

# Every death counts: measurement of maternal mortality via a census

Cynthia Stanton,<sup>1</sup> John Hobcraft,<sup>2</sup> Kenneth Hill,<sup>3</sup> Nicaise Kodjogbé,<sup>4</sup> W.T. Mapeta,<sup>5</sup> Francis Munene,<sup>6</sup> Moshen Naghavi,<sup>7</sup> Victor Rabeza,<sup>8</sup> Bounthavy Sisouphanthong,<sup>9</sup> & Oona Campbell<sup>10</sup>

**Abstract** Methods for measuring maternal mortality at national and subnational levels in the developing world lag far behind the demand for estimates. We evaluated use of the national population census as a means of measuring maternal mortality by assessing data from five countries (Benin, Islamic Republic of Iran, Lao People's Democratic Republic, Madagascar, and Zimbabwe) which identified maternal deaths in their censuses.

Standard demographic methods were used to evaluate the completeness of reporting of adult female deaths and births in the year prior to the census. The results from these exercises were used to adjust the data. In four countries, the numbers of adult female deaths needed to be increased and three countries required upward adjustment of the numbers of recent births. The number of maternal deaths was increased by the same factor as that used for adult female deaths on the assumption that the proportion of adult female deaths due to maternal causes was correct. Age patterns of the various maternal mortality indicators were plausible and consistent with external sources of data for other populations.

Our data suggest that under favourable conditions a national census is a feasible and promising approach for the measurement of maternal mortality. Moreover, use of the census circumvents several of the weaknesses of methods currently in use. However, it should also be noted that careful evaluation of the data and adjustment, if necessary, are essential. The public health community is urged to encourage governments to learn from the experience of these five countries and to place maternal mortality estimation in the hands of statistical agencies.

**Key words** Maternal mortality; Censuses; Data collection/methods; Evaluation studies; Developing countries (*source: MeSH*).

**Mots clés** Mortalité maternelle; Recensement; Collecte données/méthodes; Etude évaluation; Pays en développement (*source: INSERM*).

**Palabras clave** Mortalidad materna; Censos; Recolección de datos/métodos; Estudios de evaluación; Países en desarrollo (*fuentes: BIREME*).

*Bulletin of the World Health Organization*, 2001, **79**: 657–664.

Voir page 663 le résumé en français. En la página 664 figura un resumen en español.

## Introduction

High levels of maternal mortality in the developing world have been increasingly recognized as an urgent public health concern during the past decade. The 1987 Safe Motherhood Conference in Nairobi, Kenya, drew attention to the fact that maternal mortality ratios in the developing world are at least 100 times greater than those found in industrialized countries, identify-

ing maternal mortality as the health indicator with the greatest disparity between rich and poor countries. Subsequently, several international forums including the 1990 World Summit for Children, the 1994 International Conference on Population and Development (ICPD), and the 1996 International Conference on Women in Beijing, China, included a 50% reduction in maternal mortality over the following decade among its stated goals. This emphasis was reaffirmed by the Programme of Action approved by the 1999 ICPD + 5 in The Hague, Netherlands (1).

<sup>1</sup> Director, Monitoring/Evaluation and Research, Maternal and Neonatal Health Project, JHPIEGO, 1615 Thames Street, Suite 100, Baltimore, MD 21231, USA (email: cstanton@jhpiego.org). Correspondence should be addressed to this author.

<sup>2</sup> Professor of Population Studies, Department of Social Policy, London School of Economics, London, England.

<sup>3</sup> Professor, Johns Hopkins School of Hygiene and Public Health, Baltimore, MD, USA.

<sup>4</sup> Director of the Census, Institut National de la Statistique et de l'Analyse Économique, Cotonou, Benin.

<sup>5</sup> Demographer, Central Statistical Office, Harare, Zimbabwe.

<sup>6</sup> Demographer, Central Bureau of Statistics, Nairobi, Kenya.

<sup>7</sup> Epidemiologist, Ministry of Health and Medical Education, Tehran, Islamic Republic of Iran.

<sup>8</sup> Demographer, Centre National de Recherches sur l'Environnement, Antananarivo, Madagascar.

<sup>9</sup> Director of the Census, National Statistical Center, Vientiane, Lao People's Democratic Republic.

<sup>10</sup> Senior Lecturer, London School of Hygiene and Tropical Medicine, London, England.

Ref. 99-0118

This heightened attention to maternal health has greatly increased demand for measures of maternal mortality at the national and subnational level. Such data serve well as broad indicators of progress but cannot be linked to specific interventions. However, the public health community has been slow to accept the fact that maternal mortality data cannot be used to evaluate the impact of the Safe Motherhood programme (2, 3). Using such data to assess specific interventions can be dangerous. In Matlab, Bangladesh, for example, where there has been a recently reported decline in maternal mortality, efforts to link the decline to specific interventions failed when it was shown that similar decreases in maternal mortality occurred in both intervention and control areas (4).

Regardless of the intended use of the data, methods for measuring and monitoring maternal mortality lag far behind the demand for such statistics. In the industrialized world, civil registration systems generate the needed data on maternal mortality, albeit with substantial, and often acknowledged, underreporting (5–7). In the majority of developing countries, however, civil registration data are simply too incomplete to be useful, leading a growing number of countries to turn to sample surveys as a means of measuring maternal mortality.

### Disadvantages of surveys for determining maternal mortality

Survey methods which attempt to identify recent maternal deaths in households require prohibitively large sample sizes because maternal deaths are relatively rare events. Demographic surveillance systems, though valuable for research purposes, cannot safely be generalized to a national population. Direct estimation techniques based on survey questions concerning the survival of each respondent's sisters are able to increase the sample size at relatively low cost (8, 9). Even using this methodology, however, sample sizes of 5000–15 000 female respondents, such as is common in the Demographic and Health Surveys (DHS) programme, still generate highly imprecise direct estimates of maternal mortality with confidence limits of plus or minus 30%, even for reference periods that include events occurring over 7 or more years (10). Indirect sisterhood estimates have similarly wide confidence intervals. Given this imprecision, survey-based methods can only provide a national-level estimate, cannot provide information on differentials in maternal mortality, and can only give an estimate for a period that often covers 7 or more years. The degree of imprecision can be seen from the maternal mortality ratios and 95% confidence intervals (CI) from recent surveys: Central African Republic 1451 (95% CI: 1194–1709); Indonesia 454 (95% CI: 378–529); and Peru 218 (95% CI: 148–288) (10). Given the shortcomings of the more commonly used approaches summarized above for the measurement

of maternal mortality, the attributes of an ideal methodology are outlined in Box 1.

### Advantages of census-based measurement of maternal mortality

Looking at the attributes in Box 1, ideally census measurement of maternal mortality would meet all the criteria. A high-quality, decennial census that includes questions on deaths in the household in the last one to two years, followed by questions which would permit identification of maternal deaths would produce current national and subnational maternal mortality statistics, as well as various differentials. This type of census could produce all four of the commonly used maternal mortality indicators, and would allow for trend analysis if undertaken more than once. The issue of sampling or other random error would be eliminated or greatly reduced as a census is not sample based. It would be possible — in order to reduce cost — to restrict the maternal mortality questions to a sufficiently large subsample

#### Box 1. Attributes of an ideal methodology for estimating maternal mortality

- The method should be capable of producing acceptably precise estimates at the national level, as well as producing differentials in maternal mortality by region, urban/rural residence, age, and other characteristics of interest.
- The method should be capable of producing multiple indicators of maternal mortality, i.e. in addition to the maternal mortality ratio, the method should also generate the maternal mortality rate, the proportion of adult female deaths due to maternal causes, and lifetime risk of maternal death. The interplay between changing rates of maternal mortality and fertility often produces unexpected results. Sole reliance on one indicator such as the maternal mortality ratio is insufficient and may produce misleading information for programme and policy purposes.
- Maternal mortality data should be collected by an institution other than those responsible for implementation of maternal health programmes. The burden of data collection on small, community-based programmes seriously detracts from their primary mandate of providing health services.
- The method should be capable of generating indicators annually in order to provide information on long-term trends. Even complete vital statistics, however, may not provide useful annual estimates because of the rarity of maternal deaths. Annual data on maternal mortality from industrialized countries over the last century are almost always presented as 5-year rolling averages to avoid the erratic nature of the maternal mortality ratio (11). Annual data on mortality levels are not necessary, however, for programme planning and policy. Furthermore, dramatic declines in maternal mortality over a short period of time in the developing world are not expected — given our understanding of the critical role of skilled health care personnel, health infrastructure, and access to emergency obstetric care in reducing maternal deaths (12, 13). Consequently, a practical method for maternal mortality measurement need only generate these estimates once every 10 years or so.

of the census. Also, data collection would be undertaken by an institution removed from health service provision. Finally, periodicity would be adequate since most developing countries undertake a census every 10 years or so.

The discussion of maternal mortality above implies measurement of a particular subset of all causes of deaths of adult females, i.e. deaths due to maternal causes. The existing literature on direct estimation of overall adult mortality via a census in the developing world suggests that questions about recent deaths in the household in a census have rarely provided useful information (14). For example, in the majority of African censuses, 40–50% of deaths may have been omitted. One reason for omission may be the break-up of the household after the death of a mother. Given this background, it seems timely to evaluate the experience of countries which have used a census for the measurement of maternal mortality and, on that basis, develop appropriate recommendations. This approach is endorsed by the 1999 ICPD + 5 Programme of Action, which specifically calls on the United Nations and donors to support developing countries in undertaking censuses and surveys and to develop innovative and cost-effective solutions for improving estimates of maternal mortality (1).

## Determining the maternal mortality ratio

The most widely used indicator of maternal mortality, the maternal mortality ratio, relates the number of maternal deaths in a particular time period to the number of births in the same period. In order to calculate this indicator from a census, data have to be collected on deaths by age and sex (to identify deaths of women of reproductive age), on whether the death of a woman of reproductive age was due to maternal causes, and on births. Evaluation of a census as a means of estimating maternal mortality ratios thus

requires evaluation of the completeness of recording of adult female deaths, of the adequacy of the approach used to identify maternal deaths, and of the completeness of data on births.

## Census data

Five countries were identified which collected maternal mortality data in their most recent censuses (Benin, Islamic Republic of Iran, Lao People's Democratic Republic, Madagascar, and Zimbabwe). The characteristics of these censuses varied considerably, as shown in Table 1. The number of enumerators trained to conduct the census ranged from 4800 in Benin to over 22 000 in Zimbabwe. The length of the census instrument also varied from 26 questions in Lao People's Democratic Republic to 52 questions in Benin. The duration of enumerator training, traditionally very brief, ranged from 1 week or less in Madagascar, Zimbabwe, and Lao People's Democratic Republic, to 2–4 weeks in Benin and the Islamic Republic of Iran. In the Islamic Republic of Iran, the census was conducted with all respondents in Farsi. In the other countries the census instrument was written in the administrative language of the country and translated as required in the field for respondents speaking other languages.

## Data collection and question formulation

The data collection methods and question formulation varied between countries. All five countries collected adult mortality data by asking the age and sex for all deaths in the household in the year before the interview. However, the methods used to identify maternal deaths varied substantially (Table 2). In Benin, Lao People's Democratic Republic, and Zimbabwe, a "time-of-death" approach was used: one or more questions were asked to determine if adult female deaths occurred during pregnancy, childbirth, or the postpartum period. In Madagascar, the following question was asked: "Were there any live births in this household during the last 12 months

Table 1. Characteristics of the census in five countries

Parameters	Benin	Islamic Republic of Iran	Lao People's Democratic Republic	Madagascar	Zimbabwe
Census date	Feb. 1992	Oct. 1996	Mar. 1995	Aug. 1993	Aug. 1992
National population	6 000 000	60 055 488	4 570 000	12 390 000	10 412 548
No. of enumerators	4800	NA <sup>a</sup>	14 000	15 000	22 225
Duration of enumerator training	2 weeks	3–4 weeks	3 days	1 week	5 days
No. of questions in census instrument	52	40 (22 supplementary)	26	43	33
Languages	French/ translation as required	Farsi	Lao/ translation as required	Malagashe/ translation as required	English/ translation as required

<sup>a</sup> NA = not available.

Table 2. Formulation of questions for maternal mortality estimation in the five censuses

Country (census date)	Wording of questions on maternal deaths and births
<b>Benin</b> (February 1992)	<p><i>Were there any births in the household since January 1 1991?</i> (matched to the line number of the mother)</p> <p>If yes: asked the name, sex, and date of birth (month and year).</p> <p><i>Were there any deaths in the household since January 1 1991?</i></p> <p>If yes: asked name, sex, date of death (month and year), age at death (day, month, and year) of the person who died.</p> <p><i>Did the deceased die during pregnancy?</i></p> <p><i>Did the deceased die following delivery?</i> (Enumerators were also instructed to ask if the death occurred during the postpartum period.)</p> <p><i>Did the deceased die of other causes?</i></p>
<b>Islamic Republic of Iran</b> (October 1996)	<p><b>Census questions</b></p> <p><i>Has anybody in your family died since last year?</i> (census was done at start of school year, a date which is well known).</p> <p>If yes: asked address, age, and sex.</p> <p><b>Supplementary questions</b> asked in households only if the census-recorded death was female, aged 10–50 years.</p> <p><i>Was there a death in the last year in this household?</i></p> <p><i>How old was the woman who died</i> (in years)?</p> <p><i>What was the date of her death</i> (month and year)?</p> <p><i>Where did she die</i> (at hospital, including identifiers, at home (address or road))?</p> <p><i>How did she die?</i></p> <p>If she went to the doctor: <i>What was the medical diagnosis?</i></p> <p><i>What happened when she died?</i></p> <p><i>At the time of death, was she pregnant?</i></p> <p><i>Was she within 42 days of delivery?</i></p> <p><i>Was it from another cause?</i></p> <p><b>Supplementary questions</b> asked regarding deaths which occurred in hospital.</p> <p>If she died in hospital, interviewers sought medical records and recorded: chief complaint at admission, time elapsed between admission and death, final diagnosis, cause of death on medical record, evidence of the timing of death in the medical record (in relation to pregnancy, delivery, or 42 days postpartum).</p>
<b>Lao People's Democratic Republic</b> (March 1995)	<p>Number of children born in last 12 months was estimated by adding the number of children aged 0 years in the household listed on the day of the census and the number who had died at age 0 years during the last 12 months.</p> <p><i>Did any deaths occur in the household in the last 12 months?</i></p> <p>If yes: <i>Was the deceased male or female?</i></p> <p><i>How old was the deceased</i> (age in completed years)?</p> <p>For women aged 15–49 years and for deaths other than caused by an accident:</p> <p><i>Did she die while pregnant, while giving birth, or within 42 days after giving birth?</i></p>
<b>Madagascar</b> (August 1993)	<p><i>Were there any births in this household during the last 12 months<sup>a</sup>?</i></p> <p>If yes: asked sex of child.</p> <p><i>Were there any deaths in this household during the last 12 months?</i></p> <p>If yes: asked sex of person who died and age in completed years.</p> <p><i>Were there any live births in this household during the last 12 months whose mother died (in last 12 months)<sup>a</sup>?</i></p> <p>If yes: asked number of children and sex of child.</p>
<b>Zimbabwe</b> (August 1992)	<p><i>When was [name's] last live birth</i> (month and year)? (asked of women aged 12–49 years).</p> <p><i>Did any deaths occur in the household in the last 12 months?</i></p> <p>If yes: <i>Was the deceased male or female?</i></p> <p><i>How old was the deceased</i> (age in completed years)?</p> <p>For women aged 12–49 years and for deaths not caused by an accident:</p> <p><i>Did she die while pregnant, while giving birth, or within about 1 month after giving birth?</i></p>

<sup>a</sup> There is some ambiguity in the months and years cited in the census instrument.

whose mother died (in the last 12 months)?” The Islamic Republic of Iran used a follow-up interview within 2 months of the census in households reporting

the death of a woman of reproductive age. At these follow-up interviews, the interviewers, who had been trained to carry out verbal autopsies, asked a series of

questions concerning the symptoms surrounding the death, and for deaths that were reported as occurring in health facilities, examined the available medical records.

### Completeness of reporting

For each country, standard evaluation methods were used to assess the completeness of reporting of all female deaths and births. The completeness of reporting of adult female deaths was assessed using the general growth balance technique that compares reported deaths to mortality information encapsulated in the census age distribution (15, 16). The method makes use of the fact that for any population (or segment of a population, such as people of a given age or older) the entry rate into the segment minus the growth rate of the segment must be equal to the exit rate from the segment. Systematic differences between the entry rate and the growth rate (a residual estimate of the exit rate calculated from the census age distributions) on the one hand and the exit rate (calculated from information about deaths by age) on the other imply an inconsistency between the reporting of population and the reporting of deaths. The magnitude of the inconsistency can be interpreted as a measure of completeness of death reporting relative to population reporting and can then be used to adjust the mortality estimates calculated from the original data. Although several variations of the original method exist, all are based on the assumption that misreporting of deaths is constant across age group. Net migration is generally assumed to be negligible (15, 16).

**Evaluation of birth data.** The evaluation of the birth data was carried out using two different techniques. Firstly, reverse projection was used to estimate the number of births from the number of young children in the population, after allowing for risks of childhood death. For example, the number of children aged 0–4 years in the population can be divided by the probability of surviving from birth to the age group 0–4 years (a standard life-table function) to estimate the number of births in the 5 years before the census. This technique requires both the age distribution of the population and some basis for estimating mortality risks under the age of 5 years. For the application described here, child mortality was estimated from information available from the census on the numbers of children ever born and children surviving, by age of the mother (16).

The second technique, generally called the P/F ratio method, which compares average parity to cumulated current fertility, involves comparing data on births in the year before the census by age of the mother with data on the average numbers of children ever born by women in each age group (16). This technique relies on the equivalence of lifetime fertility and cumulated age-specific fertility rates. For example, cumulated age-specific fertility rates for women aged 15–24 years would be equal to the lifetime fertility of women aged exactly 25 years. Appropriately cumu-

lated age-specific fertility rates calculated from births in the 12 months preceding the census can be compared with average numbers of children ever born for women classified by 5-year age groups; these rates should be equal if data are accurate and fertility is not changing (16). If the cumulated age-specific fertility rates are systematically lower than the average numbers of children ever born, births in the 12 months preceding the census are probably underreported. Application of this method requires care in situations of changing fertility, where cumulated current fertility will not be equal to lifetime fertility, but conclusions can still be drawn from the results.

### Evaluation of maternal death identification.

There are no demographic methods for the evaluation of the identification of maternal deaths. Our evaluation therefore relied on an assessment of the plausibility of age patterns of maternal mortality and a comparison of the census results to external sources of data, where available, or to empirical regularities such as an expected J-shape in the maternal mortality ratio by age, or an inverted J-shape for the proportion of all deaths of women of reproductive age that were due to maternal causes.

### Estimates of the maternal mortality ratio

Given the historical record of estimates of mortality and fertility based on events reported in the year prior to the census in developing countries, it was expected that data for most if not all countries would require substantial upward adjustment: this expectation was confirmed. Table 3 presents the results of this analysis for adult female deaths, births, and the resulting maternal mortality ratios. Although the adjustment factors were often large, the evaluation techniques were deemed, on the basis of their internal

Table 3. Unadjusted and adjusted maternal mortality ratios (MMRatios) from the five censuses

	Benin	Islamic Republic of Iran	Lao People's Democratic Republic	Madagascar	Zimbabwe
Unadjusted MMRatio	168	39	821	NA <sup>a</sup>	395
Adjustment factor					
Births	1.34	1.30	1.65	1.00	1.00
Deaths	2.7	3.0	1.6	2.5	1.0
Adjusted MMRatio	338	88	796	NA	395
High variant	250	58	746	NA	None <sup>b</sup>
Low variant	375	95	871	NA	None <sup>b</sup>
MMRatio from external sources of data	498	NA	NA	NA	393

<sup>a</sup> NA = not available.

<sup>b</sup> Adjustments were not deemed necessary.

patterns, to have worked well enough to give reasonably precise estimates, though it should be noted that no standard significance tests can be applied to these results.

The evaluation techniques described above generated two to three possible adjustment factors for the data on adult female deaths and births. The different factors were calculated by using different methods, or by variations in the assumptions underlying a particular method, or by differing age groups selected for analysis. Preferred adjustments (shown in Table 3) represent the group consensus after reviewing the results, bearing in mind the demographic conditions of each country. Thus, for example, the comparison of cumulated current fertility with lifetime fertility (P/F ratio method) was given little weight for the Islamic Republic of Iran and Zimbabwe, since fertility is known to have fallen rapidly in both countries. Comparison of adult female deaths to the age distribution of the population, which assumes an unchanging population age distribution, was also given low weight in both the Islamic Republic of Iran and Zimbabwe, where growth rates have been changing quickly, thus violating an assumption of the method. For the three other countries, adjustment factors tended to be similar regardless of the methodologies used.

With the exception of Zimbabwe, where reporting was estimated to be complete, the numbers of adult female deaths reported in these censuses required upward adjustment by factors ranging from 1.6 to 3.0. Data on births in the last year required adjustment in three of the five countries, with adjustment factors ranging from 1.30 to 1.65; reporting of births in Madagascar and Zimbabwe was deemed to be complete. Regarding maternal deaths, the expected J-shaped age pattern of the maternal mortality ratio was evident in four of the five countries. Likewise, the proportion of adult female deaths due to maternal causes was as expected and was consistent with data on age at first childbirth (data not shown). It was not possible to analyse the maternal death data from Madagascar: problems with question formulation meant that there were no data on age at death of the mother.

### Comparisons with survey data

Recent estimates of maternal mortality were available in Benin and Zimbabwe from national surveys (DHS) for comparative purposes. The DHS estimate of 498 in Benin refers to the period 1989–96 (17). Although higher than the adjusted census estimate of 338, the census estimate falls near the confidence interval surrounding the survey-based estimate. In Zimbabwe, the census and DHS estimates are virtually identical (395 and 393, respectively). However, the DHS estimate was based on only 55 maternal deaths reported over the 7-year period from 1988–94 compared to 1419 maternal deaths reported to the census over the 12 months preceding interview in August 1992 (10).

### Box 2. Recommendations for governments considering maternal mortality measurement

- Questions on deaths in each household in a clearly defined reference period of approximately 12 months, including name, sex, and age in completed years of each deceased person, should be included in censuses for countries lacking adequate vital registration (as recommended by the United Nations (18)).
- Additional questions should be included, either in the main census instrument or, under appropriate circumstances (outlined in recommendation no. 6), in a separate follow-up exercise, to identify maternal deaths among deaths of women of reproductive age.
- Questions on births (in the same clearly defined reference period), children ever born, and children surviving be included for each woman of reproductive age (as recommended by the United Nations (18)).
- Evaluation and adjustment, if necessary, of data on births, deaths, and attribution of deaths as being maternal should be an essential part of the exercise.
- Depending on national resources and priorities, census questions to identify maternal deaths among deaths of females aged 10–55 years could take the following forms:
  - One question *Was she pregnant, in childbirth, or within 6 weeks [or other clearly defined, similar period] of completion of pregnancy when she died?*
  - Separate questions *Was she pregnant when she died? Was she in childbirth when she died? Was she within six weeks [or other clearly defined, similar period] of completion of pregnancy when she died?*
  - Same as b, but adding the question *Was the death due to injury?*
- A separate questionnaire applied shortly after the census to identify maternal deaths among all deaths of women of reproductive age can be used if there is a suitable statistical infrastructure, a clear and unambiguous address system, and a motivated health system.
- Careful field testing, including purposive identification of maternal deaths, be included in the development of the census instrument and data-processing procedures in order to test skip patterns to assure the correct flow of questions.
- Careful training of field-based census supervisors should be carried out, stressing the need to check for non-response to the questions on adult and maternal mortality and to avoid inclusion of events outside the scope of these census questions (i.e. particularly age and sex).
- Explicit time allowance for extra training of enumerators be included in the overall plan for enumerator training. This training should emphasize, among other things, that:
  - additional questions should only be posed in the case of deaths of females aged 10–55 years;
  - time-of-death questions should be asked even if the respondent volunteers a cause of death;
  - the postpartum period should be explicitly specified;
  - enumerators should be sensitive to cultural taboos;
  - enumerators know how to deal with grief and anger of the respondents.
- Results should be published on all four indicators of maternal mortality (maternal mortality ratio, maternal mortality rate, proportion of adult deaths due to maternal causes, and lifetime risk of maternal death) by age group, geographical area, type of place of residence, and some socioeconomic characteristics of the household.
- For analytical and evaluation purposes, raw data should be kept in machine-readable form.

## Conclusions

The findings from this evaluation exercise suggest that a census is a feasible and promising approach for maternal mortality measurement under certain favourable conditions. Given the competition for additional questions in a population census, directors of census offices from the five countries in this analysis all agreed that the most important condition to be met before considering the addition of maternal mortality questions is a commitment on the part of the Ministry of Health to use the data for programming and policy-level decision-making. For example, high values for certain regions or population subgroups could help in targeting interventions. The second essential condition is a commitment to evaluate census results following data collection. All stages of data collection and evaluation need to be carried out with appropriate technical input. As is obvious from the results presented here, evaluation of the data using standard demographic procedures often leads to substantial upward adjustment of results.

Based on the experience in these five countries, recommendations were compiled for governments considering maternal mortality measurement in the future (see Box 2). It was not possible to estimate the cost implications of adding questions to the censuses of the five countries studied. However, while it is expected that each additional question affects to some extent the average duration of the interview and data processing, many developing countries already inquire into all births and deaths within the household, as is recommended by the United Nations (18). If this is the case, measuring maternal mortality requires only one to three additional questions, depending on the format selected to identify maternal deaths. Furthermore, the question or questions will only be asked where a recent adult female death has taken place, which is expected to occur in less than 1% of households. When considering the differential costs associated with a survey versus a census, one should also remember that a census provides data on regional differences, as well as on other variables of interest, as opposed to one

national estimate that would be available from a survey.

### Choosing a census to determine maternal mortality

Clearly, all pragmatic data collection methods in both the industrialized and developing world generate estimates of maternal mortality that are only approximate. The census is no exception. Nonetheless, given the expense, imprecision, and the fact that adjustment techniques do not exist for the traditional methods in use, the census has several advantages which make it worth advocating.

In all of the five countries except Madagascar, the initial motivation for the pioneering efforts made by the census bureaus originated from a request from a ministry of health, a women's union, or from an international health agency. The results of our evaluation should serve as a call to health ministries and census bureaus in developing countries to learn from the experience of these five countries and follow the recommendations listed above. Further implementation of the approach and attention to these recommendations may also lead to improvements in the future. By doing so, the public health community, armed with essential information on differentials in maternal mortality, is free to concentrate its efforts on interventions to reduce maternal deaths, while measurement is left to statistical agencies familiar with the complexities of the task. ■

### Acknowledgements

This study was made possible by support from the United States Agency for International Development under the terms of Cooperative Agreement HRN-A-00-97-00018-00. The opinions expressed are those of the authors and do not necessarily reflect the views of the United States Agency of International Development.

**Conflicts of interest:** none declared.

## Résumé

### Chaque décès compte : mesure de la mortalité maternelle à partir des recensements

Les méthodes de mesure de la mortalité maternelle au niveau national et subnational dans les pays en développement sont très insuffisantes en regard de la demande d'estimations. Nous avons évalué l'utilisation des recensements nationaux de population comme moyen de mesurer la mortalité maternelle, en analysant les données de cinq pays (Bénin, Madagascar, République démocratique populaire lao, République islamique d'Iran et Zimbabwe) dans lesquels les décès maternels sont identifiés dans les recensements.

Des méthodes démographiques classiques ont été utilisées pour évaluer l'exhaustivité de la notification des décès de femmes adultes et des naissances au cours de

l'année précédant le recensement. Les résultats de ces études ont été utilisés pour ajuster les données. Il a fallu revoir à la hausse le nombre de décès de femmes adultes dans quatre pays et le nombre de naissances récentes dans trois pays. Le nombre de décès maternels a été augmenté du même facteur que celui de décès de femmes adultes en partant de l'hypothèse que la proportion de décès de femmes adultes liés à la maternité était correcte. La répartition par âge des divers indicateurs de mortalité maternelle était plausible et compatible avec les sources extérieures de données pour d'autres populations.

Nos données indiquent que, dans des circonstances favorables, l'utilisation du recensement national

constitue une approche réalisable et intéressante pour la mesure de la mortalité maternelle, et qu'elle évite en outre certaines faiblesses des méthodes actuellement en usage. Il faut cependant noter qu'il est indispensable d'évaluer soigneusement les données et si nécessaire

de les ajuster. Les acteurs de santé publique sont instamment invités à encourager les gouvernements à tirer parti de l'expérience de ces cinq pays et à confier les estimations de mortalité maternelle à des agences de statistique.

## Resumen

### Determinación rigurosa del número de defunciones: medición de la mortalidad materna mediante un censo

Los métodos disponibles para medir la mortalidad materna a nivel nacional y subnacional en el mundo en desarrollo están muy a la zaga de la demanda de estimaciones. Evaluamos el uso del censo de la población nacional como medio de medición de la mortalidad materna, analizando para ello los datos de cinco países (Benin, la República Islámica del Irán, la República Democrática Popular Lao, Madagascar y Zimbabue) que consignaban las defunciones maternas en sus censos.

Se usaron métodos demográficos convencionales para evaluar el grado de completación de la notificación de las defunciones de mujeres adultas y de los nacimientos durante el año previo al censo, y los resultados obtenidos se utilizaron para ajustar los datos. En cuatro países hubo que aumentar las cifras correspondientes a las defunciones de mujeres adultas, y tres países requirieron un ajuste al alza de las cifras de los nacimientos recientes. El número de defunciones maternas fue incrementado

empleando el mismo factor que para las defunciones de mujeres adultas, suponiendo que la proporción de esas defunciones atribuible a causas maternas era correcta. Los perfiles por edades de los diversos indicadores de la mortalidad materna fueron plausibles y coherentes con las fuentes externas de datos para otras poblaciones.

Nuestros datos parecen indicar que, en condiciones favorables, el uso de un censo nacional es un método factible y prometedor para medir la mortalidad materna. Además, el uso del censo permite soslayar varias de las deficiencias de los métodos actualmente empleados. No obstante, debe señalarse también que para ello es esencial evaluar detenidamente los datos, y ajustarlos si es necesario. Hay que apremiar a la comunidad de salud pública para que aliente a los gobiernos a aprender de la experiencia de esos cinco países y a encomendar las estimaciones de la mortalidad materna a los organismos de estadística oportunos.

## References

1. *Proposals for key actions for the further implementation of the Programme of Action of the International Conference on Population and Development; report of the Secretary General.* United Nations Economic and Social Council, 1999 (E/CN.9/1999/PC/4).
2. **Graham W, Filippi V, Ronsmans C.** Demonstrating programme impact on maternal mortality. *Health Policy and Planning*, 1996, **11** (1): 16–20.
3. *The Safe Motherhood Action Agenda, priorities for the next decade.* Report on the Safe Motherhood Technical Consultation 18–23 October 1997, Colombo, Sri Lanka. New York, Family Care International, 1998.
4. **Ronsmans C et al.** Decline in maternal mortality in Matlab, Bangladesh, a cautionary tale. *Lancet*, 1997, **350**: 1810–1814.
5. **Atrash H, Alexander S, Berg C.** Maternal mortality in developing countries: not just a concern of the past. *Obstetrics and Gynecology*, 1995, **86** (4, part 2): 700–705.
6. **Bouvier-Colle MH et al.** Reasons for the under-reporting of maternal mortality in France, as indicated by a survey of all deaths among women of childbearing age. *International Journal of Epidemiology*, 1991, **20** (3): 717–721.
7. **Campbell O, Graham W.** *Measuring maternal mortality and morbidity: levels and trends.* London, London School of Hygiene and Tropical Medicine, 1991.
8. **Graham W, Brass W, Snow R.** Estimating maternal mortality: the sisterhood method. *Studies in Family Planning*, 1989, **20** (3): 125–135.
9. **Rutenberg N, Sullivan J.** Direct and indirect estimates of maternal mortality from the sisterhood method. In: *Proceedings of the Demographic and Health Surveys World Conference, 5–7 August 1991, Washington, DC, USA. Vol. 3.* Columbia, MD, Institute for Resource Development/Macro International, 1991: 1669–1696.
10. **Stanton C, Abderrahim N, Hill K.** *DHS maternal mortality indicators: an assessment of data quality and implications for data use.* Calverton, MD, Macro International, 1997 (Demographic and Health Survey Analytic Reports, No. 4).
11. **Loudon I.** *Death in childbirth, an international study of maternal care and maternal mortality 1800–1950.* Oxford, Clarendon Press, 1992.
12. Healthy pregnancy and childbearing. In: Tsui A, Wasserheit J, Haaga J, eds. *Reproductive health in developing countries; expanding dimensions and building solutions.* Washington, DC, National Academy Press, 1997: 116–145.
13. **McCarthy J.** The conceptual framework of the prevention of maternal mortality network. *International Journal of Gynaecology and Obstetrics*, 1997, **59** (Suppl. 2): S15–S21.
14. **Timaeus I.** Measurement of adult mortality in less industrialized countries: a comparative review. *Population Index*, 1991, **57** (4): 552–568.
15. **Hill, K.** Estimating census and death registration completeness. *Asian and Pacific Census Forum*, 1987, **1** (3): 8–13.
16. *Manual X. Indirect techniques for demographic estimation. Populations Studies No. 81.* New York, United Nations, Department of Economic and Social Affairs, 1983.
17. **Kodjogbé N et al.** *Enquête démographique et de la santé, République du Bénin. [Demographic and Health Survey, Republic of Benin.]* Calverton, MD, Macro International, 1996.
18. *Principles and recommendations for population and housing censuses, revision 1.* United Nations, Department of Economic and Social Affairs (Series M, No. 67/Rev. 1), 1998.