100 000 live births) by 5-year periods, 1990–2010, by United Nations Millennium Development Goal region (indicated in bold) and other grouping

Region	MMR[a]					% change in MMR between 1990 and 2010	Average annual % change in MMR between 1990 and 2010[b]
	1990	1995	2000	2005	2010		
World	400	360	320	260	210	–47	–3.1
Developed regions[c]	26	20	17	15	16	–39	–2.5
Developing regions	440	400	350	290	240	–47	–3.1
Africa	760	740	670	570	460	–39	–2.5
Northern Africa[d]	230	170	120	93	78	–66	–5.3
Sub-Saharan Africa	850	820	740	630	500	–41	–2.6
Eastern Africa[e]	800	770	680	570	450	–45	–2.9
Middle Africa[f]	910	900	810	710	600	–34	–2.1
Southern Africa[g]	260	270	350	370	300	19	0.9
Western Africa[h]	970	930	830	700	550	–44	–2.8
Asia	400	320	270	200	150	–61	–4.7
Eastern Asia[i]	120	83	61	45	37	–69	–5.7
Eastern Asia excluding China	53	72	64	49	45	–15	–0.8
Southern Asia[j]	590	490	400	290	220	–64	–4.9
Southern Asia excluding India	590	500	410	320	240	–59	–4.4
South-eastern Asia[k]	410	300	240	190	150	–63	–4.9
Western Asia[l]	170	140	110	88	71	–57	–4.2
Caucasus and Central Asia[m]	71	74	62	51	46	–35	–2.1
Latin America and the Caribbean	140	120	100	88	80	–41	–2.6
Latin America[n]	130	110	96	80	72	–43	–2.8
Caribbean[o]	280	250	220	210	190	–30	–1.8
Oceania[p]	320	270	260	230	200	–38	–2.4

[a,b] See footnotes in Annex 2.

[c] 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.

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

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

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

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

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

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

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

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

[l] Bahrain, Iraq, Jordan, Kuwait, Lebanon, Oman, Qatar, Saudi Arabia, Syrian Arab Republic, Turkey, United Arab Emirates, West Bank and Gaza Strip (territory), Yemen.

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

[n] 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).

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

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

Appendix 7. Estimates of maternal mortality ratio (MMR, maternal deaths per 100 000 live births), number of maternal deaths, and lifetime risk by WHO region, 2010

Region	MMR[a]	Range of MMR uncertainty		Number of maternal deaths[a]	Lifetime risk of maternal death[a]: 1 in:
		Lower estimate	Upper estimate		
Africa	480	380	710	148 000	42
Americas	63	53	76	9700	710
Eastern Mediterranean	250	180	390	39 000	120
Europe	20	18	24	2200	2900
South-East Asia	200	140	290	76 000	190
Western Pacific	49	36	71	12 000	1200
World	210	170	300	287 000	180

[a] See footnote in Annex 1.

Appendix 8. Trends in estimates of maternal mortality ratio (MMR, maternal deaths per 100 000 live births) by 5-year periods, 1990–2010, by WHO region

Region	MMR[a]					% change in MMR between 1990 and 2010	Average annual % change in MMR between 1990 and 2010[b]
	1990	1995	2000	2005	2010		
Africa	820	800	720	600	480	–42	–2.7
Americas	100	91	80	68	63	–40	–2.5
Eastern Mediterranean	430	410	360	300	250	–42	–2.6
Europe	44	37	29	22	20	–54	–3.8
South-East Asia	590	460	370	270	200	–66	–5.2
Western Pacific	140	100	77	60	49	–66	–5.2
World	400	360	320	260	210	–47	–3.1

[a,b] See footnotes in Annex 2.

Appendix 9. Estimates of maternal mortality ratio (MMR, maternal deaths per 100 000 live births), number of maternal deaths, and lifetime risk by UNICEF region, 2010

Region	MMR[a]	Range of MMR uncertainty		Number of maternal deaths[a]	Lifetime risk of maternal death[a]: 1 in:
		Lower estimate	Upper estimate		
Africa	460	360	680	165 000	46
Sub-Saharan Africa	500	400	750	162 000	39
Eastern and Southern Africa	410	310	580	58 000	52
West and Central Africa	570	430	910	94 000	32
Middle East and North Africa	170	110	280	17 000	190
Asia	160	120	230	106 000	270
South Asia	220	160	320	83 000	150
East Asia and the Pacific	82	60	120	23 000	680
Latin America and Caribbean	81	68	99	8800	520
Central and Eastern Europe and the Commonwealth of Independent States	32	28	39	1800	1700
Industrialized countries	12	11	14	1400	4700
Developing countries	240	190	330	284 000	150
Least developed countries	430	340	620	121 000	52
World	210	170	300	287 000	180

[a] See footnote in Annex 1.

Appendix 10. Trends in estimates of maternal mortality ratio (MMR, maternal deaths per 100 000 live births) by 5-year periods, 1990–2010, by UNICEF region

Region	MMR[a]					% change in MMR between 1990 and 2010	Average annual % change in MMR between 1990 and 2010[b]
	1990	1995	2000	2005	2010		
Africa	760	740	670	570	460	–39	–2.5
Sub-Saharan Africa	850	820	740	630	500	–41	–2.6
Eastern and Southern Africa	740	720	640	530	410	–45	–2.9
West and Central Africa	940	910	820	700	570	–39	–2.5
Middle East and North Africa	290	260	220	190	170	–42	–2.7
Asia	410	340	280	210	160	–61	–4.6
South Asia	620	500	410	300	220	–64	–5.0
East Asia and the Pacific	210	160	130	100	82	–62	–4.7
Latin America and Caribbean	140	120	100	88	81	–41	–2.6
Central and Eastern Europe and the Commonwealth of Independent States	70	61	49	36	32	–54	–3.8
Industrialized countries	12	11	11	12	12	2	0.1
Developing countries	440	400	350	290	240	–47	–3.1
Least developed countries	870	790	660	540	430	–51	–3.5
World	400	360	320	260	210	–47	–3.1

[a,b] See footnotes in Annex 2.

Appendix 11. Estimates of maternal mortality ratio (MMR, maternal deaths per 100 000 live births), number of maternal deaths, and lifetime risk by UNFPA region, 2010

Region	MMR[a]	Range of MMR uncertainty		Number of maternal deaths[a]	Lifetime risk of maternal death[a]: 1 in:
		Lower estimate	Upper estimate		
Arab States	140	94	230	10 000	220
Asia and the Pacific	160	120	230	107 000	270
Eastern Europe and Central Asia	32	28	39	1800	1700
Latin America and the Caribbean	81	68	99	8800	520
Sub-Saharan Africa	500	390	740	158 000	40
Non-UNFPA list	13	12	15	1600	4500
World	210	170	300	287 000	180

[a] See footnote in Annex 1.

Appendix 12. Trends in estimates of maternal mortality ratio (MMR, maternal deaths per 100 000 live births) by 5-year periods, 1990–2010, by UNFPA region

Region	MMR[a]					% change in MMR between 1990 and 2010	Average annual % change in MMR between 1990 and 2010[b]
	1990	1995	2000	2005	2010		
Arab States	260	210	180	150	140	–47	–3.1
Asia and the Pacific	410	340	280	210	160	–61	–4.6
Eastern Europe and Central Asia	70	62	49	36	32	–54	–3.8
Latin America and the Caribbean	140	120	100	88	81	–41	–2.6
Sub-Saharan Africa	850	820	740	630	500	–41	–2.6
Non-UNFPA list	13	12	12	12	13	–1	–0.1
World	400	360	320	260	210	–47	–3.1

[a,b] See footnotes in Annex 2.

Appendix 13. Estimates of maternal mortality ratio (MMR, maternal deaths per 100 000 live births), number of maternal deaths, and lifetime risk by World Bank region and income group, 2010

Region and income group	MMR[a]	Range of MMR uncertainty		Number of maternal deaths[a]	Lifetime risk of maternal death[a]: 1 in:
		Lower estimate	Upper estimate		
Low income	410	330	590	107 000	56
Middle income	190	140	260	178 000	220
Lower middle income	260	200	380	160 000	120
Upper middle income	53	41	69	19 000	1000
Low and middle income	230	190	330	285 000	160
East Asia and Pacific	83	61	120	23 000	670
Europe and Central Asia	32	28	39	1900	1700
Latin America and the Caribbean	81	68	100	8800	520
Middle East and North Africa	80	59	120	6200	420
South Asia	220	160	320	83 000	150
Sub-Saharan Africa	500	400	750	162 000	39
High income	14	12	16	1700	4200
World	210	170	300	287 000	180

[a] See footnote in Annex 1.

Appendix 14. Trends in estimates of maternal mortality ratio (MMR, maternal deaths per 100 000 live births) by 5-year periods, 1990–2010, by World Bank region and income group

Region and income group	MMR[a]					% change in MMR between 1990 and 2010	Average annual % change in MMR between 1990 and 2010[b]
	1990	1995	2000	2005	2010		
Low income	810	740	630	520	410	–49	–3.3
Middle income	360	320	280	230	190	–49	–3.3
Lower middle income	560	480	420	330	260	–53	–3.7
Upper middle income	120	91	76	63	53	–55	–3.9
Low and middle income	440	400	350	290	230	–47	–3.1
East Asia and Pacific	220	160	130	100	83	–62	–4.7
Europe and Central Asia	70	61	49	36	32	–54	–3.8
Latin America and the Caribbean	140	120	110	89	81	–41	–2.6
Middle East and North Africa	220	170	130	98	80	–63	–4.8
South Asia	620	500	410	300	220	–64	–5.0
Sub-Saharan Africa	850	820	740	630	500	–41	–2.6
High income	16	14	13	13	14	–15	–0.8
World	400	360	320	260	210	–47	–3.1

[a,b] See footnotes in Annex 2.

Appendix 15. Estimates of maternal mortality ratio (MMR, maternal deaths per 100 000 live births), number of maternal deaths, and lifetime risk by UNPD region, 2010

Region	MMR[a]	Range of MMR uncertainty		Number of maternal deaths[a]	Lifetime risk of maternal death[a]: 1 in:
		Lower estimate	Upper estimate		
Africa	460	360	680	165 000	46
Sub-Saharan Africa	500	400	750	162 000	39
Asia	150	110	210	111 000	290
Europe	15	13	18	1200	4200
Latin America and the Caribbean	80	68	99	8800	520
Northern America	20	17	23	920	2600
Oceania	93	47	190	550	460
More developed countries	16	14	18	2200	3800
Less developed countries	240	190	330	284 000	150
Least developed countries	430	340	620	121 000	52
Other less developed countries	180	140	250	164 000	230
World	210	170	300	287 000	180

[a] See footnote in Annex 1.

Appendix 16. Trends in estimates of maternal mortality ratio (MMR, maternal deaths per 100 000 live births) by 5-year periods, 1990–2010, by UNPD region

Region	MMR[a]					% change in MMR between 1990 and 2010	Average annual % change in MMR between 1990 and 2010[b]
	1990	1995	2000	2005	2010		
Africa	760	740	670	570	460	–39	–2.5
Sub-Saharan Africa	850	820	740	630	500	–41	–2.6
Asia	380	310	260	190	150	–61	–4.6
Europe	36	27	21	16	15	–57	–4.1
Latin America and the Caribbean	140	120	100	88	80	–41	–2.6
Northern America	12	11	14	17	20	68	2.6
Oceania	130	120	120	110	93	–29	–1.7
More developed countries	26	20	17	15	16	–39	–2.5
Less developed countries	440	400	350	290	240	–47	–3.1
Least developed countries	870	790	660	540	430	–51	–3.5
Other less developed countries	350	300	270	220	180	–50	–3.4
World	400	360	320	260	210	–47	–3.1

[a,b] See footnotes in Annex 2.

Appendix 17. Summary of country consultations

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 briefly here.

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 2010 round of maternal mortality estimates was initiated with an official communication from WHO to all Member States on 8 December 2011. This letter informed Member States of the forthcoming exercise in maternal mortality estimation 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 e-mail: (1) a copy of 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 20 February 2012. Of the 181 Member States included in the analysis, WHO received designated officials from 119 Member States (in cases where more than one official was appointed from a given country or territory, they were required to submit a unified response to the inquiry), and received feedback, comments and/or data from 66 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 data if they were representative of the national population and referred to a specific time interval within the period from the late 1980s until the present. As a result of the country consultation, 138 new country-years of data observations were included for the maternal mortality estimates from 33 countries and consisted of 101 country-years of vital registration data and 37 country-years from other sources, mainly from sisterhood survey data and maternal mortality surveillance systems. As in the previous country consultation, the new observations were primarily from civil registration systems; however, the increase in number of other new observations also shows that countries lacking functioning civil registration systems are increasingly investing in monitoring maternal mortality with empirical data from alternative sources.