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An Assessment of Maternal Mortality Estimates from Demographic and Health Surveys

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Abstract

One of the Millenium Development Goals (MDG5) is to reduce the maternal mortality ratio in all developing countries by 75% between 1990 and 2015. Progress toward this goal has been documented by the World Health Organization (WHO) and the Institute for Health Metrics and Evaluation (IHME), using similar models to estimate levels and trends in virtually all countries. The Demographic and Health Surveys (DHS) are the principal source of data for the WHO and IHME models. Approximately 114 DHS surveys have included the maternal mortality module, which provides data for the direct sisterhood method. DHS is currently undertaking an assessment of the quality of the data and the published estimates. This is the first such assessment since 1997, when only 14 surveys had included the module. The paper will present the strategy for this assessment and describe potential implications for the WHO and IHME models.

An Assessment of Maternal Mortality Estimates

from Demographic and Health Surveys

1. Introduction

There is currently widespread interest in estimates of the levels and trends of maternal mortality rates, ratios, and numbers of deaths. One of the Millenium Development Goals (MDG5) is the reduction of the maternal mortality ratio by 75% by 2015, compared with 1990. Maternal mortality is important in itself but it is also the most extreme negative indicator of the status of maternal health and reproductive health.

The main data source of such estimates for developing countries is the direct sisterhood maternal mortality module in the Demographic and Health Surveys. This paper will describe an assessment of the quality of maternal mortality data in DHS surveys that is currently underway. It will not include any of the findings or conclusions from that assessment, but instead will focus on the issues to be addressed and the strategies to be employed. The paper will provide other researchers with an opportunity to contribute to the structure of the assessment.

The only comparable evaluation of these data was DHS Analytical Report #4, "DHS Maternal Mortality Indicators: An Assessment of Data Quality and Implications for Data Use", by Cynthia Stanton, Noureddine Abderrahim, and Kenneth Hill, published in 1997. Only 14 surveys could be included in that assessment. Virtually every one of the strategies employed in the 1997 report will be repeated in the current one, and several others will be added.

The World Health Organization (WHO) and its UN partners currently publish periodic estimates of maternal mortality. New estimates will appear this month, May 2012. The Institute for Health Metrics and Evaluation (IHME) also produces estimates, the most recent ones appearing in *The Lancet* in September 2011.[i] WHO and IHME use similar models and rely heavily on DHS data. UNICEF is adding a maternal mortality module to round 4 of the Multiple Indicator Cluster Surveys (MICS) that is virtually identical to the DHS module. UNICEF has also developed a new website on maternal mortality to include the DHS (and other) point estimates and modeled estimates (www.maternalmortalitydata.org).

A paradox in the measurement of maternal mortality for developing countries is the disconnect between, on the one hand, the high importance that policy makers attach to the estimates and, on the other hand, the high level of uncertainty that is inherent in the estimates, both as published in a survey report and after adjustment in a statistical model by WHO or IHME. It is not unusual for the ratio of the high end to the low end of an uncertainty interval to be approximately 2:1. With such high uncertainty, it is very difficult to identify differences between countries, sub-national differences, or changes over time. This reality does not diminish the attention given to the estimates.

This paper will first provide some technical specificity and then go into the strategies for the assessment.

2. Technical background

This section will describe six quite different kinds of technical background information: first, definitions related to maternal deaths; second, a review of the alternative indicators of maternal mortality; third, a review of the questions and information in the DHS questionnaire; fourth, some data processing steps; fifth, the content of the generic chapter on adult and maternal mortality in the DHS country reports; and sixth, the construction of the WHO and IHME estimates.

2.1 Definitions of maternal deaths

Since 1990, and during the entire period of the surveys being assessed, ICD-10 has been the standard for classification of deaths. Three types of deaths are included as maternal, and they are listed in Box 1 (which is extracted from WHO report xx).

Box 1. Definitions related to maternal death in ICD-10

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.

The label "maternal" is somewhat problematic, because it implies motherhood, which is not required for the death to be classified as maternal. For example, unsafe abortions are a leading cause of maternal deaths, and they are distinctly not maternal. Nevertheless, the label is widely used and efforts to replace it with "pregnancy-related" have had limited success.

Many of the countries with high levels of maternal mortality also have substantial numbers of AIDS-related deaths to women. If a death that would otherwise be classified as maternal occurs to a woman who has AIDS, there could be a question about the allocation of the death to one cause or the other. In a developing country setting, very few deaths will be accompanied by a death certificate in which a medical officer or physician has had to confront this question. Rather, the allocation of possible maternal deaths to either accidents or other causes such as AIDS is done at an aggregate level with statistical algorithms. The method of allocation can be a source of differences between two models that use the same DHS data, but DHS has no role in making such allocations.

2.2 Alternative indicators of maternal mortality

If the definition of maternal deaths could be accurately and consistently applied in a population with complete registration of vital events, then it would be possible to produce a count of the number of maternal deaths (which we will call MD) during a reference interval of time. In the absence of such a registration system, alternative methods such as surveys and surveillance systems are employed to assess the level of maternal mortality.

We will review the several measures of maternal mortality, first from a perspective in which the entry point is MD, and then from a perspective in which the entry point comes from a survey. All refer to an interval of time and a well-defined population. The reproductive years for women are generally assumed to be in the age range 15-49.

If MD is the starting number, and time periods or sub-populations or other populations are to be compared, then the natural impulse of a demographer is to match MD with a denominator that measures risk. There are three possible candidates for a denominator: the number of births (B); the number of women (W); and the number of deaths to these women, from all causes (D). It is reasonable to expect that the number of maternal deaths will be roughly proportional to each of these numbers. All three indicators are used, and are defined as follows, ignoring factors such as 1,000 or 100,000.

(1) The maternal mortality ratio, MMratio or MMR, defined by MMR=MD/B.

(2) The maternal mortality rate, MMrate, defined by MMrate=MD/W.

(3) The proportion of women's deaths that are maternal, PMDF or PM, defined by PM=MD/D.

(4) To be complete, this list of measures should include MD itself, the number of maternal deaths.

MDG5 is expressed in terms of the maternal mortality ratio, MMR. The other three measures are commonly encountered, but because of the political emphasis on the MMR, it will be taken as the primary measure.

A number of inter-relationships among these measures are easily developed, because W, B, and D are used in the construction of other established rates, i.e. the death rate for women 15-49 (which will be called DR), and the General Fertility Rate (GFR):

(4) The death rate for women, DR, is defined by DR=D/W.

(5) The General Fertility Rate, GFR, is defined by GFR=B/W.

Algebraic manipulation will confirm that the maternal mortality ratio can be calculated from any of the following formulas:

MMR=MD/B

MMR=PM*(D/B)

MMR=PM*(DR/GFR)

MMR=MMrate/GFR

In a perfect data setting, these formulas would agree exactly. The MMR could be calculated from its definition, MMR=MD/B, but it could be calculated equivalently from any of the other three formulas. In a less-than-perfect data setting, in which the components are estimated from different sources, or somewhat different reference periods, etc., these alternatives may not agree.

2.3 A review of DHS questions

Suppose now that maternal mortality is to be estimated from cross-sectional demographic surveys such as those conducted as part of the Demographic and Health Surveys (DHS). Information about the mortality of adult women is obtained with the "direct sisterhood method", in which respondents report on the survivorship of their sisters. If there is a parallel survey of men, they may also be asked about sisters' survivorship. Respondents are typically asked about survivorship of brothers as well as sisters.

The core questions in the DHS maternal mortality module, often referred to as the MM module, will now be listed. Note that siblings are defined to be brothers and sisters with the same mother as the respondent. Some additional questions are sometimes asked.

1A. Now I would like to ask you some questions about your brothers and sisters, that is, all of the children born to your natural mother, including those who are living with you, those living elsewhere and those who have died. Did your mother give birth to any children other than yourself?

1B. How many sons did your mother have who are still alive?

1C. Besides yourself, how many daughters did your mother have who are still alive?

1D. How many sons did your mother have who have died?

1E. How many daughters did your mother have who have died?

1F. Has your mother given birth to other children for whom you do not know whether they are still alive or have died?

1G. How many other children has your mother had for whom you do not know whether they are still alive or have died?

Then, for every sibling listed:

5. Is X male or female?

6. How old is X?

7. How old is X?

8. How many years ago did X die?

9. How old was X when he/she died

10. [For sisters] Was X pregnant when she died?

11. Did X die during childbirth?

12. Did X die within two months after the end of a pregnancy or childbirth?

13. How many live born children did X give birth to during her lifetime (before this pregnancy)?

There is a parallel here with the questions that a woman is asked about her own fertility. Those questions begin with the numbers of sons and daughters who died and survived, confirmation of the accuracy of the totals, preparation of a roster with names, and then filling in information about each child. The questions about siblings follow a similar logic.

The questions about maternal deaths (10-12) are imbedded in a larger set of questions about all deaths, from any cause. The maternal mortality module is, in effect, an *adult and maternal mortality* module. It gives two points of entry into the set of maternal mortality indicators. First, the data can be used to calculate (or estimate) the MMrate. Second, the data can be used to calculate the PM, and then

2.4 Data processing

The standard recode variables constructed from the responses are given below. There is a standard set of up to 15 variables (usually fewer than the full 15), based on the preceding questions for each line in the siblings roster, up to 20 siblings. The variables are indexed by the line in the siblings roster, _01 through_20. All 20 lines are included but have missing value codes for lines that go beyond the respondent's actual number of siblings.

mm1: sex of sibling (1: male; 2: female; 8: dk)

mm2: sibling's survival status (0: dead; 1: alive; 8: dk)

mm3: sibling's current age (97: 97+; 98: dk) mm4: cmc for date of birth of sibling (DHS estimate from mm3)

mm5: sibling's marital status (0: never married; 1: ever married; 8: dk)

mm6: years ago sibling died (97: 97+; 98: dk)

mm7: sibling's age at death (97: 97+; 98: dk)

mm8: cmc (century month code) for date of death of sibling (DHS estimate from mm6 and mm7)

mm9: sibling's death and pregnancy (0: never pregnant; 1: death not related; 2: died while pregnant; 3: died during delivery; 4: died since delivery; 5: 6 weeks after delivery; 6: 2 months after delivery; 98: don't know)

mm10: death and pregnancy are related (0: no; 1: yes; 8: dk)

mm11: sibling's cause of death (country specific)

mm12: time between delivery and death (100: same day; 101: unit is days; number of days; 201: unit is months; number of months; 301 unit is years; number of years; 997 inconsistent; 998 don't know)

mm13: place of death (country specific)

mm14: number of sibling's children

mm15: sibling's year of death (9998: dk; omitted if mm8 has been estimated)

Several of these variables (mm5, mm10, mm11, mm12, mm13, and mm14) will only be used if the questions listed in section 2.3 are supplemented with additional questions. mm15 is usually not used because it is superfluous if mm8 has been estimated, using DHS algorithms to estimate the month and year of an event. Variables that are not used will still be included in the data files but with a missing value code for all cases.

2.5 Generic chapter in DHS country reports

To maximize comparability, DHS country reports have a very consistent structure and sets of tabulations. One chapter in the report is on adult and maternal mortality. For several years the chapter has included four tables, with content described as follows.

Standard table 1. Data on siblings: Number of siblings reported and completeness of reported data on sibling's age, age at death (AD), and years since death (YSD). This table gives the numbers and percentages of "don't know" responses for survival status (mm2), age if alive (mm3), and YSDxAD if dead (mm6 and mm7), separately for male and female siblings as well as combined.

Standard table 2. Adult mortality: Direct estimates of adult mortality rates for the ten-year period preceding the survey, by age. This table gives the numbers of deaths, person-years of exposure, and mortality rates by five-year age intervals 15-19 through 45-49, separately for men and women. The mortality rates are calculated as the ratio of deaths to exposure (including a factor of 1000). An aggregate rate is given for age 15-49, but it is not the ratio of total deaths to total exposure; it is "adjusted to reflect the age distribution of respondents in the household".

Standard table 3. Trends in adult mortality: Trends in female and male adult mortality rates. This table does not include any new information. It simply reproduces the rates in table 2, and the corresponding rates from earlier surveys.

Standard table 4. Maternal mortality: Direct estimates of maternal mortality rates and ratio for the ten-year period preceding the survey. This is the crucial table for maternal mortality estimates. It gives the numbers of *maternal* deaths and woman-years of exposure in five-year age intervals for the respondent's sisters. Compared with table 2, the woman-years of exposure are exactly the same, but the deaths are reduced to those that are maternal (pregnancy-related). An overall maternal mortality rate is calculated from the age-specific maternal mortality rates after they have been re-weighted, i.e. "adjusted to reflect the age distribution of respondents in the household". Table 4 includes the General Fertility Rate estimated from the respondents' birth histories. The overall maternal mortality rate is divided by the General Fertility Rate, producing the Maternal Mortality Ratio.

There has been some evolution in the tabulation plan for this chapter, including a change that is taking place as this paper is being written but will not be described here, except to say that information on the importance of sampling error will be made more explicit.

2.6 Construction of the WHO and IHME estimates

Other data sources contribute to the comprehensive international estimates that are periodically prepared by WHO and IHME, but DHS surveys are one of the main sources. WHO obtains its DHS data from the DHS country reports; IHME goes into the sampling histories in the DHS data files and constructs estimates for different time intervals and makes some adjustments to the data. Both WHO and IHME make upward adjustments for likely under-reporting, downward adjustments for likely inclusion of accidental and incidental deaths, and adjustments for potential ambiguity in the classification of pregnancy-related and AIDS-related deaths. They apply multi-level random effects models with survey-level covariates such as the proportion of births with skilled attendants. Differences between the models are described in [xx]. For specific cases, the differences are mainly in the adjustments for AIDS, in the choice of covariates, and in the extent to which the model smooths the data.

It would be desirable to have a thorough investigation into the differences between the DHS and IHME models, and the reasons why two models wit same data sources can produce dramatically different estimates for some specific countries. However, such an effort is not in the scope of the present assessment.

3. Potential sources of error in maternal mortality estimates

To the extent that WHO and IHME estimates depend on DHS data, at least xx major types of errors are possible. "Error" here means a difference between an estimated value and an unknown "true" value, which is fundamentally a probability. These can be summarized as follows:

--sampling error

--non-sampling errors

--definitional inconsistencies

--imperfect adjustments and specifications of models

Each of these will be discussed briefly.

3.1 Sampling error

Sampling error is the easiest type of error to quantify. It is simply the difference between the number that appears in a DHS report, or that could be calculated from DHS data files, with reference to the sample, and the corresponding number that would be calculated if the survey could be enlarged to the entire population.

Sampling error is a very important source of uncertainty for maternal mortality estimates. To give a sense of how serious it is, consider the 2006 DHS survey in Uganda. It had 8,531 respondents in the age range 15-49 and they reported on a total of 57,855 siblings. Among the sisters, 1,511 deaths were reported in the age range 15-49, and 151 of those deaths were maternal. The MMR, calculated as described in generic table 4, using the GFR, is 435 maternal deaths per 100,000 births. This estimate spans the ten-year interval before the survey, approximately 1996 through 2005.

The estimate is directly proportional to the number of maternal deaths. A 95% confidence interval for the expected number of maternal deaths in these data would convert to a confidence interval for the MMR ranging between approximately 365 and 505. (Such an estimate ignores the additional uncertainty associated with the estimate of the GFR, which is included in the calculation and comes from the respondents' own birth histories, and also ignores the survey design.) Clearly, this level of uncertainty will complicate any interpretation of trends and differences.

3.2 Non-sampling error

The final summary of the 1997 assessment provided a helpful list of potential non-sampling errors that is largely unchanged:

--Deaths related to induced abortion are under-reported to an unknown extent.

--Recall of distant events most likely leads to under-reporting or shifting of adult and maternal deaths.

--Respondents may report a sister's death but be unaware that the sister was pregnant at the time of death. This would lead to a misclassification of the death as nonmaternal.

--Placement of adult deaths in calendar time can be difficult for respondents.

--By using a time of death definition of maternal death, non-maternal deaths occurring during the 11-month period of pregnancy, childbirth, and the postpartum period are counted as maternal deaths.

--A preliminary evaluation suggests that male and female adult mortality is more likely to be under-estimated than over-estimated even for the recent period. (Stanton, Abderrahim, and Hill, 1997, p. 43)

Non-sampling errors such as these can be only partially mitigated by improvements in the structure of the questionnaire, interviewer training, and other components of the data collection and analysis. The limited knowledge and memory of the respondent place a natural limit on how complete and accurate the responses can be.

3.3 Definitional inconsistencies

The terminology of the DHS questions is far different than that in the ICD 10 specification of maternal or pregnancy-related deaths. Some deaths that an attending physician might have classified as maternal will not be recognized as such by the respondent. Conversely, the respondent may say that a death was pregnancy related, but an attending physician would not have said that. The reference time period following childbirth or pregnancy termination is 42 days in the ICD 10 definition and "two months" in the DHS questionnaire, but even the "two months" will certainly not be applied consistently.

There has been considerable research on the use of verbal autopsies to get a better understanding of cause of death from respondents who lack medical training. It is not feasible for surveys on the scale of DHS to go into that depth about the circumstances of the death.

3.4 Imperfect adjustments and specifications of models

WHO makes some adjustments to correct for under-reporting and mis-classification. In most developing countries, these are across-the-board rather than country-specific, with borrowing and pooling of available studies from other countries. In addition, models are used that relate maternal mortality levels and trends with covariates, specifically the per capita gross domestic product (GDP), general fertility rate (GFR), and the percentage of births with a skilled attendant (SAB). The GFR and SAB typically come from DHS surveys. It is likely that the underlying link between maternal mortality and these covariates is stronger in some countries than others and that the model works better in some countries than in other. More information about the WHO model is available at http://www.maternalmortalitydata.org/methodology.html. As stated earlier, the IHME model is similar.

As an example of the difference between the DHS estimates and the WHO estimates, we return to the Uganda 2006 survey. As noted above, the ten-year estimate of the maternal mortality ratio (MMR) for (approximately) 1996-2005 was 435 maternal deaths per 100,000 births. The current WHO model estimates that the MMR for Uganda was 690 in 1995, 640 in 2000, and 510 in 2005. These estimates are for a point in time, rather than an interval of time, but they span the ten-year interval of the DHS estimate. With a simple linear interpolation between 1995 and 2000, and then between 2000 and 2005, the WHO estimates average out to a mean of 620 during the ten years for which the DHS estimate is 435. The WHO estimate is about 43% greater than the DHS value.

Even if one accepts that overall, across all countries, the estimate from the model is closer to the true value of the MMR, there can be no question that for specific years and countries the model may be farther from the correct value. Indeed, both WHO and IHME calculate uncertainty intervals, which are substantially broader than 95 confidence intervals. The uncertainty intervals are obtained by repeating the model many times, with all possible combinations of assumptions. The WHO uncertainty intervals for the MMR in Uganda in 1995 range from 390 to 1000; in 2000 from 360 to 940; in 2005 from 290 to 770. Throughout the time period, the ratio of the high end to the low end is greater than 2:1. There is evidence of a decline, but the high end of the interval for 2005 (770) is still about twice as large as the low end of the interval for1995 (390).

To summarize, although the DHS the numbers coming out of the DHS data need to be assessed, it is important to maintain perspective, and to understand that maternal mortality data quality issues in any specific country are partly confounded with, and are largely secondary to, the other sources of error described here: sampling error; non-sampling error that rests largely on the imperfect knowledge and memory of respondents; inconsistency due to the impossibility of applying the strict medical definition of maternal and pregnancy-related mortality; and the imperfect assumptions of any model that converts the original estimates into “official” estimates.

4. Strategies for the adult and maternal mortality data quality assessment

The analytical strategies for this assessment will be broadly similar to earlier assessments of DHS data, including the maternal mortality assessment by Stanton, Abderrahim, and Hill (1997) and earlier and more general reports by Rutstein and Bicego (1990) and Boerma, et al. (1994). Pullum’s assessments of ages and dates (2006) and the health and nutrition data (2008), added some new methods, mainly by adapting aggregate and demographic approaches to a framework of individual-level multivariate statistical models. The main references here will be to the siblings data in the surveys of women, but the analysis will also include male surveys that have included the module, with an interest in whether male and female data are consistent and can be safely combined. When “other data” are referred to, in the context of external comparisons, it should be understood that successive surveys in the same country will always be compared with respect to periods of overlap.

4.1 *Outcomes and covariates*

Key outcomes are the following

The reported number of siblings

The sex of each sibling (male / female)

Current age of sibling, if still alive

Whether the sibling died

Age at death and years since sibling's death, if dead

Relation of sibling's death to a pregnancy

Number of children ever born to the sibling (often omitted during data collection)

For some of the data quality assessment, particularly the individual-level multivariate analysis, covariates will be used. These will include (but may not be limited to) the following, in relation to adult deaths and/or the classification of an adult death as maternal:

Type of place of residence (urban / rural)

Age of respondent

Education of respondent

Wealth quintile of respondent

Respondent's number of siblings

Estimated years since death and age at death (for the classification as maternal)

Length or complexity of the non-MM part of the interview

The indicators or methods fall largely into the following categories.

4.2 *Individual-level methods*

Levels of missing and "don't know" responses. Missing and DK are usually not random and have the potential to bias the estimates, typically downwards. Their relative frequency can also be a symptom of the quality of the fieldwork and the accuracy of the other responses. The first standard table on this topic in the main country report presents the levels of missing. Logit regression will be applied for this purpose (see Pullum 2006).

Level of heaping or digit preference. In the present context, heaping can be either on ages, dates (calendar years), years ago, or possibly even on the numbers of siblings. Heaping is a type of rounding that indicates uncertainty about the correct response. It may induce bias if on the boundary of an interval. A multinomial logit version of Myers' Index will be used (see Pullum 2006).

Transfers across boundaries of age or time. We would expect that within birth cohorts of respondents, the distribution of numbers of siblings by calendar year of birth or years ago will follow a regular pattern. There is some possibility of displacement across age 15 or across the boundary for the child health questions or across the year 2000. Few such transfers are expected but can easily be checked for with logit regression (see Pullum 2006).

Omission of siblings. Omission is difficult to distinguish from displacement, because statistical methods generally require that the sum of the expected frequencies match the sum of the observed frequencies. However, because more questions are asked about female deaths than about male deaths, it is possible that some interviewers will tend to systematically drop sisters at a higher rate than brothers. A logit regression in which the sibling's sex (male / female) is the outcome will be examined to identify evidence of significant deviation from the expected sex ratio.

Discrepancies between daughters' and mothers' reports in the same household. In a preliminary investigation, there are substantial numbers of respondents who reside in the same household as the mother, and both the respondent and the mother are in the age range 15-49 and have been interviewed. The mother's report of the number of children alive and dead, by sex, should agree exactly with the daughter's report of the number of siblings alive and dead, by sex—after adding in the daughter herself. Discrepancies in these number (number of sisters, number of brothers, number of dead sisters, number of death brothers) will be analyzed using logit regression (a dependent variable will be coded 0 if the responses agree and 1 if they disagree). It is possible that agreement will be partially due to consultation during the interview or correction by the interviewer. Patterns of discrepancies will be examined further. (Note: this kind of check is novel but has been suggested by both Shea Rutstein and Michel Garenne.)

Sibship selectivity. If siblings tend to have correlated risks of dying, either due to genetic similarities or due to similar backgrounds, and responses about sibling survivorship are obtained from a surviving sibling, then it is possible that higher-mortality sibships will tend to be omitted and the estimates will be biased toward lower-mortality sibships. This kind of selectivity can be adjusted for with the Gakidou-King adjustment, but there is conflicting evidence about the extent of selectivity and the need to correct for it. If there are correlated risks within sibships, they would have more impact on adult mortality from all causes from on a relatively rare outcome such as maternal mortality. The impact of this adjustment will be checked in all surveys.

4.3 Aggregate-level methods

Comparison of fertility rates of respondents' mothers with other data. The sibling histories are in effect the birth histories of the mothers. They can be converted to period-specific fertility rates, with three caveats. First, they cannot be reliably keyed to age, because the age of the mother is not known (unless the mother is in the same household) although the age distribution of the mothers can be estimated. Second, it is conditional on women (in the generation of the respondents'mothers) having at least one child. Third, going being the second caveat, there is selectivity for higher fertility women in the mother's generation. The probability that a woman (in the mother's generation) will have a daughter in the survey is directly proportional to the number of daughters that such a woman had who are currently age 15-49. It is possible, with models and indirect standardization, to use the sibling histories to construct estimated fertility rates for approximately the past 20 years. Those estimated rates can be compared with fertility rates coming from the birth histories or other sources.

Comparing the fertility of siblings with other data. The number of children born to siblings, mm15, is generally not collected, because of concerns about omission, but if it is collected, it will also be compared with other estimates of fertility coming from the respondents themselves, from the generation of mothers, or other sources.

Comparison of mortality rates of siblings with other data. The sibling histories are used to produce estimates of adult mortality, but they can also be use to estimate fertility of children under 15, including children under 5. Death rates for intervals of age and time, specific for boys and girls, can be calculated from both the sibling histories and the birth histories of all women in the survey. There will be imperfect overlap, because the rates from the sibling histories will apply to somewhat earlier time periods, but there will be enough overlap to permit a comparison. It will also be possible to compare the age-period death rates for all ages, as calculated from the sibling histories, with Population Division and U.S. Census Bureau estimates and model life tables. Such comparisons may provide additional evidence of displacement or omission.

4.4 Sensitivity of the MMR to auxiliary estimates of fertility and mortality

As noted above in section 2.2, there are alternative (but related) formulas for the Maternal Mortality Ratio, MMR, that can mix components from different sources: MMR=MD/B; MMR=PM*(D/B); MMR=PM*(DR/GFR); and MMR=MMrate/GFR. All of these involve combining MD, PM, or MMrate, which come directly from the sibling histories, with a measure of fertility—either the matching number of births (B) or the General Fertility Rate (GFR). The quality of the correspondence will be approached from several different directions, using data from the DHS itself, from other sources, and from models.

5. **Conclusions**

This paper has given a brief overview of planned assessment of the DHS adult and maternal mortality data that is currently being conducted. Preliminary results are not included here because of the thorough review that will be necessary before findings are released. Maternal mortality has become a politically important indicator of reproductive health despite the difficulty of measuring it accurately.

The main purpose of the assessment is to identify biases in the estimates that are published in the main DHS reports, and potential caveats for the re-analysis of the individual-level responses to produce estimates for shorter time intervals or intervals farther in the past. If there is evidence of biases, DHS will attempt to improve the questionnaire design and the training and supervision of interviewer. It is normal DHS policy not to introduce adjustments to the data, but to leave it up to users (such as WHO and IHME) to make any adjustments.

The content of the DHS surveys has expanded enormously since the project began in 1984. There has been concern that the addition of new modules and biomarkers, and the increasing length of the interview and the questionnaire, has tested the limits of the respondents. It is possible that the maternal mortality module, in particular, has caused some degradation of the responses to other questions. That possibility will be investigated in another data quality assessment, but not in this one.

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