Trends in **Maternal Mortality: 1990 to 2008**

Estimates developed by
WHO, UNICEF, UNFPA and The World Bank

World Health Organization

unicef

UNFPA

The World Bank

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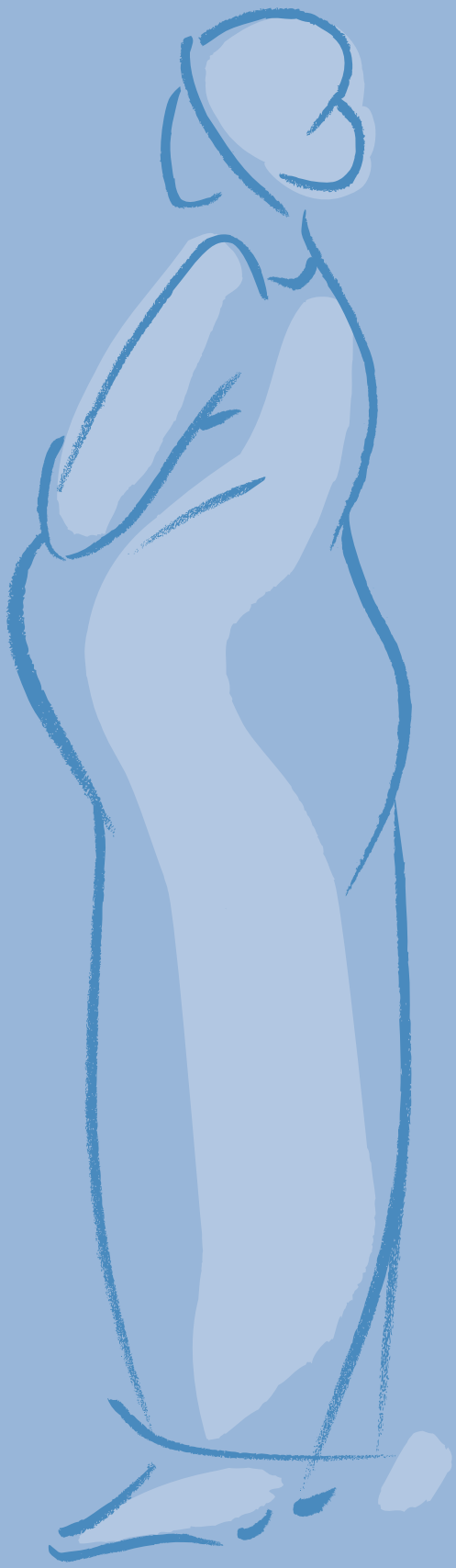

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ACRONYMS AND ABBREVIATIONS

AMDF	AIDS adjusted PMDF
CEMD	Confidential Enquiry into Maternal Deaths
DHS	Demographic and Health Surveys
GDP	gross domestic product per capita based on purchasing power parity conversion
GFR	general fertility rate
HDI	Human Development Index
HIV/AIDS	human immunodeficiency virus/acquired immunodeficiency syndrome
ICD-10	International Statistical Classification of Diseases and Related Health Problems (10th Revision)
MDG	Millennium Development Goal
MMEIG	Maternal Mortality Estimation Inter-Agency Group
MMR	maternal mortality ratio
MMRate	maternal mortality rate
PMDF	proportion maternal among deaths of females of reproductive age
PPP	purchasing power parity
RAMOS	reproductive-age mortality studies
SAB	skilled attendant at birth as a proportion of total live births
TAG	Technical Advisory Group
TFR	total fertility rate
UNAIDS	The Joint United Nations Programme on HIV/AIDS
UNFPA	United Nations Population Fund
UNICEF	United Nations Children's Fund
UNPD	United Nations Population Division
WHO	World Health Organization

EXECUTIVE SUMMARY

Five years remain until the 2015 deadline to achieve the Millennium Development Goals (MDG) adopted at the 2000 Millennium Summit. There are two targets for assessing progress in improving maternal health (MDG 5): reducing the maternal mortality ratio (MMR) by three quarters between 1990 and 2015, and achieving universal access to reproductive health by 2015. Closer examination of maternal mortality levels is needed to inform planning of reproductive health programmes, to guide advocacy efforts and research at the national and international levels, and to inform decision-making for the achievement of MDG 5. To be useful for the latter purpose, the country estimates must be internationally comparable.

It has been a challenge to assess the extent of progress towards the MDG 5 target due to the lack of reliable and accurate data on maternal mortality – particularly in developing-country settings where maternal mortality is high. The World Health Organization (WHO), the United Nations Children's Fund (UNICEF), and the United Nations Population Fund (UNFPA) have previously published internationally comparable estimates of maternal mortality for 1990, 1995, and 2000. In 2005, the three agencies, along with The World Bank, developed country, regional, and global estimates and made the first attempt to assess trends in MMR at the regional and global levels. As an update to this ongoing effort, the four agencies now present the global maternal mortality data for 2008 as well as for years 1990, 1995, 2000, and 2005. These estimates revise and improve upon the earlier methodology used.

An estimated 358 000 maternal deaths occurred worldwide in 2008, a 34% decline from the levels of 1990. Despite this decline, developing countries continued to account for 99% (355 000) of the deaths. Sub-Saharan Africa and South Asia accounted for 87% (313 000) of global maternal deaths. Eleven countries including Afghanistan, Bangladesh, the Democratic Republic of the Congo, Ethiopia, India, Indonesia, Kenya, Nigeria, Pakistan, Sudan, and the United Republic of Tanzania, comprised 65% of all maternal deaths in 2008.

Overall, it was estimated that there were 42 000 deaths due to HIV/AIDS among pregnant women in 2008. About half of those were assumed to be maternal. The contribution of HIV/AIDS was highest in sub-Saharan Africa where 9% of all maternal deaths were due to HIV/AIDS. Without these deaths, the MMR for sub-Saharan Africa would have been 580 maternal deaths per 100 000 live births instead of 640.

The MMR in 2008 was highest in developing regions (290) in stark contrast to developed regions (14) and countries of the Commonwealth of Independent States (40). Among developing regions, sub-Saharan Africa had the highest MMR at 640 maternal deaths per 100 000 live births in 2008, followed by South Asia (280), Oceania (230), South-Eastern Asia (160), North Africa (92), Latin America and the Caribbean (85), Western Asia (68), and Eastern Asia (41). Forty-five countries had high estimated MMR (MMR ≥300) with four countries (Afghanistan, Chad, Guinea-Bissau, and Somalia), having extremely high MMR (MMR ≥1000). Outside of sub-Saharan Africa, the seven countries with high MMR were: Afghanistan (1400), the Lao People's Democratic Republic (580), Nepal (380), Timor-Leste (370), Bangladesh (340), Haiti (300), and Cambodia (290).

During the period 1990–2008, 147 countries experienced a decline in MMR, 90 of which showed a decline of 40% or more. In two countries, there was no estimated change in MMR, while 23 countries had an increase.

The adult lifetime risk of maternal death (the probability that a 15-year-old female will die eventually from a maternal cause) as measured in 2008 is highest in sub-Saharan Africa (at 1 in 31), followed by Oceania (1 in 110), and South Asia (1 in 120), while developed regions had the smallest lifetime risk (1 in 4300). Of the 172 countries and territories, Afghanistan had the highest estimated lifetime risk of 1 in 11.

The fifth MDG aims to improve maternal health with a target of reducing MMR by 75% between 1990 and 2015 – that is, it seeks to achieve a 5.5% annual decline in MMR from 1990. Globally the annual percentage decline in MMR between 1990 and 2008 was only 2.3%. Among countries with an MMR ≥100 in 1990, it is evident that 30 countries have made insufficient or no progress, including 23 from sub-Saharan Africa.

These estimates provide an up-to-date indication of the extent of the maternal mortality problem globally. They reflect the efforts by countries, which have increasingly been engaged in studies to measure maternal mortality and strengthen systems to obtain better information about maternal deaths. The modest and encouraging progress in reducing maternal mortality is likely due to increased attention to developing and implementing policies and strategies targeting increased access to effective interventions. Such efforts need to be expanded and intensified, to accelerate progress towards reducing the still very wide disparities between developing and developed worlds.

1. INTRODUCTION

Improving maternal health is one of the eight Millennium Development Goals (MDG) adopted at the 2000 Millennium Summit. The two targets for assessing progress in improving maternal health (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. With only five years left until the 2015 deadline to achieve the MDGs, closer examination of maternal mortality levels is needed to inform planning of reproductive health programmes and to guide advocacy efforts and research at the national level. These estimates are also needed at the international level, to inform decision-making concerning funding support for the achievement of MDG 5. To be useful for the latter purpose, the country estimates must be internationally comparable.

It has been a challenge to assess the extent of progress towards the MDG 5 target, due to scarcity of reliable and accurate data on maternal mortality – particularly in developing-country settings where maternal mortality is high. WHO, UNICEF, UNFPA, and The World Bank have collaborated to develop and update five-yearly estimates of maternal mortality using statistical modelling for countries where no reliable data on maternal mortality exist. The latest interagency estimates were published in 2007, reporting on maternal mortality in 2005.[1,2] Recently, another study by an academic institute reported a set of estimates developed using an alternative methodology.[3]

The four agencies have now updated the global maternal mortality data for 2008 as well as for 1990, 1995, 2000, and 2005. The Maternal Mortality Estimation Inter-Agency Group (MMEIG), together with a Technical Advisory Group (TAG) consisting of outside technical experts, has revised and improved the previous methods used to estimate maternal mortality[1,2] with a particular emphasis on developing methods for estimating trends in maternal mortality from 1990 to 2008. The MMR estimates were released in September 2010 to provide input to the United Nations General Assembly on progress towards achieving the MDGs.

Following the development of the MMR estimates, consultations with countries were carried out during July–August 2010: 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. After the consultations, the statistical model was run again to incorporate any new data provided by countries.

This report presents the global, regional, and country estimates of maternal mortality in 2008, and the findings of the assessment of trends of maternal mortality levels since 1990. It summarizes the challenges involved in measuring maternal mortality and the main approaches to measurement, and explains the methodology of the 2008 maternal mortality estimates. The final section discusses the use and limitations of the estimates, with an emphasis on the importance of improved data quality for estimating maternal mortality. The appendices present the sources of data for the country estimates as well as MMR estimates for the different regional groupings for WHO, UNICEF, UNFPA, The World Bank, and UNPD.

2. MEASURING MATERNAL MORTALITY

2.1 Concepts and definitions

In the *International Statistical Classification of Diseases and Related Health Problems, Tenth Revision*, 1992 (ICD-10), 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 obstetric deaths are those resulting from obstetric complications of the pregnant state (pregnancy, delivery, and postpartum), from interventions, omissions, incorrect treatment, or from a chain of events resulting from any of the above. Deaths due to, for example, haemorrhage, pre-eclampsia/eclampsia or those due to complications of anaesthesia or caesarean section are classified as direct obstetric deaths. Indirect obstetric deaths are those resulting from previous existing disease, or diseases that developed during pregnancy, and which 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 indirect obstetric deaths.

Accurate identification of the causes of maternal deaths by differentiating the extent to which they are due to direct or indirect obstetric causes, or due to accidental or incidental events, is not always possible – particularly in settings where deliveries occur mostly at home, and/or where civil registration systems with correct attribution of causes of death are inadequate.

With the publication of ICD-10, WHO recommended adding a checkbox on the death certificate for recording a woman's pregnancy status at the time of death.[4] This would help to identify indirect maternal deaths, but 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 A34 (maternal tetanus) were counted as maternal deaths.

A concept of "pregnancy-related death" included in ICD-10 is defined as any death during pregnancy, childbirth, or the postpartum period even if it is due to accidental or incidental causes (Box 1). This alternative definition allows measurement of deaths that are related to pregnancy, even though they do not strictly conform with the standard "maternal death" concept in settings where accurate information about causes of deaths based on medical certificates are unavailable. For instance, in surveys, relatives of a reproductive-age woman who has died are asked about her pregnancy status at the time of death without eliciting any further information on cause of death. These surveys usually measure pregnancy-related deaths rather than maternal deaths.

Prior to 2010, indirect maternal deaths due to HIV, which were coded to Chapter 1 according to ICD-10 rule 5.8.3 (in Vol. 2), were not included in the tally of maternal deaths. An amendment has recently been made to ICD-10, introducing code O98.7 to identify indirect maternal deaths due to HIV. These indirect maternal deaths are those in which HIV complicates the pregnancy or the delivery. Incidental HIV deaths in which the women happened to be pregnant would not be included in the MMR.

Complications of pregnancy or childbirth can also lead to death beyond the six-weeks postpartum period. In addition, increasingly available modern life-sustaining procedures and technologies enable 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. An alternative concept of late maternal death was included in ICD-10, in order to capture these delayed deaths that occur between six weeks and one year postpartum (Box 1). Some countries, particularly those with more developed civil registration systems, use this definition.

2.2 Measures of maternal mortality

The number of maternal deaths in a population is essentially the product of two factors: the risk of mortality associated with a single pregnancy or a single live birth, and 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.

By contrast, the maternal mortality rate (MMRate) is defined as the number of maternal deaths in a population divided by the number of women of reproductive age. It reflects not only the risk of maternal death per pregnancy or per birth (live birth or stillbirth), but also 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 (Box 2). An alternative measure of maternal mortality, the proportion maternal among deaths of females of reproductive age (PMDF), is calculated as the number of maternal deaths divided by the total deaths among females aged 15–49 years.

Box 1. Alternative definitions of maternal death in ICD-10

Pregnancy-related death	The death of a woman while pregnant or within 42 days of termination of pregnancy, irrespective of the cause of death.
Late maternal death	The death of a woman from direct or indirect obstetric causes, more than 42 days but less than one year after termination of pregnancy.

Box 2. Statistical measures of maternal mortality

Maternal mortality ratio	Number of *maternal deaths* during a given time period per 100 000 *live births* during the same time-period.
Maternal mortality rate	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 of dying from a maternal cause during a woman's reproductive lifespan.

2.3 Approaches for measuring maternal mortality

Although widely-used standardized definitions of maternal mortality exist, it is difficult to measure accurately the levels of maternal mortality in a population – for several reasons. First, it is challenging to identify maternal deaths precisely, particularly in settings where routine recording of deaths is not complete within civil registration systems, and the death of a woman of reproductive age might not be recorded. Second, even if such a death were recorded, the woman's pregnancy status may not have been known and the death would therefore not have been reported as a maternal death even if the woman were pregnant. 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 unidentified 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 deaths.[5–9] A specific example of such an investigation is the Confidential Enquiry into Maternal Deaths (CEMD). An early form of this system has been established in England and Wales since 1928, and has been reporting for the United Kingdom since 1985.[10] The most recent report of CEMD (for 2003–2005) identified 90% more maternal deaths than was reported in the routine civil registration system.[10] 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 up to almost 200% higher than routine reports.[7] Appendix 1 summarizes the results of a literature review for such studies. These have estimated adjustment factors for misclassification of maternal mortality in death registration data ranging from 0.9 to 3.2 with a median value of 1.5.

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.

Under identification of maternal deaths was more common among the following.

- Early pregnancy deaths, 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 ICD-9 or ICD-10, most often seen in cases of deaths caused by:
  - cerebrovascular diseases;
  - cardiovascular diseases.

Potential reasons cited for under reporting/ misclassification include the following.

- Inadequate understanding of 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).

In the absence of complete and accurate civil registration systems, MMR estimates are based upon a variety of methods – including household surveys, sisterhood methods, reproductive-age mortality studies (RAMOS), verbal autopsies, and censuses. Each of these methods has limitations in estimating the true levels of maternal mortality. Brief descriptions of the methods together with their limitations are shown in Box 3.

Box 3. Approaches to measuring maternal mortality

Civil registration systems	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.[11]
Household surveys	Where civil registration data are not available, household surveys provide an alternative. Limitations of household surveys include the following: • the survey identifies pregnancy-related deaths (not maternal deaths); • because maternal deaths are rare events in epidemiological terms, surveys to measure their levels require large sample sizes to provide statistically reliable estimates and therefore they are expensive; • even with large sample sizes, the obtained estimates are still subject to uncertainty (wide confidence intervals), making it difficult to monitor changes over time.
Sisterhood methods[12,13]	Sisterhood methods obtain information by interviewing a representative sample of respondents about the survival of all their adult sisters (to determine the number of ever-married sisters, how many are alive, how many are dead, and how many died during pregnancy, delivery, or within six weeks of pregnancy). This approach reduces the sample size, but: • it identifies pregnancy-related deaths, rather than maternal deaths; • the problem of wide confidence intervals remains, thereby precluding trend analysis; • the originally developed version (*indirect sisterhood* method) is not appropriate for use in settings where fertility levels are low (i.e. total fertility rate <4) or where there has been substantial migration or other causes of social dislocation; • it provides a retrospective rather than a current maternal mortality estimate (over 10 years prior to the survey); • the Demographic and Health Surveys (DHS) use a variant of the sisterhood approach (*direct sisterhood* method) – this approach relies on fewer assumptions than the original method and collects more information than the indirect method (i.e. the age of all siblings, age at death and year of death of those dead, in addition to the information obtained by the indirect method), but requires larger sample sizes and the analysis is more complicated; • the estimates refer to a period approximately five years prior to the survey; and • as in the indirect method, the problem of wide confidence intervals remains (hence, the monitoring of trends is limited) and this approach also provides information concerning pregnancy-related deaths rather than maternal deaths.

continued on next page

Box 3. continued

Reproductive-age mortality studies (RAMOS)[12–14]	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, vital 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. • Inadequate identification of all deaths of reproductive-aged women results in underestimation of maternal mortality levels. • 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. • 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[15–17]	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. Records of births and deaths are collected periodically among small populations (typically in a district) under demographic surveillance systems maintained by research institutions in developing countries. The following limitations characterize this approach. • Misclassification of causes of reproductive-aged female deaths with this technique is not uncommon. • This approach 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. • Demographic surveillance systems are expensive to maintain, and the findings cannot be extrapolated to obtain national MMRs.
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 the entire population is covered) and hence allows a more detailed breakdown of the results, including time trends, 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. • The training of enumerators is crucial, since census activities collect information on a range of other topics which are unrelated to maternal deaths. • Results must be adjusted for the completeness of births and deaths declared in the census, and for distortions in age structures, in order to arrive at reliable estimates.

3. THE DEVELOPMENT OF 2008 ESTIMATES OF MATERNAL MORTALITY

3.1 Sources of country data used for the 2008 estimates

The most recent data, available by May 2010, on maternal mortality and other relevant variables, were obtained through databases maintained by WHO, UNPD, UNICEF, UNAIDS, The World Bank, and the Center for International Comparisons at the University of Pennsylvania. For instance, deaths due to HIV/AIDS were obtained from UNAIDS (unpublished tables based upon the 2008 *Report on the global AIDS epidemic*, UNAIDS/WHO, July 2008), deaths among females 15–49 years from WHO life tables,[19] live births from United Nations Population Division 2008 revision,[20] skilled attendant at birth as a proportion of total live births from UNICEF,[21] and GDP per capita measured in purchasing power parity (PPP) from The World Bank,[22,23] Penn World Tables,[24] and the World Health Organization (unpublished data, National Health Accounts). These various agencies revise their estimates on a regular basis to take into account new data and improved methods.

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

Numerous surveys (such as the DHS) and censuses have collected information on maternal deaths using the direct sisterhood method or deaths reported in the 12 or 24 months prior to data collection. There is evidence that such data systematically underestimate true levels of mortality. Previous studies have shown that the direct sisterhood method or reported deaths in the household surveys may lead to biased estimates of levels of maternal mortality, but not necessarily to biased values of PMDF.[25] In such data, both maternal deaths and total female deaths at ages 15–49 years tend to be underreported, affecting both the numerator and the denominator of the PMDF in a similar fashion. For this reason, the observed PMDF was used as the preferred data input from all available sources for estimating maternal mortality. The observed PMDF 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 PMDF using estimates of all-cause female deaths aged 15–49 from WHO, and live births from the UN Population Division.

A total of 172 countries and territories were included in this assessment, representing 99.8% of world birth; countries and territories with populations under 250 000 have not been included. Data available from countries varied in terms of the source and methods. Countries were classified into three groups, based on the source and type of maternal mortality data (Table 1, and Appendices 2–4). The database of observed MMR and PMDF from civil registration, surveillance systems, household surveys, censuses, and special studies (such as RAMOS surveys and confidential enquiries), includes 2961 country-years of data across 172 countries, of which 2010 country-years are derived from civil registration data, 819 from survey-based sisterhood data, and the remainder from surveillance systems, censuses, and other sources. Observation intervals refer to 1985 or later. All nationally representative 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 developing the 2008 estimates

Group	Source of maternal mortality data	Number of countries/ territories	% of countries/ territories in each category	% of births in 172 countries/ territories covered
A	Civil registration characterized as complete, with good attribution of cause of death [a]	63	37	15
B	Countries lacking good complete registration data but where other types of data are available	85	49	82
C	No national data on maternal mortality	24	14	4
	Total	172	100	100

[a] For the Bahamas, Belgium, Iceland, and Malta (0.1% of global births), the statistical model was used because the paucity of the event of maternal mortality gave implausible trends.

3.2 Methods used to estimate MMR in 2008 according to data source

Two broad strategies were followed to develop the maternal mortality estimates for 172 countries and territories. The steps taken for estimating maternal mortality with these strategies are summarized below. A technical report of the methodology, data sets and the statistical analysis code used to prepare these estimates, will be available in a technical report accessible at www.who.int/reproductivehealth/publications/monitoring/9789241500265/en/index.html.

For 63 countries with relatively complete data from civil registration systems, as defined below (Group A), these data were used directly for estimating MMR. For countries in Groups B and C, a multilevel regression model was developed using available national-level data from surveys, censuses, surveillance systems and death registration. For four countries in Group A (Bahamas, Belgium, Iceland, and Malta), which have complete data from national death registration systems but very few events of maternal mortality for the target periods (1990, 1995, 2000, 2005 and 2008), the same multilevel regression model was used to generate estimates for all time periods, in order to avoid unrealistic time trends.

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

Civil registration on maternal deaths were used directly to estimate maternal mortality for the 63 countries that met the following criteria (see Appendix 2 for the list of countries).

- Earliest year of data available is before 1996.
- Latest year of data available is after 2002.
- Data were available for more than half of the range of years (from the first year available to the last year available).
- Estimated completeness of death registration of at least 85% for all years, with at the most 1 or 2 exceptions.
- Deaths coded to ill-defined cause codes (ICD-10 R codes) in data did not exceed 20% or exceeded 20% for only 1 or 2 years.

Civil registration on maternal deaths were adjusted for incompleteness and for misclassification. For misclassification, an adjustment factor of the median 1.5 was applied, based upon available evidence (Appendix 1), unless a country-specific factor was available from one or more studies. For each of the target years t=1990, 1995, 2000, 2005, 2008, the available maternal mortality death counts and the corresponding live births20 are then pooled for the 5-year periods, i.e. years t–2 to t+2. The pooled maternal deaths were divided by the pooled live births. A few countries lack maternal death data for

the interval centred on 1990 or have only one year of observation in the interval 2003–2007. For these countries, the estimate from the multilevel regression model was used instead. If data exist for 2008 or 2009, the average 2004–2008 or 2004–2009 was taken as the point estimate for 2008. When data were not yet available for 2008 or 2009, it was assumed that the point estimate for 2005 (based on the 2003–2007 average) remained constant through 2008.

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

Previous interagency estimates of maternal mortality used a covariate-based regression analysis to obtain out-of-sample PMDF predictions for countries without recent reliable data, and used the most recent PMDF observation for countries with data.[1,2] In the current round, a multilevel regression model was developed to derive estimates and projections of maternal deaths at specific time points (1990, 1995, 2000, 2005, and 2008). The model represents maternal deaths due to direct obstetric causes or to indirect causes other than HIV/AIDS deaths for which pregnancy was a substantial aggravating factor. HIV-related indirect maternal deaths were treated separately. The three selected covariates of the model are: the gross domestic product per capita (GDP), the general fertility rate (GFR), and the presence of a skilled attendant at birth as a proportion of total live births (SAB). These covariates were chosen from a broader list of potential covariates which 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).

Covariate time series

Virtually complete time series of annual estimates for three covariates were obtained or constructed back to 1985. Annual estimates were then averaged over the time interval of each PMDF or MMR observation to create covariates for use in estimating the regression model.

- GDP per capita measured in purchasing power parity (PPP) equivalent international dollars using 2005 as the base year (derived from World Bank,[22,23] Penn World Tables,[24] and WHO (unpublished data, National Health Accounts). Where the 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 from average births and female population over the PMDF or MMR time interval using data from the UN Population Division, 2008 revision.[20]
- SAB data consist of time series derived using all available data from health surveys and other sources (in databases maintained by UNICEF).[21] Annual series were estimated by fitting a simple model of the logit (or 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 with more than one observation (including Fiji, Guyana, Montenegro, New Zealand, and Thailand), the logit model did not fit well. For such cases, annual values were estimated as follows:
  - estimates before the first observation were assumed equal to the first observation;
  - if the desired time reference fell between the reference points of two observations, the estimated value was calculated by linear interpolation between the two observations;
  - estimates after the last observation were assumed equal to the last observation.

Adjustments to the input data

When civil registration data were used as inputs into the model, maternal deaths were adjusted for misclassification and divided by the number of female deaths 15–49 to derive the PMDF.

When non-civil registration data (censuses, surveys or enquiries) reported specific adjustment

factors for bias, these were retained. If no specific adjustments for completeness were reported, PMDFs derived from these data sources were adjusted upwards by a factor of 1.1 to take account of the likely under-identification of maternal deaths due to unreported abortion-related deaths or other causes. To estimate a maternal PMDF from a pregnancy-related PMDF, pregnancy-related deaths were adjusted downwards by a factor of 0.9 (a 10% reduction) for sub-Saharan African countries and 0.85 (a 15% reduction) for other low- and middle-income countries, respectively, to account for incidental or accidental deaths. These factors were derived from an analysis of the average risk of injury deaths in the reproductive ages for women.[26]

Multilevel regression model

A regression model was used for deriving MMR estimates for 113 countries (which includes Bahamas, Belgium, Iceland, and Malta from Group A, as explained previously). 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.

Multilevel (or hierarchical) modelling offers 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.[27] The model was fit with three selected covariates (GDP, GFR, and SAB) and random intercept effects for countries and regions.

The model can be described as follows:

$$\log\left(PMDF_i\right) = \beta_0 + \beta_1 \log\left(GDP_i\right) + \beta_2 \log\left(GFR_i\right) + \beta_3\, SAB_i + \alpha^{C}_{j[i]} + \alpha^{R}_{k[i]} + \log\left(1 - a_i\right) + \varepsilon_i$$

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

$PMDF_i$ = proportion maternal among deaths of females of reproductive age

GDP_i = gross domestic product per capita (in 2005 PPP dollars)

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

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

a_i = proportion of AIDS deaths among total deaths to women aged 15–49

ε_i = error term.

The model was estimated using the 'lme4' package[28] in the R statistical language.[29]

Use of a non-zero offset, $\log(1-a)$, changes the interpretation of the regression model, which becomes a predictive model for log(*AMDF*) rather than log(*PMDF*), since, in general:

$$AMDF = \text{AIDS-adjusted } PMDF = \frac{PMDF}{1-a}$$

Only non-HIV-related maternal deaths are included in the numerator of the PMDF used as the dependent variable of the regression model. The AMDF defined in this manner minimizes the influence of the HIV epidemic on observed PMDF values by removing HIV/AIDS deaths from both the numerator and the denominator.

The model was fitted to the complete set of observations for 172 countries. Observations from civil registration data were collapsed into five-year time periods, and each such observation received a weight of one in the regression model. Most other data sources (a single survey, census, special study, etc.) yielded a single observation referring to some 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 PMDF using the model, country covariate data and relevant country and regional effects were used. For countries with data available on maternal mortality, predictions 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 for indirect maternal deaths due to HIV/AIDS (see below), predicted PMDF values were converted to estimates of the MMR as follows:

$$MMR = PMDF \frac{D}{B}$$

where D is the number of female deaths at ages 15–49 estimated from WHO death rates,[19] and UNPD[20] population estimates, and B is the number of live births from UNPD population estimates.[20]

Estimation of indirect HIV maternal deaths

For countries with high HIV/AIDS prevalence, HIV/AIDS has become a leading cause of death during pregnancy and the postpartum period. There is also some evidence from community studies that women with HIV infection have a higher risk of maternal death, although this may be offset by lower fertility.[30–32] If HIV is prevalent, then there will also be more incidental deaths among pregnant women. 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 MMEIG/TAG examined several approaches for dealing with this issue and adopted a strategy that involves further adjustment of observed PMDF values to create a set of observations for a "maternal, non-HIV-related" PMDF. Thus, the dependent variable of the regression model described above includes only "maternal" deaths properly defined but excludes all HIV/AIDS deaths from "pregnancy-related" observations (even HIV/AIDS deaths that could properly be termed "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 indirect maternal deaths due to HIV/AIDS 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 of intervals 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.

For estimates derived from the multilevel regression model, the components of uncertainty were divided into two groups: those reflected within the regression model (internal sources), and those due to assumptions or calculations that occur outside the model (external sources). Estimates of the total uncertainty reflect a combination of these various sources.

The internal component includes only the inferential uncertainty affecting the estimates themselves, and not the additional uncertainty of prediction with respect to individual data points. The external component includes uncertainty regarding assumptions for key parameters that are inputs to the modelling process (e.g. adjustment factors applied to observed data), along with uncertainty about data inputs to calculations that occur outside the model in the process of deriving the final estimates.

For estimates computed directly from civil registration data, the external component of uncertainty was treated in the same manner as described above. For the internal component, however, the regression analysis was replaced by a simple model of stochastic variation as a function of population size.

To obtain the intervals presented here, all components of estimation uncertainty were depicted by probability distributions. For the internal component, the parameters of these distributions were obtained from the output of the regression model (using 'lme4' in R).[28,29] For the external component, distributions were chosen by assumption after considering a range of plausible alternatives and assessing the sensitivity of final estimates to choices within that range. After simulating the combined effect of these components on the estimation process, uncertainty intervals were chosen by computing the 2.5th and 97.5th percentiles of a simulated distribution of estimates. Details can be found at the web page: www.who.int/reproductivehealth/publications/monitoring/9789241500265/en/index.html.

3.3 Calculation of adult lifetime risk of maternal mortality

In countries where there is a high risk of maternal death, many girls die in childhood before reaching reproductive age. For this reason, it makes sense to consider the lifetime risk of maternal mortality conditional on survival to adulthood. Data presented here include estimates of *adult lifetime risk of maternal mortality,* which equals the probability that a 15-year-old female will die eventually from a maternal cause if she experiences throughout her lifetime the risks of maternal death and the overall levels of fertility and mortality that are observed for a given population.

The adult lifetime risk of maternal mortality can be derived using either the maternal mortality ratio, MMR, or the maternal mortality rate, 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[33] as shown in Box 4. This formula yields an estimate of the adult lifetime risk that takes into account competing causes of

Box 4. Formula for estimating adult lifetime risk

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

where ℓ_{15}, T_{15}, and T_{50} are quantities from a life table for the female population during the period in question (ℓ_{15} equals the probability of survival from birth until age 15, and $\left(T_{15} - T_{50}\right)/\ell_{15}$ equals the average number of years lived between ages 15 and 50 – up to a maximum of 35 years – among survivors to age 15).

death. The 2008 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 6, 8,10, 12, and 14.

3.4 Global and regional estimates

Global and regional maternal mortality estimates (according to the MDG, WHO, UNICEF, UNFPA, The World Bank and UNPD 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 $\left(T_{15} - T_{50}\right)/\ell_{15}$ for a given region multiplied by the MMRate of that region.

3.5 Differences in the 2008 methodology compared with 2005

There were substantial differences in the methods used for the 2008 maternal mortality estimation compared with those for 2005.[2]

- Compared with the 2005 estimates, the database employed for this exercise was much larger, consisting of 2961 country-years of data across 172 countries, of which 2010 country-years derive from civil registration data, 819 from survey-based sisterhood data, and the remainder from surveillance systems, censuses, and other sources.
- Previous interagency estimates of maternal mortality used a regression model to generate PMDF estimates referring to a single point in time. The model was used to obtain out-of-sample predictions of PMDF for countries without recent data, and used the most recent PMDF observation for countries with data. In the current round of estimation, a multilevel regression model was developed to derive estimates of maternal deaths at multiple time points from 1990 to 2008. The multilevel approach (with random intercepts for both countries and regions) offers 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.
- Unlike the 2005 estimation, this round of estimation took into consideration the issue of incidental and indirect maternal deaths among HIV-positive women in estimating maternal mortality for countries with high HIV/AIDS prevalence (described in detail in Appendix 5).
- In the approach for the 2008 estimates, an effort was made to exclude incidental deaths during pregnancy in order to better capture true maternal deaths.
- For the 2008 estimates, countries were classified into just three groups on the basis of available data (as noted above) instead of the eight groups used for the 2005 estimates (the latter were based on the data source used for deriving an estimate for the most recent time period). One reason for this change is that for the 2008 estimation some countries had multiple data sources over time so that they could not be assigned to a single data source. For instance, El Salvador had data from civil registration (which was not complete), reproductive health surveys and RAMOS; Turkey has moved from one-time special studies to ongoing surveillance systems to improve data quality.

3.6 Differences from other recent estimates

Recently, an academic institute (Institute of Health Metrics and Evaluation – IHME) published estimates of maternal mortality for 181 countries using an alternative statistical methodology.[3] There are differences in various aspects of the IHME study and this interagency analysis by MMEIG/TAG described here. These include:

- Input data: the type of data sources and adjustments made to data from various sources (e.g. to sibling history data) differed. The interagency estimates used only nationally representative data, while the IHME study used subnational data in some cases.
- Statistical models: modelling strategies differed.

- Covariates: the IHME analysis used total fertility rate, GDP, HIV prevalence, neonatal mortality rate, and female education, while the interagency analysis used GDP, GFR, and SAB.
- Addressing HIV: the IHME analysis used HIV prevalence as a covariate for the model which included HIV/AIDS-related maternal deaths in the output variable. The interagency analysis separately estimated the numbers of non-HIV related deaths and indirect maternal deaths due to HIV/AIDS, and combined them later.
- Number of female deaths at ages 15–49: both analyses applied the estimated PMDF to the estimated number of deaths to women at reproductive age. The life tables used for this application were different. Even if the estimated PMDFs from the two analyses were similar, differences in the number of deaths of women of reproductive age would contribute to different findings. The IHME used the life tables created by their institute, while this interagency analysis used the WHO life tables.
- Process: the interagency estimation involved a period of interaction with countries to give the opportunity to review the preliminary estimates, data sources and methods; to obtain additional data sources that may not have been used; and to build mutual understanding of the strengths and weaknesses of available data.

4. ANALYSIS AND INTERPRETATION OF 2008 ESTIMATES

4.1 Maternal mortality estimates for 2008

Table 2 and Annex 1 present the estimates of MMR, the range of uncertainty of MMR estimates, the number of maternal deaths, and the lifetime risk by MDG regional groupings and by country, respectively. Although the point estimates are considered the most likely levels of MMR, the uncertainty ranges are intervals estimated to contain the true MMR with 95% probability.

For 2008, there were an estimated 358 000 maternal deaths in the world, or a maternal mortality ratio (MMR) of 260 maternal deaths per 100 000 live births. There is a range of uncertainty around both estimates, suggesting that the true number of maternal deaths in 2008 could plausibly have been as low as 265 000 or as high as 503 000. Likewise, the plausible range for the global MMR in 2008 extends from 200 to 370.

Of the estimated total of 358 000 maternal deaths worldwide, developing countries accounted for 99% (355 000) (Table 2). Nearly three fifths of the maternal deaths (204 000) occurred in the sub-Saharan Africa region alone, followed by South Asia (109 000). Thus, sub-Saharan Africa and South Asia accounted for 87% (313 000) of global maternal deaths. The MMR in 2008 was highest in developing regions (290) in stark contrast to developed regions (14) and countries of the Commonwealth of Independent States (40). Among the developing regions, sub-Saharan Africa had the highest MMR at 640 maternal deaths per 100 000 live births in 2008, followed by South Asia (280), Oceania (230), South-Eastern Asia (160), North Africa (92), Latin America and the Caribbean (85), Western Asia (68), and Eastern Asia (41).

By country (Annex 1), India had the largest number of maternal deaths (63 000), followed by Nigeria (50 000), the Democratic Republic of the Congo (19 000), Afghanistan (18 000), Ethiopia (14 000), Pakistan (14 000), the United Republic of Tanzania (14 000), Bangladesh (12 000), Indonesia (10 000), Sudan (9700), and Kenya (7900). These 11 countries comprised an estimated 65% of the global maternal deaths reported in 2008. In contrast, 27 countries (all middle- or high-income countries) had five or fewer maternal deaths in 2008.

As shown in Annexes 1 and 2, 45 countries had high MMR (defined as MMR ≥300 maternal deaths per 100 000 live births) with four countries (Afghanistan, Chad, Guinea-Bissau, and Somalia), having extremely high MMR (defined as MMR ≥1000 maternal deaths per 100 000 live births). In 2008, the 10 highest MMR countries in sub-Saharan Africa in descending order were: Chad (1200), Somalia (1200), Guinea-Bissau (1000), Liberia (990), Burundi (970), Sierra Leone (970), the Central African Republic (850), Nigeria (840), Mali (830), and Niger (820). Although most sub-Saharan African countries had high MMR, Mauritius and Cape Verde had low MMR (defined as MMR 20–99 maternal deaths per 100 000 live births), while Namibia and Botswana had moderate MMR (defined as MMR 100–299 maternal deaths per 100 000 live births). Outside sub-Saharan Africa, the seven countries with high MMR were Afghanistan (1400), the Lao People's Democratic Republic (580), Nepal (380), Timor-Leste (370), Bangladesh (340), Haiti (300), and Cambodia (290).

Among developing regions, the adult lifetime risk of maternal death (the probability that a 15-year-old female will die eventually from a maternal cause) is highest in sub-Saharan Africa (at 1 in 31), followed by Oceania (1 in 110) and South Asia (1 in 120), while the developed regions had the smallest lifetime risk (1 in 4300). Of all 172 countries and territories for which estimates were made, Afghanistan had the highest estimated lifetime risk of 1 in 11.

Appendices 6, 8, 10, 12, and 14 present the MMR, number of maternal deaths, and adult lifetime risk for WHO, UNICEF, UNFPA, The World Bank, and UNPD regions, respectively.

Overall, it was estimated that there were 42 000 deaths due to HIV/AIDS among pregnant women. About half of those were assumed to be maternal (21 000, u=0.5; see Appendix 5). The contribution of

HIV/AIDS was highest in sub-Saharan Africa where 9% of all maternal deaths were due to HIV/AIDS as shown in Table 3. Without HIV/AIDS, the MMR for sub-Saharan Africa would have been 580 maternal deaths per 100 000 live births instead of 640.

Estimates of MMR trends, 1990–2008

The methodological approach used to estimate maternal mortality in this round of MMEIG/TAG estimates is substantially different from the ones used in the earlier rounds. In addition, more input data were available for the analysis of this round as a result of consultations with countries and the increased attempts by countries to measure the MMR in recent years. Therefore, the findings of this exercise should not be compared with the earlier MMEIG published estimates.[1,2] This exercise generated updated MMR figures for years 1990, 1995, 2000, 2005 and 2008 with new and improved methodology. The findings, presented in Annex 3, allow analysis of trends in maternal mortality between 1990 and 2008.

Table 4 shows the comparison of the MDG regional groupings of maternal mortality estimates for 1990 and 2008 and the percentage change in the MMR between 1990 and 2008 (similar tables for the different regional groupings for WHO, UNICEF, UNFPA, The World Bank, and UNPD are shown in Appendices 7, 9, 11, 13, and 15, respectively). Worldwide, maternal deaths fell from 546 000 in 1990 to 358 000 in 2008 while the MMR declined by 34% from 400 in 1990 to 260 in 2008 (Table 4). Annually, the MMR declined 2.3% (uncertainty interval 1.8 to 2.8).

Table 2. Estimates of maternal mortality ratio (MMR, deaths per 100 000 live births), number of maternal deaths, and lifetime risk by United Nations MDG regions, 2008

Region	Estimated MMR[a]	Number of maternal deaths[a]	Lifetime risk of maternal death[a]: 1 in:	Range of uncertainty on MMR estimates	
				Lower estimate	Upper estimate
WORLD TOTAL	260	358 000	140	200	370
Developed regions[b]	14	1700	4300	13	16
Countries of the Commonwealth of Independent States (CIS)[c]	40	1500	1500	34	48
Developing regions	290	355 000	120	220	410
Africa	590	207 000	36	430	850
Northern Africa[d]	92	3400	390	60	140
Sub-Saharan Africa	640	204 000	31	470	930
Asia	190	139 000	220	130	270
Eastern Asia	41	7800	1400	27	66
South Asia	280	109 000	120	190	420
South-Eastern Asia	160	18 000	260	110	240
Western Asia	68	3300	460	45	110
Latin America and the Caribbean	85	9200	490	72	100
Oceania	230	550	110	100	500

[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: <1000, rounded to nearest 10; 1000–9999, rounded to nearest 100; and >10 000, rounded to nearest 1000.

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

[c] The CIS countries are Armenia, Azerbaijan, Belarus, Georgia, Kazakhstan, Kyrgyzstan, Tajikistan, Turkmenistan, the Republic of Moldova, the Russian Federation, and Uzbekistan.

[d] Excludes Sudan, which is included in sub-Saharan Africa.

By the broad MDG regions, all regions presented declines in MMR between 1990 and 2008, both in the total for the period and annually. The total MMR percentage decline in developing regions was 34%, more than twice that of the developed regions of 13%. It is important to note that it is easier to reduce the MMR when levels are high than when they are low. Among the developing regions, Eastern Asia had the largest decline, 63%, followed by South-Eastern Asia 57%, South Asia 53%, Asia 52%, Western Asia 52%, Latin America and the Caribbean 41%, sub-Saharan Africa 26%, and Oceania 22%.

Annex 3 presents MMR estimates by country for the period 1990–2008, as well total and annual percentage change for the same period. Out of the 172 countries and territories that were covered in this exercise, between 1990 and 2008, there was no estimated change in MMR in 2 countries, while 23 countries had an increase in MMR and 147 countries experienced total MMR percentage declines. The list of the 90 countries with a decline of 40% or more in the MMR between 1990 and 2008 is presented in Annex 4.

Among sub-Saharan African countries, it is estimated that the largest total percentage declines in MMR occurred in: Equatorial Guinea (–73%), Eritrea (–69%), Cape Verde (–58%), Ethiopia (–53%) and Rwanda (–51%). The five countries that experienced the estimated largest percentage increases were: Botswana (133%), Zimbabwe (102%), South Africa (80%), Swaziland (62%), and Lesotho (44%). The latter group of countries are all in Southern Africa, the subregion with the highest HIV prevalence in the world.

Table 3. Estimates of maternal mortality due to HIV/AIDS by United Nations MDG regions, 2008

Region	MMR (maternal deaths per 100 000 live births)[a]	HIV-specific maternal mortality ratio	Number of maternal deaths due to HIV/AIDS[a]	Percentage of maternal deaths due to HIV/AIDS	Number of maternal deaths[a]
WORLD TOTAL	260	15	21 000	5.8	358 000
Developed regions[b]	14	1	90	5.6	1700
Countries of the Commonwealth of Independent States (CIS)[c]	40	2	70	4.7	1500
Developing regions	290	17	21 000	5.8	355 000
Africa	590	52	18 000	8.9	207 000
Northern Africa[d]	92	0	10	0.3	3400
Sub-Saharan Africa	640	58	18 000	9.0	204 000
Asia	190	2	1700	1.2	139 000
Eastern Asia	41	0	80	1.0	7800
South Asia	280	3	1300	1.2	109 000
South-Eastern Asia	160	3	310	1.7	18 000
Western Asia	68	0	0	0	3300
Latin America and the Caribbean	85	4	480	5.2	9200
Oceania	230	2	10	1.1	550

[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: <1000, rounded to nearest 10; 1000–9999, rounded to nearest 100; and >10 000, rounded to nearest 1000.

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

[c] The CIS countries are Armenia, Azerbaijan, Belarus, Georgia, Kazakhstan, Kyrgyzstan, Tajikistan, Turkmenistan, the Republic of Moldova, the Russian Federation, Ukraine, and Uzbekistan.

[d] Excludes Sudan, which is included in sub-Saharan Africa.

Issues to consider in using the 2008 maternal mortality estimates

The estimates for 2008 provided in this report are the fifth in a series of attempts by the UN agencies to examine the likely global dimensions of the problem of maternal mortality. Several issues should be considered in using these estimates.

First, it should be noted that the data and methods have improved over time. The 2008 estimates should not be compared with those from the previous exercises to assess changes in time. Trends in maternal mortality calculated using the same improved methodology and presented for years 1990, 1995, 2000, 2005, and 2008 in this report show the changes over time.

Second, depending on the type of data source used, the primary data for individual countries had to be adjusted for specific characteristics. These characteristics included the extent of potential underreporting of maternal deaths, which is an issue even in highly developed civil registration systems, to obtain MMR estimates that are comparable across study designs. Such an adjustment allows regional and global aggregation. For this reason, the presented point estimates usually differ from the country-reported figures.

Third, despite the improved methodology, the global database on maternal mortality remains weak. Only slightly over a third of countries/territories have complete civil registration systems and good attribution of cause of death (Group A). The ability to generate country, regional, and global estimates with higher precision and accuracy would be greatly facilitated if country civil registration systems were further improved. This improvement would obviate

Table 4. Comparison of 1990 and 2008 maternal mortality by United Nations MDG regions

Region	1990[a]		2008[a]		% change in MMR between 1990 and 2008	Annual % change in MMR between 1990 and 2008
	MMR	Maternal deaths	MMR	Maternal deaths		
WORLD TOTAL	400	546 000	260	358 000	–34	–2.3
Developed regions[b]	16	2000	14	1700	–13	–0.8
Countries of the Commonwealth of Independent States (CIS)[c]	68	3200	40	1500	–41	–3.0
Developing regions	450	540 000	290	355 000	–34	–2.3
Africa	780	208 000	590	207 000	–25	–1.6
Northern Africa[d]	230	8600	92	3400	–59	–5.0
Sub-Saharan Africa	870	199 000	640	204 000	–26	–1.7
Asia	390	315 000	190	139 000	–52	–4.0
Eastern Asia	110	29 000	41	7800	–63	–5.5
South Asia	590	234 000	280	109 000	–53	–4.2
South-Eastern Asia	380	46 000	160	18 000	–57	–4.7
Western Asia	140	6100	68	3300	–52	–4.0
Latin America and the Caribbean	140	17 000	85	9200	–41	–2.9
Oceania	290	540	230	550	–22	–1.4

[a] The 1990 estimates have been revised using the same methodology used for 2008, which make them comparable. The MMRs 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.

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

[c] The CIS countries are Armenia, Azerbaijan, Belarus, Georgia, Kazakhstan, Kyrgyzstan, Tajikistan, Turkmenistan, the Republic of Moldova, the Russian Federation, Ukraine, and Uzbekistan.

[d] Excludes Sudan, which is included in sub-Saharan Africa.

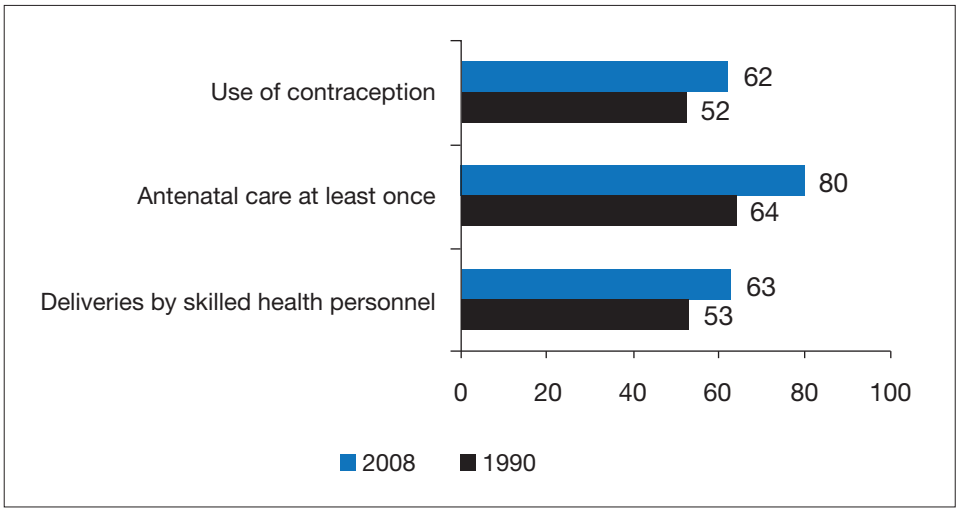
the need to conduct special maternal mortality studies – which are time-consuming, expensive, and of limited use in monitoring trends – or to employ statistical models that have their own weaknesses.

Potential reasons for declining maternal mortality

Several reasons, from improvement in health systems to increased female education, could account for the decline in maternal mortality during 1990–2008. In developing regions, not only has the MMR declined but also other MDG 5 indicators have improved during the same period. For instance, as shown in Figure 1, in developing regions the proportion of deliveries attended by skilled health personnel rose from 53% in 1990 to 63% in 2008.[34] Similarly, the proportion of women attended at least once during pregnancy by skilled health-care personnel increased from 64% to 80%, while the proportion of women aged 15–49 who are using any method of contraception also increased from 52% to 62%.

Improvement in the coverage of these health-care interventions over the past two decades may have contributed to improved outcomes. For example, Eastern Asia, which experienced the greatest MMR decline, has a contraceptive prevalence rate of 86% 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 focus on increasing access to effective interventions, and on improving quality of health care.

Figure 1. Improved reproductive health indicators in developing regions, 1990 and 2008 (percentage)



For contraception, data were available for 1990–2007.

Source: United Nations. *The Millennium Development Goals Report 2010.*

5. IS THE FIFTH MDG ACHIEVABLE?

The fifth MDG aims to improve maternal health with a target of reducing the MMR by 75% between 1990 and 2015. That is, it seeks to achieve an average annual decline of 5.5% in the MMR from 1990 to 2015. According to these new estimates, both the number of maternal deaths and the MMR fell by a third or more since 1990. Globally the average annual percentage decline in the MMR between 1990 and 2008 was 2.3%. None of the broad MDG regions was on track to achieve MDG 5, except Eastern Asia with a 5.5% annual decline (Table 4). Oceania and sub-Saharan Africa have made the least progress at 1.4% and 1.7%, respectively. Fourteen countries achieved an average annual decline of 5.5% or more between 1990 and 2008: Bhutan, Bolivia (Plurinational State of), China, Egypt, Equatorial Guinea, Eritrea, Estonia, Iran (Islamic Republic of), Latvia, Maldives, Poland, Romania, Turkey, and Viet Nam (Annex 3).

To measure progress, countries with an 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 annual percentage decline between 1990 and 2008 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". As shown in Annex 3, of the 87 countries with an MMR ≥100 in 1990, 10 countries are considered to be "on track" to improving maternal health, 47 countries have been "making progress", 22 have made "insufficient progress" and 8 have made "no progress". In sub-Saharan Africa only Equatorial Guinea, and Eritrea and are "on track", while three countries in South Asia (Bhutan, Iran (Islamic Republic of), Maldives) are also "on track".

The international community has been increasingly concerned about the fairly slow progress in improving maternal health. During 2010, the United Nations Secretary-General launched the Global Strategy for Women's and Children's Health, which seeks to catalyse action for renewed and enhanced commitments by all partners for adequate financing and policy to improve women's and children's health.[35] The commitments would support the following elements to accelerate progress towards MDG 5:

- **Country-led health plans** – development partners to support governments to implement country-led plans to improve access to reproductive health services.
- **A comprehensive, integrated package of essential interventions and services** – women and children should have access to a package of integrated services including family planning, antenatal care, skilled care at birth, emergency obstetric and newborn care, safe abortion services (where abortion is not prohibited by law) and prevention of mother-to-child transmission of HIV services.
- **Health systems strengthening** – development partners to support governments to strengthen health systems to deliver high-quality services particularly in underserved communities.
- **Health workforce capacity building** – development partners to work with governments to address the critical shortage of health workers by implementing national plans to train, retain and deploy health workers.
- **Coordinated research and innovation** – development partners to develop, fund and implement a prioritized, coordinated and innovative research agenda for women's and children's health.

Fulfilling these commitments in line with the elements of the Global Strategy for Women's and Children's Health should help advance progress in maternal health.

ANNEXES

Annex 1. Estimates of maternal mortality ratio (MMR, deaths per 100 000 live births), number of maternal deaths and lifetime risk (2008)

Country	Estimated MMR[a]	Range of uncertainty on MMR estimates		Number of maternal deaths[a]	Lifetime risk of maternal death[a]: 1 in:	Proportion of maternal deaths due to HIV(%)[b]	PMDF[c] (%)	Group[d]
		Lower estimate	Upper estimate					
Afghanistan	1400	740	2600	18 000	11		39.8	B
Albania	31	19	50	14	1700		1.5	B
Algeria	120	61	220	840	340		6.2	B
Angola	610	270	1400	4800	29		15.3	C
Argentina	70	61	77	480	600		4.8	A
Armenia	29	18	45	14	1900		1.4	B
Australia	8	6	10	20	7400		0.6	A
Austria	5	5	6	4	14 300		0.3	A
Azerbaijan	38	24	60	63	1200		1.6	B
Bahamas	49	38	57	3	1000		1.5	A
Bahrain	19	11	30	3	2200		1.8	B
Bangladesh	340	170	660	12 000	110		8	B
Barbados	64	55	72	2	1100		1.6	A
Belarus	15	12	20	15	5100		0.4	A
Belgium	5	4	7	6	10 900		0.3	A
Belize	94	56	140	7	330		5.6	A
Benin	410	250	690	1400	43		15.1	B
Bhutan	200	110	370	30	170		6.6	B
Bolivia (Plurinational State of)	180	120	280	470	150		9.2	B
Bosnia and Herzegovina	9	5	16	3	9300		0.4	B
Botswana	190	84	380	91	180	77.9	2.1	B
Brazil	58	38	87	1800	860		2.6	B
Brunei Darussalam	21	13	34	2	2000		1.9	B
Bulgaria	13	11	15	9	5800		0.4	A
Burkina Faso	560	330	950	4000	28		17	B
Burundi	970	410	2300	2700	25		17.4	C
Cambodia	290	180	480	1100	110		8.4	B
Cameroon	600	360	960	4200	35	14.2	11.6	B
Canada	12	7	20	42	5600		0.7	A
Cape Verde	94	39	210	11	350		6	C
Central African Republic	850	490	1400	1300	27	11.6	12.1	B
Chad	1200	670	2100	5900	14		27.8	B
Chile	26	15	43	64	2000		2	A
China	38	23	60	6900	1500		1.9	B
Colombia	85	74	94	780	460		6.5	A
Comoros	340	140	780	72	71		12.7	C
Congo	580	330	1000	720	39	11.8	11.8	B
Costa Rica	44	24	82	33	1100		3.5	A
Côte d'Ivoire	470	290	730	3400	44	15.2	10.5	B
Croatia	14	11	17	6	5200		0.7	A
Cuba	53	36	76	63	1400		2.2	A
Cyprus	10	4	23	<2	6600		0.9	C
Czech Republic	8	5	12	9	8500		0.5	A

Annex 1. continued

Country	Estimated MMR[a]	Range of uncertainty on MMR estimates		Number of maternal deaths[a]	Lifetime risk of maternal death[a]: 1 in:	Proportion of maternal deaths due to HIV(%)[b]	PMDF[c] (%)	Group[d]
		Lower estimate	Upper estimate					
Democratic People's Republic of Korea	250	84	690	810	230		5.4	C
Democratic Republic of the Congo	670	340	1300	19 000	24		19.7	B
Denmark	5	5	6	3	10 900		0.4	A
Djibouti	300	140	610	73	93	14.9	6.8	C
Dominican Republic	100	62	170	240	320	12.2	5.5	B
Ecuador	140	81	230	380	270		6.6	B
Egypt	82	51	130	1600	380		5.8	B
El Salvador	110	71	170	140	350		4.8	B
Equatorial Guinea	280	130	630	70	73	12.6	6.3	C
Eritrea	280	160	510	520	72	6.6	15.5	B
Estonia	12	9	14	2	5300		0.5	A
Ethiopia	470	270	790	14 000	40		16.4	B
Fiji	26	14	48	5	1300		1.1	B
Finland	8	7	8	4	7600		0.5	A
France	8	5	14	63	6600		0.6	A
Gabon	260	150	420	100	110	26.1	5.2	B
Gambia	400	190	910	250	49		15.7	C
Georgia	48	30	76	25	1300		1.8	B
Germany	7	6	8	49	11 100		0.4	A
Ghana	350	210	600	2600	66	9.6	11.3	B
Greece	2	2	3	2	31 800		0.2	A
Guatemala	110	56	190	480	210		7.1	A
Guinea	680	390	1100	2700	26		21.2	B
Guinea-Bissau	1000	440	2300	650	18		25	C
Guyana	270	180	410	37	150		5.7	B
Haiti	300	180	520	820	93	7.3	9.3	B
Honduras	110	71	180	230	240		8	B
Hungary	13	10	17	13	5500		0.5	A
Iceland	5	5	6	<2	9400		0.6	A
India	230	150	350	63 000	140		8.2	B
Indonesia	240	140	380	10 000	190		6.1	B
Iran (Islamic Republic of)	30	18	50	420	1500		1.9	B
Iraq	75	41	140	710	300		4.9	B
Ireland	3	2	3	2	17 800		0.3	A
Israel	7	6	7	9	5100		1.2	A
Italy	5	4	6	26	15 200		0.3	A
Jamaica	89	60	120	47	450	8.9	3.4	B
Japan	6	5	8	65	12 200		0.4	A
Jordan	59	35	100	92	510		5.3	B
Kazakhstan	45	34	61	140	950		1.2	A
Kenya	530	320	850	7900	38	13.9	12	B
Kuwait	9	8	10	5	4500		1.4	A
Kyrgyzstan	81	50	130	97	450		3.1	B
Lao People's Democratic Republic	580	320	1000	980	49		14.5	B

Annex 1. continued

Country	Estimated MMR[a]	Range of uncertainty on MMR estimates		Number of maternal deaths[a]	Lifetime risk of maternal death[a]: 1 in:	Proportion of maternal deaths due to HIV(%)[b]	PMDF[c] (%)	Group[d]
		Lower estimate	Upper estimate					
Latvia	20	18	23	5	3600		0.5	A
Lebanon	26	14	48	17	2000		1.4	B
Lesotho	530	260	850	310	62	58.9	3.6	B
Liberia	990	520	1800	1400	20		27.5	B
Libyan Arab Jamahiriya	64	26	140	94	540		5.2	C
Lithuania	13	11	16	4	5800		0.3	A
Luxembourg	17	15	19	<2	3800		1.1	A
Madagascar	440	270	700	3000	45		19	B
Malawi	510	300	760	3000	36	31.8	9.1	B
Malaysia	31	14	68	170	1200		2.4	C
Maldives	37	21	64	2	1200		4.2	B
Mali	830	520	1400	4500	22		21.3	B
Malta	8	7	9	<2	9200		0.7	A
Mauritania	550	300	980	590	41		18.3	B
Mauritius	36	30	41	7	1600		1.6	A
Mexico	85	74	95	1700	500		6.2	A
Mongolia	65	27	150	32	730		2.4	C
Montenegro	15	8	26	<2	4000		0.8	B
Morocco	110	63	190	720	360		8.4	B
Mozambique	550	310	870	4800	37	25.5	8.7	B
Myanmar	240	140	410	2400	180		4.7	B
Namibia	180	93	270	100	160	50.1	3.4	B
Nepal	380	210	650	2800	80		9.3	B
Netherlands	9	7	10	16	7100		0.6	A
New Zealand	14	12	15	8	3800		1	A
Nicaragua	100	57	180	150	300		7.7	B
Niger	820	470	1400	6500	16		33.8	B
Nigeria	840	460	1500	50 000	23		17.9	B
Norway	7	4	12	4	7600		0.6	A
Oman	20	9	45	12	1600		2.4	C
Pakistan	260	140	490	14 000	93		12.8	B
Panama	71	58	84	50	520		5	A
Papua New Guinea	250	110	560	530	94		9.3	C
Paraguay	95	57	150	150	310		8	B
Peru	98	62	160	600	370		6.5	B
Philippines	94	61	140	2100	320		6.5	B
Poland	6	2	13	21	13 300		0.3	A
Portugal	7	5	10	8	9800		0.4	A
Puerto Rico	18	12	26	10	3000	19.8	1.1	B
Qatar	8	4	19	<2	4400		1.5	C
Republic of Korea	18	16	20	81	4700		0.9	A
Republic of Moldova	32	28	35	14	2000		0.9	A
Romania	27	17	44	57	2700		1	A
Russian Federation	39	33	46	600	1900		0.7	A
Rwanda	540	320	910	2200	35	5.0	18.6	B
Saudi Arabia	24	13	45	140	1300		2.2	B
Senegal	410	240	680	1900	46		18.1	B

Annex 1. continued

Country	Estimated MMR[a]	Range of uncertainty on MMR estimates		Number of maternal deaths[a]	Lifetime risk of maternal death[a]: 1 in:	Proportion of maternal deaths due to HIV(%)[b]	PMDF[c] (%)	Group[d]
		Lower estimate	Upper estimate					
Serbia	8	7	9	9	7500		0.4	A
Sierra Leone	970	530	1800	2200	21		22	B
Singapore	9	8	10	3	10 000		0.5	A
Slovakia	6	5	6	3	13 300		0.3	A
Slovenia	18	15	20	3	4100		1.1	A
Solomon Islands	100	44	240	16	230		8	C
Somalia	1200	510	2800	4800	14		34.5	C
South Africa	410	240	610	4500	100	42.5	2.8	B
Spain	6	5	7	28	11 400		0.4	A
Sri Lanka	39	26	57	140	1100		2.2	B
Sudan	750	420	1300	9700	32		19.4	B
Suriname	100	86	110	10	400		3.8	A
Swaziland	420	180	800	150	75	75.1	3	B
Sweden	5	3	8	5	11 400		0.5	A
Switzerland	10	8	11	7	7600		0.7	A
Syrian Arab Republic	46	20	100	270	610		3.9	C
Tajikistan	64	29	140	120	430		4.9	C
Thailand	48	32	68	470	1200	23.1	1.2	B
The former Yugoslav Republic of Macedonia	9	6	14	2	7300		0.5	A
Timor-Leste	370	150	860	160	44		24.2	C
Togo	350	210	600	740	67	14.6	9.2	B
Trinidad and Tobago	55	35	82	11	1100		1.7	A
Tunisia	60	32	110	98	860		4	B
Turkey	23	15	36	310	1900		1.8	B
Turkmenistan	77	33	190	85	500		2.3	C
Uganda	430	240	670	6300	35	24.0	11.3	B
Ukraine	26	20	33	120	3000		0.5	A
United Arab Emirates	10	4	24	7	4200		1.3	C
United Kingdom	12	11	14	90	4700		0.8	A
United Republic of Tanzania	790	470	1300	14 000	23	11.1	15.8	B
United States of America	24	20	27	1000	2100		1.3	A
Uruguay	27	22	33	14	1700		1.7	A
Uzbekistan	30	25	35	170	1400		1.5	A
Venezuela (Bolivarian Republic of)	68	59	75	400	540		4.6	A
Viet Nam	56	27	120	840	850	6.7	2.6	C
Yemen	210	110	400	1800	91		14.2	B
Zambia	470	250	680	2600	38	37.0	7.8	B
Zimbabwe	790	410	1200	3000	42	52.7	4.3	B

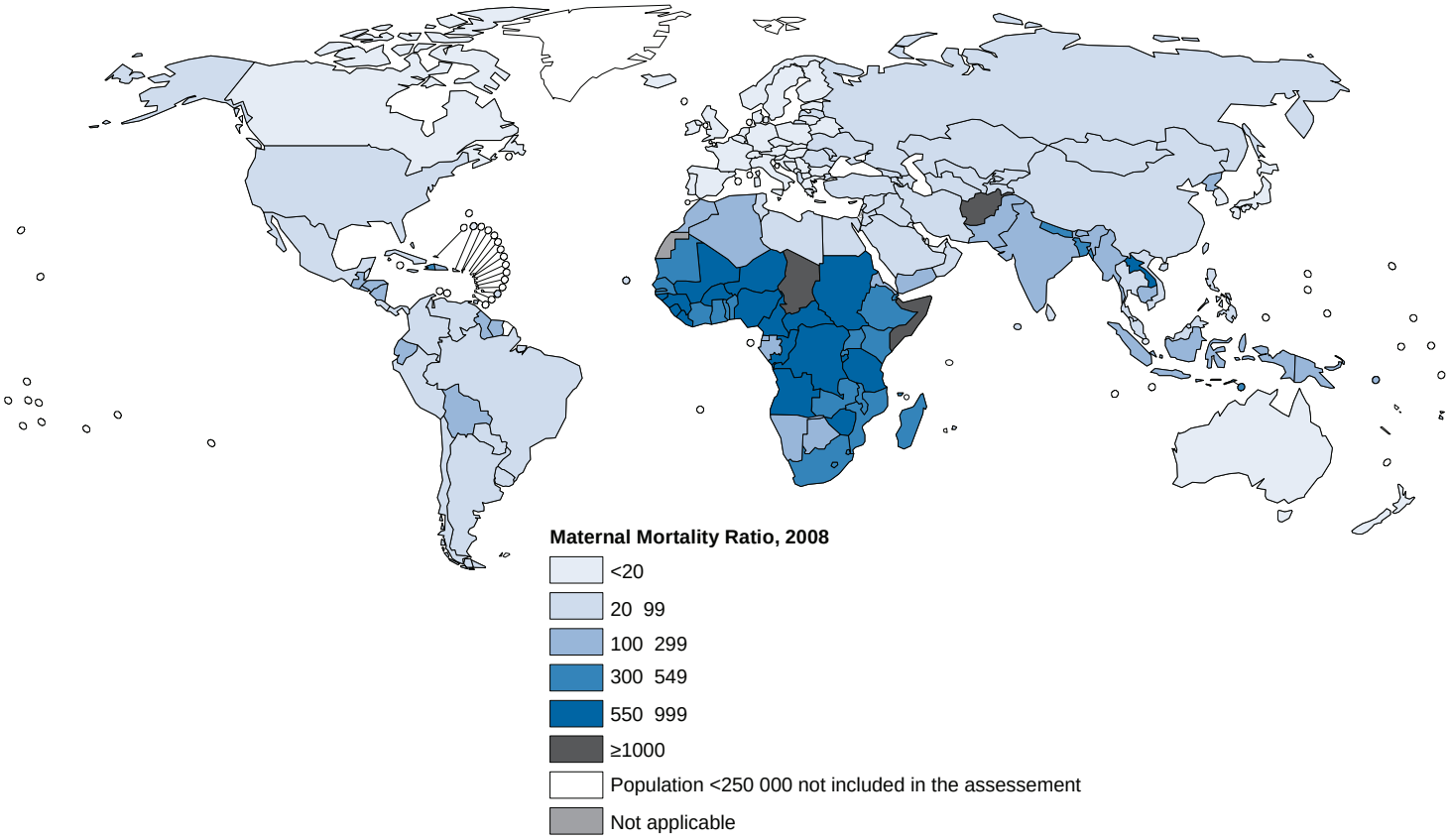
a The MMR and lifetime risk have been rounded according to the following scheme: <100, no rounding; 100–999, rounded to nearest 10; and >1000, rounded to nearest 100. The numbers of maternal deaths have been rounded as follows: <100, no rounding; 100–999 rounded to nearest 10; 1000–9999, rounded to nearest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

b The proportion of maternal deaths due to HIV/AIDS in countries with high HIV/AIDS prevalence. Data are not presented for countries without generalized HIV epidemic.

c The proportion of maternal deaths among females of reproductive age (PMDF).

d Group A=63 countries with good civil registration systems; Group B=85 countries with modelled MMR estimates using available country data; Group C=24 countries with modelled MMR estimates but with no available maternal mortality data.

Annex 2. Map with countries by category according to their maternal mortality ratio (MMR, deaths per 100 000 live births), 2008



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 World Health Organization 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 on maps represent approximate border lines for which there may not yet be full agreement.

Annex 3. Comparison of 1990, 1995, 2000, 2005, and 2008 estimates of maternal mortality ratio (MMR, deaths per 100 000 live births) by country

Country	Estimated MMR[a]					% change in MMR between 1990 and 2008	Annual % change in MMR between 1990 and 2008[b]	Progress towards improving maternal health[c]
	1990	1995	2000	2005	2008			
Afghanistan	1700	1800	1800	1500	1400	–17	–1.0	insufficient progress
Albania	48	44	41	34	31	–35	–2.4	
Algeria	250	180	140	120	120	–53	–4.1	making progress
Angola	1000	1000	880	720	610	–41	–2.9	making progress
Argentina	72	61	63	70	70	–3	–0.2	
Armenia	51	44	34	32	29	–44	–3.2	
Australia	10	13	9	8	8	–22	–1.4	
Austria	10	7	5	5	5	–48	–3.7	
Azerbaijan	64	79	59	44	38	–41	–2.9	
Bahamas	55	59	56	48	49	–11	–0.7	
Bahrain	25	22	23	21	19	–25	–1.6	
Bangladesh	870	640	500	420	340	–61	–5.3	making progress
Barbados	120	42	50	62	64	–47	–3.5	making progress
Belarus	37	28	31	20	15	–58	–4.8	
Belgium	7	7	6	5	5	–20	–1.2	
Belize	72	32	100	94	94	32	1.5	
Benin	790	690	560	460	410	–48	–3.6	making progress
Bhutan	940	650	420	260	200	–79	–8.6	on track
Bolivia (Plurinational State of)	510	410	300	220	180	–65	–5.8	on track
Bosnia and Herzegovina	18	15	11	10	9	–50	–3.8	
Botswana	83	130	310	280	190	133	4.7	
Brazil	120	98	79	64	58	–52	–4.0	making progress
Brunei Darussalam	28	25	24	23	21	–23	–1.4	
Bulgaria	24	23	28	14	13	–49	–3.7	
Burkina Faso	770	730	650	600	560	–27	–1.8	insufficient progress
Burundi	1200	1200	1200	1100	970	–17	–1.0	insufficient progress
Cambodia	690	640	470	350	290	–58	–4.8	making progress
Cameroon	680	680	660	640	600	–12	–0.7	insufficient progress
Canada	6	7	7	12	12	94	3.7	
Cape Verde	230	200	170	120	94	–58	–4.9	making progress
Central African Republic	880	890	900	910	850	–3	–0.2	insufficient progress
Chad	1300	1300	1300	1200	1200	–5	–0.3	insufficient progress
Chile	56	40	29	26	26	–54	–4.3	
China	110	82	60	44	38	–66	–6.0	on track
Colombia	140	120	110	85	85	–41	–2.9	making progress
Comoros	530	450	390	360	340	–36	–2.5	making progress
Congo	460	520	590	590	580	26	1.3	no progress
Costa Rica	35	42	41	43	44	25	1.3	
Côte d'Ivoire	690	620	580	530	470	–31	–2.1	making progress
Croatia	8	14	11	14	14	64	2.8	

Annex 3. continued

Country	Estimated MMR[a]					% change in MMR between 1990 and 2008	Annual % change in MMR between 1990 and 2008[b]	Progress towards improving maternal health[c]
	1990	1995	2000	2005	2008			
Cuba	63	62	65	53	53	–16	–1.0	
Cyprus	17	17	14	11	10	–41	–3.0	
Czech Republic	15	9	7	7	8	–49	–3.8	
Democratic People's Republic of Korea	270	270	260	250	250	–7	–0.4	insufficient progress
Democratic Republic of the Congo	900	910	850	740	670	–26	–1.7	insufficient progress
Denmark	7	11	5	4	5	–27	–1.8	
Djibouti	370	350	330	320	300	–19	–1.2	insufficient progress
Dominican Republic	220	170	120	100	100	–52	–4.1	making progress
Ecuador	230	190	170	140	140	–40	–2.9	making progress
Egypt	220	150	110	90	82	–63	–5.5	on track
El Salvador	200	170	140	120	110	–44	–3.2	making progress
Equatorial Guinea	1000	900	480	320	280	–73	–7.3	on track
Eritrea	930	590	420	330	280	–69	–6.6	on track
Estonia	48	46	14	23	12	–76	–7.9	
Ethiopia	990	920	750	560	470	–53	–4.2	making progress
Fiji	40	36	32	28	26	–34	–2.3	
Finland	7	5	5	6	8	16	0.8	
France	13	13	10	8	8	–35	–2.4	
Gabon	260	250	260	260	260	–2	–0.1	insufficient progress
Gambia	750	690	560	460	400	–46	–3.4	making progress
Georgia	58	64	50	52	48	–17	–1.0	
Germany	13	9	7	7	7	–42	–3.0	
Ghana	630	540	500	400	350	–44	–3.3	making progress
Greece	6	2	5	3	2	–60	–5.2	
Guatemala	140	140	110	110	110	–27	–1.7	insufficient progress
Guinea	1200	1100	920	780	680	–43	–3.2	making progress
Guinea-Bissau	1200	1100	1100	1100	1000	–16	–1.0	insufficient progress
Guyana	310	250	120	190	270	–12	–0.7	insufficient progress
Haiti	670	620	450	350	300	–55	–4.4	making progress
Honduras	210	180	160	130	110	–47	–3.5	making progress
Hungary	23	23	10	10	13	–43	–3.2	
Iceland	8	7	6	6	5	–33	–2.2	
India	570	470	390	280	230	–59	–4.9	making progress
Indonesia	620	440	350	270	240	–62	–5.4	making progress
Iran (Islamic Republic of)	150	90	59	38	30	–80	–8.9	on track
Iraq	93	94	84	82	75	–19	–1.2	
Ireland	6	4	6	2	3	–57	–4.6	
Israel	12	10	9	7	7	–43	–3.1	
Italy	10	6	4	5	5	–53	–4.2	
Jamaica	66	76	91	87	89	36	1.7	

Annex 3. continued

Country	Estimated MMR[a]					% change in MMR between 1990 and 2008	Annual % change in MMR between 1990 and 2008[b]	Progress towards improving maternal health[c]
	1990	1995	2000	2005	2008			
Japan	12	9	9	7	6	–49	–3.7	
Jordan	110	95	79	66	59	–48	–3.6	making progress
Kazakhstan	78	76	59	45	45	–42	–3.0	
Kenya	380	460	560	580	530	38	1.8	no progress
Kuwait	10	10	8	9	9	–8	–0.4	
Kyrgyzstan	77	98	81	78	81	5	0.3	
Lao People's Democratic Republic	1200	970	790	650	580	–51	–4.0	making progress
Latvia	57	58	42	21	20	–64	–5.7	
Lebanon	52	45	36	29	26	–50	–3.8	
Lesotho	370	340	470	570	530	44	2.0	no progress
Liberia	1100	1400	1100	1100	990	–14	–0.8	insufficient progress
Libyan Arab Jamahiriya	100	85	74	68	64	–39	–2.7	making progress
Lithuania	34	21	20	12	13	–61	–5.2	
Luxembourg	6	11	11	17	17	170	5.5	
Madagascar	710	680	580	490	440	–38	–2.6	making progress
Malawi	910	830	770	620	510	–44	–3.2	making progress
Malaysia	56	46	39	34	31	–44	–3.2	
Maldives	510	240	110	52	37	–93	–14.6	on track
Mali	1200	1100	980	880	830	–31	–2.1	making progress
Malta	14	12	11	9	8	–41	–2.9	
Mauritania	780	710	640	590	550	–30	–2.0	making progress
Mauritius	72	67	28	32	36	–50	–3.9	
Mexico	93	85	90	87	85	–8	–0.5	
Mongolia	130	110	93	79	65	–48	–3.6	making progress
Montenegro	15	18	20	17	15	1	0	
Morocco	270	220	160	130	110	–59	–5.0	making progress
Mozambique	1000	890	780	640	550	–47	–3.5	making progress
Myanmar	420	350	290	250	240	–43	–3.1	making progress
Namibia	180	170	220	240	180	–3	–0.2	insufficient progress
Nepal	870	700	550	440	380	–56	–4.6	making progress
Netherlands	10	11	13	8	9	–16	–1.0	
New Zealand	18	13	12	14	14	–22	–1.4	
Nicaragua	190	170	140	110	100	–44	–3.2	making progress
Niger	1400	1300	1100	910	820	–43	–3.1	making progress
Nigeria	1100	1100	980	900	840	–24	–1.5	insufficient progress
Norway	9	4	8	9	7	–21	–1.3	
Oman	49	35	27	22	20	–60	–5.1	
Pakistan	490	410	340	290	260	–48	–3.6	making progress
Panama	86	71	71	71	71	–18	–1.1	
Papua New Guinea	340	300	290	270	250	–25	–1.6	insufficient progress
Paraguay	130	120	110	100	95	–28	–1.8	insufficient progress
Peru	250	220	160	120	98	–61	–5.2	making progress

Annex 3. continued

Country	Estimated MMR[a]					% change in MMR between 1990 and 2008	Annual % change in MMR between 1990 and 2008[b]	Progress towards improving maternal health[c]
	1990	1995	2000	2005	2008			
Philippines	180	140	120	110	94	–48	–3.6	making progress
Poland	17	14	8	5	6	–67	–6.2	
Portugal	15	10	9	8	7	–51	–3.9	
Puerto Rico	29	31	23	19	18	–37	–2.6	
Qatar	15	13	11	9	8	–46	–3.4	
Republic of Korea	18	18	19	18	18	1	0	
Republic of Moldova	62	60	39	25	32	–49	–3.7	
Romania	170	72	52	31	27	–84	–10.3	on track
Russian Federation	74	72	57	39	39	–47	–3.6	
Rwanda	1100	1400	1100	720	540	–51	–3.9	making progress
Saudi Arabia	41	32	28	25	24	–41	–3.0	
Senegal	750	690	560	460	410	–45	–3.3	making progress
Serbia	13	15	9	8	8	–40	–2.8	
Sierra Leone	1300	1400	1300	1100	970	–25	–1.6	insufficient progress
Singapore	6	6	15	10	9	50	2.3	
Slovakia	15	11	13	6	6	–62	–5.4	
Slovenia	11	11	12	15	18	59	2.6	
Solomon Islands	130	110	110	110	100	–22	–1.4	insufficient progress
Somalia	1100	1200	1200	1200	1200	12	0.6	no progress
South Africa	230	260	380	440	410	80	3.3	no progress
Spain	7	4	5	6	6	–13	–0.8	
Sri Lanka	91	73	59	45	39	–58	–4.8	
Sudan	830	780	770	760	750	–9	–0.5	insufficient progress
Suriname	84	39	110	100	100	21	1.0	
Swaziland	260	220	340	440	420	62	2.7	no progress
Sweden	7	5	5	4	5	–25	–1.6	
Switzerland	8	8	7	8	10	22	1.1	
Syrian Arab Republic	120	77	58	50	46	–61	–5.2	making progress
Tajikistan	120	170	120	75	64	–44	–3.3	making progress
Thailand	50	52	63	51	48	–4	–0.2	
The former Yugoslav Republic of Macedonia	16	14	15	10	9	–43	–3.2	
Timor-Leste	650	590	520	420	370	–43	–3.2	making progress
Togo	650	550	450	380	350	–46	–3.5	making progress
Trinidad and Tobago	86	90	59	55	55	–36	–2.5	
Tunisia	130	110	83	67	60	–54	–4.3	making progress
Turkey	68	51	39	29	23	–66	–6.0	
Turkmenistan	91	98	95	82	77	–16	–0.9	
Uganda	670	690	640	510	430	–36	–2.5	making progress
Ukraine	49	45	35	26	26	–47	–3.5	
United Arab Emirates	28	20	15	12	10	–62	–5.4	
United Kingdom	10	10	12	13	12	20	1.0	
United Republic of Tanzania	880	920	920	860	790	–10	–0.6	insufficient progress

Annex 3. continued

Country	Estimated MMR[a]					% change in MMR between 1990 and 2008	Annual % change in MMR between 1990 and 2008[b]	Progress towards improving maternal health[c]
	1990	1995	2000	2005	2008			
United States of America	12	11	14	24	24	96	3.7	
Uruguay	39	35	25	27	27	–30	–2.0	
Uzbekistan	53	32	29	30	30	–44	–3.2	
Venezuela (Bolivarian Republic of)	84	88	82	68	68	–20	–1.2	
Viet Nam	170	120	91	66	56	–66	–6.0	on track
Yemen	540	460	340	250	210	–61	–5.3	making progress
Zambia	390	490	600	560	470	19	1.0	no progress
Zimbabwe	390	450	670	830	790	102	3.9	no progress

[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.

[b] Negative values indicate a decreasing MMR from 1990 to 2008, while positive values indicate an increasing MMR. Given that the uncertainty intervals are wide for some countries, these will have to interpreted with caution.

[c] Countries with MMR ≥100 in 1990 are categorized as “on track” if there has been 5.5% decline or more annually, “making progress” if MMR has declined between 2% and 5.5%, making “insufficient progress” if MMR has declined less than 2% annually, and having “no progress” if there has been an annual increase in MMR. Countries with MMR <100 in 1990 are not categorized.

Annex 4. Countries with 40% or more decrease in maternal mortality ratio (MMR, deaths per 100 000 live births) between 1990 and 2008

Country	% change in MMR between 1990 and 2008[a]
Maldives	–93
Romania	–84
Iran (Islamic Republic of)	–80
Bhutan	–79
Estonia	–76
Equatorial Guinea	–73
Eritrea	–69
Poland	–67
China	–66
Turkey	–66
Viet Nam	–66
Bolivia (Plurinational State of)	–65
Latvia	–64
Egypt	–63
Indonesia	–62
Slovakia	–62
United Arab Emirates	–62
Bangladesh	–61
Lithuania	–61
Peru	–61
Syrian Arab Republic	–61
Yemen	–61
Greece	–60
Oman	–60
India	–59
Morocco	–59
Belarus	–58
Cambodia	–58
Cape Verde	–58
Sri Lanka	–58
Ireland	–57
Nepal	–56
Haiti	–55
Chile	–54
Tunisia	–54
Algeria	–53
Ethiopia	–53
Italy	–53
Brazil	–52
Dominican Republic	–52
Lao People's Democratic Republic	–51
Portugal	–51
Rwanda	–51
Bosnia and Herzegovina	–50

Country	% change in MMR between 1990 and 2008[a]
Lebanon	–50
Mauritius	–50
Bulgaria	–49
Czech Republic	–49
Japan	–49
Republic of Moldova	–49
Austria	–48
Benin	–48
Jordan	–48
Mongolia	–48
Pakistan	–48
Philippines	–48
Barbados	–47
Honduras	–47
Mozambique	–47
Russian Federation	–47
Ukraine	–47
Gambia	–46
Qatar	–46
Togo	–46
Senegal	–45
Armenia	–44
El Salvador	–44
Ghana	–44
Malawi	–44
Malaysia	–44
Nicaragua	–44
Tajikistan	–44
Uzbekistan	–44
Guinea	–43
Hungary	–43
Israel	–43
Myanmar	–43
Niger	–43
The former Yugoslav Republic of Macedonia	–43
Timor-Leste	–43
Germany	–42
Kazakhstan	–42
Angola	–41
Azerbaijan	–41
Colombia	–41
Cyprus	–41
Malta	–41
Saudi Arabia	–41
Ecuador	–40
Serbia	–40

[a] Percentages have been rounded.

APPENDICES

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

Country	Period/year	Additional maternal deaths identified (%)	Adjustment factor
Australia	2000–2002	110	2.1
	2003–2005	90	1.9
Austria	1980–1998	60	1.6
Brazil, capital cities	2002	40	1.4
Canada	1988–1992	60	1.6
	1997–2000	50	1.5
China, Taiwan	1984–1988	60	1.6
El Salvador	June 2005–May 2006	220	3.2
Finland	1987–1994	–10	0.9
	1999–2000	100	2.0
France	1999	10	1.1
	1988 Dec–1989 Mar	130	2.3
	2001–2003	20	1.2
	2004–2006	20	1.2
Japan	2005	35	1.35
Netherlands	1983–1992	40	1.4
	1993–2005	50	1.5
United Kingdom	1985–1987	40	1.4
	1988–1990	40	1.4
	1991–1993	50	1.5
	1994–1996	60	1.6
	1997–1999	80	1.8
	2000–2002	70	1.7
	2003–2005	70	1.7
USA	1995–1997	50	1.5
USA, Maryland	1993–2000	60	1.6
USA, North Carolina	1999–2000	10	1.1
Median			**1.5**

Appendix 2. Sixty-three countries with civil registration data characterized as complete, with good attribution of cause of death[a]

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

[a] For the Bahamas, Belgium, Iceland and Malta (0.1% of global births), the statistical model was used because the paucity of the event of maternal mortality gave implausible trends.

Appendix 3. Eighty-five countries lacking good complete registration data but where registration and/or other types of data are available

Afghanistan	Fiji	Namibia
Albania	Gabon	Nepal
Algeria	Georgia	Nicaragua
Armenia	Ghana	Niger
Azerbaijan	Guinea	Nigeria
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	Saudi Arabia
Brazil	Jamaica	Senegal
Brunei Darussalam	Jordan	Sierra Leone
Burkina Faso	Kenya	South Africa
Cambodia	Kyrgyzstan	Sri Lanka
Cameroon	Lao People's Democratic Republic	Sudan
Central African Republic	Lebanon	Swaziland
Chad	Lesotho	United Republic of Tanzania
China	Liberia	Thailand
Congo	Madagascar	Togo
Côte d'Ivoire	Malawi	Tunisia
Democratic Republic of the Congo	Maldives	Turkey
Dominican Republic	Mali	Uganda
Ecuador	Mauritania	Yemen
Egypt	Montenegro	Zambia
El Salvador	Morocco	Zimbabwe
Eritrea	Mozambique	
Ethiopia	Myanmar	

Appendix 4. Twenty-four countries with no nationally representative data on maternal mortality meeting inclusion criteria

Angola	Gambia	Solomon Islands
Burundi	Guinea-Bissau	Somalia
Cape Verde	Libyan Arab Jamahiriya	Syrian Arab Republic
Comoros	Malaysia	Tajikistan
Cyprus	Mongolia	Timor-Leste
Democratic People's Republic of Korea	Oman	Turkmenistan
Djibouti	Papua New Guinea	United Arab Emirates
Equatorial Guinea	Qatar	Viet Nam

Appendix 5. Estimation of maternal deaths due to HIV

To construct the dependent variable of the multilevel regression model, a fraction of estimated HIV deaths among pregnant women was subtracted from PMDF observations (already adjusted for completeness and misclassification) to create $PMDF_{\mathrm{na}}$ for maternal, non-HIV-related deaths as follows:

$$PMDF_{\mathrm{na}} = PMDF_{\mathrm{adj}} - a\tilde{u}v$$

where

a is the proportion of HIV/AIDS deaths among all deaths to women aged 15–49. It is derived from the number of deaths as estimated by WHO for its life tables and from the number of deaths due to HIV/AIDS as estimated by UNAIDS.

$\tilde{u}$ is the fraction of HIV/AIDS deaths in the pregnancy-related period that were presumably included in a PMDF or MMR observation. It is assumed that $\tilde{u}$ equals one for all observations with a "pregnancy-related" definition (with or without accidents) and that $\tilde{u}$ equals zero for all vital registration (VR) data. For non-VR observations with a "maternal" definition, the value of $\tilde{u}$ is based on empirical evidence when possible and is assumed to be 0.5 otherwise (this choice affects rather few data points in situations where HIV/AIDS deaths are frequent).

v is the proportion of HIV/AIDS deaths to women aged 15–49 that occur during pregnancy.

The value of v can be computed as follows:

$$v = \frac{c\,k\,GFR}{1 + c(k-1)GFR}$$

where

GFR is the general fertility rate

c is the average exposure time (in years) to the risk of pregnancy-related mortality per live birth (set equal to 1 for this analysis);

k is the relative risk of dying from HIV/AIDS for a pregnant versus a non-pregnant woman (reflecting both the decreased fertility of HIV-positive women and the increased mortality risk of HIV positive pregnant women).

The value of k proved difficult to estimate directly from available study data, and instead a statistical approach was adopted that involved choosing a value of k to maximize measures of goodness of fit for the regression model. The resulting value of k=0.4 was used for all countries.

For pregnancy-related observations, the definitional adjustment described earlier (removing 10% or 15% of such deaths) was applied after subtracting HIV-related deaths.

After estimating $PMDF_{\mathrm{na}}$ using the multilevel regression model, final PMDF estimates were computed by adding back a constant fraction, u, of the estimated number of pregnancy-related HIV/AIDS deaths, which are counted here as "indirect maternal" deaths:

$$\textit{estimated PMDF} = \text{estimated } PMDF_{\mathrm{na}} + auv$$

where

u is the fraction of pregnancy-related deaths among HIV-infected women assumed to be indirect maternal deaths.

The MMEIG/TAG reviewed available study data on HIV/AIDS deaths among pregnant women and recommended using $u = 0.5$. Given the scarcity of appropriate data for choosing the proper value of this parameter (which could vary over time and space), the value of 0.5 was chosen in order to minimize the expected error that is implied by any symmetrical probability distribution of uncertainty (over the interval of zero to one). Overall, it was estimated that there were 42 000 deaths due to HIV/AIDS among pregnant women. About half of those are estimated to be maternal.

Appendix 6. Estimates of maternal mortality ratio (MMR, deaths per 100 000 live births), number of maternal deaths and lifetime risk by WHO regions, 2008

Region	Estimated MMR[a]	Range of uncertainty on MMR estimates		Number of maternal deaths[a]	Lifetime risk of maternal death:[a] 1 in:
		Lower estimate	Upper estimate		
Africa	620	450	890	190 000	32
Americas	66	56	80	10 000	670
South-East Asia	240	160	350	91 000	150
Europe	21	19	25	2300	2900
Eastern Mediterranean	320	220	520	52 000	84
Western Pacific	51	35	74	13 000	1100
WORLD	260	200	370	358 000	140

[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: <1000, rounded to nearest 10; 1000–9999, rounded to nearest 100; and >10 000, rounded to nearest 1000.

Appendix 7. Comparison of 1990, 1995, 2000, 2005, and 2008 estimates of maternal mortality ratio (MMR, deaths per 100 000 live births) by WHO regions

Region	Estimated MMR[a]					% change in MMR between 1990 and 2008	Annual % change in MMR between 1990 and 2008[b]
	1990	1995	2000	2005	2008		
Africa	850	830	780	690	620	–27	–1.7
Americas	110	93	81	70	66	–39	–2.7
South-East Asia	580	470	380	280	240	–59	–5.0
Europe	44	37	29	22	21	–52	–4.1
Eastern Mediterranean	430	410	390	350	320	–24	–1.5
Western Pacific	130	97	75	58	51	–59	–5.0
WORLD	400	370	340	290	260	–34	–2.3

[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.

[b] Negative values indicate a decreasing MMR from 1990 to 2008, while positive values indicate an increasing MMR. Given that the uncertainty values are wide for some countries, these will have to be interpreted with caution.

Appendix 8. Estimates of maternal mortality ratio (MMR, deaths per 100 000 live births), number of maternal deaths and lifetime risk by UNICEF regions, 2008

Region	Estimated MMR[a]	Range of uncertainty on MMR estimates		Number of maternal deaths[a]	Lifetime risk of maternal death:[a] 1 in:
		Lower estimate	Upper estimate		
Africa	590	430	840	207 000	36
Sub-Saharan Africa	640	470	920	204 000	31
Eastern and Southern Africa	550	400	770	79 000	38
Western and Central Africa	720	490	1100	115 000	26
Middle East and North Africa	170	120	270	17 000	190
Asia	200	140	290	135 000	210
South Asia	290	190	430	109 000	110
East Asia and Pacific	88	61	130	27 000	600
Latin America and Caribbean	85	72	110	9200	480
Central and Eastern Europe and the Commonwealth of Independent States	34	29	41	1900	1700
Industrialized countries	14	12	16	1600	4300
Developing countries	290	220	410	356 000	120
Least developed countries	590	420	840	166 000	37
WORLD	260	200	370	358 000	140

[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: <1000, rounded to nearest 10; 1000–9999, rounded to nearest 100; and >10 000, rounded to nearest 1000.

Appendix 9. Comparison of 1990, 1995, 2000, 2005, and 2008 estimates of maternal mortality ratio (MMR, deaths per 100 000 live births) by UNICEF regions

Region	Estimated MMR[a]					% change in MMR between 1990 and 2008	Annual % change in MMR between 1990 and 2008[b]
	1990	1995	2000	2005	2008		
Africa	780	770	720	650	590	–25	–1.6
Sub-Saharan Africa	870	850	790	710	640	–26	–1.7
Eastern and Southern Africa	750	760	720	630	550	–26	–1.7
Western and Central Africa	980	940	870	780	720	–27	–1.7
Middle East and North Africa	270	230	200	180	170	–37	–2.6
Asia	410	340	300	230	200	–51	–4.0
South Asia	610	510	430	330	290	–53	–4.2
East Asia and Pacific	200	160	130	100	88	–56	–4.5
Latin America and Caribbean	140	130	110	91	85	–41	–2.9
Central and Eastern Europe and the Commonwealth of Independent States	69	60	48	36	34	–52	–4.0
Industrialized countries	12	10	11	14	14	16	0.8
Developing countries	440	410	370	320	290	–34	–2.3
Least developed countries	900	840	750	650	590	–35	–2.4
WORLD	400	370	340	290	260	–34	–2.3

[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.

[b] Negative values indicate a decreasing MMR from 1990 to 2008, while positive values indicate an increasing MMR. Given that the uncertainty values are wide for some countries, these will have to be interpreted with caution.

Appendix 10. Estimates of maternal mortality ratio (MMR, deaths per 100 000 live births), number of maternal deaths and lifetime risk by UNFPA regions, 2008

Region	Estimated MMR[a]	Range of uncertainty on MMR estimates		Number of maternal deaths[a]	Lifetime risk of maternal death:[a] 1 in:
		Lower estimate	Upper estimate		
Asia and the Pacific	200	140	290	136 000	210
Eastern Europe and Central Asia	32	27	39	1900	1800
Latin America and the Caribbean	85	72	110	9200	480
Middle East and North Africa	250	170	390	21 000	120
Sub-Saharan Africa	630	460	910	189 000	31
Non-UNFPA list (40 countries)	15	13	17	1700	4000
WORLD	260	200	370	358 000	140

[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: <1000, rounded to nearest 10; 1000–9999, rounded to nearest 100; and >10 000, rounded to nearest 1000.

Appendix 11. Comparison of 1990, 1995, 2000, 2005, and 2008 estimates of maternal mortality ratio (MMR, deaths per 100 000 live births) by UNFPA regions

Region	Estimated MMR[a]					% change in MMR between 1990 and 2008	Annual % change in MMR between 1990 and 2008[b]
	1990	1995	2000	2005	2008		
Asia and the Pacific	400	340	290	230	200	–51	–4.0
Eastern Europe and Central Asia	66	57	45	34	32	–52	–4.0
Latin America and the Caribbean	140	130	110	91	85	–41	–2.9
Middle East and North Africa	340	310	280	260	250	–27	–1.8
Sub-Saharan Africa	870	850	790	700	630	–27	–1.8
Non-UNFPA list (40 countries)	13	11	12	15	15	16	0.8
WORLD	400	370	340	290	260	–34	–2.3

[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.

[b] Negative values indicate a decreasing MMR from 1990 to 2008, while positive values indicate an increasing MMR. Given that the uncertainty values are wide for some countries, these will have to be interpreted with caution.

Appendix 12. Estimates of maternal mortality ratio (MMR, deaths per 100 000 live births), number of maternal deaths and lifetime risk by The World Bank regions and income groups, 2008

Region and income group[a]	Estimated MMR[b]	Range of uncertainty on MMR estimates		Number of maternal deaths[b]	Lifetime risk of maternal death:[b] 1 in:
		Lower estimate	Upper estimate		
Low income	580	420	830	162 000	39
Middle income	200	150	290	195 000	190
Lower middle income	230	160	330	181 000	160
Upper middle income	82	64	100	14 000	570
Low and middle income	290	210	400	357 000	120
East Asia and Pacific	89	62	130	26 000	580
Europe and Central Asia	32	27	39	1900	1800
Latin America and the Caribbean	86	72	110	9200	480
Middle East and North Africa	88	62	130	6700	380
South Asia	290	190	430	109 000	110
Sub-Saharan Africa	650	470	920	203 000	31
High income	15	14	17	1900	3900
WORLD	260	200	370	358 000	140

[a] Income groups were based on 2009 gross national income per capita estimates: low income, US$ 995 or less; lower middle income US$ 996–3945; upper middle income US$ 3946–12 195; and high income, US$ 12 196 or more.

[b] 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: <1000, rounded to nearest 10; 1000–9999, rounded to nearest 100; and >10 000, rounded to nearest 1000.

Appendix 13. Comparison of 1990, 1995, 2000, 2005, and 2008 estimates of maternal mortality ratio (MMR, deaths per 100 000 live births) by The World Bank regions and income groups

Region and income group[a]	Estimated MMR[b]					% change in MMR between 1990 and 2008	Annual % change in MMR between 1990 and 2008[c]
	1990	1995	2000	2005	2008		
Low income	850	800	740	640	580	–32	–2.1
Middle income	350	310	280	230	200	–41	–3.0
Lower middle income	400	360	320	260	230	–43	–3.1
Upper middle income	120	100	97	88	82	–31	–2.0
Low and middle income	440	410	370	320	290	–34	–2.3
East Asia and Pacific	200	160	130	100	89	–56	–4.6
Europe and Central Asia	66	57	45	34	32	–52	–4.0
Latin America and the Caribbean	140	130	110	91	86	–41	–2.9
Middle East and North Africa	210	160	120	98	88	–59	–4.9
South Asia	610	510	430	330	290	–53	–4.2
Sub-Saharan Africa	870	850	800	710	650	–26	–1.7
High income	15	14	13	15	15	–1	–0.1
WORLD	400	370	340	290	260	–34	–2.3

[a] Income groups were based on 2009 gross national income per capita estimates: low income, US$ 995 or less; lower–middle income US$ 996–3945; upper–middle income US$ 3946–12 195; and high income, US$ 12 196 or more.

[b] 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.

[c] Negative values indicate a decreasing MMR from 1990 to 2008, while positive values indicate an increasing MMR. Given that the uncertainty values are wide for some countries, these will have to be interpreted with caution.

Appendix 14. Estimates of maternal mortality ratio (MMR, deaths per 100 000 live births), number of maternal deaths and lifetime risk by United Nations Population Division regions, 2008

Region	Estimated MMR[a]	Range of uncertainty on MMR estimates		Number of maternal deaths[a]	Lifetime risk of maternal death:[a] 1 in:
		Lower estimate	Upper estimate		
Africa	590	430	840	207 000	36
Sub-Saharan Africa region	640	470	920	204 000	31
Asia	180	130	270	139 000	230
Europe	16	14	18	1200	4200
Latin America and the Caribbean	85	71	110	9200	490
Northern America	23	20	26	1100	2200
Oceania	100	48	210	570	410
More developed regions	17	16	19	2400	3600
Less developed regions	290	220	410	356 000	120
Least developed countries	590	420	840	166 000	37
Other less developed regions	200	150	290	190 000	190
WORLD	260	200	370	358 000	140

[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: <1000, rounded to nearest 10; 1000–9999, rounded to nearest 100; and >10 000, rounded to nearest 1000.

Appendix 15. Comparison of 1990, 1995, 2000, 2005, and 2008 estimates of maternal mortality ratio (MMR, deaths per 100 000 live births) by United Nations Population Division regions

Region	Estimated MMR[a]					% change in MMR between 1990 and 2008	Annual % change in MMR between 1990 and 2008[b]
	1990	1995	2000	2005	2008		
Africa	780	770	720	650	590	–25	–1.6
Sub-Saharan Africa region	870	850	790	710	640	–26	–1.7
Asia	370	320	270	210	180	–51	–4.0
Europe	35	27	21	16	16	–55	–4.4
Latin America and the Caribbean	140	130	110	90	85	–41	–2.9
Northern America	12	11	13	23	23	97	3.8
Oceania	120	110	120	110	100	–12	–0.7
More developed regions	26	20	17	17	17	–33	–2.2
Less developed regions	440	410	370	320	290	–34	–2.3
Least developed countries	900	840	750	650	590	–35	–2.4
Other less developed regions	340	300	270	230	200	–41	–2.9
WORLD	400	370	340	290	260	–34	–2.3

[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.

[b] Negative values indicate a decreasing MMR from 1990 to 2008, while positive values indicate an increasing MMR. Given that the uncertainty values are wide for some countries, these will have to be interpreted with caution.

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