

Questions and Answers

Trends in Maternal Mortality: 1990 to 2015. Estimates by WHO, UNICEF, UNFPA, World Bank Group and the United Nations Population Division

1. What is new about these estimates?

The November 2015 release of the United Nations (UN) Interagency maternal mortality estimates includes trends in maternal mortality ratio (MMR, maternal deaths per 100 000 live births) and numbers of maternal deaths at national, regional, and global levels for 1990 to 2015.

The current update uses available national data on maternal mortality to characterize levels and trends of maternal mortality for 183 countries. This analysis involves a larger dataset than previous rounds and updates earlier published estimates for 1990-2013, and reports estimates for 1990 to 2015.

The methodology employed by the Maternal Mortality Estimation Inter-Agency Group (MMEIG) in this update followed an improved approach that built directly upon methods used to produce the previously published 1990-2008, 1990-2010, and 1990-2013 maternal mortality estimates.^{1,2,3}

Estimates for this round were generated using a Bayesian approach, referred to as the Bayesian maternal mortality estimation model, or BMat model.⁴ This enhanced methodology uses the same core estimation method as in those previous rounds, but adds refinements to optimize the use of country-specific data sources and excludes late maternal deaths⁵. The BMat model applies a unified estimation approach for all countries, which is flexible enough to be appropriate for all countries and is able to closely track country level data.

The new model still incorporates the same predictor factors (covariates) as in previous rounds which are: the Gross Domestic Product per capita based on purchasing power parity conversion - GDP (World Bank Group, 2011 Int.\$), the general fertility rate - GFR (UNPD, 2015), and proportion of births attended by a skilled health worker – SAB (UNICEF, 2015).

2. How do the newly released estimates compare with the estimates released in 2014? Which one should be used?

This analysis includes a larger dataset and uses a refined methodology to provide more reliable estimates. As in the past, this publication will supersede all previously published estimates and therefore the findings of the previous estimates published in 2014 for the period 1990 to 2013 are not comparable to the current update for 1990-2015.

¹ WHO, UNICEF, UNFPA and the World Bank. Trends in maternal mortality: 1990 to 2008. Estimates developed by WHO, UNICEF, UNFPA and The World Bank. Geneva: World Health Organization; 2010.

² WHO, UNICEF, UNFPA, The World Bank, United Nations Population Division. Trends in Maternal Mortality: 1990 to 2010. Geneva: World Health Organization; 2012.

³ WHO, UNICEF, UNFPA, The World Bank, United Nations Population Division. Trends in maternal mortality: 1990 to 2013. Geneva: World Health Organization; 2014.

⁴ Alkema L, Zhang S, Chou D, Gemmill A, Moller A, Ma Fat D, et al. A Bayesian approach to the global estimation of maternal mortality. 2015

⁵ The deaths of a women from direct or indirect deaths from 42 days to 1 year after termination of pregnancy.

3. Why a change in the estimation method at the end of MDG period?

The methodology employed in this round builds upon the methodology previously published.⁶ Notable refinements are:

- a more robust assessment of vital registration (VR) data quality and availability, thereby avoiding the en bloc assessment of data quality which precluded the incorporation of improvements in data quality over time; the ability to follow trends in country-level data, which the previous estimation approach could not do for countries without high quality VR data. Many countries worked to obtain data in the last years of the MDG monitoring period. The refinements implemented were needed in order to be able to fully utilize these data points. Had we remained with the exact same methodology as before, these studies would not have informed the trends obtained from the estimation process, leaving covariates to predict trends in MMR for countries without high quality VR data.

4. Why are interagency estimates necessary? What should countries do with their own national estimates?

Global estimates have to be internationally comparable. In order to achieve international comparability, it is necessary for national data collected through a variety of methods, with their different degrees of bias, to be adjusted to a level that makes them comparable and that is likely to be close to the true maternal mortality level. Countries who produce robust data on maternal mortality can continue to use those figures for national planning purposes. As with the global estimation exercise, country-level comparisons should only be made against “like and like” data; e.g., a times series of household surveys, not between different types of data; e.g. census and specialized mortality survey; for those to be comparable, adjustments such as those undertaken by the MMEIG would be necessary.

5. How is country level data used in the estimation process?

Country level data are reviewed and categorized as civil registration systems, censuses, special maternal mortality surveillance systems or studies, and “national population-based surveys (like the Demographic and Health Surveys (DHS)). Because these cannot be directly compared due to different degrees of sources of bias, certain adjustments are made. Some countries already apply a correction factor to their own civil registration data based on studies they have carried out that establish the level of completeness of their data and the misclassification/underestimation related to maternal mortality. Wherever countries have conducted studies and documented the methodology and analysis of under-registration and/or misclassification, the MMEIG has used these to inform the estimation process for the country.

6. If country level data is used in the estimation process, why are there differences between national MMR figures and the modelled estimates; even for countries with high quality data?

To answer this question it is useful to first review the general approach that the MMEIG uses to estimate MMR. The maternal mortality ratio is defined as the number of maternal deaths divided by live births. However, to account for potential incompleteness of death recording in various data sources, the MMEIG first computes the fraction of deaths due to maternal causes from original data

⁶ Wilmoth J, Mizoguchi N, Oestergaard M, Say L, Mathers C, Zureick-Brown S, et al. Levels and trends of maternal mortality in the world: The development of new estimates by the United Nations. Technical report (submitted to the WHO, UNICEF, UNFPA, and The World Bank). 2010.

sources (referred to as the “proportion maternal”, or PM), and then applies that fraction to WHO estimates of total deaths among women of reproductive age to obtain an estimate of the number of maternal deaths. In other words, the following fraction is first computed from country data sources:

$$PM = \frac{\text{Number of maternal deaths 15 – 49}}{\text{All female deaths at ages 15 – 49}}$$

and then the PM is used to compute the MMR as follows:

$$MMR = PM \times \frac{\text{All female deaths at ages 15 – 49}}{\text{Number of live births}}$$

where the estimate of all deaths at ages 15-49 in the second equation is derived from WHO life tables⁷, and the number of live births is from the World Population Prospects 2015⁸

With this as background, a few reasons that MMEIG estimates may differ from national statistics are as follows:

1. Civil registration and vital statistics systems are not always complete (i.e., they do not always capture 100% of all deaths) and completeness may change over time. The MMEIG estimation approach attempts to correct for this by using the above approach, which involves first computing the PM.
2. The MMEIG often applies adjustment factors to the PM computed from original data to account for measurement issues (such as how the country defined “maternal” deaths; misclassification; or undercounting).
3. The MMEIG uses the standardized series of live births from the United Nation Population Division, as published in World Population Prospects 2015, in the denominator of the MMR equation. To better inform the WPP, countries should discuss discrepancies directly with the UNPD. The contact address is population@un.org; this email address is monitored regularly and messages are dispatched to the appropriate analysts for each country or concern.
4. Statistically speaking, maternal deaths are a relatively rare event, which can lead to noisy time trends in data over time. As the goal of the MMEIG estimates is to track long term progress in reducing maternal mortality, the estimation process involves some smoothing to generate a curve that better captures changes in underlying risk of maternal death over time, rather than matching each data point from year-to-year.

7. Why are covariates used to generate the interagency estimates? How do the covariates play out in countries with good maternal mortality data? How about countries with no or poor data? How is maternal mortality estimated for countries with no data or “poor data”?

To inform projection of trends across periods where data are sparse, or for countries with little or no data at all, the BMaT model includes factors known to be associated with maternal mortality as predictor covariates. As described above the estimates are informed or predicted by the three covariates; GDP, GFR and SAB. These are the same covariates used in previous estimation rounds to inform trends in situations without high quality data availability.

⁷ Life tables for WHO Member States 1990–2012. Geneva: World Health Organization; 2014.

⁸ World Population Prospects: The 2015 Revision. New York: United Nations Population Division; 2015.

For countries with the highest quality data through the entire time series, covariates have almost no influence on the estimate; in other words, the estimate relies on the reported VR data point. For countries whose VR data improved over time, the influence of the covariates is stronger where there is lower quality data in earlier years, and as the VR data quality improves, covariates have less and less influence on the estimates in later years.

But even the best modelling cannot provide us with the real figures for maternal mortality, and so we derive estimates with large uncertainty ranges. Therefore we advocate for greater investments to generate better data on maternal deaths: every maternal death must be counted.

8. How to interpret the uncertainty ranges around the estimates?

Accurately estimating maternal mortality proves challenging due to many countries' limited data availability, and due to quality issues in the data that is available. In this round of estimates the 80% uncertainty intervals (UI) were calculated (rather than the standard 95%) because of the substantial uncertainty inherent in maternal mortality outcomes. The extent of uncertainty about a particular estimate, indicated by the size of the 80% UI, is determined by the amount and quality of data used to produce that estimate. The BMat model is set up to assess the quality of data and to include those considered of "poor quality" with more uncertainty. For a country with very accurate sources of maternal mortality data, the MMR can be estimated with greater precision, and the 80% UI will be smaller, than for a country with little data, or with data from less reliable sources.

We now include a "Box" in the report to describe the interpretation of the UI.

9. Why is the current global maternal mortality ratio (MMR) higher in this round of estimates than the estimates of 2013?

The increase in the estimated global MMR from 210 in 2013 to 216 in 2015 (resulting in an increased estimate in the number of maternal deaths globally for 2015) is primarily due to new data from Nigeria, Democratic Republic of Congo and Sierra Leone. Recent Demographic and Health Surveys (DHS) from these countries indicate a much higher MMR than previously thought for those countries, and given the large population sizes of Nigeria and Democratic Republic of Congo this has a noticeable impact at global level.

10. How are the AIDS-related maternal deaths accounted for in the estimates?

For countries with high HIV prevalence, AIDS is an important indirect cause of death during pregnancy and the postpartum period. There is evidence from community studies that women with HIV infection have a higher risk of maternal death, although this may be balanced by lower fertility in women due to the effects of HIV. If HIV is prevalent, then there will also be more incidental AIDS deaths among pregnant women (i.e. those due to HIV/AIDS, not related with pregnancy). It is thus important to separate incidental and indirect maternal deaths among HIV-positive women in estimating maternal mortality in these countries. The current estimates use an approach that involves first, analysis of deaths that include only "maternal" deaths properly defined but excludes all AIDS deaths from deaths during pregnancy (pregnancy-related deaths) and then adding back the estimated number of "AIDS-related indirect maternal deaths to obtain the total number of maternal deaths. This is the same approach used in previous estimation rounds.

11. Why is it difficult to agree on the measurement of maternal mortality?

Maternal mortality is one of the most difficult indicators to measure reliably. Not only does it require a correct assessment of the number of deaths of women of reproductive age, which in itself may be a challenge in many developing countries, but it also requires the correct classification of these deaths by cause. Maternal deaths are more often misclassified than others, not only because they are easily confused with deaths due to other causes, but also because health institutions may prefer to attribute them to other causes, due to the sensitivities of potential inadequate treatment associated with maternal death. This is particularly the case of indirect obstetric causes. Consequently, even in the best civil registration systems in the world, it has been found that maternal causes can be substantially underreported. Given that different data sources will not necessarily yield the same results and that common adjustments to those data involve assumptions, variations in the estimates that can be produced for the same country can be considerable. Obviously, this creates problems for both countries and for agencies as the estimates serve for monitoring and evaluation purposes that can have important political implications.

12. Why do the UN agencies produce estimates? Shouldn't they be developed by academic institutions?

Tracking population health is critical for informed decision making and assess progress on improving health, and UN agencies work to ensure that accurate and timely information is available. However, it is worth noting that UN agencies do not do this alone. As is done in many other health areas, we invite experts from academic institutions to work through expert groups to develop and review the best possible methods of estimation. Collaboration with and technical support from academic institutions is essential to develop better methods. The MMEIG is supported by experts from the following universities and institution; Berkeley, Harvard, Johns Hopkins, Aberdeen, Umeå, Imperial College London, University of Massachusetts, African population and Health Centre, and ICF International (DHS).

Agencies also work closely with countries. All numbers go through a process of country consultation, in which new data are uncovered, estimates are discussed and improved in cases where new data or information are obtained. The aim is to come up with accurate and comparable estimates that can be used by countries. We welcome the efforts of other groups to improve the estimation methods and look forward to collaborating with all interested parties to share data, examine different methodology and develop tools that can be used by countries. However, the most crucial efforts should target strengthening capacity for data availability and analysis in countries and ultimately development of complete civil registration systems with correct cause of death information in countries.

13. Should the interagency estimates be used as baseline for the maternal mortality related Sustainable Development Goal (SDG) 3.1?

While transitioning from MDG 5 monitoring, to setting maternal mortality related targets for the SDGs, a vision of ending all preventable maternal deaths has emerged.⁹ While it is recognized that even in the best of circumstances, maternal deaths may still occur, in a world without preventable maternal deaths, everything that could be done to avoid a maternal death is done and is done appropriately. Working towards this aim, the SDG target of reducing global maternal mortality to less than 70 deaths per 100 000 live births by 2030 has been agreed as a key target for SDGs. Using

⁹ Bustreo F, Lale S, Koblinsky M, Pullum TW, Temmerman M, Pablos-Méndez A. Ending preventable maternal deaths: the time is now. *Lancet Glob Health*. 2013;1(4):e176-7.

this round of estimates as the baseline for the SDG target, the annual rate of reduction (ARR) required to achieve the SDGs is 7.5%.

14. How do the interagency estimates compare with estimates generated by other institutions such as IHME? Which estimates should be used?

The Institute of Health Metrics and Evaluation (IHME) at the University of Washington published maternal mortality estimates in January 2015 in the Lancet. Both MMEIG and IHME estimates use model-based estimates, but use different modelling approaches including the model specification, selection of covariates, and approach to addressing AIDS deaths. While input databases used by both groups may be similar regarding the data sources considered, the pre-processing of data may vary. Lastly, there are differences in the other inputs like the adult mortality among women of reproductive ages.

Unlike IHME, the UN Interagency group engages countries in a formal country consultation process when the preliminary estimates are derived to discuss methods and data inputs. Despite these differences, the global numbers of maternal mortality death from both analysis are quite similar for 2013; IHME estimates that there were 292 000 maternal deaths and the MMEIG estimates 315 000 (303 000 to 356 000).

For 1990 however IHME estimated that there were 374,000 number of deaths which is much lower than the 532 000 (496 000 to 590 000) maternal deaths estimated by the MMEIG. The reasons for these differences can be understood through in-depth examination of inputs and methods used for that particular country. To allow such comparisons, MMEIG makes its methods, databases, and statistical codes publicly available at the same time of the release of its report.

For the purposes of MDG reporting, the UN MMEIG estimates are used.