Maternal mortality ratio – trends in the vital registration data

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Background. The paucity of quality data on maternal deaths and possible mis-specification of models have resulted in a range of estimates of the maternal mortality ratio (MMR) for South Africa.

Objectives. This paper contrasts the estimates from multi-country models for estimating the MMR with the South African data from vital registration.

Method. A literature review was undertaken to identify estimates of the MMR for South Africa and methodologies used. In addition, cause of death data from Statistics SA were analysed for trends.

Results. In contrast to prediction models used by international agencies, the Health Data Advisory and Co-ordinating Committee (HDACC) recommended the use of the vital registration data adjusted for under-registration and misclassification of causes to monitor maternal mortality. HDACC also recommended that, as is done by the Maternal Mortality Estimation Interagency Group (MMEIG), the number of maternal deaths identified be scaled up by 50% to account for the general under-reporting of maternal deaths. Based on this approach, the baseline MMR in 2008 was estimated to be 310 per 100 000 live births. From vital statistics, the indications are that by 2009, South Africa had not yet managed to reverse the upward trend in MMR. The increase is largely a result of an increase in the number of maternal deaths from indirect causes, as might be expected in the context of the HIV pandemic. However, the number of indirect maternal deaths increased markedly only since 2003, a few years later than the rapid increase in AIDS mortality.

Conclusions. There are opportunities to improve monitoring maternal mortality, including strengthening the information systems (vital registration, the confidential enquiry and the routine health information system) and exploring opportunities for linking data from different sources. Better data on the role of HIV in maternal mortality are needed.

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Tracking the level of maternal mortality reliably in developing countries is extremely challenging. In an ideal setting, vital statistics, based on good-quality medical certification of the cause of death, would provide the number of deaths from maternal causes. In developed countries it is sometimes necessary to supplement this with a monitoring system to identify all maternal deaths. However, in most developing countries with established vital registration systems, of which South Africa is one, not all deaths are registered and the quality of the cause of death information is often inadequate.[1] Alternative approaches to collecting information on maternal mortality are used, such as censuses, surveys, demographic surveillance systems, health facility data and active surveillance of reproductive age deaths. Despite significant advances in the measurement of maternal mortality, Graham *et al.*[2] argue that there is still much room for improvement, and that there is a need to assess the magnitude and direction of biases of the different methodologies and their implications for different uses to which the data are put.

Multi-country models

Given the lack of quality data in many countries, demographic and statistical modelling has been essential to assess country differentials and progress in reducing maternal mortality towards Millennium Development Goal 5. For those countries without good-quality vital registration data, the UN interagency group on maternal mortality estimation (MMEIG)[3] estimates the total number of deaths of females aged 15 - 49 years after removing the number due to HIV as estimated by UNAIDS, and then makes use of a prediction equation to estimate the proportion of non-AIDS deaths of women aged 15 - 49 that are maternal deaths based on the observed relationship of the number of these deaths with the gross domestic product, the general fertility rate, and the proportion of women who are assisted during delivery by a skilled attendant. To this they add the proportion of AIDS deaths of women aged 15 - 49 that can be assumed to be maternal. For this number of indirect maternal deaths associated with AIDS, there are limited epidemiological data for several of the required parameters. In particular there are limited data for the proportion of pregnancy-related deaths associated with AIDS that are actually indirect maternal deaths, as well as the relative risk of dying from 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 Institute for Health Metrics Evaluation (IHME)

used a different approach and estimated the maternal mortality rate including maternal AIDS deaths using a regression equation which includes, in addition to the factors used by MMEIG, the neonatal mortality rate and the HIV prevalence as predictors.[4,5] From this they estimated the number of maternal deaths and calculated the MMR.

Possible mis-specification of models and lack of reliable data to benchmark the estimates have generated a wide range of estimates (Fig. 1). In 2010 the MMEIG estimated that MMR reached a peak in 2006 and dropped to 410 per 100 000 live births by 2008. This trend appears to follow closely the decrease in the adult AIDS mortality, which peaked in 2006. On the other hand, the IHME estimated the MMR to have increased steadily since 1990 to reach 237 per 100 000 live births in 2008.[4] However, they recently revised this estimate,[5] apparently using an extended global database and a more sophisticated but similar statistical model, down to 91 per 100 000 for the year 2011, after peaking in 2007 at a level of about 129. This is completely unrealistic, particularly given that the estimates purport to include deaths due to HIV that occur during the pregnancy risk period including 42 days after delivery. A rough calculation using the formula in the paper[5] indicates that pregnancy-related HIV deaths alone amount to at least 700 per 100 000 live births. (In 2007, the general fertility rate for South Africa was about 8%, and there were probably over 107 000 HIV/AIDS deaths in women aged 15 - 49,[6] and around 1.07 million births.) Leaving aside the debate about including in an indicator of maternal mortality deaths that are not associated directly or indirectly with pregnancy or childbirth, and swamping the non-AIDS maternal deaths,[7] the estimates call into question the correctness of the more recent IHME estimates or their description of the method they used. Case definition, however, is extremely important.[8] Given that the policy implications are different, it is difficult to justify counting coincidental HIV-related deaths during the pregnancy risk period as maternal deaths. We recommend that the case definition of maternal deaths be carefully considered by the global community concerned about reducing maternal deaths.

South African data

There has been an enormous increase in the total number of registered deaths. In part this has been due to a considerable improvement in the completeness of death registration since 1994, and it is estimated that now more than 90% of adult deaths are registered.[9] While between 1997 and 2008 there was a huge increase in the number of deaths of young adults as a result of a rapid increase in deaths from infectious diseases,[10] since 2006, the numbers of registered deaths have started to decline.

There are problems with the quality of the cause of death information, and the data cannot be used at face value.[8] Studies have highlighted high levels of misattribution of HIV/AIDS as well as cardiovascular causes.[11,12] Only 2 - 2.5% of registered deaths are attributed to HIV,[13] while epidemiological models suggest that nearly 40% of deaths are due to HIV. Only 24% of the deaths of females aged 15 - 49 years have the pregnancy question completed, making it necessary to rely on the cause of death details to identify maternal deaths from direct and indirect obstetric causes. However, there have not been any studies investigating the validity of maternal causes in the vital statistics.

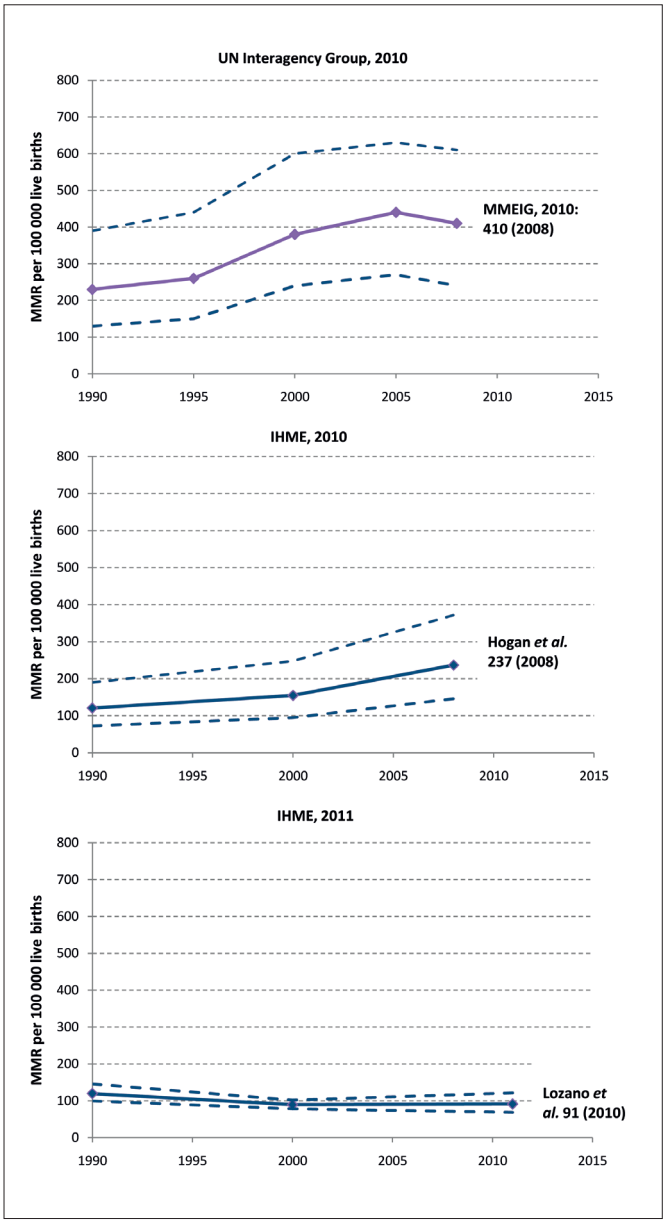

Fig. 1. Comparison of the estimated maternal mortality ratio per 100 000 live births for South Africa (source: adapted from MMEIG,[3] Hogan et al.[4] *and Lozano* et al.[5]*)*

Fig. 2 shows estimates for maternal mortality ratios (MMRs) and pregnancy-related mortality ratios (PRMRs) for South Africa from a variety of sources. The MMR comprises deaths from direct and indirect obstetric causes, while the PRMR includes all deaths during the pregnancy risk period, including incidental maternal deaths. It can be seen that the routine sources, i.e. vital registration and the confidential enquiry, provide values that are much lower than the estimates from surveys and the census. In the context of high adult mortality from AIDS, it can be assumed that there would be a high number of incidental deaths during the pregnancy risk period that would be reflected in the estimates from surveys and the census and may explain the high MMR of 625 for 2007 in the MDG Country Report, which was apparently derived from the Community Survey.[14] While the levels from the routine data are too low, both the vital registration data and the confidential enquiry data suggest that the MMR has increased, reaching a level of about 167 per 100 000 in 2008. The vital registration data suggests that the PRMR

may have peaked in 2006 but that by 2008 there was no sign of reversal in the upward trend of the MMR. This again indicates the importance of the case definition of maternal deaths.

After considering the options for performance monitoring, the Health Data Advisory and Co-ordinating Committee (HDACC) recommended basing the indicator of maternal mortality for monitoring the progress under the Health Minister's Negotiation Service Delivery Agreement (NSDA)[15] on the vital registration data adjusted for under-registration and misclassification of causes. Once it had been adjusted for the 8% incompleteness of adult death registration and the 14% of deaths due to ill-defined natural causes, the MMR in 2008 was revised to just over 200 per 100 000 live births. HDACC noted, further, that on the experience of some 22 studies of countries with good vital registration, MMEIG adds 50% to the numbers reported by the vital registration system[3] to adjust the estimates of the MMR in these countries to account for the general under-notification of maternal deaths as being maternal. Based on this adjustment, the MMR indicator in 2008 was increased to 310 per 100 000 live births. Applying the same method, the adjusted value for 2009 was 333 per 100 000 live births. Although there is a great deal of uncertainty about the actual level of the MMR, it is clear that maternal mortality has been increasing since at least the late 1990s and that South Africa is not on track to meet MDG 5.

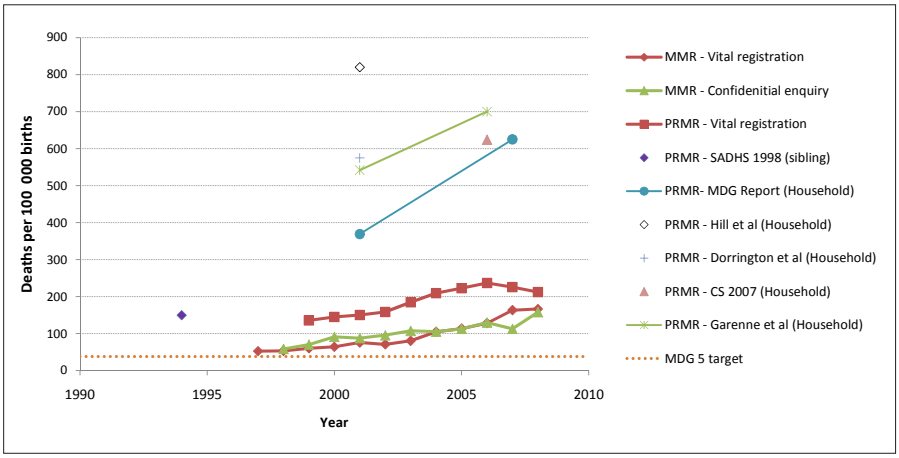

Fig. 2. Comparison of the estimated maternal mortality ratio per 100 000 live births (source: adapted from Dorrington and Bradshaw[9]).

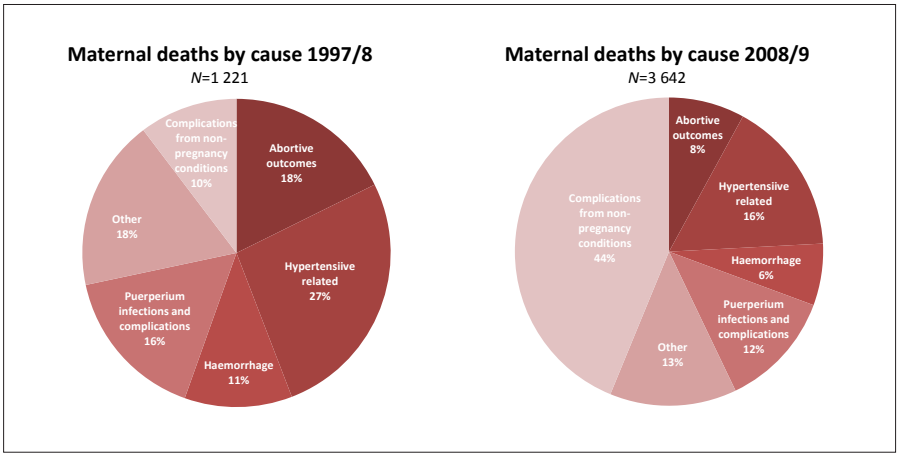

Fig. 3. Maternal deaths by cause for 1997/8 and 2008/9 (source: own calculations from data from Stats SA).

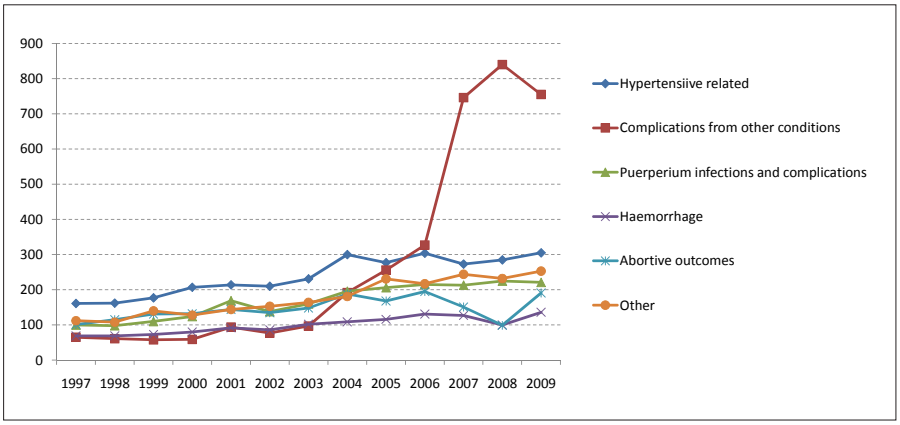

Fig. 4. Trend in causes of maternal deaths, 1997-2009 (source: own calculations from data from Stats SA).

Trend in causes of maternal death

The causes of maternal death have changed considerably over the period 1997 - 2009 (Fig. 3). In particular, complications from non-pregnancy conditions have increased from 10% to 44%.

From Fig. 4 it can be seen that there has been a marked increase in the number of indirect maternal deaths since 2003. Unfortunately, there is no breakdown of the actual cause of the complications as they are all assigned to a single ICD code in the data, but it is likely that HIV has been the major contributor to the increase. However, the timing of the increase is possibly unexpected given that the rapid increase in the mortality of women aged 15 - 49 due to HIV started some 7 - 8 years and peaked some 2 - 3 years earlier than the 'complications from other causes'. The delayed increase in the indirect maternal mortality is possibly due to the selective effect of pregnancy (those near death due to HIV are less likely to fall pregnant) or a delaying of death (and possibly increasing the risk of maternal complications) due to antiretroviral therapy. It should be noted that the peak in numbers of deaths from complications from other conditions in 2007 - 2009 is accompanied by an inverse trend in abortive outcomes for those years, which could possibly indicate some form of misclassification. The delayed increase in the number of indirect maternal deaths may also reflect changes in cause of death certification practice, or could possibly be associated with

increasing numbers of women with longer durations of exposure to HIV as the epidemic matures. Adverse effects of antiretroviral therapy are also a possibility.

Conclusion

Shortcomings in the maternal mortality data leave no alternative but to derive an estimate of the level of maternal mortality using a number of strong assumptions and to accept a high degree of uncertainty. Agencies such as MMEIG and IHME are concerned about estimating maternal mortality using a standard method that can be applied to many countries. As such the method has to be able to work with a minimal data set (common to all countries) and to be more or less automated, and for countries without good-quality vital statistics, they rely on regression equations which leave little scope for interpretation of local data. The HDACC, on the other hand, has recommended that the vital registration data be used to monitor the performance of the Minister. They argue that it is essential that empirical data rather than output from a prediction model be used to monitor performance, as they are more likely to be able to identify the effects of any interventions. HDACC has acknowledged that there is uncertainty in the actual level of the MMR and has recommended that as additional data become available, they be used to benchmark both the baseline value for 2008 and the approach for measuring any changes.

South Africa clearly needs to strengthen its systems for monitoring maternal mortality and progress towards the MDG targets, in order to determine appropriate policy. The Commission on Information and Accountability for Women's and Children's Health[16] has renewed momentum for building action-orientated maternal mortality surveillance systems, and has highlighted the need for active civil society engagement to ensure that the circumstances surrounding each death are fully elucidated and that there are comprehensive and feasible recommendations for follow-up actions. Linking mortality surveillance with remedial action is the centrepiece of an accountability framework. A maternal death surveillance and response system that includes maternal death identification, reporting, review and response can provide the essential information to stimulate and guide actions to prevent future maternal deaths and improve the measurement of maternal mortality.[17] The confidential enquiry system provides a substantive foundation for this, but there are areas in which monitoring and responding to maternal mortality at different levels of the health system can be improved. These include:

- Improving vital registration and cause of death statistics, i.e. improving the
  - quality of cause of death information
  - completeness of pregnancy status on the death notification
  - completeness of registration in all districts.
- Improving the health facility audit (confidential enquiry), i.e. ensuring that
  - deaths in general medical and surgical wards are included
  - deaths in the private sector are included
  - information about antiretroviral status of deaths is collected
  - responsiveness at provincial level is enhanced.
- Strengthening routine reporting of the number of deaths in facilities through the routine district health information system (DHIS), so that each district can monitor progress on reducing maternal mortality.
- Exploring data linkage opportunities in order to improve the estimation of MMR, particularly at district level, for example, linking
  - the confidential enquiry with cause of death data
  - the registered births and deaths.

During this phase of data improvement there will inevitably be uncertainty about the exact level of the MMR and competing estimates derived using different methodologies. Despite the uncertainty about the exact level of the MMR in South Africa, the vital registration data indicate that by 2009, the country had not yet managed to reverse the upward trend. Understanding what caused the sudden increase in indirect maternal deaths, as well as the continued rise in maternal deaths, is important to guide the response needed.

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