Monitoring MDG 5: Interpreting Maternal Mortality Estimates*

HNPNotes

Introduction

Reducing maternal mortality by three-quarters from 1990 to 2015 is a target for Millennium Development Goal 5.[1] However, accurately measuring the maternal mortality ratio (MMR) is a challenge in many low- and middle- income countries because they lack **complete and accurate civil registration systems with good attribution of the causes of death**.[2]

The Maternal Mortality Estimation Inter-Agency Group (MMEIG), which includes the WHO, UNICEF, UNFPA, and the World Bank has been collaborating with the University of California at Berkeley to develop global, regional and country to measure progress towards MDG 5. **The purpose of this *HNPNotes* is to provide World Bank operational task teams an overview of methods for measuring MMR and the interpretation of the MMEIG MMR estimates**. In a later section, the MMEIG approach is compared to the one employed by the Institute of Health Metrics and Evaluation (IHME).

What is maternal mortality?

Maternal death refers to 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.[3] Two other related terms—"pregnancy-related deaths" and "late maternal deaths"—are explained in Box 1.

MMR, the key indicator for gauging progress towards achieving MDG5, is the number of maternal deaths during a given time period per 100,000 live births occurring in the same period. Two other statistical measures of maternal mortality, which are less frequently used, are also defined in Box 1.

Box 1: Definitions of maternal mortality and statistical measures

Maternal mortality

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

Pregnancy-related death: The death of a woman while pregnant or within 42 days of termination of pregnancy, irrespective of the cause of death.

Late maternal death: The death of a woman from direct or indirect obstetric causes, more than 42 days, but less than one year, after termination of pregnancy.

Statistical measures of maternal mortality

Maternal mortality ratio (MMR): Number of maternal deaths during a given time period per 100,000 live births during the same period.

Maternal mortality rate: Number of maternal deaths in a given period per 100,000 women of reproductive age during the same period.

Adult lifetime risk of maternal death: The probability that a 15-year-old woman will eventually die from a maternal cause.

Source: International Statistical Classification of Diseases and Related Health Problems. 2010. Tenth Revision. Vol. 1: Tabular list. Vol. 2: Instruction manual. Geneva: WHO.

* This HNPNotes was prepared by Emi Suzuki (HDNHE) and Samuel Mills (HDNHE). Peer reviewer comments from Akiko Maeda (HDNHE), Melanie Mayhew (HDNOP), and Patrick Osewe (AFTHE) of the World Bank; and Ann-Beth Moller and Doris Chou of WHO are gratefully acknowledged.

How is maternal mortality measured?

To compute MMR, divide the number of maternal deaths by the number of live births (in the same area and period) and multiply by 100,000. However, accurate measurements of the number of maternal deaths are unavailable in 115 countries due to inadequate civil registration systems.[2] Accordingly, most countries use less-preferred methods for measuring MMR. The different sources of data are explained in Box 2.

The 2012 MMEIG report details the advantages and disadvantages of each data source [2] Even in the 65 countries with relatively good civil registration systems, maternal deaths can, on occasion, be misclassified (ie incorrect coding of female deaths) or the coverage of death registration can be incomplete.

Box 2: Sources of maternal mortality data

Civil registration system – This is the ideal source of data. Countries should strive to strengthen civil registration systems and vital statistics for recording births and deaths.

Household survey – The Demographic and Health Surveys (DHS) is a source of maternal mortality data for several low income countries. However, it measures pregnancy-related deaths—not maternal deaths; furthermore, female deaths might be underreported.

Census – National census is a source of maternal mortality data if a question is included to capture female deaths one or two years prior to the census.

Reproductive-age mortality studies – This entail investigating all female deaths aged 15–49 years using multiple sources including burial records.

Verbal autopsy – Interviews of the deceased woman's family members can help determine the cause(s) of death.

Summary of the methodology used in the MMEIG 2010 estimates

First, a total of 180 countries/territories with a population size of 100,000 or more were categorized into three groups as shown in Table 1. Second, for the countries with good civil registration systems (category A), maternal deaths (after adjusting for misclassification and completeness) were used to compute MMR. Third, for countries in categories B and C, a statistical multilevel regression model was used to derive the estimates. The three predictor variables in the model inlcuded: gross domestic product per capita (GDP), general fertility rate (GFR), and proportion of births by skilled attendants (SAB). Details of the model are described in the 2012 MMEIG report.[2]

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

Source of maternal mortality data	Countries/ territories	
	Number	%
A. Civil registration characterized as complete, with good attribution of cause of death	65	36.1
B. Countries lacking good complete registration data but where other types of data are available	88	48.9
C. No national data on maternal mortality	27	15.0
Total	**180**	**100.0**

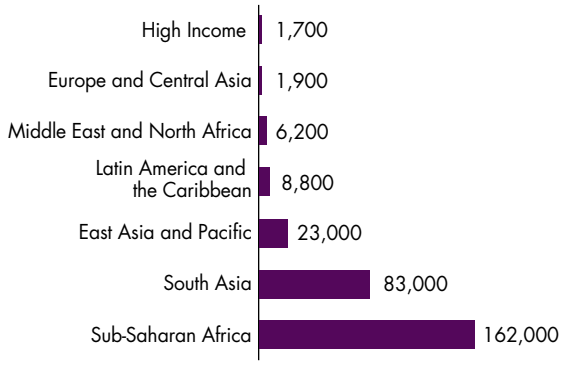
Maternal mortality estimates for 2010

Worldwide, in 2010, there were an estimated 287,000 maternal deaths, yielding a global MMR of 210 maternal deaths per 100,000 live births, down from 400 maternal deaths per 100,000 live births in 1990. In 2010, MMR in low-income countries (410) was 88 times higher than in high-income countries (14) and 16 times higher than in middle-income countries (230).

By World Bank regions, in 2010, the **Africa region (AFR) had the highest MMR at 500 maternal deaths per 100,000 live births, while the Europe and Central Asia** (ECA) region had the lowest among the six regions, at 32 maternal deaths per 100,000 live births. MMRs among the remaining regions include: South Asia (SAR) 220, East Asia and Pacific (EAP) 83, Latin America and the Caribbean (LAC) 81, and Middle East and North Africa (MNA)

80. Globally, AFR accounted for 56% of maternal deaths while SAR accounted for 29% (Figure 1). At the country level, **two countries accounted for a third of global maternal deaths: India at 20% (56,000) and Nigeria at 14% (40,000).**

Figure 1. Number of maternal deaths by region, 2010



The **top 10 countries with the highest MMR in 2010** were: Chad (1,100), Somalia (1,000), Central African Republic (890), Sierra Leone (890), Burundi (800), Guinea-Bissau (790), Liberia (770), Sudan (730), Cameroon (690) and Nigeria (630). In contrast, **among low and middle income countries, the top 10 countries with the lowest MMR in 2010** were Belarus (4), Bosnia and Herzegovina (8), Lithuania (8), Montenegro (8), Macedonia (10), Bulgaria (11), Serbia (12), Turkey (20), Iran (21) and Grenada (24).

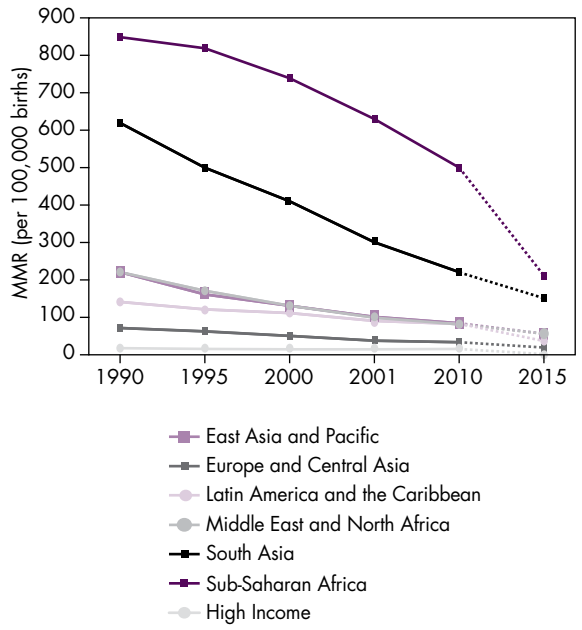
Updates on the 57 Reproductive Health Action Plan (RHAP) priority countries

The RHAP which was endorsed by the World Bank Executive Board in 2010, prioritized 57 countries with high MMR (220 or more based on the MMEIG 2005 estimates) and high fertility.[4] However, according to the MMEIG 2010 MMR estimates, of these 57 priority countries, the following 10 countries subsequently have MMR less than 220: Bolivia, Botswana, Djibouti, Guatemala, Honduras, Iraq, Nepal, Philippines, Solomon Islands, and Yemen.

Trends in MMR from 1990 to 2010 and progress towards MDG 5

As noted earlier, countries or regions will attain MDG 5 if MMR decreases by 75% from 1990 to 2015. Accordingly, a country is considered to be "on track" if the average annual percentage decline between 1990 and 2010 is 5.5% or more. If the annual decline in MMR is between 2% and 5.5%, the country is considered to be "making progress". Countries with an annual decline of less than 2% are considered to have made "insufficient progress" and countries with rising MMR have been categorized as making "no progress". Notably, countries with low MMR (< 100) in 1990 are not categorized, as it is generally not easy to reduce MMR further when already low. **While not one of the World Bank regions is 'on track' to achieve MDG 5, ECA had a low MMR of 70 maternal deaths per 100,000 live births in 1990**. The remaining regions are all "making progress": **SAR had the largest average annual percentage decline (5.0%)**, followed by MNA (4.8%), EAP (4.7%), LAC (2.6%), and AFR (2.6%). Figure 2 depicts these trends. In order to achieve MDG 5, **AFR needs to achieve an average annual decline of 17.1% between 2010 and 2015**.

Figure 2. Trends in estimates of MMR 1990–2010, and MDG5 target 2015



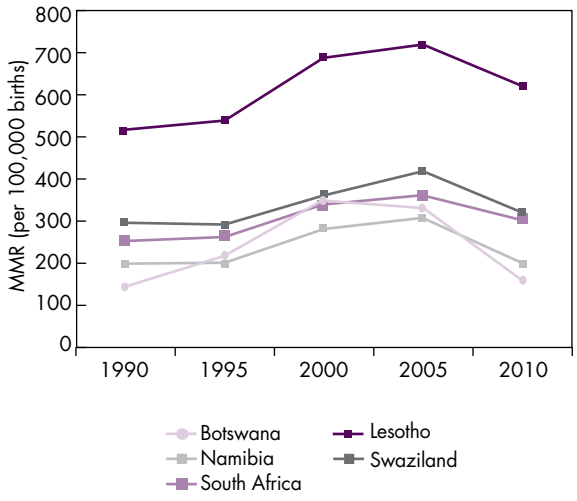
Regarding country-level trends, **10 countries have already achieved MDG 5** (assuming MMR does not increase in these countries between 2010 and 2015): Estonia (95%), Maldives (93%), Belarus (88%), Romania (84%), Bhutan (82%), Equatorial Guinea (81%), Iran (81%), Lithuania (78%), Nepal (78%), and Vietnam (76%). **Additionally, nine**

countries are "on track": Eritrea (6.3%), Oman (6.2%), Egypt (6%), Timor-Leste (6%), Bangladesh (5.9%), China (5.9%), Lao People's Democratic Republic (5.9%), Syrian Arab Republic (5.9%), and Cambodia (5.8%).

MMR due to HIV has been decreasing

In addition to weak health systems and barriers to accessing health services,[4] deaths due to AIDS contributed to the slow decline in MMR between 1990 and 2010 in AFR. Nevertheless, in the last decade, MMR has been decreasing in Southern African countries with generalized HIV epidemics.[5] As shown in Figure 3, **five countries (Botswana, Lesotho, Namibia, South Africa, and Swaziland) all experienced MMR decline from 2005 to 2010**. **This is partly attributed to the increasing availability of antiretroviral medicine.** Indeed, all five of these countries have surpassed the 2001 United Nations General Assembly Special Session goal of ensuring that 80% of pregnant women living with HIV who receive antiretroviral medicine for the prevention of mother-to-child transmission: Botswana (>95%); Lesotho (89%), Namibia (>95%), South Africa (>95%), and Swaziland (>95%).[5] **All the same, the proportions of maternal deaths attributed to HIV remain high in these countries** ranging from 41.5% in Lesotho to 67.3% in Swaziland.[2] Indeed, Swaziland's in 2010 would have been 104 maternal deaths per 100,000 live births instead of 320 if no pregnant women were living with HIV.

Figure 3. Trends in estimates of MMR for 5 Southern African countries with high HIV prevalence



Similarities and differences between the MMEIG 2008 and 2010 methodologies

The **methodology employed for the 2010 round of estimates was similar to that used for the 2008 round**. The main differences were: i) a larger dataset was available for the 2010 round compared to 2008's; ii) the WHO updated the data on the level of national adult mortality and this increased the figure representing the overall female deaths used in the 2010 round; and iii) the population size cut-off for countries included in the analysis changed from 250,000 in the 2008 round to 100,000 in the 2010 round, making the total number of countries covered 172 and 180 countries respectively. As result, MMR estimates for some countries were markedly different in 2008 and 2010 estimates. Table 2 presents explanations for countries with the largest differences between the two rounds of estimates.

Why the 2010 estimates are different from the DHS estimates

When the 2008 round of estimates was released, there were queries from operational Task Teams regarding the difference between household surveys such as DHS MMR estimates and MMEIG estimates. In fact, surveys do not provide an accurate MMR estimate for several reasons including: i) surveys do not collect information on cause(s) of death and thus identify pregnancy-related deaths rather than maternal deaths; ii) pregnancy-related deaths are underreported in surveys; and iii) the DHS methodology yield an MMR estimate that reflects the situation as it existed several years prior to the survey.

Further, previous studies have shown that **the DHS method may lead to a biased estimate of the level of maternal mortality, but not necessarily to biased values when it comes to the proportion of maternal of deaths of women of reproductive age** (PM).[6] Therefore, the MMEIG used the PM from such surveys in the statistical model rather than MMR estimates reported through surveys.

Similarities and differences between the MMEIG and IHME methodology

The Institute of Health Metrics and Evaluation (IHME) at the University of Washington released MMR esti-

mates in September 2011.[7] While there are similarities between the MMEIG and IHME methodologies, there are some notable differences.

Data sources

- Both MMEIG and IHME used data on deaths due to AIDS from UNAIDS and live births from the UN Population Division's World Population Prospects 2010. But MMEIG uses WHO life tables whereas IHME uses its own life tables. For other data sources, the MMEIG tend to use only nationally representative data, whereas IHME sometimes uses subnational data.

Addressing AIDS deaths

The MMEIG does not use all AIDS deaths during pregnancy, whereas IHME uses all those in the model.

Predictor variables

- The MMEIG uses GDP, GFR, and SAB in the model but IHME uses total fertility rate, GDP, HIV prevalence, neonatal mortality rate, and female education.

Model specification and predictor variables

- MMEIG used a two-part parametric model while IHME used a statistical model that is an ensemble of individual component models.
- Both the MMEIG and IHME use out-of-sample predictive measures for model evaluations.

Process for collecting and reviewing new data

- Unlike IHME, the MMEIG engaged countries in a formal country consultation process when the preliminary estimates were derived and in the process obtained additional data from countries.

Conclusion

Accurately measuring MMR is generally too difficult to accomplish except in countries that have complete civil registration systems with good attribution of the cause(s) of death. This makes MMR unsuitable for monitoring short-term changes in projects aimed at improving maternal health in countries with deficient civil registration systems. In a typical five-year health project, it is therefore not advisable to use MMR as an indicator.

The high-level Commission on Information and Accountability for Women's and Children's Health recommended that "*by 2015, all countries have taken significant steps to establish a system for registration of births, deaths and causes of death, and have well-functioning health information systems that combine data from facilities, administrative sources and surveys*".[8] Countries are encouraged to implement this recommendation to facilitate the measurement of MMR and the monitoring of MDG 5.

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Table 2. Differences in MMR in 2008 round and 2010 round, selected countries

Country	MMR in 2008 round	MMR in 2010 round	Difference 2008–2010	Explanation for 2010–2008 difference
Afghanistan	1391	459	–932	New data on maternal mortality from Afghanistan Mortality Survey 2010. Change in predictor variables in the model ■ higher GDP per capita ■ higher % in skilled attendant at birth Change in overall female mortality ■ less number of overall deaths of women 15–49
Tanzania	790	455	–335	Change in predictor variables in the model ■ higher % in skilled attendant at birth Change in overall female mortality ■ less number of overall deaths of women 15–49
Mali	825	538	–287	Change in overall female mortality and live births ■ more number of births ■ less number of overall deaths of women 15–49
Burkina Faso	558	299	–259	Change in overall female mortality ■ less number of overall deaths of women 15–49
Liberia	986	769	–217	Change in overall female mortality ■ less number of overall deaths of women 15–49
Zimbabwe	789	575	–214	Change in overall female mortality ■ less number of overall deaths of women 15–49
Nepal	380	168	–212	Change in overall female mortality ■ less number of overall deaths of women 15–49
Nigeria	836	626	–210	Change in overall female mortality ■ less number of overall deaths of women 15–49
Guinea-Bissau	995	786	–209	Change in predictor variables in the model ■ higher GDP per capita