DHS ANALYTICAL REPORTS

4

DHS Maternal Mortality Indicators: An Assessment of Data Quality and Implications for Data Use

DHS

DEMOGRAPHIC AND HEALTH SURVEYS

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For information about the Demographic and Health Surveys program, write to DHS, Macro International Inc., 11785 Beltsville Drive, Suite 300, Calverton, MD 20705, U.S.A. (Telephone 301-572-0200; Fax 301-572-0999).

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DHS Maternal Mortality Indicators: An Assessment of Data Quality and Implications for Data Use

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Preface

One of the most significant contributions of the DHS program is the creation of an internationally comparable body of data on the demographic and health characteristics of populations in developing countries. The *DHS Analytical Reports* series and the *DHS Comparative Studies* series examine these data across countries in a comparative framework, focusing on specific topics.

The overall objectives of DHS comparative research are: to describe similarities and differences between countries and regions, to highlight subgroups with specific needs, to provide information for policy formulation at the international level, and to examine individual country results in an international context. While *Comparative Studies* are primarily descriptive, *Analytical Reports* utilize a more analytical approach.

The comparative analysis of DHS data is carried out primarily by staff at the DHS headquarters in Calverton, Maryland. The topics covered are selected by staff in conjunction with the DHS Scientific Advisory Committee and USAID.

The *Analytical Reports* series is comprised of in-depth, focused studies on a variety of substantive topics. The studies employ a range of methodologies, including multivariate statistical techniques, and are based on a variable number of data sets depending on the topic under study.

It is anticipated that the *Analytical Reports* will enhance the understanding of significant issues in the fields of international population and health for analysts and policymakers.

Martin Vaessen
Project Director

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Executive Summary

This report is a compilation of the maternal mortality data collected in 14 DHS surveys. The objectives of the report are to document DHS procedures for the use of the maternal mortality module, to assess the quality of the sibling history data used to derive the maternal mortality indicators, to provide standardized analyses of these data and to discuss the appropriate use and interpretation of DHS maternal mortality estimates.

Three aspects of data quality in the sibling histories are assessed in this report; 1) the completeness of the data for events reported in the sibling history, 2) an examination of evidence suggesting possible omission in the reporting of events and 3) the plausibility of the patterns of sibling births and deaths shown in these data. In general, the sibling history data pertaining to basic demographic indicators such as reported vital status, sex, age for living siblings and age at death for dead siblings are remarkably complete in most surveys. Two variables within the sibling history, however, show particularly high percentages with incomplete data. These are: the number of years since the occurrence of a sibling's death and the timing of death relative to pregnancy, childbirth and the postpartum period for adult female deaths. Adjustments are made for both of these deficiencies in the data. It is also interesting to note that despite concerns regarding differential reporting by sex in the sibling history, the data quality indicators among reported events reflect nearly identical patterns for brothers and sisters.

Detecting underreporting of events is a considerably more difficult task. Although the evidence is far from conclusive, comparisons of DHS sibling estimates of adult mortality to external sources of the same suggest that the sibling measures are more likely to be underestimates than overestimates of actual adult mortality for the seven year period preceding the surveys. For the case of underreporting, the data also suggest that the downward bias is probably somewhat greater for females than males. As maternal mortality is a subset of adult female mortality, it is assumed that maternal mortality is underreported for the recent period as well.

The maternal mortality indicators presented in this report, including maternal mortality rates, ratios and lifetime risk of maternal death, show implausible increases between the periods 7 to 13 and 0 to 6 years before the surveys for a majority of the 14 countries considered in this report. This pattern is evident in countries of high and low mortality. For example, in the Central African Republic the MMRatio increased 87 percent from 775 in the distant period compared with 1451 for the recent period; in Namibia, the MMRatio increased over 150 percent from 154 to 395 for the same periods. These large increases most likely reflect underreporting due to recall problems associated with the estimates for the distant period, and or inaccurate reporting on the timing of the reported events.

Although the percent increases for some of the countries range from 50 to over 100 percent, few of these increases are statistically significant due to the rarity of maternal deaths and the DHS sample sizes. The 95 percent confidence intervals for the MMRatio estimates are, on average, plus or minus 30 percent of the estimate. The imprecision of the individual estimates, coupled with the implausible increases seen for a number of the countries, clearly imply that these data cannot support trend analysis for adult nor maternal mortality.

It is important for users of the DHS maternal mortality indicators to realize the strengths and weaknesses of these measures and to realize that MMRatios from virtually any method will only provide an approximate level of maternal mortality. Although the limitations of the maternal mortality indicators are slowly beginning to be recognized, serious misinterpretation of these data is common. Among the goals outlined at conferences such as the 1990 United Nations World Summit for Children and the 1995 International Conference on Population and Development include a reduction by one half in maternal mortality. These data, as well as efforts by others, effectively demonstrate that in most cases the measurement techniques currently feasible at a national level will not permit meaningful monitoring of maternal mortality over time. It is, therefore, essential that our attentions be focused on the measurement and monitoring of indicators which reflect the components or processes that determine a positive or adverse pregnancy outcome. Only through experimentation in data collection and analysis will the most effective package of indicators emerge.

1 Introduction

Greatly increased attention has been directed toward the issues surrounding maternal health since the launching of the Safe Motherhood Initiative in 1987. A primary goal of this initiative is the reduction of maternal mortality. The hospital and small community-based studies which were responsible for first shedding light on the severity of the problem, however, have not been adequate for national level policymaking and program management. The increased awareness of the problem has resulted in a much greater demand to measure and monitor maternal mortality at a national and subnational level.

Developing country governments and international donor agencies have long relied on Demographic and Health Survey (DHS) data to monitor a variety of family planning and child survival program indicators. In response to the increased interest in maternal mortality, DHS began collecting maternal mortality data in an optional module to the core DHS questionnaire in 1988. Since that time, the maternal mortality module has been included in the questionnaires for approximately 20 countries. This report examines the maternal mortality data from 14 countries, for which data sets were available at the time this report was being prepared (see Table 1.1).

The purposes of this report are to document the DHS approach to data collection and analysis used in these countries, to compile the data for comparative purposes, to assess the quality of the data collected in the maternal mortality module and to discuss the appropriate use and interpretation of these data. This first chapter describes the methods currently available for population-based measurement of maternal mortality, with detailed descriptions of the two approaches which rely on sisterhood data. Chapter 2 covers the comparability of the DHS instruments used to collect the sibling data. Chapter 3 consists of a data quality assessment of the variables collected in the sibling history. Levels and patterns of maternal and adult mortality and fertility from DHS surveys are covered in Chapter 4. A summary and policy implications are presented in Chapter 5.

1.1 INDICATORS OF MATERNAL MORTALITY

The definition of a maternal death according to the Tenth Revision of the International Classification of Diseases follows:

A maternal death is the death of a woman while pregnant or within 42 days of termination of pregnancy, irrespective of the duration and the site of the pregnancy, from any cause related to or aggravated by the pregnancy or its management but not from accidental or incidental cause (WHO, 1993).

A pregnancy-related death is defined as:

A pregnancy-related death is the death of a woman while pregnant or within 42 days of termination of pregnancy, irrespective of cause (WHO, 1993).

A pregnancy-related death, therefore, is determined solely by timing of death relative to pregnancy, childbirth, and the postpartum period. A true maternal death requires specific cause of death information. As described in this chapter, data collection methods vary by their capacity to identify pregnancy-related versus true maternal deaths. Regardless of the definition used, the results are generally reported as maternal deaths.

A number of different indicators have been developed for the measurement of maternal mortality. The four most commonly used indicators are included in the standardized tables presented in this report, and are described below.

The most commonly used indicator is the maternal mortality ratio (MMRatio), which is defined as:

$$\frac{n\ of\ maternal\ deaths}{n\ of\ live\ births} * 100{,}000 = MMR \qquad (1)$$

By expressing maternal deaths per *live birth*, rather than per woman of reproductive age, the MMRatio was designed to express obstetric risk. In fact, the MMRatio overestimates obstetric risk by excluding from the denominator pregnancies which do not terminate in a live birth, but which may be responsible for a maternal death. Though in theory it would be desirable to refine the MMRatio by including all pregnancies in the denominator, in practice, suitable data on pregnancies that do not result in a live birth are rarely available. Because the MMRatio is not an age-standardized measure (as is the total fertility rate, for example), MMRatios across countries are not completely comparable.

Table 1.1 Countries included in this report, Demographic and Health Surveys 1989-1995

Country	Year of survey	Sample size	Respondents
Africa			
Central African Republic	1994-95	5,884	All women 15-49
Madagascar	1992	6,260	All women 15-49
Malawi	1992	4,850	All women 15-49
Morocco	1992	9,256	All women 15-49
Namibia	1992	5,421	All women 15-49
Niger	1992	6,503	All women 15-49
Senegal	1992-93	6,310	All women 15-49
N. Sudan	1989-90	5,860	Ever-married women 15-49
Zimbabwe	1994	6,128	All women 15-49
Asia			
Indonesia	1994	28,168	Ever-married women 15-49
Philippines	1993	15,029	All women 15-49
Latin America			
Bolivia 1	1989	7,923	All women 15-49
Bolivia 2	1993-94	8,603	All women 15-49
Peru	1991-92	15,882	All women 15-49

By convention, the MMRatio is expressed per 100,000, in contrast to all other mortality indicators which are expressed per 1,000. This decision was made in order to focus attention on the problem of maternal death not only in the developing world, but also in the developed countries where MMRatios expressed per 1,000 would be less than one. Expressing MMRatios per 100,000 has created an effective advocacy tool, however, it also implies a potentially misleading degree of accuracy. For example, an MMRatio that might be cited as 539 (per 100,000), would not normally be expressed as 5.39 (per 1,000).

The MMRatio is frequently, though erroneously, referred to as the maternal mortality rate (MMRate). The MMRate is an indicator of the risk of maternal death among women of reproductive age. It is the equivalent of a cause-specific death rate. This indicator conceals the effect of differing levels of fertility in cross-country comparisons. However, because it is a woman-based statistic, it does provide an indication of the burden of maternal death in the adult female population. The MMRate is defined as:

$$\frac{n\ of\ maternal\ deaths}{n\ of\ women\ aged\ 15\text{-}49} * 1000 = MMRate \quad (2)$$

The relationship between the MMRate and the MMRatio is as follows:

$$\frac{MMRate}{General\ Fertility\ Rate} = MMR \quad (3)$$

The third indicator is the proportion of adult female deaths due to maternal causes, referred to here as the proportion maternal. The proportion maternal is simply:

$$\frac{n\ of\ maternal\ deaths}{female\ deaths\ ages\ 15\text{-}49} = Proportion\ maternal \quad (4)$$

A fourth indicator of maternal mortality is the lifetime risk (LTR) of maternal death. LTR reflects the chances of a woman dying from maternal causes over her 35 year reproductive life span. In doing so, it accounts for the probability of a death due to maternal causes each time a woman experiences a pregnancy. Although it is interpreted as a cohort measure, it is calculated using period data (Fortney, 1987) for practical reasons. For ease of interpretation, the reciprocal of the LTR is more frequently used than the LTR itself. For example, an LTR of .028 is interpreted as: one in 35 women will experience a death from maternal causes throughout her reproductive lifetime. The calculation of LTR will vary according to the MMRatio estimation technique selected. These differences are described below in the notes on indirect and direct estimation. However, two commonly used equations for the approximation of LTR are (Campbell and Graham, 1991):

$$LTR = 35 * MMRate \quad (5)$$

$$(1 - LTR) = (1 - MMR)^{TFR} \quad (6)$$

LTRs shown in DHS final country reports are calcu lated using equation (6). For the purposes of this report, the LTR is calculated using age-specific adult female mortality rates and the age-specific proportions of adult female deaths due to maternal causes. LTR estimates are obtained as follows: age-specific mortality rates are first converted to probabilities of death (${}_5q_{15}$, ${}_5q_{20}$, etc.), these probabilities are multiplied by the age-specific proportions maternal, age-specific probabilities of survival are obtained by subtraction from one, lifetime probability of survival is calculated via multiplication of all survival probabilities, and LTR of maternal death, or the maternal ${}_{35}q_{15}$, is obtained by subtraction from one. This approach is considered preferable in that it avoids the unnecessary reliance on the approximations described above by utilizing data available within the sibling history. The results of this approach were found to be systematically lower by roughly 10 percent than those from equation (6).

Among the possible indicators of maternal mortality, the MMRatio has received the attention of policymakers, program managers, and the donor community nearly to the exclusion of the other indicators. This is unfortunate since the MMRatio has a number of limitations, some of which may be circumvented by use of these other indicators or by presenting a combination of indicators. For example, because the MMRatio is not an age-standardized measure (maternal deaths/live-births), MMRatios are not directly comparable across countries as are other major demographic indicators such as probabilities of infant and child death and the total fertility rate. Focusing attention on the risk of maternal death per birth also ignores the fact that women face this same risk numerous times over their reproductive lifespan. Lastly, appreciating a risk per 100,000 events is not immediately intuitive.

By contrast, the LTR of maternal death avoids all of these shortcomings. The MMRate which expresses the rate of maternal deaths per 1,000 women, provides an indicator that is more closely comparable to other mortality indicators such as adult, infant, or under-five mortality rates.[1] This comparison effectively conveys the frequency of maternal deaths in the population relative to these more commonly measured deaths. Likewise, the proportion of adult female deaths due to maternal causes provides a clear picture of the burden of maternal death in the population, regardless of the level.

Different aspects of the level of maternal mortality are reflected in each of the indicators described above. Even with highly precise data, a variety of indicators are needed to understand the level and pattern of maternal mortality and how each of those may have changed over time. The interplay between changes in maternal mortality and fertility often produces unexpected results. The following examples illustrate this point. In an area where fertility has fallen and the risk of maternal death per birth has remained constant, the MMRate will decrease. Fewer births result in fewer maternal deaths, thus the rate decreases. The MMRatio, however, may well increase in an area where fertility has dropped and no new safe motherhood interventions are in place. A larger proportional decrease in the number of births than in the number of maternal deaths will result in an increased MMRatio. Likewise, in situations where the risk of maternal death per woman has remained constant, the proportion maternal may change substantially if the cause of death structure is altered (for example, from AIDS mortality). To summarize, a level of maternal mortality should be interpreted in light of the risk per woman and per birth, and with consideration of the changes in fertility and the distribution of deaths by cause.

1.2 SOURCES OF DATA ON MATERNAL MORTALITY

Traditionally, information on maternal mortality in the developing world has been collected in hospital-based studies, from hospital service statistics, or from relatively small community-based studies (WHO, 1991). In rare circumstances, population surveillance systems have reported on maternal deaths (Campbell and Graham, 1991). In the developed world, maternal mortality statistics generally result from vital registration systems. The serious limitations of these various data sources in both the developing and the developed world have been well documented elsewhere (Atrash et al., 1995; Baranov, 1991; Berg et al., 1996; Bobadilla et al., 1989; Bouvier-Colle et al., 1991; Campbell and Graham, 1991; Comas et al., 1990; Graham et al., 1989; Kane et al., 1992; Laurenti, 1993; Royston and Armstrong, 1989). In summary, the problems vary by source, but generally fall into the following categories: lack of generalizability to the population at large, underreporting of maternal deaths and/or very small numbers of events due to the rarity of maternal death.

[1] These indicators may not be completely comparable to the MMRate as they are frequently expressed as probabilities of death, rather than rates.

1.3 POPULATION-BASED DATA COLLECTION

In response to the limitations of the traditional sources of data on maternal mortality, several approaches have been developed which permit the collection of population-based data. Reproductive Age Mortality Surveys (RAMOS) are often considered the gold standard. A RAMOS study seeks to identify all female reproductive age deaths in a defined population by turning to a number of traditional and nontraditional sources of information. For instance, information on female deaths may be collected from household interviews, hospital and health center records, vital registration, and word of mouth. Once a death is identified, some of the same sources mentioned above, as well as verbal autopsies and interviews with birth attendants, are used to classify the death as due to maternal or nonmaternal causes. Final classification of maternal deaths is usually decided by a team of physicians who review all of the evidence.

The package of techniques selected to identify female deaths is determined by the feasibility and appropriateness of each approach in that setting. However, data from surveillance systems, such as the Matlab study area in Bangladesh, and even data from studies in the developed world, have shown that with each additional source of information, the number of maternal deaths ascertained will increase (Berg et al., 1996; Koenig et al., 1988). The obvious drawbacks to this thorough approach are the expense and labor intensive effort required, particularly if the survey is designed to cover a large geographical area. For that reason, only a few national RAMOS surveys have been conducted. These include, for example: Jamaica (Golding et al., 1989), Honduras (Castellanos et al., 1991), Guinea Bissau (Osterbaan and Barreto da Costa, 1991) and Egypt (Ministry of Health, 1994).

1.4 HOUSEHOLD SURVEYS

Other population-based methods include the addition of questions on all deaths within the last one or two years to a household survey or census. Once a female adult death is identified, three additional questions would be asked to determine if the death occurred during pregnancy, childbirth or the postpartum period. This was the method used for the India National Family Health Survey in 1992-93 (International Institute for Population Studies, 1995). For smaller-scale surveys, Boerma and Mati (1989) have described the networking method of identifying maternal deaths. This involves asking women interviewed in a household survey if they know of any maternal deaths in the surrounding villages. Names and residences are cross-checked to avoid double counting. The method is only appropriate for settings in which the sampling unit is a complete village and the geographical scope of the study is quite limited.

1.5 SISTERHOOD METHOD: THE ORIGINAL INDIRECT METHOD

In 1989, Graham, Brass, and Snow described an indirect technique for estimating maternal mortality for advocacy purposes in settings with inadequate data from other sources. This indirect estimation technique is referred to as the "sisterhood" method and is based on the principles and the assumptions of the indirect sibling survivorship method for estimating adult mortality (Graham et al., 1989). The adaptation of this method for the estimation of maternal mortality involves asking a representative sample of adults a small number of questions regarding the survivorship of all of their sisters (sisters born to the respondent's mother). By inquiring about female siblings in a high fertility setting, one effectively expands the sample size with very little additional cost. The questions required by the indirect sisterhood method are as follows:

- How many sisters (born to the same mother) have you ever had who were ever-married (including those who are now dead)?[2]
- How many of these ever-married sisters are alive now?
- How many of these ever-married sisters are dead?
- How many of these dead sisters died while they were pregnant, or during childbirth, or during the six weeks after the end of the pregnancy?
  (Source: Graham et al., 1989)

Thus, by classifying *any* death which occurs during pregnancy, childbirth, or the postpartum period as maternal, the indirect sisterhood approach identifies pregnancy-related deaths as opposed to true maternal deaths. By using a time of death definition, it is understood that deaths due to incidental or nonobstetric causes will be classified as maternal. The effect of this time of death definition on the estimation of maternal mortality is debatable. Cause of death studies have shown that the large majority of the deaths which occur during this

[2] In settings where premarital pregnancy is common, the question would refer to sisters above an appropriate age for the setting (for example, 13, 15, etc.).

approximate 11 month period are due to maternal causes. For example, in the Matlab study area in Bangladesh between 1976-1985, 82 percent of deaths during pregnancy and a 90-day postpartum period were due to maternal causes (Faveau et al., 1988). Among the remaining 18 percent, half were due to concomitant medical conditions and half to violent death or injury. More than three-quarters (77 percent) of the violent deaths and deaths resulting from injury occurred during pregnancy. Further analysis of these data suggest that the risks associated with these two cause categories are greatly increased among unmarried, as compared with married women (Faveau and Blanchet, 1989). All of these results suggest that some proportion of accidental deaths from injury or domestic violence, traditionally considered nonmaternal causes of death, may in fact be related to pregnancy.

In contrast, Stecklov (1995) argues that the non-pregnancy related risk of death during the pregnancy and postpartum period is significant. Separating the pregnancy and nonpregnancy related risk of death during this 11-month period by assuming independence between the two causes of death, Stecklov estimates that for the case of the DHS Bolivia (1) survey, only 69 percent of the deaths identified as maternal deaths in the sibling history were true maternal deaths.

To counterbalance possible overestimation of maternal mortality due to the inclusion of some non-maternal deaths, it is well established that induced abortions are likely to go unreported (Barreto et al., 1992; Belsey, 1989; Bleek, 1987; Casterline, 1989; and Coeytaux, 1988), and it follows that maternal deaths resulting from induced abortion would be underreported as well. In fact, data from the Matlab study area in Bangladesh showed that only 36 percent of maternal deaths due to induced abortion as recorded in the Matlab surveillance system were later reported by a sibling in a validation study of the indirect sisterhood approach. None of the maternal deaths due to induced abortions among never-married women was reported in the study (Shahidullah, 1995). Therefore, it is reasonable to assume that the omission of induced abortions provides a compensating error to the inclusion of nonmaternal deaths, though the extent of the compensation is unknown.

The original indirect sisterhood method was developed for use with multipurpose surveys or as additions to population censuses. To date, approximately 30 indirect sisterhood surveys have been conducted (Graham, 1996). This method has been used for both large and small scale studies using both population-based and facility-based samples. The method is based on the following assumptions:

- Women are able to report on their siblings.
- No relationship exists between the number of siblings and their survival probabilities.
- There has been no change in the pattern of fertility by age.
- The distribution of siblings by age can be approximated. The average age of respondents is equal to the average age of siblings.
- The distribution of lifetime risk of maternal death is approximated by a Gompertz relational model.
- The sisters of respondents are representative of the population exposed to the risk of maternal death.

Table 1.2 is an example of data resulting from the indirect technique which was used in the 1988 DHS survey in Egypt. The data are organized in column A by the age group of the respondent. Columns B, C, and D contain the numbers of DHS household respondents by age, the numbers of ever-married sisters of all ages and the numbers of maternal deaths of all ages reported by respondents in each respective age group. Column E contains the adjustment factors derived for this method to convert the reported number of sisters into sister units of exposure. The statistic produced by the indirect method is the LTR of maternal death, which is obtained by dividing the number of maternal deaths by the number of sister units of exposure. In order to avoid an erratic pattern of mortality due to the small numbers in individual age groups, the authors recommend aggregating the data to generate one estimate of LTR.

As described, the MMRatio can be approximated from the LTR by using equation (6) and the total fertility rate for the appropriate period. The LTR and the corresponding MMRatio obtained from the indirect method are derived from data covering the period from the survey date to roughly 40 to 50 years before the survey, but center on 12 years before the survey, that is, 12 years is the average duration between the occurrence of the maternal deaths identified by this method and the survey. The statistical notes describing the adjustment factors and the time location calculations are included in the original article (Graham et al., 1989).

Table 1.2 Indirect estimate of maternal mortality, Egypt Demographic and Health Survey, 1988

Age of respondent	Number of DHS household respondents (A)	Sisters ever-married (B)	Maternal deaths (C)	Adjustment factors (D)	Sister units of risk exposure (E)	Lifetime risk of maternal death (F)	Proportion of dead sisters (all ages) dying of maternal causes (G)
15-19	2,976	5,707[a]	0	0.107	611	0.000	0.00
20-24	2,672	5,124[a]	4	0.206	1,056	0.004	0.17
25-29	2,026	3,885[a]	9	0.343	1,333	0.007	0.23
30-34	1,691	3,057	12	0.503	1,538	0.008	0.21
35-39	1,616	3,186	24	0.664	2,116	0.011	0.27
40-44	1,290	2,565	24	0.802	2,057	0.012	0.20
45-49	1,103	2,123	20	0.900	1,911	0.010	0.14
50-54	885	1,601	20	0.958	1,534	0.013	0.12
55-59	784	1,432	16	0.986	1,412	0.011	0.07
60 +	1,750	2,770	21	1.000	2,770	0.008	0.03
Total	16,793	31,451	150		16,336	0.009	0.09
MMR[b]	170						

[a] Ever-married sisters for these three age groups are inflated by a factor equal to the average number of sisters to respondents aged 30+.
[b] The TFR for 10-14 years before the survey was estimated at 5.3 (Egypt Fertility Survey, 1979-1980)

The indirect method also produces estimates of the proportion of female deaths due to maternal causes. These estimates are shown in Column H. Each proportion shown represents the proportion of ever-married female deaths *of all ages* due to maternal causes reported by respondents in a specific age group. It does not represent the age-specific proportion of ever-married female deaths due to maternal causes. The sharp decline in the proportion maternal shown in Column H is expected. This reflects the increasing competing risks of other causes of death, as well as the decreased exposure to the risk of maternal death, with the advancement of age.

1.6 SIBLING HISTORY DATA: THE DHS DIRECT METHOD

In the late 1980s the DHS project began experimenting with the collection of maternal mortality data. The 1988 Egypt DHS was the first survey to include a maternal mortality module. In Egypt, the four questions listed above for the original indirect technique were expanded into seven questions and integrated into the household schedule. Only the formulation of the original questions was altered. For example, the fourth question on timing of death in relation to pregnancy, childbirth, and the postpartum period was broken into three separate questions.

Soon thereafter, other DHS surveys began to include questions for the estimation of maternal mortality in the individual woman's questionnaire. In these questionnaires, data were collected to allow for direct estimation of maternal mortality. Direct estimation relies on the same underlying principle as the indirect method. That is, sibling data are collected both as a means of expanding the sample size and of gathering information on deceased siblings who are not present and therefore, could not be interviewed. An example of the sibling history in a DHS questionnaire is included in Appendix A.

The data requirements for the direct method are considerably more demanding than the indirect approach. In the direct approach, a respondent is asked to provide the birth history of her mother, including the current age of all living siblings and the age at death and years since death for all deceased siblings. These data allow deaths and births to be placed in calendar time and, therefore, permit the calculation of sex and age-specific death rates for reference periods defined by the analyst. (A description of the approach used for the calculation of exposure is included in Appendix B). The three timing-of-death questions are used to distinguish maternal from non-maternal deaths.

As with the indirect method, the direct method defines a maternal death based on time of death relative to pregnancy, childbirth, and the postpartum period. The indirect method defines the postpartum period as six weeks following childbirth, reflecting the 42-day period recommended in the ICD definition. To simplify reporting for the respondent, in most surveys the direct method defines the postpartum period as the two months following childbirth. It is assumed that this discrepancy between the direct and indirect methods has little effect, in that studies have shown that a large majority of maternal deaths occur in the peripartum period (Faveau et al., 1988; Kane et al., 1992; and Ministry of Health, 1994). Below is a list of questions required for the direct approach to maternal mortality estimation:

- How many children did your mother give birth to?
- How many of these births did your mother have before you were born?
- What was the name given to your oldest (next oldest) brother or sister?

Then, for each sibling:
- Is (NAME) male or female?
- Is (NAME) still alive?
- How old is (NAME)?
- In what year did (NAME) die? OR
- How many years ago did (NAME) die?
- How old was (NAME) when she died?

For dead sisters only:
- Was (NAME) pregnant when she died?
- Did (NAME) die during childbirth?
- Did (NAME) die within two months after the end of pregnancy or childbirth?

The direct method requires fewer assumptions than the indirect method. Both methods assume that there is no relationship between the number of siblings and their survival probabilities. The only other assumption required for the direct method is that respondents are able to report accurately on the current age of their living siblings and the age at death and years since death for all dead siblings. It is acknowledged that this is a far-reaching assumption given the context in which these surveys are conducted. Nonetheless, reliance on the data provided by respondents avoids the necessity of turning to modeled distributions.

Table 1.3 presents an example of the results from the direct method for the 1992 DHS survey in Niger. For the direct method, the data are organized by the age of the sister and not by the respondent's age as is done for the indirect method. By asking the timing of death relative to pregnancy and childbirth for all adult female siblings reported to be dead, age-specific maternal mortality rates are calculated. Due to small numbers, the sisters' data are aggregated across all age groups to generate an MMRate for women 15-49. As shown in equation (3), the MMRatio can then be obtained from the MMRate of women 15-49 and the General Fertility Rate (GFR). The MMRatio from DHS surveys, therefore, relies on data from two sections of the questionnaire. The MMRate is calculated from the sibling history and the GFR is calculated using data from women's birth histories. It is likely that the GFR is more accurate than the MMRate, given that the GFR is based on women reporting on their own children, as opposed to women reporting on events to their sisters.

Table 1.3 Direct estimate of maternal mortality, Niger Demographic and Health Survey, 1992

Age of sisters	Maternal deaths	Exposure years	MM rate per 1,000	MMRates per 1,000 age-adjusted	Proportion maternal
15-19	12.0	13,949.0	0.858	0.183	0.198
20-24	30.6	14,572.9	2.100	0.386	0.503
25-29	30.0	13,273.9	2.262	0.436	0.568
30-34	20.0	10,353.6	1.927	0.291	0.396
35-39	12.8	6,737.0	1.900	0.220	0.413
40-44	7.4	4,011.5	1.846	0.144	0.289
45-49	0.6	2,340.3	0.247	0.015	0.023
Total	113.4	65,238.4	1.736	1.675	0.370
GFR: 249 per 1,000					
MMR: 672 per 100,000					

After reviewing the experiences of using the indirect estimation technique in Egypt (1988) and the direct approach in Sudan (1989) and Bolivia (1989), the decision was made at DHS to proceed with the direct approach for future surveys. This decision was based on the following advantages found to be associated with the direct approach (Rutenberg and Sullivan, 1991). These are summarized below. The direct approach:

Requires fewer assumptions than the indirect approach

- Allows one to calculate rates/ratios for the reference period of interest
- Allows one to monitor trends
- Permits analysis of maternal mortality by parity (or other characteristics added to the questionnaire)
- Permits a substantial number of data quality checks for completeness and plausibility that are not possible with the indirect approach.

The disadvantages of the direct approach are that it:

- Requires an additional 8-10 minutes on average per interview
- Requires additional training and supervision in the field
- Adds considerable complexity to data processing.

The following chapters examine some of these assumed advantages and disadvantages from the perspective of having completed approximately 20 surveys.

2 Comparability of Maternal Mortality Questionnaire Modules

The maternal mortality module used with the individual woman's questionnaire or with the household schedule consists of a sibling history. In this sibling history, respondents are asked to provide information about each of the children born to their natural mother. Specifically, respondents are asked to record the names of each of their siblings in order from oldest to youngest. The interviewer then proceeds to ask the respondent a series of questions pertaining to each sibling. These questions include vital status and current age for living siblings. For dead siblings, respondents are asked their age at death and years since death. For female siblings above the age of 12, respondents are also asked if the sister died during pregnancy, childbirth, or the postpartum period. An example of the sibling history is included in Appendix A. All of the countries included in this report with the exception of the Bolivia (2) survey used the maternal mortality module in the individual woman's questionnaire. The second survey in Bolivia included the maternal mortality module in the household schedule. By including this module in the household schedule, all male and female adult household members were asked the sisterhood questions. In order to be comparable to other surveys in this report, only the maternal mortality data from DHS female respondents are used for Bolivia (2). Sudan is the only subnational survey considered here. The Sudan DHS was restricted to Northern Sudan.

The questions cited above are the basic questions required for direct estimation of maternal mortality. Table 2.1 compares the content of the maternal mortality modules used in various countries to the questions in the DHS core module. Although the data required for direct estimation are included in each of the modules, the formulation of the questions and the number of questions included in the modules vary from country to country. Some of the variations are simply differences in questionnaire format. Certain of these formats may have aided the interviewer in efficiently completing the table. It is doubtful, however, that the differing formats used in these surveys would have a substantial effect on the data collected. Examples of these formatting differences include: the insertion of a question to determine where in the sibling history the respondent's birth falls (Appendix A: Core Question # 903), the recording of the household line number for all female siblings of reproductive age and a question at the end of the sibling history to verify the total number of siblings.

Other differences between the DHS Core Module and the individual country questionnaires could potentially affect the information collected. For example, the DHS Core Module recommends that respondents be asked three questions regarding all dead siblings. These are: the calendar year of death, the number of years ago that the death occurred, and the sibling's age at death. Only three surveys included the question on calendar year of death (Bolivia 1, 2, and Indonesia). Every survey except Indonesia included the question on years since death.

A second example is the age at death cutoff used for the questions on a sister's time of death relative to pregnancy, childbirth, or the postpartum period. The Core Module recommends that these questions be posed regarding all sisters who died at ages 12 or more. Five of the nine African surveys and both surveys from Asia used an age at death cutoff of 10 years. The age cutoff in Namibia was 13 years, and Morocco, Niger, and Senegal used an age at death cutoff of 15 years. The Bolivia (1) and Peru surveys did not restrict questioning on time of death by age of sister. In Bolivia (1), however, these questions were asked only of ever-married sisters. The Bolivia (2) survey restricted the time of death questions to dead sisters aged 12-49.

Furthermore, the formulation of the questions on time of death in relation to pregnancy, childbirth, and the postpartum period varies in some countries. In the Core Module it is recommended that three time-of-death questions be asked, one each to cover the pregnancy, childbirth, and the postpartum period. In the Bolivia (1), Peru, Sudan, and Indonesia surveys, the questions covering pregnancy and childbirth were combined into one question. In Peru, all three time-of-death questions were collapsed into one question.

Another example of differences between the survey questionnaires is the duration of the postpartum period. In the Core Module the postpartum period is defined as a two-month period after the end of the pregnancy or childbirth. In the Central African Republic, Malawi, Namibia, and Zimbabwe, the question on the postpartum period was defined as the six-week period following pregnancy or childbirth. The Indonesia survey question defines this period as 42 days after the end of the pregnancy.

An important difference between the individual country questionnaires and the Core Module is whether the time of death questions are asked of all dead adult female siblings or are restricted to dead ever-married female sisters. In Sudan and Indonesia, the questions were restricted to dead ever-married sisters, just as the DHS questionnaire was based on a sample of ever-married women. In Bolivia (1), Madagascar, and Morocco, the sisterhood questions were restricted to ever-married sisters even though the DHS sample included all women of reproductive age.

A complete sibling history from each DHS respondent was not collected in the Bolivia (1) and Peru surveys if the respondent had one or more siblings in the same household who were also eligible for the DHS interview. The sibling history was collected from one respondent and those data were copied into her siblings' questionnaires during data processing. This was done originally as a means to eliminate replication of effort. Following these two surveys this practice was no longer used, and all DHS respondents were asked to respond to the sibling history.

Following the time-of-death questions in the core module is an additional question asking if the death was related to complications of pregnancy or childbirth. Eight of the 14 countries included this question, although the skip patterns into and out of this question vary across countries. This question was not used as a criterion for defining a maternal death. It was included experimentally to see the approximate proportion of maternal deaths due to nonmaternal causes. Due to the different skip patterns into this question, these data will not be examined in this report.

The last question in the Core Module asks how many children the sister had given birth to in her lifetime. All of the surveys presented in this report include some permutation of this question, although the formulations are not comparable. Some modules specify whether the birth associated with the sister's death is to be included. Some modules inquire about the number of pregnancies experienced by the sister at the time of her death, and some ask about the number of sons and daughters to whom the sister gave birth. In some questionnaires this question was restricted to maternal deaths, and in some this question was asked of all dead adult sisters. The original purpose of this question was to examine levels of maternal mortality by parity.

A number of country-specific questions were added to the various modules. For example, the questionnaires used in Morocco, Niger, and Senegal included an open-ended question on the cause of death for sisters who died during pregnancy or by the end of the postpartum period. The Bolivia (1) and (2) questionnaires included a number of questions regarding the woman's geographical location at the time of death, her principal symptoms at death, and whether she was attended by medical personnel.

It is difficult to predict the effect of each of the discrepancies cited in this chapter on the estimates of maternal mortality. For example, in the case of samples restricted to ever-married women, if single women are excluded from the line of questioning that would allow the identification of maternal deaths, then some maternal deaths will go unreported. However, in cultures where premarital sex is socially unacceptable, it is unlikely that these deaths would be reported even with questioning. Likewise, a small number of maternal deaths may go unreported due to the varying age at death cutoffs described above and due to the varying durations defined for the postpartum period. Realistically, however, few maternal deaths occur between the ages of 10 and 15. They are likely to be related to induced abortion and, therefore, less likely to be reported even after inquiry. Given that the vast majority of maternal postpartum deaths occur during the first week postpartum, the six week versus two month definition most likely has little effect. Nevertheless, there has been less comparability in the DHS instruments used to collect maternal mortality data than there has been for other DHS fertility and mortality estimates. This lack of comparability has been due in some degree to the evolution of the module over time, a willingness to experiment and also to specific requests for changes in individual countries.

Table 2.1 Comparability of the maternal mortality modules used in Demographic and Health Survey questionnaires, 1989-1995

	Comparison of the module in individual country questionnaires to the DHS-III Core questionnaire													
	Africa									Asia		Latin America		
DHS core questions posed to all DHS respondents	CAR	MAD	MLW	MAR	NAM	NGR	SEN	SUD	ZBW	IND	PHP	BOL 1	BOL 2	PRU
Intro: How many children did your mother give birth to, including you OR excluding you?	x	-	x	-	x	-	-	-	x	x	x	-	x	-
Filter for only child	x	x	x	x	x	x	x	x	x	x	x	x	x	x
How many of these births did your mother have before you were born?	x	-	x	-	x	-	-	-	x	x	x	-	x	-
What was the name given to your oldest (next oldest) brother or sister?	x	x	x	x	x	x	x	x	x	x	x	x	x	x
Is NAME male or female?	x	x	x	x	x	x	x	x	x	x	x	x	x	x
Is NAME still alive?	x	x	x	x	x	x	x	x	x	x	x	x	x	x
How old is NAME? (if living)	x	x	x	x	x	x	x	x	x	x	x	x	x	x
In what year did NAME die? (if dead)	-	-	-	-	-	-	-	-	-	x	-	-	x	-
How many years ago did NAME die?	x	x	x	x	x	x	x	x	x	-	x	x	x	x
How old was NAME when she/he died?	x	x	x	x	x	x	x	x	x	x	x	x	x	x
DHS core questions posed only re: dead sisters aged 12+														
Age restrictions: dead sister questions posed to those ≥:												*		*
10 years	x	x	x					x	x	x	x			
12 years														x
12-49 years													x	
13 years					x									
15 years				x		x	x							
Countries which restrict time of death questions to ever-married women		x (AW)		x (AW)				x (EM)		x (EM)		x (AW)		
Was NAME pregnant when she died?	x	x	x	x	x	x	x	C	x	C	x	C	x	C
Did NAME die during childbirth?	x	x	x	x	x	x	x	C	x	C	x	C	x	C
Did NAME die within [two months] after the end of a pregnancy or childbirth?		x		x		x	x	x				x	x	C
Above question with other durations for postpartum period: 6 weeks	x		x		x				x					
42 days										x				
open: (coded in days/months/years)											x			x
Was her death due to complications of pregnancy or childbirth?**	x	-	-	x	-	x	x	-	x	x	x	-	x	-
How many children did NAME give birth to during her lifetime? OR the following variations: How many children had she given birth to?		x						x						

Continued

Table 2.1—*Continued*

	Comparison of the module in individual country questionnaires to the DHS-III Core questionnaire													
	Africa									Asia		Latin America		
	CAR	MAD	MLW	MAR	NAM	NGR	SEN	SUD	ZBW	IND	PHP	BOL 1	BOL 2	PRU
How many sons and daughters did she have in her lifetime?												x	x	x
How many pregnancies did NAME have including the one associated with her death?				x		x	x							
Country specific questions not included in the core														
Identification (household line number) of respondents reproductive aged sisters living in the household: OR		x												
Identification (household line number) of respondent's siblings OR				x		x	x	x						
Identification (household line number) of the one respondent in the sibling history who provided the collective information for the sibling history												x		x
Posed re: living siblings: Has NAME ever been married?		x		x			x	x		x				
Posed re: dead adult sisters Had NAME ever been married?		x		x			x	x		x		x	x	x
Had NAME ever been pregnant?											x			
What was the name of her husband?								x						
What were the principal symptoms of death?													x	
Who attended her at death?													x	
Why didn't NAME receive medical attention?													x	
Where did NAME die?													x	
In what department did NAME die?													x	
Where was NAME living before her death?													x	x
What language did she usually speak?													x	
Posed re: dead adult sisters who died during pregnancy, or within postpartum period, without reported complications and death occurred in last 20 years to sister < 50 years old:														
What was her cause of death? (Open-ended question)				x		x	x							
Verification of total number of siblings	x	x		x		x	x	x						

NOTES: Bolivia (2) survey included the maternal mortality questions in the household schedule.
Legend:
C = questions coded C were combined together.
\- = standard module questions were not included in this country questionnaire.
x = question included in this country questionnaire.
AW = all woman DHS sample.
EM = ever-married woman DHS sample.
* No age restrictions specified in the questionnaire for the time of death questions
** The skips into and out of this question vary from survey to survey

3 The Sibling History: An Assessment of Data Quality

Direct estimation of maternal mortality requires the collection of a complete sibling history from each survey respondent. Data based on the first two DHS surveys to include the maternal mortality module showed that the integration of this module into the DHS core questionnaire added 10 minutes on average to the duration of the interview (Rutenberg and Sullivan, 1991). As a means of evaluating the quality of the data used to derive the maternal mortality indicators and as a means of more fully exploring the available data, this chapter examines various aspects of the sibling history data. Particular emphasis is placed on the completeness of reporting, patterns of missing data, patterns of fertility and the plausibility of adult and maternal mortality estimates.

3.1 INTERNAL CHARACTERISTICS OF THE DATA

Missing data in the sibling history is one simple indicator of the combined abilities of interviewers and respondents to provide the data requested for mortality estimation. Tables 3.1-3.3 present the percent of siblings with missing data for basic demographic variables. The percent of all siblings with unknown vital status by sex is shown in Table 3.1. A large age difference between a respondent and her sibling, or distant migration from the family household by the respondent or her siblings are examples of situations which could lead to a report of unknown vital status.

Overall, there are extremely few occurrences of missing data for the question on sibling vital status. In every country there was less than 1 percent of the siblings for whom no vital status was recorded. In 11 of the 14 countries, there was a small number of siblings reported with unknown sex, and often between one-quarter to one-half of these siblings were also lacking information on vital status.

The percent of living siblings with missing data for current age and the percent of dead siblings with missing age at death and years since death are presented by sex in Tables 3.2 and 3.3. As would be expected, there are considerably lower levels of missing data for living than for dead siblings. In nine of the 14 countries, less than 1 percent of living siblings are missing a current age. Overall, with the exception of Madagascar, more than 95 percent of the living siblings had a recorded age. This is quite similar to data shown from previous DHS surveys on respondents' ability to report their own ages (Institute for Resource Development, 1990). In Madagascar, 9 percent of all living siblings were missing a current age. Regardless of the amount of missing age data, differences by sex of the sibling are not apparent.

Direct estimation of adult and maternal mortality requires that the births and deaths of the siblings be placed in calendar time. This information is obtained for dead siblings by asking respondents the sibling's age at death and years since his or her death occurred. This approach was considered more feasible than asking for actual birth and death dates. Table 3.3 and Figures 3.1-3.2 present the percent of dead siblings with missing age at death or years since death by sex. From Figure 3.1, it is immediately apparent that of the two questions asked regarding dead siblings, placing the death in time is considerably more difficult for the respondent than declaring the sibling's age at death. In every country, less than 3 percent of the dead siblings are missing an age at death, whereas a number of countries show between 10 and nearly 25 percent of dead siblings with missing years since death. A brief description of the procedures used by DHS to impute missing data for these two variables is included in Appendix C.

Figure 3.1 also suggests that the variation in the amount of missing data between countries is the result of differences in survey implementation procedures, and is not reflective of the population's capacity to report ages and dates. For example, Sudan, Senegal, and the Central African Republic are all countries with low levels of female education and yet show less than 1 percent of dead siblings with missing data for years since death. By contrast, the Latin American countries and Madagascar show between 10 and 22 percent with missing years since death. Levels of education or other development indicators do not explain the differences between these countries. Clearly, interviewers in Zimbabwe, Malawi, the Central African Republic, Morocco, Senegal, the Sudan, Indonesia, and the Philippines were instructed to work with the respondent to estimate unknown data in the field, and these instructions were enforced. Interviewers in the remaining countries were no doubt trained and instructed to estimate in the field, but were allowed to submit questionnaires with missing data.

Table 3.1 Percentage of siblings with unknown vital status by sex, Demographic and Health Surveys, 1989-1995

Country	Unknown vital status							
	Sisters		Brothers		Siblings of unknown sex			
	Percent	Number	Percent	Number	Percent	Number	Total	Number of siblings
Africa								
Central African Republic	0.1	15,162	0.0	15,356	0.0	0	0.1	30,518
Madagascar	0.1	20,087	0.1	20,642	0.0	0	0.1	40,729
Malawi	0.1	15,107	0.2	14,792	48.8	270	0.6	30,169
Morocco	0.1	29,488	0.1	31,012	0.0	1	0.1	60,501
Namibia	0.3	15,469	0.5	15,472	62.9	243	0.9	31,184
Niger	0.0	18,156	0.1	19,064	24.4	96	0.1	37,316
Senegal	0.0	17,214	0.1	18,343	43.5	46	0.1	35,603
Sudan	0.1	30,520	0.1	32,058	52.5	7	0.1	62,586
Zimbabwe	0.0	19,200	0.1	19,265	22.2	56	0.1	38,521
Asia								
Indonesia	0.0	86,744	0.0	91,883	22.7	675	0.1	179,302
Philippines	0.1	43,047	0.1	44,641	81.6	221	0.3	87,909
Latin America								
Bolivia 1	0.5	15,269	0.2	16,773	0.0	2	0.3	32,044
Bolivia 2	0.1	20,909	0.1	22,094	27.4	97	0.1	43,100
Peru	0.1	40,639	0.2	42,927	0.0	0	0.2	83,565

Table 3.2 Percentage of living siblings with missing current age by sex, Demographic and Health Surveys, 1989-1995

Country	Sisters	Brothers	Siblings of unknown sex	All siblings	Number of siblings
Africa					
Central African Republican	0.0	0.0	-	0.0	24,688
Madagascar	9.6	9.4	0.0	9.5	33,703
Malawi	0.1	0.1	0.0	0.1	20,804
Morocco	0.2	0.1	0.0	0.2	49,787
Namibia	4.1	3.9	6.0	4.0	26,685
Niger	3.3	3.0	0.0	3.1	26,992
Senegal	0.3	0.3	0.0	0.3	27,405
Sudan	0.3	0.4	0.0	0.3	51,053
Zimbabwe	0.1	0.1	0.0	0.1	32,708
Asia					
Indonesia	0.3	0.4	2.3	0.4	149,437
Philippines	0.3	0.3	16.5	0.3	79,517
Latin America					
Bolivia 1	3.3	3.4	0.0	3.3	27,875
Bolivia 2	0.4	0.4	0.0	0.4	35,206
Peru	2.8	2.9	0.0	2.9	72,941

A concern with the sisterhood approach is that there may be differential reporting by sex in the sibling history. Some would argue that sisters are very likely to remain in contact and possibly even assist each other in the late stages of pregnancy, thus constituting excellent sources of information on female siblings (Graham et al., 1989). In contrast, there is also concern that in patrilocal societies in which women relocate to their husband's household at marriage, female siblings may not have current information on each other. Figure 3.2 shows that there are no differences in the completeness of reporting on years since death for brothers compared with sisters in the sibling history. The data presented in Tables 3.1-3.2 on unknown vital status and current age for living siblings also support the conclusion that there is no systematic difference in the quality of reporting on brothers and sisters.

It is generally assumed that events in the distant past are more likely to go unreported than more recent events. It is reasonable to extend this assumption to data quality, such that among reported events, those in the distant past are more likely to be incompletely and inaccurately reported than recent events. If recall regarding deaths in the period 7 to 13 years before the survey is more difficult than recall regarding deaths 0 to 6 years before the survey, it would be expected that a greater proportion of ages at death would require imputation in the distant period than in the recent period. Table 3.4 presents the percent of all dead siblings with an imputed age at death by a seven-year time period and sex of the sibling. Surprisingly, no evidence of increased imputation for the distant period is shown in this table for sisters or brothers.

Table 3.3 shows that respondents find it difficult to place deaths in calendar time. Figures 3.3 and 3.4 illustrate the percent distributions of all female deaths and of maternal deaths by number of years before the survey (i.e., years since death) for the 14 countries included in this report. The line across the graphs represents the median percentage at each point in time for all of the countries. The heaping on certain digits apparent in these figures is suggestive of imprecise dating of events.

Several features of these graphs deserve discussion. First, heaping on 5, 10, 15, and 20 years before the survey is very evident in both graphs, with particular concentration on 10 years before the survey. Heaping is also apparent, though to a lesser degree on even numbers. One should note, however, that heaping is not restricted to reporting on maternal or female deaths, but is a problem inherent in much of the birth history data collected in DHS surveys (Institute for Resource Development, 1990). Second, the distributions of all female deaths across time follow a fairly consistent pattern among these countries, but this is not the case for maternal deaths. Although the median percentages for all deaths and for maternal deaths are remarkably similar at each point in time, the distributions of maternal deaths are more variable than those for all female deaths, as is expected when numbers are small. Third, clustering of deaths in the recent period is very apparent for both maternal and adult female deaths. This is discussed further in Chapter 4.

3.2 MOTHER'S PARITY

An additional concern with the use of sibling data for estimating maternal mortality is that reporting on events in the distant past may be faulty due to recall problems among older respondents. The same problem could also result from younger respondents reporting on events to their siblings which occurred when the respondents were very young children or even prior to their birth. The effect on the resulting estimate of maternal mortality will vary depending on the estimation technique in question. For example, recall problems in data to be used for direct estimation will most likely appear as an increasing trend in maternal mortality. By contrast, recall problems in data to be used for indirect estimation will be less apparent and will underestimate lifetime risk of maternal death 12 years before the survey. Tables 3.5 and 3.6 explore the data on the respondents' mothers' fertility over time. Table 3.5 presents male to female sex ratios at birth by five-year periods preceding the survey. If respondents are more likely to omit older sisters than older brothers, one would expect to see decreasing sex ratios at birth as one moves forward in time toward the year of interview. The results in Table 3.5 do not suggest a specific pattern of omission by sex over time, though levels do vary. The sex ratios for all siblings in the Central African Republic, Malawi, Namibia, and Zimbabwe are lower than in the other countries, generally falling close to 1.0. Senegal and the Latin American countries tend to be higher with overall values ranging between 1.07 and 1.10.

With the possible exception of countries in the infertility belt in sub-Saharan Africa, fertility in most developing countries has either remained high and stable or decreased over the past 35 years. Examining the parity of mothers of increasingly older respondents is another means of shedding light on the fertility component of the sibling history. Table 3.6 addresses this issue by showing the average parity of respondents' mothers by respondent's age. In 11 of the 14 countries, fertility increased over time according to reports in the sibling history. In some countries, for example, the Central African Republic, Madagascar, Morocco, and Senegal, average parity increased more than 20 percent from reports by respondents aged 45 to 49 compared with respondents aged 15 to 19. Moreover, some of the mothers of the younger respondents could still have additional births.

Table 3.3 Percentage of dead siblings with missing age at death/years since death by sex, Demographic and Health Surveys, 1989-1995

Country	Sisters	Brothers	All siblings[1]	Number of dead siblings
Africa				
Central African Republic				5,814
missing age at death only	0.2	0.4	0.3	
missing yrs. since death only	0.2	0.1	0.1	
missing both	0.0	0.0	0.0	
Madagascar				6,976
missing age at death only	2.2	2.7	2.5	
missing yrs. since death only	22.4	22.1	22.2	
missing both	8.0	9.6	8.9	
Malawi				9,190
missing age at death only	0.3	0.4	0.3	
missing yrs. since death only	0.4	0.3	0.4	
missing both	0.1	0.1	0.3	
Morocco				10,665
missing age at death only	0.1	0.1	0.1	
missing yrs. since death only	0.8	1.0	0.9	
missing both	1.2	1.1	1.1	
Namibia				4,231
missing age at death only	2.9	4.8	3.9	
missing yrs. since death only	8.5	9.3	9.1	
missing both	11.1	11.8	11.7	
Niger				10,285
missing age at death only	0.7	0.9	0.8	
missing yrs. since death only	5.5	4.0	4.7	
missing both	3.8	5.8	5.4	
Senegal				8,160
missing age at death only	0.2	0.3	0.3	
missing yrs. since death only	0.3	0.4	0.4	
missing both	0.5	1.0	0.8	
Sudan				11,488
missing age at death only	0.2	0.4	0.3	
missing yrs. since death only	1.7	1.2	1.4	
missing both	0.7	0.6	0.7	
Zimbabwe				5,780
missing age at death only	0.4	0.7		
missing yrs. since death only	0.2	0.4	0.3	
missing both	0.1	0.1	0.1	
Asia				
Indonesia				29,683
missing age at death only	1.3	1.4	1.7	
missing yrs. since death only	0.7	1.0	0.9	
missing both	0.2	0.3	0.7	
Philippines				8,132
missing age at death only	1.2	1.6	1.5	
missing yrs. since death only	1.3	0.7	0.9	
missing both	1.2	1.4	1.5	
Latin America				
Bolivia 1				4,063
missing age at death only	2.7	2.3	2.5	
missing yrs. since death only	10.6	10.6	10.6	
missing both	7.5	8.8	8.2	
Bolivia 2				7,842
missing age at death only	0.6	0.6	0.7	
missing yrs. since death only	8.6	8.6	8.5	
missing both	1.7	1.8	2.5	
Peru				10,480
missing age at death only	1.6	1.7	1.7	
missing yrs. since death only	13.7	12.5	13.0	
missing both	5.8	7.0	6.4	

[1] Total of all siblings includes siblings of unknown sex.

Figure 3.1 Percent of missing data for sisters, Demographic and Health Surveys, 1989-1995

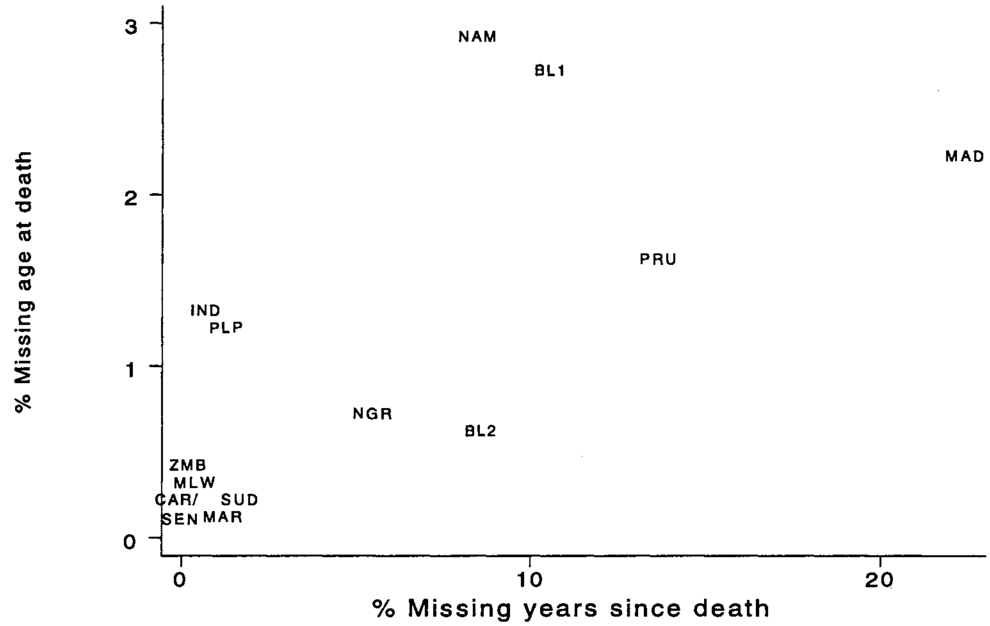


Figure 3.2 Percent of missing years since death by sex, Demographic and Health Surveys, 1989-1995

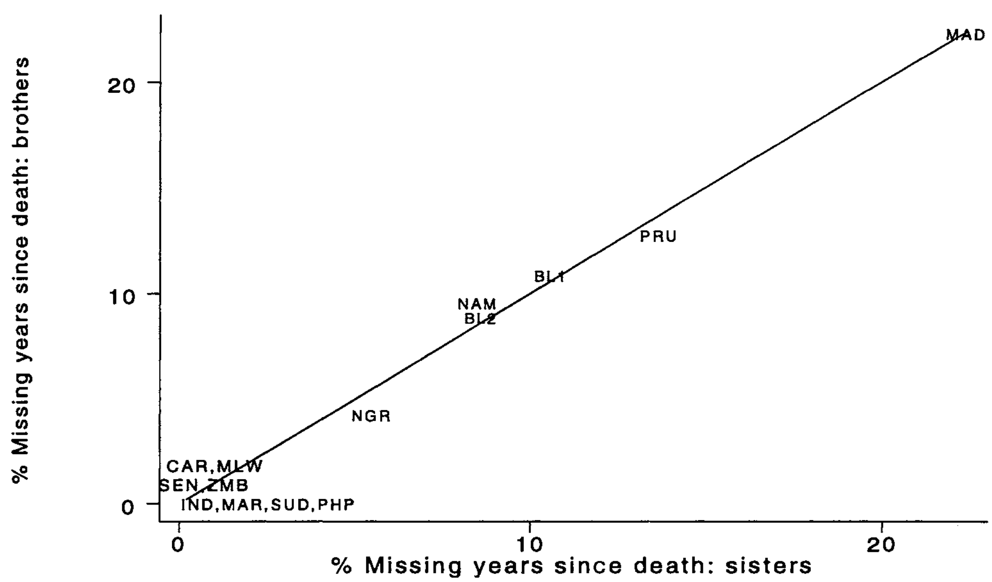


Table 3.4 Percentage of dead siblings with imputed age at death by seven-year periods, Demographic and Health Surveys, 1989-1995

	Imputed age at death			
	Sisters (Years before survey)		Brothers (Years before survey)	
Country	0-6	7-13	0-6	7-13
Africa				
Central African Republic	0.2	0.3	0.0	1.1
Madagascar	7.3	6.4	10.6	5.3
Malawi	0.2	0.5	0.8	0.3
Morocco	0.9	0.9	1.6	0.2
Namibia	11.3	12.7	12.2	14.6
Niger	2.6	2.2	5.5	2.9
Senegal	0.2	0.7	1.1	1.3
Sudan	0.1	0.9	0.4	0.4
Zimbabwe	0.1	0.0	0.3	0.6
Asia				
Indonesia	0.5	0.6	0.6	0.8
Philippines	1.9	2.1	1.3	2.4
Latin America				
Bolivia 1	8.5	6.8	4.8	6.3
Bolivia 2	1.1	1.6	1.5	1.5
Peru	5.2	3.8	6.1	6.4

Figure 3.3 Percent distribution of adult female deaths and median percent by years before survey, Demographic and Health Surveys, 1989-1995

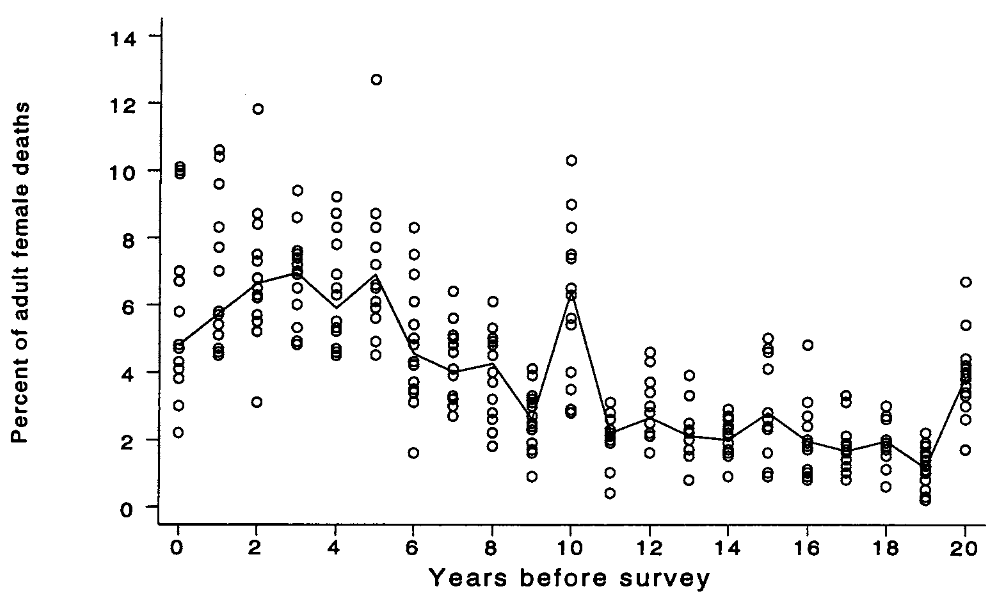


Figure 3.4 Percent distribution of maternal deaths and median percent by years before the survey, Demographic and Health Surveys, 1989-1995

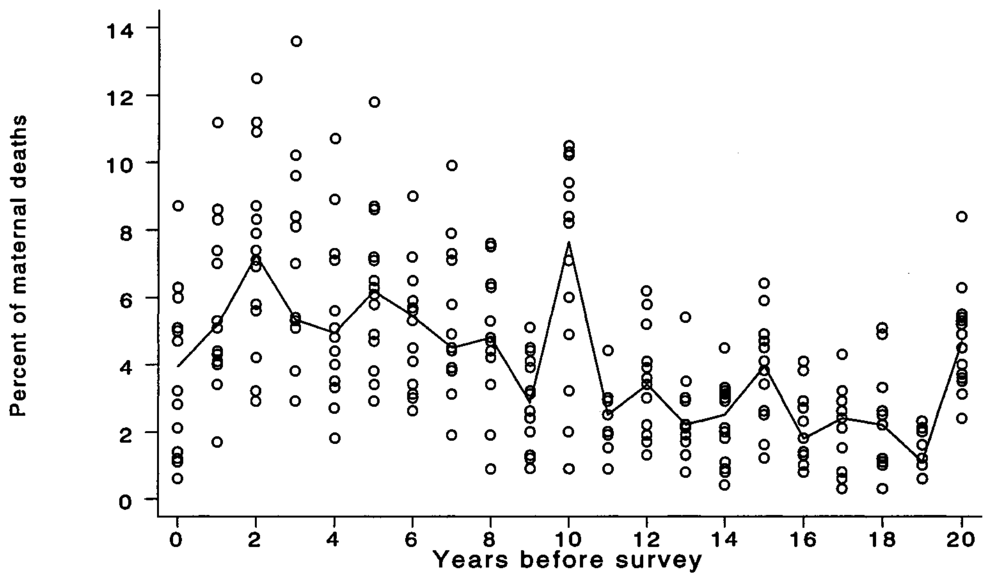


Table 3.5 Sex ratios at birth (m:f) for five-year periods preceding the survey, Demographic and Health Surveys, 1989-1995

	Sex-ratios for 5-year period preceding the survey							
Country	45-49	40-44	35-39	30-34	25-29	20-24	15-19	Total
Africa								
Central African Republic	0.95	1.01	1.01	1.03	1.01	1.01	1.03	1.01
Madagascar	1.03	1.04	1.08	1.03	1.00	1.01	1.04	1.03
Malawi	0.93	1.00	0.98	1.03	0.96	0.95	0.99	0.98
Morocco	1.05	1.10	1.02	1.07	1.05	1.06	1.04	1.05
Namibia	1.02	0.95	1.06	1.01	0.97	0.98	1.03	1.00
Niger	1.07	1.09	1.06	1.08	1.02	1.04	1.04	1.05
Senegal	1.08	1.02	1.10	1.06	1.03	1.07	1.08	1.07
Sudan	1.10	1.08	1.06	1.01	1.02	1.08	1.05	1.05
Zimbabwe	1.00	0.96	0.97	1.00	1.01	1.01	1.03	1.00
Asia								
Indonesia	1.08	1.09	1.07	1.03	1.07	1.03	1.07	1.06
Philippines	1.02	1.01	1.02	1.05	1.06	1.03	1.05	1.04
Latin America								
Bolivia 1	1.06	1.08	1.10	1.06	1.09	1.12	1.14	1.10
Bolivia 2	1.11	1.16	1.06	1.08	1.04	1.00	1.04	1.06
Peru	1.07	1.01	1.08	1.08	1.06	1.04	1.05	1.06

It is difficult to interpret these data. On one hand, it is implausible that fertility has increased or remained stable over the 35-year period before the survey in all of these countries. The more likely explanation for the increasing pattern of fertility is that older respondents have omitted reporting all of their mothers' births. It is plausible that the births of siblings, particularly siblings who died many years before the survey, might be forgotten and that these represent a substantial proportion of the omitted events. If the omitted births resulted in childhood deaths, the omissions would not affect the estimation of adult or maternal mortality. Likewise, if the omissions represent adult deaths which occurred more than 14 years ago, neither the direct estimate of adult nor maternal mortality would be affected because the sibling history data have not been used by DHS from beyond 0 to 13 years before the survey. Any omitted maternal death would, however, affect the indirect estimate of maternal mortality. Unfortunately, it is not possible to distinguish the omission of siblings who died during childhood versus siblings who lived into adulthood. It is doubtful, however, that omission of child deaths explains all of the increases shown in Table 3.6. Thus, this table does suggest possible omission of reporting for distant events, although the effect of that omission is uncertain. Table 3.5 suggests once again that there is no differential omission by sex of sibling.

DHS respondents constitute a representative sample of living women of reproductive age in a country. An assumption underlying both the direct and the indirect sisterhood approach is that their siblings constitute a representative sample of living and dead men and women. Table 3.7 provides the age distributions of DHS respondents (aged 15-49) and the percent distribution of all siblings[3] aged 15-49 by five year age groups, as well as their respective median years of birth. Theoretically, one would expect similar age distributions and birth years for the two groups. However, the fact that only women 15 to 49 years of age are interviewed in a DHS survey leads to truncation of the sibling age distribution below age 20 and above age 45. This is simply because there are no DHS respondents aged 10 to 14 to report on their older siblings and no DHS respondents above age 50 to report on their younger siblings. Given population growth, one would expect the effect to be stronger for the siblings aged 15-19 than for older siblings. Consequently, one would expect siblings to be slightly older on average than the respondents. Conversely, if the median year of birth of siblings aged 15 to 49 showed the siblings to be younger than the respondents, this would indicate serious underreporting of older siblings by the DHS respondents.

As expected, the age distributions of siblings illustrate the truncation effects described above. The median year of birth for siblings is one to two years greater than for respondents in 12 of the 14 countries, suggesting no serious underreporting of older siblings. Indonesia is the only country in which there is no difference in the median year of birth between siblings and respondents. The three-year difference between respondent and sibling median year of birth in Zimbabwe is unexpected. No explanation comes to mind to account for the potential underreporting of young siblings.

3.3 TIME OF DEATH

A maternal death in these surveys is defined by the timing of its occurrence in relation to pregnancy, childbirth, and the postpartum period. In opting for the sisterhood approach, one accepts that some nonmaternal deaths will be misclassified as maternal. Tables 3.8 and 3.9 present the data on time of death from the sibling history. The percent of adult female deaths with missing data on time of death for the recent and distant periods are shown in Table 3.8. With the exception of Madagascar and Morocco which have 1 percent or less with missing information, most countries show between 5 and 15 percent of adult female deaths missing enough data from the three time-of-death questions to prevent the death from being identified as maternal or nonmaternal. Malawi and Namibia report the most missing data with 17 and 25 percent, respectively. It is curious that Madagascar has such complete reporting in this section of the module, given that nearly one- quarter of the female deaths in this survey were missing information for years since death. As with other variables examined in this chapter, there is virtually no difference in the percentage of adult female deaths with missing data between the two periods.

Thus, the three variables determining time of death relative to pregnancy, childbirth, and the postpartum period show higher percentages of missing data than other variables in the sibling history. For this report, the number of maternal deaths was adjusted to account for this type of missing data. In each country, the proportion of adult female deaths due to maternal causes among those with complete reporting was applied to the number of observations with missing time-of-death data to generate an adjusted total count of maternal deaths for the calculation of the maternal mortality indicators.

[3]The sibling distribution includes both living and dead siblings, with dead siblings classified by their year of birth.

Table 3.6 Average parity of respondent's mother by respondent's age, Demographic and Health Survey, 1989-1995

	Average parity								
	Respondents' age								
Country	45-49	40-44	35-39	30-34	25-29	20-24	15-19	Number of respondents	Percentage decrease from age group 15-19 to 45-49
Africa									
Central African Republic	4.9	5.3	5.8	6.1	6.4	6.6	6.6	5,884	26
Namibia	6.3	6.4	6.7	6.8	7.0	7.0	6.7	5,421	6
Niger	6.4	6.4	6.6	6.4	6.8	6.9	7.1	6,503	10
Madagascar	6.1	7.0	7.2	7.6	7.8	7.8	7.6	6,260	20
Malawi	6.4	6.7	7.2	7.1	7.4	7.5	7.5	4,849	15
Morocco	6.1	6.8	7.4	7.8	7.9	7.8	7.7	9,256	21
Senegal	5.5	5.9	6.2	6.5	6.8	7.1	7.0	6,310	21
Sudan	6.4	6.6	6.9	7.3	7.7	7.8	7.7	9,732	17
Zimbabwe	7.2	7.6	7.7	7.6	7.5	7.3	6.7	6,128	-7
Asia									
Indonesia	5.3	5.7	5.8	5.9	5.9	5.8	5.3	38,334	0
Philippines	7.1	7.3	7.3	7.3	7.0	6.5	6.1	15,029	-16
Latin America									
Bolivia 1	4.8	5.0	5.2	5.1	5.1	5.1	4.9	7,923	2
Bolivia 2	5.2	5.7	5.9	6.3	6.2	6.1	6.1	8,603	15
Peru	6.0	6.3	6.4	6.5	6.5	6.2	6.0	15,882	0

It is well known that within the 11 months spanning pregnancy and the postpartum period, the greatest risk of death is experienced during the peripartum period, that is, between the onset of labor and the first 48 hours following delivery. Examples of the distribution of true maternal deaths[4] by time of death from studies in the Matlab study area in Bangladesh, in Giza, Egypt and from the Egyptian National Maternal Mortality Study are shown in Figures 3.5-3.7. In the Matlab study more than 50 percent of maternal deaths occurred from the day of delivery through 48 hours postpartum. The increased risk during the peripartum period is evident even in a situation in which 29 percent of maternal deaths were due to induced abortion (Faveau et al., 1988). In the Giza study, in which only 1 percent of maternal deaths were due to induced abortion, one-third (32 percent) of maternal deaths occurred on the day of delivery alone (Kane et al., 1992). In the national Egyptian study, 39 percent of deaths occurred during delivery or within 24 hours of delivery (Ministry of Health, 1994).

Table 3.9 presents the percent distribution of maternal deaths by the three time-of-death questions from the sibling history. Several aspects of these data merit discussion. First, in general, there is great variation in the distributions across these 14 countries, particularly for the periods of pregnancy and childbirth. For example, in Namibia 15 percent of all maternal deaths were reported as occurring during childbirth. In all other countries, between 20 and 50 percent of the maternal deaths are classified under childbirth. The percentages of maternal deaths reported during pregnancy are somewhat higher than would be expected from previous cause of death studies. In Namibia and Bolivia (2), for example, 66 and 58 percent of maternal deaths were reported as occurring during pregnancy. In Malawi, Senegal, and the Philippines, nearly 50 percent occurred at this time.

Deviations from the expected in these distributions do not necessarily imply faulty data in the sibling history. The categories of pregnancy, childbirth, and the two months following the termination of pregnancy may well be interpreted ambiguously among respondents. For example, a sister dying from an antepartum hemorrhage could just as easily be classified as a death during pregnancy as during childbirth. Similar problems arise with postpartum hemorrhage and numerous other conditions.

[4]True maternal death implies that the definition of maternal death in these studies was not based on a time of death definition (i.e., pregnancy, childbirth, or the postpartum period), but was based on data on maternal causes of death.

Table 3.7 Percent distribution of respondents age 15-49 and percent distribution of all siblings age 15-49[a] by five-year age groups, Demographic Health Survey 1989-1995

Country	Age group 45-49	40-44	35-39	30-34	25-29	20-24	15-19	Median year of birth
Africa								
Central African Republic								
respondent	7.2	7.8	12.0	14.4	17.5	19.1	21.9	1967
siblings	4.9	8.7	12.9	17.5	20.5	20.0	15.6	1966
Namibia								
respondent	6.6	9.3	10.5	13.3	16.4	20.6	23.2	1966
siblings	5.7	9.0	13.0	16.4	19.2	19.9	16.7	1964
Niger								
respondent	6.2	8.1	11.5	15.0	19.7	18.3	21.2	1965
siblings	5.2	8.6	12.8	17.4	19.5	20.3	16.2	1963
Madagascar								
respondent	5.4	8.8	12.0	14.5	16.4	20.2	22.7	1965
siblings	5.0	8.9	13.4	17.6	19.1	19.4	16.5	1964
Malawi								
respondent	7.1	10.5	11.1	13.6	16.0	19.4	22.3	1965
siblings	6.4	10.4	13.2	17.5	18.1	19.1	15.3	1963
Morocco								
respondent	7.2	8.0	12.7	14.8	15.9	18.2	23.2	1964
siblings	4.9	8.8	13.6	18.5	19.7	19.3	15.0	1963
Senegal								
respondent	5.9	9.3	12.7	14.0	16.5	19.0	22.6	1965
siblings	5.2	8.8	13.3	17.2	19.3	19.7	16.3	1964
Sudan								
respondent	5.6	6.7	11.4	11.5	19.3	21.0	24.5	1964
siblings	4.3	7.5	12.1	16.3	19.8	21.3	18.7	1962
Zimbabwe								
respondent	6.6	8.7	10.8	14.2	14.9	20.7	24.0	1968
siblings	6.1	9.7	13.8	17.8	18.7	18.8	15.1	1965
Asia								
respondent	8.1	9.8	13.1	15.6	16.5	17.1	19.8	1965
siblings	6.1	10.6	15.1	17.9	19.5	17.7	13.1	1965
Philippines								
respondent	7.6	10.5	12.6	14.6	16.2	17.6	21.0	1964
siblings	7.0	10.7	15.3	17.7	19.3	17.6	12.5	1962
Latin America								
Bolivia 1								
respondent	8.3	9.3	13.5	14.1	16.9	16.6	21.2	1960
siblings	6.7	10.5	14.9	16.4	18.5	18.2	14.8	1959
Bolivia 2								
respondent	8.3	9.8	12.5	14.8	15.6	17.9	21.0	1965
siblings	6.7	9.9	14.7	16.0	19.2	18.7	14.9	1964
Peru								
respondent	7.5	9.7	12.1	13.3	16.1	19.3	21.9	1964
siblings	6.4	9.4	13.8	16.5	19.5	19.3	15.1	1963

[a] Includes all living and dead siblings classified by their year of birth.

It is also likely that the higher than expected percentages of deaths during pregnancy reflect a greater number of nonmaternal deaths in this period relative to childbirth and the postpartum period purely as a function of longer exposure. Differences in the proportion of reported maternal deaths due to induced abortion would also affect the distributions. In any case, the time-of-death questions function in the sibling history solely as a means of identifying deaths within certain time boundaries relative to pregnancy. It is obvious from this table that further substantive analysis of the time of death from these data is not warranted.

Figure 3.5 Time of maternal death: Matlab 1976-85
(n = 243 maternal deaths)
Source: Faveau et al., 1988

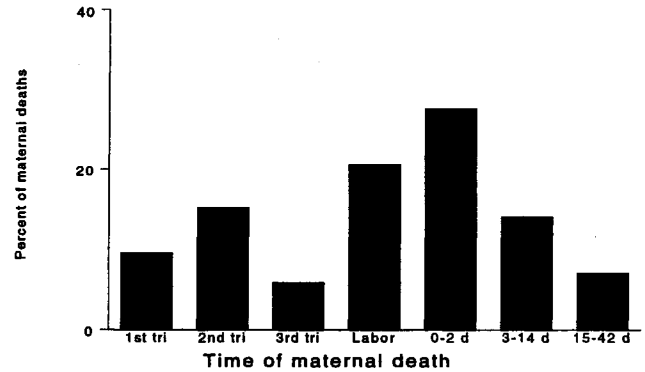


Figure 3.6 Time of maternal death: Giza, Egypt 1985-86
(n = 156 maternal deaths)
Source: Kane et al., 1992

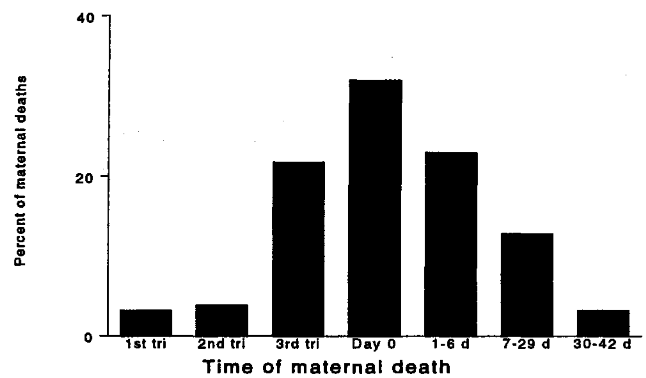


Figure 3.7 Time of maternal death: Egypt 1994
(n = 718 maternal deaths)
Source: Ministry of Health, 1994

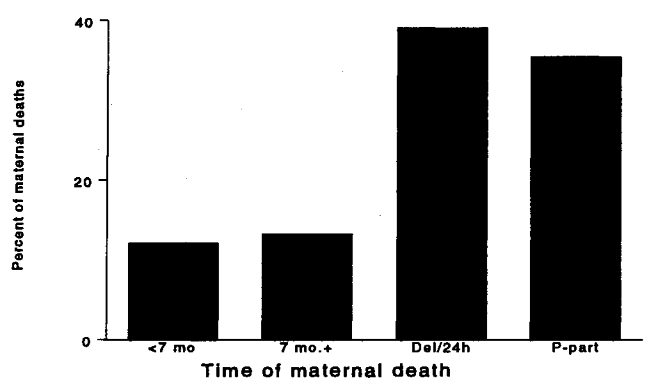


Table 3.8 Percent of adult female deaths with missing data on time of death relative to pregnancy, childbirth, and the postpartum period by time periods before the survey, Demographic and Health Surveys, 1989-1995

Country	0-6 years before survey		7-13 years before survey	
	Percentage missing timing of death data	Number of adult female deaths	Percentage missing timing of death data	Number of adult female deaths
Africa				
Central African Republic	4.8	493	3.3	211
Madagascar	1.0	495	0.5	236
Malawi	17.3	335	11.9	104
Morocco	0.6	176	0.0	166
Namibia	25.7	211	21.0	112
Niger	8.8	306	4.4	231
Senegal	11.1	199	6.8	133
Sudan	5.4	327	5.4	202
Zimbabwe	8.7	333	6.5	119
Asia				
Indonesia	8.9	824	11.8	533
Philippines	13.8	375	13.6	211
Latin America				
Bolivia 1	12.0	187	11.7	141
Bolivia 2	8.7	230	12.4	157
Peru	10.2	340	6.3	257

Table 3.9 Percent distribution of maternal deaths by time of death, Demographic and Health Surveys, 1989-1995

Country	Time of death			Total	Number of maternal deaths[a]
	Pregnancy	Childbirth	Postpartum		
Africa					
Central African Republic	23.1	54.8	22.2	100	301
Namibia	65.9	15.3	18.9	100	68
Niger	30.5	44.1	25.4	100	306
Madagascar	27.2	37.8	35.0	100	211
Malawi	46.1	21.8	32.2	100	145
Morocco	37.4	23.4	39.2	100	171
Senegal	48.1	30.8	21.2	100	156
Sudan	(79.2)	b	20.8	100	267
Zimbabwe	30.1	42.4	27.5	100	108
Asia					
Indonesia	(88.3)	b	11.7	100	432
Philippines	51.8	25.8	14.8	100	142
Latin America					
Bolivia 1	(76.2)	b	23.8	100	120
Bolivia 2	57.9	23.2	18.8	100	138
Peru	27.4	49.2	22.0	100	173

[a] Includes all reported maternal deaths in the sibling history with complete reporting on time of death.
[b] Questions on pregnancy and childbirth were combined.

3.4 EXTERNAL VALIDATION OF THE ADULT MORTALITY DATA

The sibling history collected by the DHS direct method provides estimates of age-specific mortality rates for both males and females as well as estimates of maternal mortality rates and ratios. The mortality rates can be used to compute summary measures of adult mortality such as the probability of dying between the ages of 15 and 50, ${}_{35}q_{15}$. Ideally, the accuracy of the sibling-based mortality estimates could then be assessed by comparing them with summary indicators from other valid sources. Unfortunately, in most countries where sibling histories have been collected, there are no alternative valid sources of adult mortality measures against which to compare the sibling estimates. Three types of comparison are presented here: with estimates of ${}_{35}q_{15}$ derived from general mortality indicators prepared by the United Nations in their population projections; with estimates of ${}_{35}q_{15}$ implied by the DHS estimates of child mortality using a family of model life tables; and for three countries with independent estimates of ${}_{35}q_{15}$ believed to be of good quality.

Comparisons with United Nations General Mortality Indicators

The United Nations 1994 Revision of the World Population Prospects (United Nations, 1995) provides estimates of expectation of life at birth, e(0), by sex for five-year periods. For each country with sibling data, an estimate of e(0) was made for the mid point of the seven-year reference period for the sibling mortality 0 to 6 years before each survey, using linear interpolation between the United Nations estimates, assumed to apply to the mid point of their five year periods. Thus, for example, the Zimbabwe DHS was conducted between July and November 1994, with an average date around September 1994. The seven-year reference period of the sibling estimates thus runs from about September 1987 to September 1994, with a mid point around March 1991. The United Nations estimate of e(0) for March 1991 was obtained by linear interpolation between the estimate for 1985-90 (mid point the beginning of 1988) and 1990-95 (mid point the beginning of 1993). The sibling estimate of ${}_{35}q_{15}$ is then plotted against the United Nations estimate of e(0) for a comparable time period, on a graph that shows the relationships between ${}_{35}q_{15}$ and e(0) in each of the Coale-Demeny (1983) model life tables.[5] The resulting graphs are shown in Figure 3.8 for males and Figure 3.9 for females. An observation above or to the right of the Coale-Demeny patterns indicates higher ${}_{35}q_{15}$ from sibling data than would be expected on the basis of the United Nations estimate of e(0), whereas an observation below or to the left indicates a lower ${}_{35}q_{15}$ sibling value than would be expected.

In both Figure 3.8 and Figure 3.9 there is substantial scatter around the model relationships, with observations both above and below the Coale-Demeny patterns. For both males and females, Uganda, Central African Republic, and Madagascar show higher sibling estimates than United Nations estimates, whereas for Niger, Mali, Senegal, Nepal, and Morocco, the sibling estimates are below the United Nations estimates. For the remaining countries, the sibling estimates are close to the United Nations estimates, though for female mortality the observations all fall around the Coale-Demeny relationships indicating the lowest ${}_{35}q_{15}$ for a given e(0), in the South and East families. These comparisons indicate no clear systematic pattern of deviation from the United Nations mortality estimates, though they suggest that the sibling estimates are generally lower for females than would be expected given the United Nations mortality estimates.

Comparisons with DHS Child Mortality Indicators

The DHS birth histories provide estimates of child mortality by sex and time period prior to the survey. For this exercise, estimates of the probability of dying by age five, ${}_{5}q_{0}$, have been computed for the same reference period, 0 to 6 years before each survey as for the sibling estimates of ${}_{35}q_{15}$. The two estimates have then been plotted against each other, in Figures 3.10 for males and 3.11 for females. In each figure, the relationships between the two indicators implied by the four families of Coale-Demeny model life tables are also shown. Observations above or to the left of the Coale-Demeny patterns indicate higher than expected sibling estimates of ${}_{35}q_{15}$, given the birth history estimate of ${}_{5}q_{0}$, whereas observations below or to the right indicate lower than expected sibling estimates of ${}_{35}q_{15}$.

The results show reasonable consistency between the child and adult mortality estimates. For both males and females, the sibling based estimates are higher than expected (given Coale-Demeny patterns) for Central African Republic, Uganda, and Zimbabwe, whereas the sibling based estimates are lower only for Niger. Consistency is greater for females than for males: sibling based estimates are higher than expected for males in the Philippines, Namibia, and Madagascar, but lower than expected in Morocco, Bolivia, Sudan, and Senegal.

[5]The sibling estimates for the period 0 to 6 years before the survey are shown in Table 4.3.

Figure 3.8 Sibling estimates of male adult mortality compared with United Nations expectation of life, Demographic and Health Surveys, 1989-1996

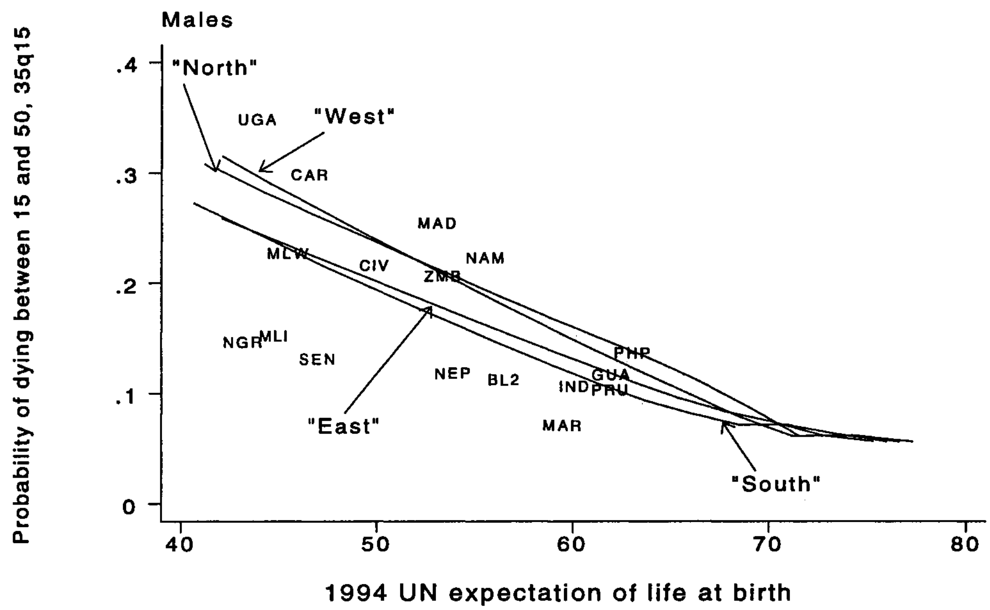


Figure 3.9 Sibling estimates of female adult mortality compared with United Nations expectation of life, Demographic and Health Surveys, 1989-1996

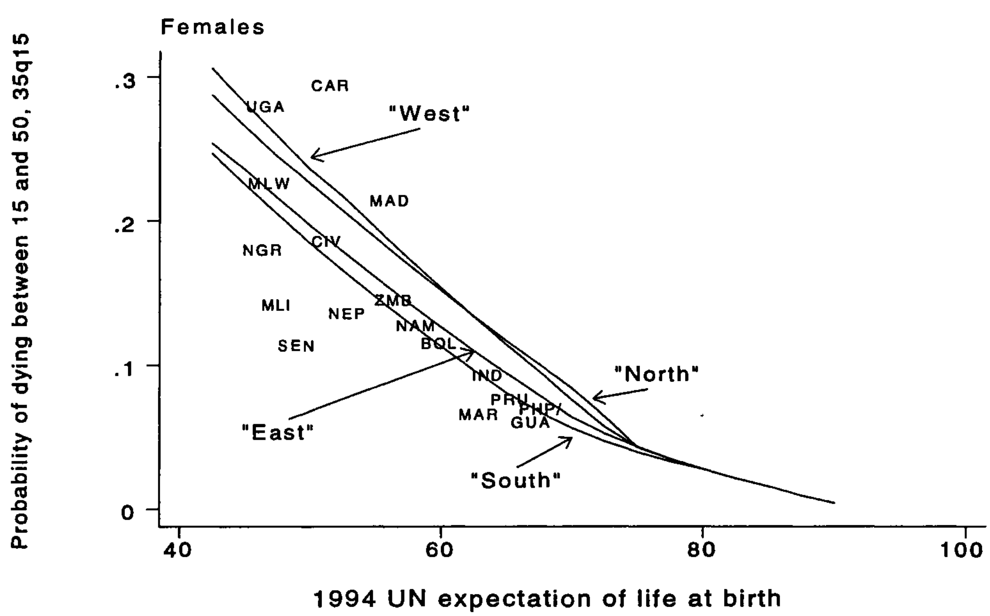


Figure 3.10 Sibling estimates of male adult mortality compared with birth history estimates of child mortality, Demographic and Health Surveys, 1989-1996

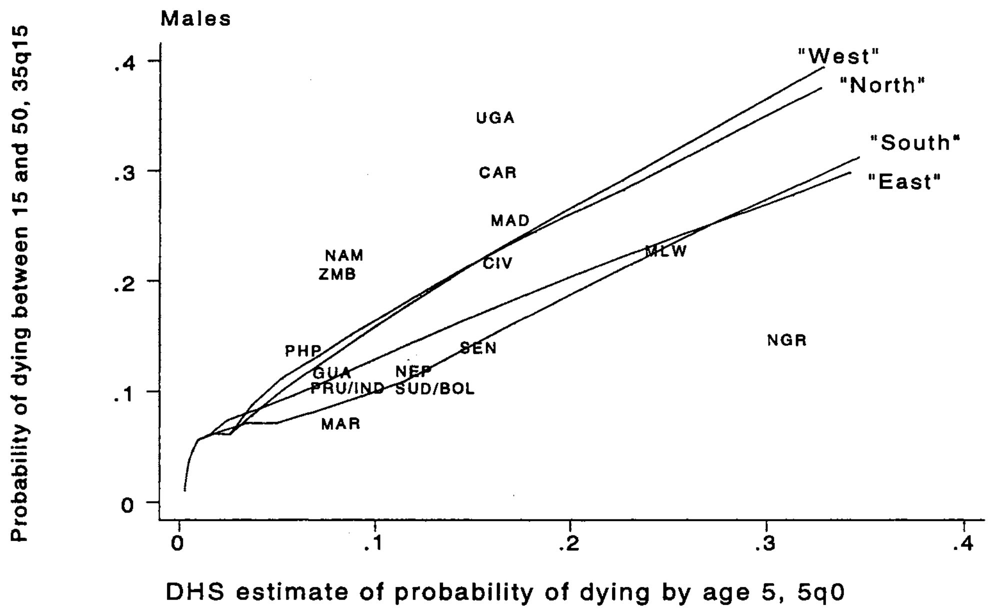
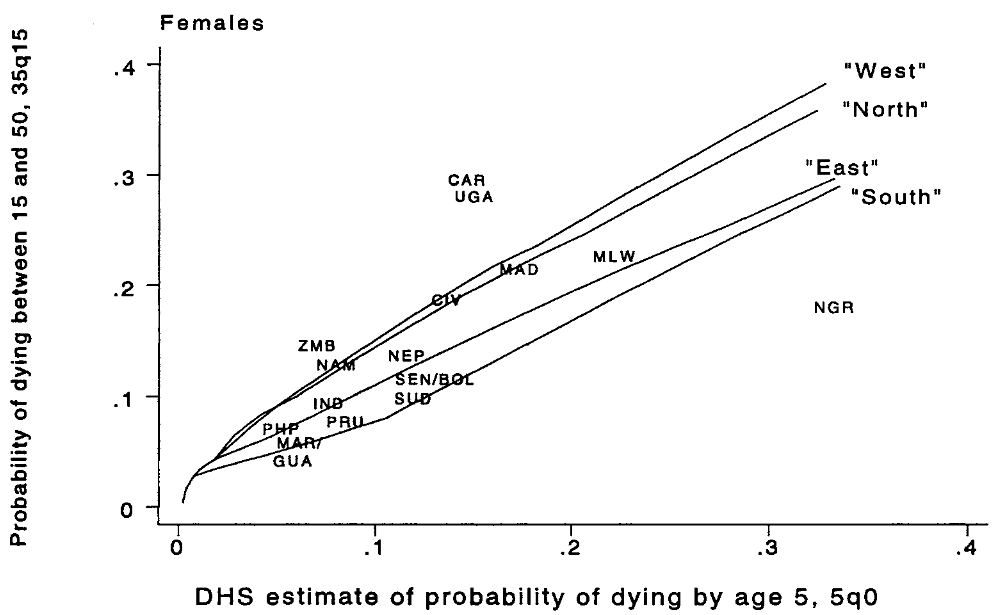


Figure 3.11 Sibling estimates of female adult mortality compared with birth history estimates of child mortality, Demographic and Health Surveys, 1989-1996



Comparison with Independent Estimates of Good Quality

For three of the countries covered by sisterhood estimates of adult mortality, independent estimates of mortality risks in adulthood deemed to be of good quality are available. The three countries are Guatemala, the Philippines, and Senegal. Two of these three countries, Guatemala and the Philippines, appear rather consistent in the previous two checks, whereas for Senegal the sibling estimate of ${}_{35}q_{15}$ is lower than would be expected given the United Nations estimates of e(0) or the male estimate of ${}_{5}q_{0}$.

The independent estimates of adult mortality come from different sources. For Guatemala, registered deaths by age and sex for 1988 are combined with the estimated population by age and sex for 1990 to calculate age-sex-specific mortality rates and hence risks of dying between 15 and 50. For the Philippines, registered deaths between 1980 and 1990 were compared with population age structures in 1980 and 1990 using the General Growth Balance procedure (Hill, 1987) to assess the coverage of deaths relative to the coverage of the 1980 and 1990 censuses.[6] Deaths were then adjusted for coverage (no adjustment was necessary for male deaths, but female deaths required an upward adjustment of 20 percent) and adjusted age-sex-specific mortality rates were computed for the 1980-90 period. The probability of dying between the ages of 15 and 50 was then obtained from the age-sex-specific mortality rates. For Senegal, the life table for adults presented in the National Research Council's report Population Dynamics in Senegal (Pison et al., 1995) was used to derive probabilities of dying between 15 and 50. The Pison et al. life table was based on a question in the 1988 population census on deaths in the 12 months before the census, adjusted for estimated coverage.

Table 3.10 compares the sibling with the independent estimates. The sibling estimate is lower than the independent estimate in all cases, the differences being larger for females than for males, ranging from a difference of about 15 percent for males in the Philippines to almost 60 percent for females in Senegal. If the independent estimates are correct, the sibling methodology is underestimating adult mortality, particularly for females and particularly in Senegal. The two previous consistency checks indicated that the sibling estimates were lower than expected in Senegal except for females in relation to female child mortality, but did not indicate problems with Guatemala or the Philippines.

[6]The data for both of these exercises come from the United Nations Demographic Yearbooks for various years.

3.5 SUMMARY

The data collected in the sibling history determine the quality of the estimates derived from this module. Information of three types are collected in the sibling history. These are births, deaths, and cause of death (maternal versus nonmaternal). Births and deaths are placed in calendar time via an indirect line of questioning, that is, current age for living siblings and age at death and years since death for dead siblings. Cause of death for adult females is defined by the time of death relative to pregnancy, childbirth, and the postpartum period.

In general, the results in this chapter show that *among reported* births and deaths of siblings, the data are quite complete for most of the basic demographic variables. For example: there are negligible numbers of siblings with unknown sex; the percentage of living siblings with a reported age is quite similar to reporting levels seen for respondent's own age in other DHS surveys; and age at death is missing for no more than 3 percent of sibling deaths.

Two variables, however, have considerable missing data. These are years since death and the three questions on the time of death relative to pregnancy, childbirth, and the postpartum period. Both are important to the estimation of maternal mortality. The first serves to place a death in calendar time and the second identifies an adult female death as maternal or nonmaternal. Imputation routines and an adjustment procedure for the missing time of death data have been devised to address these shortcomings in the data.

Assessing the data for *omission* in the reporting of the births and deaths of sibling is less straightforward. To examine the reporting of sibling births, the average parity of the respondent's mother was examined by respondent's age group. The results show an upward trend in the average number of births to respondents' mothers as one moves forward in time, suggesting omission in the reporting of sibling births among older respondents. The effect of this omission is dependent upon the vital status of the omitted siblings and the age at death and years since death among omitted sibling deaths. However, a crude examination of the median years of birth for respondents and siblings did not suggest serious underreporting of older siblings.

Table 3.10 Comparison of sibling adult mortality estimates with other estimates of good quality, Demographic and Health Surveys, 1989-1995

	Males		Females	
Country	Sibling	Other	Sibling	Other
Senegal	0.127	0.190	0.111	0.176
Philippines	0.132	0.151	0.067	0.109
Guatemala	0.113	0.135	0.064	0.091

Because maternal mortality is a subset of the adult mortality data collected in the sibling history, adult mortality estimates were compared against external sources of adult mortality indicators. Sibling estimates of adult mortality are higher for some countries but lower for others than United Nations estimates of life expectancy would suggest, though the sibling estimates tend to be somewhat lower. The sibling estimates are in general rather consistent with the estimates of under-five mortality derived from the birth histories in the same surveys. Comparisons for three countries with life tables thought to be of good quality suggest that the corresponding sibling measures are underestimates of actual adult mortality, particularly for females. Though the evidence currently available is far from conclusive, it suggests that sibling-based estimates of adult mortality for the period 0 to 6 years before a survey are more likely to be underestimates than to be overestimates, and that any downward bias in the estimates is probably greater for females than for males.

The types of problems noted here are not restricted to the sibling history, but are apparent in birth histories in most surveys from the developing world. The difference, however, is that the proportion of events affected by these types of problems in the sibling history greatly exceeds that seen for infant or under-five mortality. For example, the percentage of births 0 to 15 years before the survey for which year of birth required imputation among dead children under five was less than 2 percent in the majority of DHS-I and -II surveys. Incomplete information on age at death going back 0 to 24 years before the survey was less than 1 percent in most countries (Curtis, 1995). In contrast, as was shown in Table 3.3, a number countries required imputation for the variable years since deaths for 5 to 22 percent of female deaths. There are two explanations for the greater proportions of incomplete data seen in the sibling histories relative to birth histories. First, it is not surprising that women are better able to report on events occurring to their own children than to their siblings. Second, birth date and age at death for dead children are two of a small number of variables in the DHS for which a "don't know" response is not accepted. Interviewers are required to work with respondents to estimate these two variables if responses are not given following direct inquiry.

4 Levels of Maternal Mortality

This chapter presents the direct and indirect estimates of the maternal mortality ratios from the DHS sibling histories. Also included are the following alternative indicators of maternal mortality: lifetime risk of maternal death, the proportion of all adult female deaths due to maternal causes and the maternal mortality rate. For comparative purposes, adult mortality estimates are also included. Table 4.1 presents these indicators for the period 0 to 6 years before each survey. The MMRatio estimates shown in this chapter differ from those published in DHS country reports, sometimes by a large margin. A comparison of the estimates given here and those in the country reports, and the possible reasons for the differences, are included in Appendix E.

4.1 DHS DIRECT ESTIMATES

The levels of the MMRatio among these countries range from a high of 1,451 in the Central African Republic to a low of 208 in the Philippines. This is in stark contrast to developed countries for which the MMRatio is generally less than 15. African countries tend to fall between 400 and 700. There are too few countries represented from Latin America and Asia to describe a regional pattern, though the estimates are generally lower than those shown for Africa. With the exception of the Bolivia (1) survey, these estimates range from 200-450 per 100,000 births. The rate of maternal death per 1,000 women (MMRate) varies substantially, as well, ranging from 2.7 maternal deaths per 1,000 women in the Central African Republic to 0.3 deaths per 1,000 in Peru and the Philippines, respectively. Four of the nine African countries (Madagascar, Malawi, Niger, and Senegal) show MMRates between 1.1 and 1.7. All other countries show MMRates below 1.0 per 1000 women.

In 10 of the 14 countries, maternal deaths constitute more than 20 percent of all female deaths aged 15-49. In Morocco, Bolivia (1), the Central African Republic, Sudan, Senegal, and Niger, the proportion maternal ranges from 33 to 37 percent. Peru, the Philippines, Zimbabwe, and Namibia show the lowest proportion of maternal deaths with proportions ranging from 15 to 19 percent. By contrast, in developed countries maternal deaths comprise less than 1 percent of adult female deaths between the ages 15-49.

The risk of maternal death considered over the entire reproductive lifespan varies by a factor of 10 among these countries, a range of variation similar to that seen for the MMRatios and MMRates. In the Central African Republic, 9 percent of women will die from maternal causes during their reproductive lifetimes given current rates of maternal death. In the Philippines and Peru, LTR of maternal death is 1 percent or less. The same pattern of variation among countries is seen for LTR as for the MMRatio and the MMRate.

Compilation of these indicators for a specific country offers several perspectives on the level of maternal mortality and provides a more readily understandable picture of the situation. For example, in Malawi, there are more than 750 maternal deaths per 100,000 births. One in 18 women in Malawi will die from maternal causes at some point in her reproductive life given current death rates. At a national level, this represents somewhat fewer than 2 maternal deaths per 1,000 women annually. Maternal deaths constitute a quarter (24 percent) of all adult female deaths aged 15-49.

Two important advantages seen for the direct method of estimating maternal mortality are that the analyst is able to decide the reference period of interest when calculating the rates and ratio and that it is possible to generate rates and ratios for more than one time period to provide an indication of change over time. Table 4.2 presents the MMRatios for the periods 0 to 6 and 7 to 13 years before each survey. These time periods were selected to diminish the effect of heaping on 5 and 10 years prior to the survey for the variable years since death, a type of error described in Chapter 3.

The most striking pattern evident in these data is that in 10 of the 14 countries there is a substantial increase in the MMRatio in the recent period. These increases are evident regardless of the level of maternal mortality. For example, in Malawi and the Central African Republic where the MMRatio in the distant period is in the range of 400 to 800 per 100,000, the MMRatios for the recent period show estimates over 80 to 90 percent higher. In contrast, Zimbabwe and Namibia, with maternal mortality estimates less than 200 in the distant period, show estimates of maternal mortality which are about 150 percent higher for the recent period. In only four countries do the MMRatio estimates decrease in the recent period relative to the past, and in three of these countries the decreases are quite small. Niger and Morocco have recent MMRatio estimates which are about 15 percent lower than the distant period. There was virtually no change in the MMRatio estimate for the Philippines. Only in Peru, was there a substantial decrease, the MMRatio falling by more than 25 percent.

Table 4.1 Maternal mortality ratio, maternal mortality rate, lifetime risk of maternal death, proportion maternal, adult mortality and general fertility rate per 1,000 for the period 0-6 years before the survey, Demographic and Health Surveys, 1989-1995

Country	Year of survey	Maternal mortality ratio	Maternal mortality rate per 1,000	Lifetime risk maternal death	Proportion maternal[1]	Adult mortality ($_{35}q_{15}$) Female	Adult mortality ($_{35}q_{15}$) Male	General fertility rate per 1,000
Africa								
Central African Republic	1994	1451	2.7	0.090	34.0	0.291	0.294	184.8
Madagascar	1992	663	1.3	0.045	23.4	0.211	0.250	201.6
Malawi	1992	752	1.6	0.058	24.4	0.223	0.223	211.2
Morocco	1992	380	0.5	0.019	32.6	0.063	0.067	129.9
Namibia	1992	395	0.6	0.027	19.3	0.125	0.219	160.7
Niger	1992	672	1.7	0.054	37.0	0.177	0.143	249.3
Senegal	1992	566	1.1	0.039	35.6	0.111	0.127	199.7
Sudan	1990	569	0.9	0.033	34.2	0.103	0.107	161.7
Zimbabwe	1994	393	0.6	0.020	16.6	0.142	0.202	151.8
Asia								
Indonesia	1994	454	0.4	0.015	21.8	0.090	0.102	96.3
Philippines	1993	208	0.3	0.010	16.4	0.067	0.132	130.5
Latin America								
Bolivia 1	1989	580	0.9	0.037	33.3	0.112	0.108	161.5
Bolivia 2	1994	396	0.6	0.024	23.9	0.110	0.134	160.0
Peru	1991	218	0.3	0.008	15.4	0.073	0.099	121.2

[1] Proportion of all adult female deaths due to maternal causes.

Table 4.2 Direct estimates of the maternal mortality ratio and 95% confidence intervals for two time periods, Demographic Health Surveys, 1989-1995

Country	Year of survey	0-6 years before survey: MMR	95% CI	Relative error	Number of deaths	7-13 years before survey: MMR	95%CI	Relative error	Number of deaths	Percent change in MMR from distant period to recent	Statistically significant change
Africa											
Central African Republic	1994-95	1451	(1194-1709)	0.09	168	775	(556-995)	0.14	71	87	p<0.05
Madagascar	1992	663	(523-803)	0.10	116	543	(387-700)	0.14	67	22	
Malawi	1992	752	(497-1006)	0.17	82	408	(242-575)	0.20	42	84	p<0.05
Morocco	1992	380	(255-506)	0.16	57	438	(308-569)	0.15	62	-13	
Namibia	1992	395	(259-582)	0.17	41	154	(59-250)	0.31	15	156	p<0.05
Niger	1992	672	(511-833)	0.12	113	779	(563-995)	0.14	110	-14	
Senegal	1992-93	566	(417-715)	0.13	71	460	(288-631)	0.19	47	23	
Sudan	1989-90	569	(359-779)	0.18	112	406	(239-572)	0.20	76	40	
Zimbabwe	1994	393	(269-517)	0.16	55	159	(59-259)	0.31	17	147	p<0.05
Asia											
Indonesia	1994	454	(378-529)	0.08	179	292	(245-339)	0.08	130	55	p<0.05
Philippines	1993	208	(141-275)	0.16	62	212	(141-283)	0.17	53	-2	
Latin America											
Bolivia 1	1989	580	(360-800)	0.19	62	385	(214-557)	0.22	35	51	
Bolivia 2	1993-94	396	(237-555)	0.20	55	315	(191-439)	0.20	39	26	
Peru	1991-92	218	(148-288)	0.16	52	296	(174-417)	0.20	59	-26	

Despite seemingly large differences between the MMRatio estimates for the two time periods in many of the countries, in only five countries are the differences statistically different at the 5 percent significance level. These are the Central African Republic, Namibia, Morocco, Peru, and Indonesia. As is shown in Table 4.2, the relative errors (the standard error as a percentage of the estimate) for the recent period range from 9 to 20 percent of the estimate, and average about 15 percent.[7] By contrast, the relative errors for most DHS infant mortality estimates fall between 4 and 8 percent; relative errors for DHS fertility rates fall between 2 and 3 percent. The large standard errors lead to very wide confidence intervals for every country. For these 14 countries, the 95 percent confidence intervals represent, on average, plus or minus 30 percent of the MMRatio for the recent period. For comparative purposes, the 95 percent confidence intervals surrounding DHS infant mortality estimates are, on average, plus or minus 15 percent.[8] Estimates for the distant period are even less precise than those for the recent period. It should also be noted that the number of maternal deaths within a six-year period, in particular the period 7 to 13 years before the survey, is very small in some countries. For example, in 6 of 14 countries, fewer than 50 maternal deaths were identified for this period.

Table 4.3 presents estimates for the two time periods for the following indicators: the lifetime risk of maternal death (maternal ${}_{35}q_{15}$), probabilities of dying between ages 15 and 50 by sex (${}_{35}q_{15}$), the proportion of all female deaths aged 15-49 due to maternal causes and the general fertility rate. Figures 4.1-4.7 summarize the change between the two time periods for the MMRatio and each indicator mentioned above. Each graph includes a 45 degree line (a point falling on the 45 degree line indicates no change between periods), as well as the regression line of the more distant measure on the more recent. Observations falling below the 45 degree line represent countries in which the estimate was higher in the recent period; observations above the 45 degree line represent higher estimates for the distant period. As is shown, the pattern of increasing mortality is not restricted to the MMRatios. In a majority of the 14 countries, one also sees increases in male and female adult mortality for the recent period. In every country except Senegal, the direction of change of the MMRatio is the same as the directions of change of female adult mortality, and these changes are generally of a similar magnitude. The relationship between the estimates for the distant and recent periods appear very similar for the MMRatio, MMRate, male and female adult mortality, and to a lesser degree, the LTR of maternal death. The figures show the majority of observations falling below the 45 degree line, suggesting a positive shift from the distant to the recent period, albeit with considerable scatter. The slope coefficients for the regression equations illustrated in Figures 4.1-4.5 range from approximately 0.25 to 0.60 for the recent measure, indicating that the indicators for the earlier period are on average only 25 to 60 percent of their value for the later period. The estimates for the two time periods for the proportion of adult female deaths due to maternal causes and the general fertility rate show a very different relationship than that shown for the indicators cited above. In these graphs the regression line is above and nearly parallel to the 45 degree line. In every country fertility decreased significantly between the two time periods. The substantial decreases in fertility coupled with increases in the MMRate explain the very large increases in the MMRatio shown for some countries. On average, the proportion maternal decreased somewhat between periods, though, the pattern is not consistent across countries.

Strictly speaking, the standard errors associated with the measures of maternal mortality prevent one from drawing conclusions regarding change over time in most countries. However, the magnitude of increase shown across countries from Latin America, Asia, and Africa is implausible, regardless of the precision of the estimates. The explanation for these large increases is not apparent from this analysis, although it is likely that the low level of reporting for the distant past relative to the recent period is due to recall problems. None of the data quality indicators presented in Chapter 3, however, suggest that *among reported events*, the data from the distant period were of lesser quality than that from the recent period. Admittedly, it is not possible to demonstrate *omission of events* without an external data source for purposes of comparison. However, it is also possible that the apparent underreporting of deaths in the distant period is in part due to the displacement of events in time, as opposed to actual omission. Again, this can only be demonstrated in comparison to valid data on mortality trends.

The apparent underestimation of mortality for the distant period may be even greater in light of the results of the external validation of adult mortality in Chapter 3. These results suggest that adult mortality is likely to be underestimated for the recent period, implying that maternal mortality is likely to be underestimated as well, given that it is a subset of adult female deaths. Regardless of the underestimation for the recent period, the data presented in this chapter show clearly that the combination of both sampling and nonsampling errors associated with the sibling histories precludes plausible reporting on change over time.

[7]Standard errors were calculated using the jackknife procedure for complex rates and ratios. The software package ISSA was used for these calculations.

[8]This is based on infant mortality estimates from 50 DHS surveys.

Table 4.3 Lifetime risk of maternal death, male and female adult mortality, proportion maternal, and general fertility rate for the periods 0-6 and 7-13 years before the survey, Demographic and Health Surveys, 1989-1995

	Lifetime risk maternal death		Adult mortality ($_{35}q_{15}$)				Proportion maternal[1]		Maternal mortality rate per 1,000		General fertility rate	
Country	0-6 yrs	7-13 yrs	Female 0-6 yrs	Female 7-13 yrs	Male 0-6 yrs	Male 7-13 yrs	0-6 yrs	7-13 yrs	0-6 yrs	7-13 yrs	0-6 yrs	7-13 yrs
Africa												
Central African Republic	0.090	0.049	0.291	0.187	0.294	0.215	34.0	33.8	2.682	1.541	184.8	198.7
Madagascar	0.045	0.043	0.211	0.172	0.250	0.186	23.4	28.3	1.337	1.211	201.6	222.7
Malawi	0.058	0.033	0.223	0.089	0.223	0.101	24.4	40.6	1.588	1.017	211.2	248.8
Morocco	0.019	0.029	0.063	0.087	0.067	0.098	32.6	37.3	0.494	0.771	129.9	176.0
Namibia	0.027	0.001	0.125	0.087	0.219	0.198	19.3	13.1	0.635	0.274	160.7	177.4
Niger	0.054	0.069	0.177	0.177	0.143	0.192	37.0	47.8	1.675	2.191	249.3	281.1
Senegal	0.039	0.048	0.111	0.141	0.127	0.130	35.6	35.5	1.131	1.165	199.7	253.4
Sudan	0.033	0.029	0.103	0.097	0.107	0.129	34.2	37.9	0.920	0.905	161.7	223.0
Zimbabwe	0.020	0.014	0.142	0.094	0.202	0.125	16.6	14.4	0.597	0.334	151.8	210.4
Asia												
Indonesia	0.015	0.014	0.090	0.075	0.102	0.079	21.8	24.4	0.437	0.405	96.3	138.6
Philippines	0.010	0.012	0.067	0.057	0.132	0.103	16.4	25.3	0.272	0.326	130.5	153.6
Latin America												
Bolivia 1	0.037	0.027	0.112	0.097	0.108	0.125	33.3	24.5	0.937	0.734	161.5	190.3
Bolivia 2	0.024	0.019	0.110	0.096	0.134	0.115	23.9	24.8	0.634	0.573	160.0	182.0
Peru	0.008	0.017	0.073	0.073	0.099	0.088	15.4	22.8	0.264	0.457	121.2	154.5

[1] Proportion of all adult female deaths due to maternal causes.

Figure 4.1 Maternal mortality ratios at two time points, Demographic and Health Surveys, 1989-1995

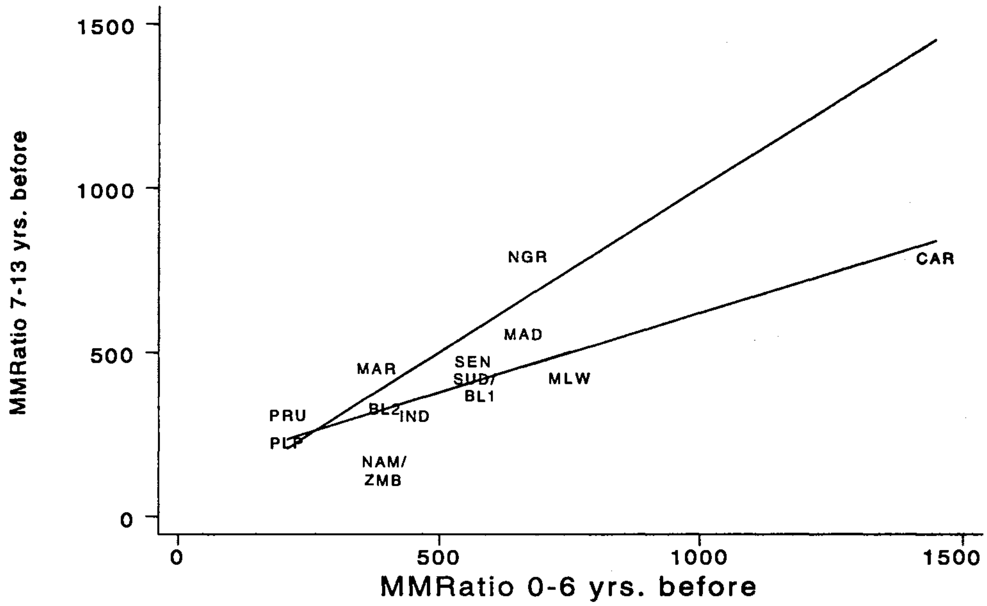


Figure 4.2 Maternity mortality rates at two time points, Demographic and Health Surveys, 1989-1995

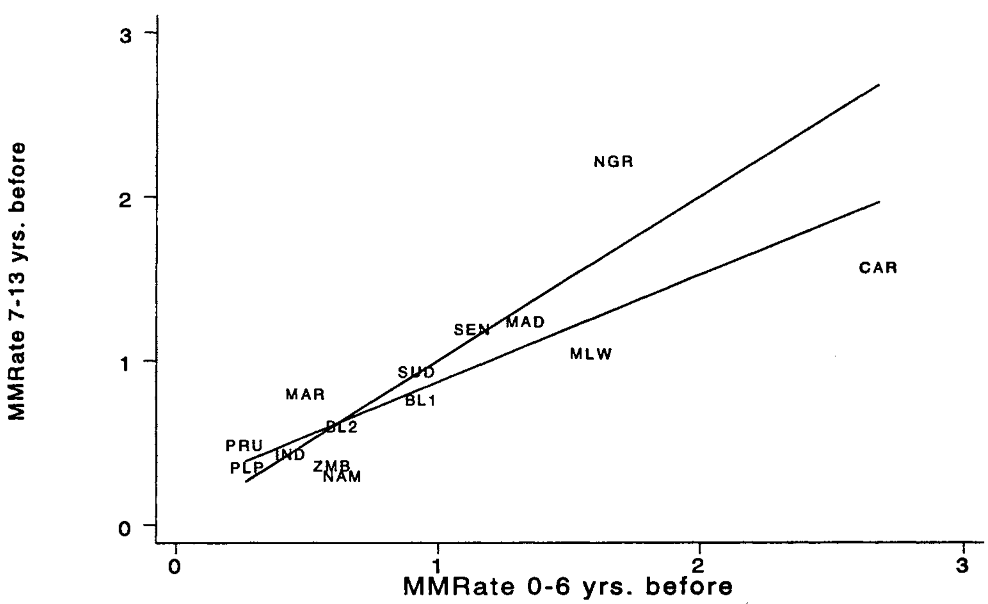


Figure 4.3 Lifetime risk of maternal death at two time points, Demographic and Health Surveys, 1989-1995

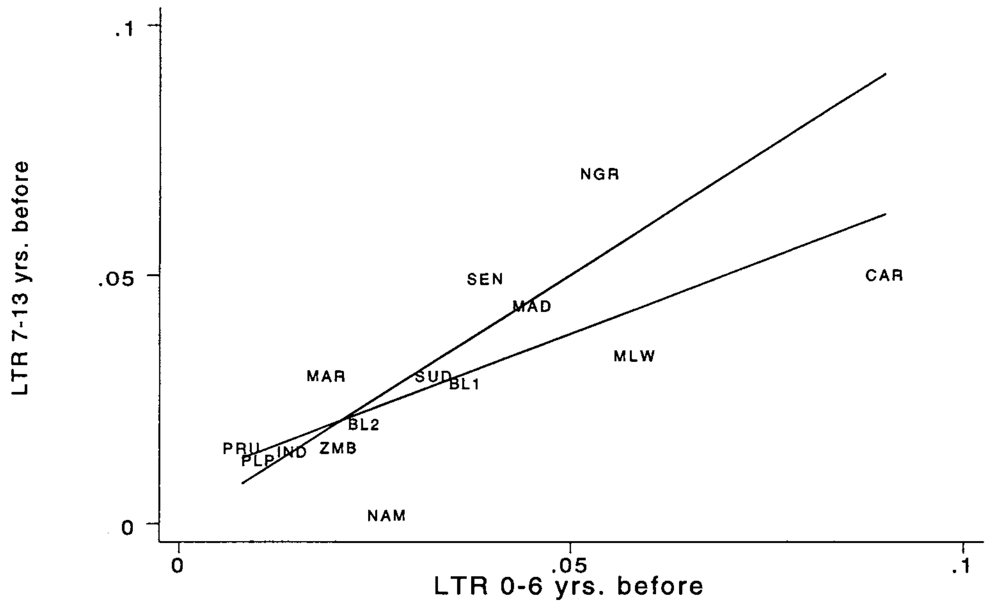


Figure 4.4 Adult male mortality: ${}_{35}q_{15}$ at two time points, Demographic and Health Surveys, 1989-1995

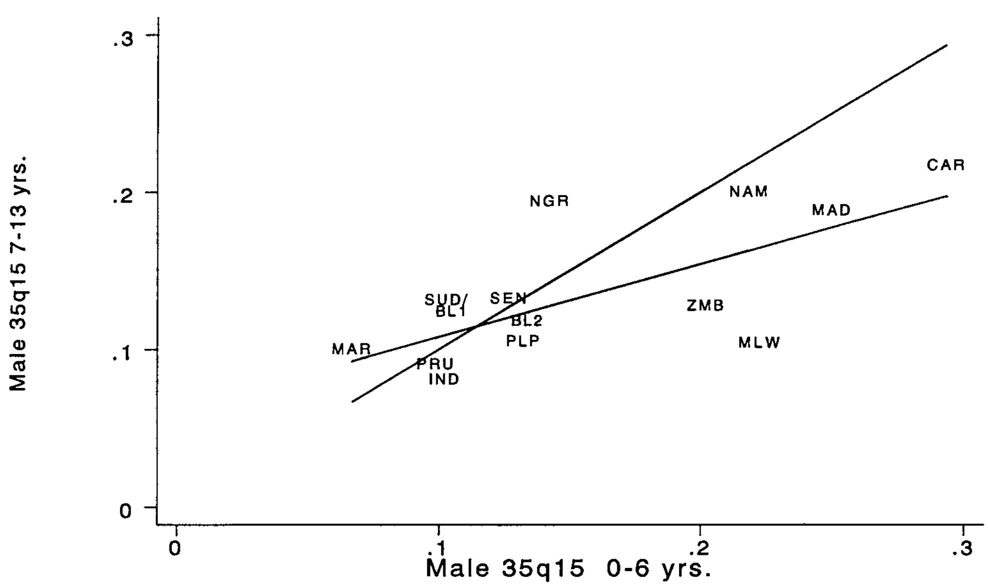


Figure 4.5 Adult female mortality: ${}_{35}q_{15}$ at two time points, Demographic and Health Surveys, 1989-1995

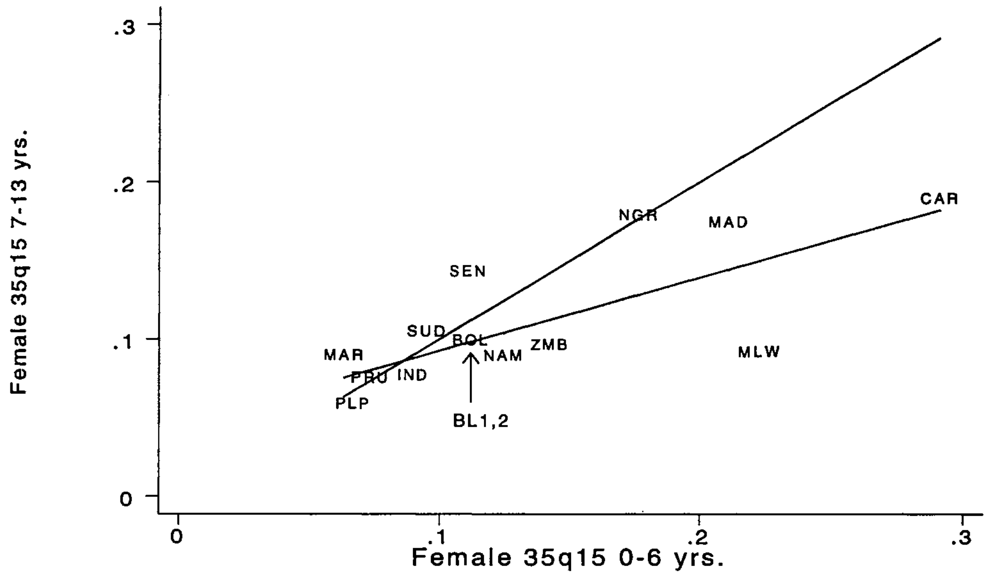


Figure 4.6 Proportion maternal at two time points, Demographic and Health Surveys, 1989-1995

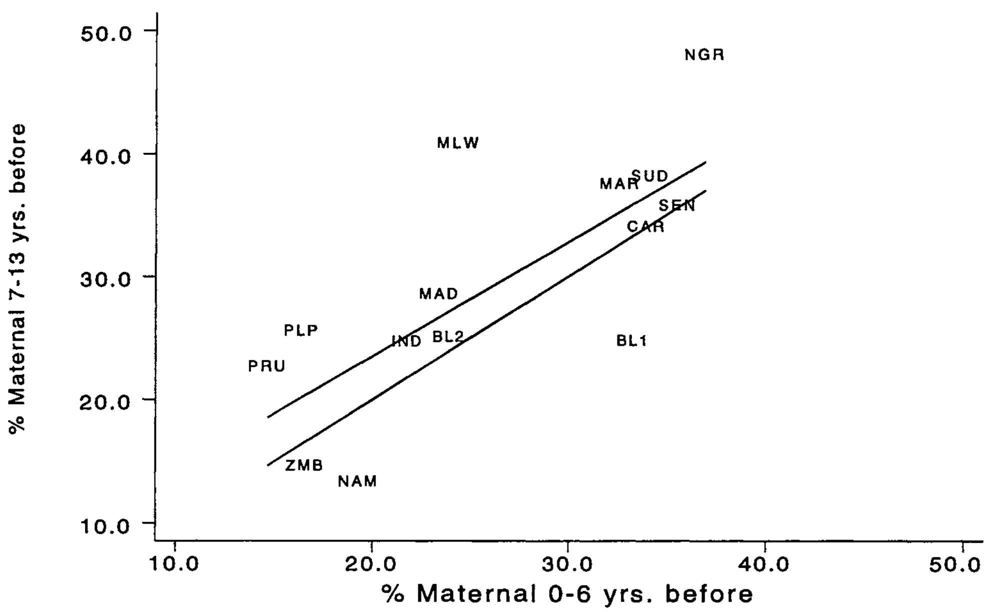
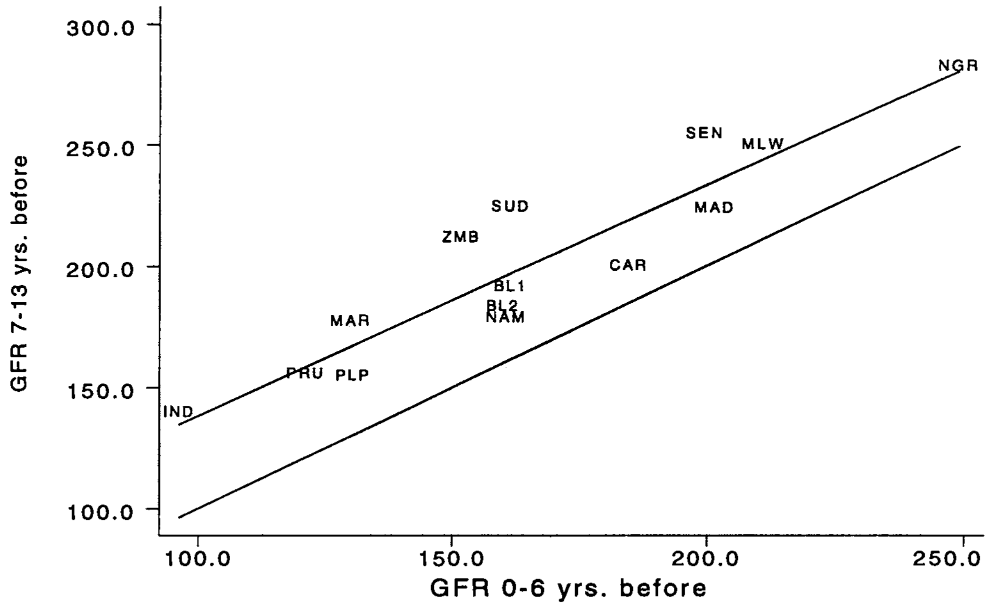


Figure 4.7 General fertility rates at two time points, Demographic and Health Surveys, 1989-1995



It is also interesting to note that in 10 of the 14 countries, adult male mortality exceeds female mortality. Although this is an expected relationship, it serves as a good reminder of the international communities' extremely narrow focus regarding adult health in the developing world. In spite of higher rates of death among men of reproductive age as compared with women, there is no concerted effort to address high male mortality.

4.2 COMPARISON OF DHS DIRECT AND INDIRECT ESTIMATES

DHS final country reports generally report both the direct and indirect estimates of the MMRatio and the LTR of maternal death. As shown above, DHS direct estimates refer to a specific period in time, for example, 0 to 6 or 0 to 9 years before the survey. The midpoint of the time period is considered the reference point for those estimates. As described earlier, the indirect estimate reflects the past 40 to 50 years of experience, but centers around 12 years before the survey under conditions of relative steady change. Therefore, the reference *point* for the estimate is considered to be 12 years before the survey. It is difficult, however, to define the reference *period* for the estimate since data covering all of the sibling reproductive life spans are used to derive the estimate.

The DHS approach for indirect estimation of maternal mortality differs in a number of ways from the original sisterhood indirect method as developed by Graham et al. (1989). In the original methodology, only the four basic questions outlined in Chapter 1 are required. The minimal data requirements are the method's main advantage. The DHS approach is to collect a complete sibling history which allows for direct estimation of maternal mortality. Indirect estimation from DHS data involves extracting the few variables needed for the indirect method from this more complete data set. The statistic obtained from the indirect method is the LTR of maternal death, which is then converted into a maternal morality ratio using equation (6). It is important to note that the MMRatio estimate obtained from the indirect method extracted from DHS data is not necessarily the same MMRatio one would obtain had one asked the originally proposed four questions. Nevertheless, there is no reason to believe that DHS indirect estimates would differ systematically from the estimates resulting from the original approach.

However, apart from that hypothetical difference, there are other procedures used by DHS for indirect estimation that differ objectively from the originally proposed method. For example, in the original methodology, sisters of interest are those who are ever married. In the case in which one is working in an area with established patterns of premarital pregnancy, the ever-married criterion would be dropped and sisters aged 15 or more retained. In DHS surveys, sisters of interest for the indirect method are those aged 15 or more as determined by the questions on a sister's current age or age at death. In 5 of the 14 countries included in this report, questions on the time of death relative to pregnancy are restricted to ever-married women. It should also be noted that in the majority of countries included in this report, a small number of maternal deaths occurring to sisters under age 15 or over age 49 were reported. Both groups of death are excluded from the calculation of the DHS direct and indirect estimates. In theory, maternal deaths to women over age 49 would be included in the original indirect approach.

In the original article by Graham et al. (1989), it is suggested that the actual number of sisters reported by the respondents in the two youngest age groups be replaced by an approximation of the true number. The approximation consists of multiplying the number of respondents by the average number of ever-married sisters reported by respondents in the age groups 25 or higher. This is done to account for the sisters of respondents under 25 who have not yet entered the reproductive age range. In this report, the number of sisters of respondents in the three youngest age groups has been replaced by the product of the number of respondents in each age group and the average number of living adult sisters for respondents aged 30 or more. DHS country reports vary by whether the number of sisters for the first two or the first three age groups have been adjusted.

Table 4.4 shows a comparison of DHS direct and indirect estimates of the MMRatio. The direct estimate is for the period 9 to 15 years before the survey. This period was selected to include a fairly wide time span that would center on 12 years prior to the survey, in an effort to produce a figure that would be comparable to the indirect approach. The general fertility rate used to convert the direct estimate of the MMRate to the MMRatio uses DHS birth history data from 9 to 15 years before the survey. Likewise, the total fertility rate used to convert the indirect estimate of the LTR of maternal death to the MMRatio also uses DHS birth history data from 9 to 15 years before the survey.

The indirect estimates of the MMRatio are higher than the direct estimates in 9 of the 14 countries. For example, in Namibia and Malawi the indirect estimates are twice the direct estimates. In the Central African Republic and Zimbabwe the indirect estimates are 40 to 50 percent higher than the direct. By contrast, the indirect MMRatio for Peru is approximately 30 percent lower than the direct. Clearly, much of this difference is due to the fact that the data used to calculate the indirect estimate encompasses deaths from the recent past. The four African countries cited above represent the countries with the greatest percent increases in the MMRatio between the distant and recent periods. Likewise, the MMRatio for Peru decreased in the recent period. Thus, caution is required in interpreting the reference point for the indirect estimates. Although the estimate centers at approximately 12 years prior to data collection, it is highly influenced in these surveys by reports of recent maternal deaths.

The data shown in this table imply that the DHS direct and indirect estimates of maternal mortality are incomparable given the different reference periods from which the estimates are derived. It follows that comparisons of DHS direct estimates with existing indirect estimates of maternal mortality from a previous survey would also be inappropriate. Although the reference point for the indirect estimate will generally precede that for the direct, these comparisons cannot be interpreted as reflecting change over time.

Table 4.4 Direct and indirect estimates of the maternal mortality ratio, Demographic and Health Surveys, 1989-1995

Country	MMRatio[1] DHS direct estimates 9 - 15 yrs before survey	MMRatio[2] DHS indirect estimates ~ 12 yrs before survey
Africa		
Central African Rep.	783	1205
Madagascar	574	730
Malawi	269	525
Morocco	429	416
Namibia	158	384
Niger	805	859
Senegal	377	462
Sudan	322	450
Zimbabwe	178	255
Asia		
Indonesia	245	328
Philippines	179	197
Latin America		
Bolivia 1	381	389
Bolivia 2	389	365
Peru	318	266

[1] The GFR used to convert the MMRate to the MMRatio for the direct estimate is for 9-15 years before the survey.
[2] The TFR used to convert the indirect estimate of LTR to the MMRatio is for 9-15 years before the survey.

4.3 MATERNAL MORTALITY AND HEALTH CARE

As a means of describing the health and health care context of the countries from which the maternal mortality indicators originate, Table 4.5 includes data on antenatal care, medically trained attendants at birth and caesarean section for births in the three years preceding the survey. Figures 4.8-4.10 display the MMRatios for the recent period plotted against these health care variables.

With the exception of Morocco, Niger, and Bolivia (2) which show quite low percentages of mothers of recent births having received three or more antenatal care visits (17 percent, 19 percent, and 38 percent, respectively), all other countries show between 50 to nearly 80 percent of births to mothers having received this care. Figure 4.8, however, shows virtually no relationship between the MMRatio and antenatal care at the aggregate level.

In general, medical assistance at birth tends to be 10 to 20 percent lower than antenatal care, although there are important exceptions to this pattern. For example, in Morocco nearly twice as many women deliver with the assistance of a medically trained person as receive three or more antenatal care visits, and in Peru medical assistance at birth is 50 percent higher than antenatal care. This is an unusual pattern and in the case of Peru is explained by medically trained personnel assisting deliveries at a woman's home. In Indonesia the opposite pattern is shown with 50 percent fewer mothers having been delivered by a medically trained person than having received antenatal care. A weak negative relationship between the MMRatio and medical assistance at birth is shown in Figure 4.9.

Caesarean section rates represent one proxy for access to emergency obstetric care in developing countries. A general guideline is that caesarean section rates should fall between 5 and 15 percent of deliveries (Koblinski et al., 1995; Maine et al., 1995). In most cases, developing country women having caesarean section deliveries are medically indicated for the procedure, although overuse of surgical delivery has been documented in some countries such as Brazil (Notzon, 1990). Those who need surgical delivery and do not have access to appropriate care suffer severe morbidity, if not maternal death. The negative relationship between the MMRatio and the caesarean section rate is well illustrated in Figure 4.10. As shown in Table 4.5, caesarean section rates vary from approximately 1 percent of recent births in Niger and Madagascar to 10 percent in Bolivia (2) and Peru. Excluding Zimbabwe and Namibia with caesarean section rates of 6 and 7 percent, respectively, all other African countries included here show rates of 3 percent or less.

Table 4.5 Percent of recent live births for which women received antenatal care (3+ visits, beginning before the 7th month of pregnancy), delivery care by a medically trained person and percent of recent births delivered by caesarean section, Demographic and Health Surveys, 1991-1995

Country	Percent births w/3+ ANC visits and 1st was before 7 mo.	Percent births with medically trained asst. at birth	Percent births delivered by caesarean section
Africa			
Central African Republic	56.1	45.9	1.9
Madagascar	60.4	56.7	1.0
Malawi	70.5	54.9	3.4
Morocco	16.9	30.8	2.0
Namibia	62.5	68.2	6.6
Niger	18.9	14.9	0.9
Senegal	51.9	47.2	2.2
Sudan	U	68.5	U
Zimbabwe	78.1	69.4	6.0
Asia			
Indonesia	73.2	39.8	2.5
Philippines	69.9	52.8	5.9
Latin America			
Bolivia 1	U	42.1	U
Bolivia 2	38.2	47.1	10.6
Peru	53.5	80.0	9.7

U = Unknown (not available)

Figure 4.8 Maternal mortality ratio and antenatal care, Demographic and Health Surveys, 1991-1995
R^2=0.00

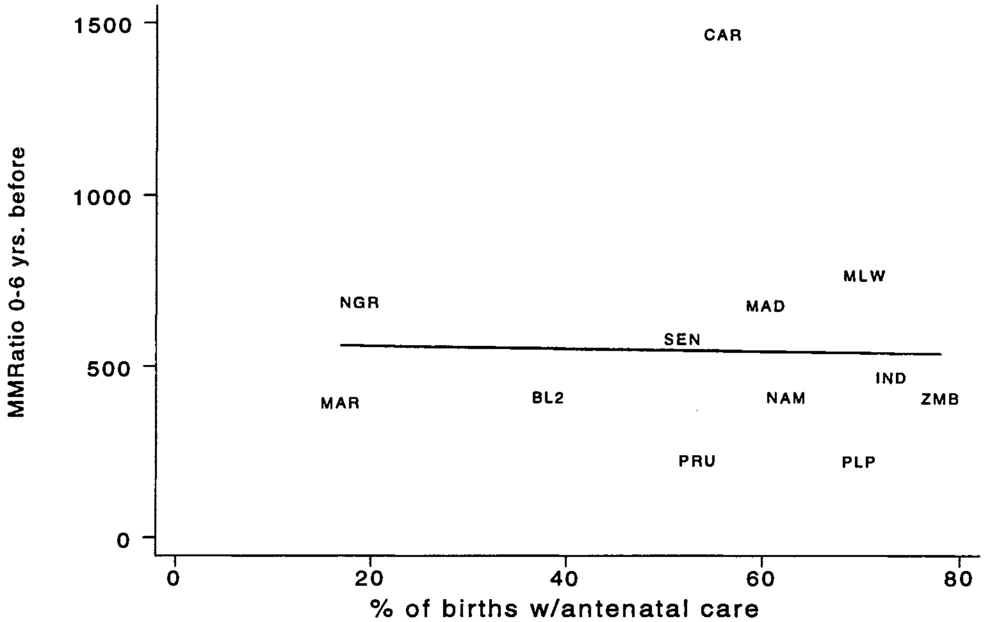


Figure 4.9 Maternal mortality ratio and trained attendant at birth, Demographic and Health Surveys, 1989-1995
R^2=0.07

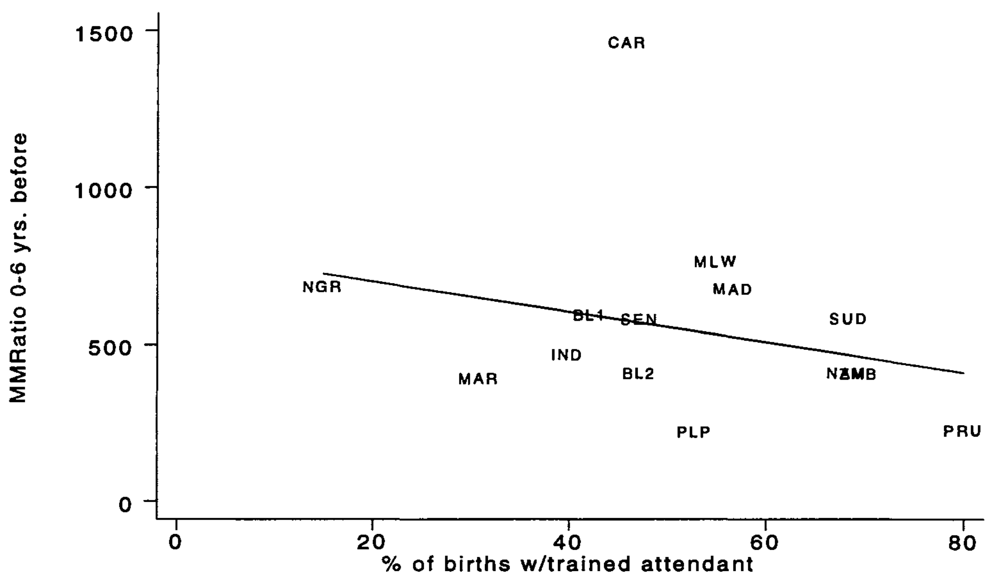
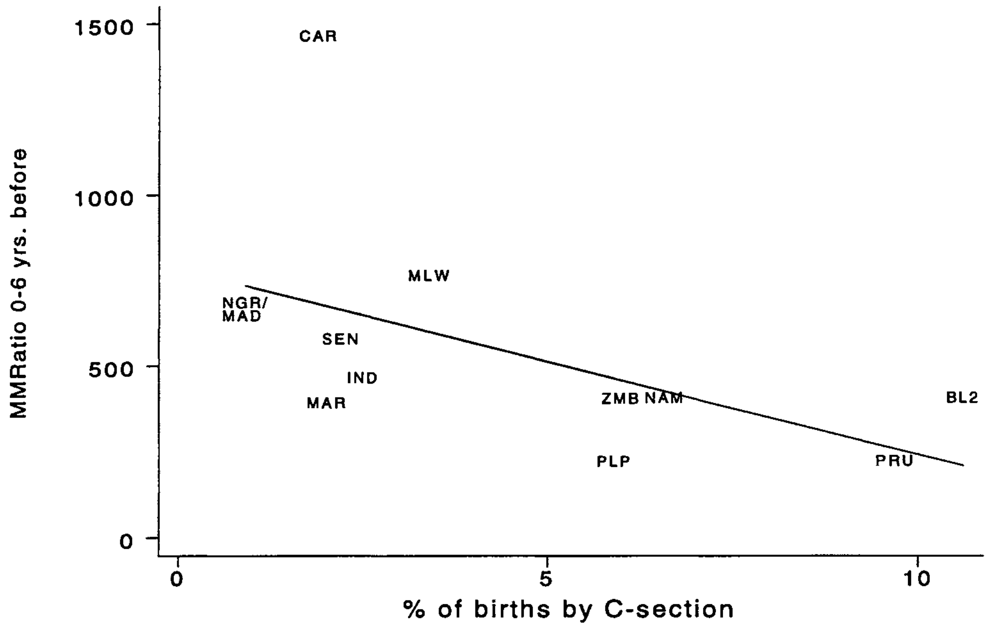


Figure 4.10 Maternal mortality ratio and deliveries by C-section, Demographic and Health Surveys, 1991-1995
R^2=0.29



5 Summary and Policy Implications

Data shown in this report represent 14 countries from widely varying mortality settings in Latin America, Asia, and Africa. Fourfold differences are seen in the probabilities of adult female mortality between some countries; for example, the probability of death between the ages of 15 and 50 for adults ranges from near 0.06 (Morocco, Philippines, and Peru) to 0.29 (Central African Republic). Probabilities of the lifetime risk of maternal death reflect even greater differences, ranging from 0.01 (the Philippines and Peru) to 0.09 (Central African Republic). Maternal mortality ratios range from over 1,400 to approximately 200 per 100,000 births. Maternal death expressed as a proportion of all adult female deaths varies substantially, though to a lesser degree than adult or maternal mortality. Proportions maternal range from near 15 percent in the Philippines and Peru to 37 percent in Niger.

All indicators presented in this report are derived from data collected in the DHS sibling history module. This module was appended to a DHS questionnaire in every country considered here except the Bolivia (2) survey, in which the data were collected in the household schedule. The data quality assessment in Chapter 3 suggests that *among reported events*, the data are quite complete with the exception of the two following variables: years since death and time of death relative to pregnancy, childbirth, and the postpartum period for adult deaths. Adjustments were made to account for these deficiencies. It is interesting to note that none of the data quality indicators suggests differential quality by sex of sibling or by time period before the survey.

The data quality assessment also suggests some omission of siblings reported by older DHS respondents. Without valid external data sets for comparative purposes, it is not possible to determine the effect, if any, on the adult or maternal mortality estimates. It is likely, however, that many if not most of these omitted siblings represent child deaths, in which case neither the adult nor maternal mortality estimates would be affected.

The assessment of adult mortality estimates for the period 0 to 6 years before the survey compared with model life table estimates and in three cases, independent data sources for the Philippines, Senegal, and Guatemala does, however, suggest underreporting of adult male and female mortality. The implausible increases in a majority of countries in the adult and maternal mortality estimates from the distant relative to the recent past suggest even more extreme underreporting for the distant period. Clearly, data from DHS sibling histories cannot support mortality trend analysis for adult nor maternal mortality.

In evaluating the maternal mortality indicators produced from sibling data (direct or indirect method), it is important to recognize the nonsampling and sampling errors which affect these estimates. They include:

Nonsampling errors

- Deaths related to induced abortion are underreported to an unknown extent.
- Recall of distant events most likely leads to underreporting 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, nonmaternal 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 underestimated than overestimated even for the recent period.

Sampling errors

The maternal mortality indicators are very imprecise. The standard errors for these estimates are large due to the rarity of maternal deaths and the sample size for DHS surveys.

As shown above, in any given country there will be simultaneous forces tending toward over and underestimation of maternal mortality, and very little existing data to allow one to know the extent to which these errors compensate for one another. However, the majority of the nonsampling errors are clearly associated with under, rather than over estimation. It is also important to acknowledge that problems such as inaccurate dating of events and omission in the reporting of deaths are problems common to mortality estimation at all ages when using retrospective reporting from a survey.

The coupling of these common types of errors with the large sampling errors associated with maternal mortality indicators leads to estimates of maternal mortality which are not of comparable precision to DHS infant and under-five mortality estimates, and should be interpreted accordingly. For example, the imprecision of the maternal mortality estimates will in most cases prevent one from documenting change in mortality over time. This is true when using estimates reflecting two subsequent time periods calculated from sibling history data (as was done in this report). It is also true when using estimates resulting from two sequential DHS surveys. In most cases, the magnitude of change required to show a statistically significant difference between the two surveys is greater than what could realistically be expected to occur at a national level. Consequently, it is advised that the maternal mortality module be included in a DHS questionnaire at most once every 10 years.

The issue of large sampling errors could be addressed by increasing DHS sample sizes. Below is a table of minimum required sample sizes for the range of levels of maternal mortality seen among the countries in this report. The simulation exercise to calculate required sample size was based on a 10 percent relative error and 1.7 sisters living to adulthood per DHS respondent. These sample sizes reflect the minimum design effect (DEFT = 1.2) associated with other DHS mortality estimates.[9] Clearly, the substantial increases in sample size required to improve the precision of the DHS maternal mortality indicators in countries with moderate or low maternal mortality would not be justified. In high mortality countries, average DHS sample sizes of 5,000-10,000 respondents are adequate for the described level of precision.

[9]Data from the 14 countries presented in this report showed the average number of sisters reaching age 15 per DHS respondent ranged from approximately 1.2 to 2.1. The design effect for infant and under-five mortality estimates ranged from 1.2 to 1.7.

Table 5.1 Minimum sample size requirements,[1] Demographic and Health Surveys

Maternal mortality rate per 1,000	Number of DHS respondents
0.2	60,500
0.6	20,100
1.0	12,000
1.4	8,600
1.8	6,700
2.2	5,500
2.6	4,600

[1] Based on 10 percent relative error, an average of 1.7 sisters living to adulthood per DHS respondent and the minimum design effect (DEFT=1.2) found for other DHS mortality estimates.

The compilation and assessment of the maternal mortality data in this report have shown that some of the advantages originally believed to be associated with direct estimation were overly optimistic. For example, it is clear that the imprecision of these indicators precludes monitoring change over time and reporting on maternal mortality by parity of the sister or other characteristics. The results presented here also call attention to the interpretation of the reference point for the indirect estimates of maternal mortality. Although the reference point is approximately 12 years before the survey, it is clearly affected by more recent mortality. This problem will exist anywhere in which there has been a change, real or artifactual, in the level of maternal mortality.

Examination of the maternal mortality data in this report also underscores the benefit of collecting a complete sibling history which permits a thorough evaluation of the data. In bringing to light the strengths and weaknesses of these data, one learns how and for what the data can best be used. Had DHS relied on the less labor-intensive indirect method, much less would be understood today about maternal mortality measurement.

5.1 POLICY IMPLICATIONS

Currently, three efforts are simultaneously underway regarding measurement issues and the safe motherhood initiative. First, there is a very strong demand for national estimates of the maternal mortality ratio. This is evidenced by the inclusion of a 50 percent reduction in the maternal mortality ratio among the goals for the Nairobi Safe Motherhood Conference in 1987, United Nations Summit of World's Children in 1990, and also among the goals for the 1994 International Conference on Population and Development (United Nations, 1995). Second, there is recognition of the limitations of maternal mortality indicators, though this tends to be restricted to those who closely follow the evaluation literature pertaining to these efforts. For example, in 1996 Graham et al. provided an excellent review of the limitations of using maternal mortality indicators for monitoring program impact. Third, there is preliminary groundwork underway to develop an alternative list of indicators designed to monitor success and change in the components or processes that determine a positive or adverse pregnancy outcome for the woman and child (Koblinsky et al., 1995; Maine et al., 1995).

These efforts are at time in conflict. For example, health personnel in developing countries must decide whether to allocate resources to measure maternal mortality in response to the call from national and international organizations in spite of the limitations of these data. Meanwhile, international organizations are hesitant to sidestep the documentation of maternal mortality ratios when alternative indicators are still in development and routine data sources for the collection of these data are not yet in place.

Nevertheless, wholesale policy changes are not without precedent in the domain of safe motherhood programs. Increasing access to essential obstetric care has replaced the original objective embraced by many national and international programs of training traditional birth attendants as a primary means of reducing maternal mortality. Given the preventive nature of virtually all primary health care endeavors, this curative approach represents a dramatic shift in policy direction. Ten years following the Nairobi Safe Motherhood Conference, there are now ample data to show the limitations of the use of maternal mortality indicators as monitoring tools. Their value as advocacy tools remains unquestioned. Statistics are not labeled "for advocacy purposes only," however, and examples abound of serious misinterpretation of maternal mortality statistics. Dissemination of the limitations of these indicators has been a slow process.

With the possible exception of Reproductive Age Mortality studies (RAMOS) conducted with adequate funding in a geographically limited area, all data collection methods generate an approximate level of maternal mortality. The indirect and direct methods described in this report embody very different strengths and weaknesses which should be taken into consideration when choosing a method of measurement and particularly when interpreting the resulting MMR estimates. Adding a maternal mortality module to a DHS survey is relatively inexpensive, though it may replace other modules of interest. Both the direct and indirect estimates may be very effective at drawing attention to the problem of maternal mortality. Publicizing the MMR represents a first stage in responding to safe motherhood issues. Indeed, this was the objective of the original sisterhood method. At this point, consciousness raising among government officials and program managers may have been achieved in many countries with or without a survey-based estimate of maternal mortality. In these countries the maternal mortality indicators have fulfilled their purpose. These indicators are not instructive as to an appropriate response to the problem. Maternal mortality ratios of 300, 500 or 700 per 100,000 births are likely to result in the same policy responses. It is clear that the time has come in the history of the safe motherhood initiative to move in earnest toward documentation of the process indicators as a means of aiding program design and monitoring program impact. Only through experimentation in data collection and analysis will the most efficient package of indicators emerge.

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Appendix A

The Maternal Mortality Module

Appendix A presents an example of a sibling history used for the collection of maternal mortality data. The questionnaire shown here is the DHS Core Module for Maternal Mortality to be used with the women's questionnaire.

SECTION 9. MATERNAL MORTALITY

NO.	QUESTIONS AND FILTERS	CODING CATEGORIES	SKIP
901	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. How many children did your mother give birth to, including you?	NUMBER OF BIRTHS TO NATURAL MOTHER..........	
902	CHECK 901: TWO OR MORE BIRTHS	ONLY ONE BIRTH (RESPONDENT ONLY)	916
903	How many of these births did your mother have before you were born?	NUMBER OF PRECEDING BIRTHS.......	

	[1]	[2]	[3]	[4]	[5]	[6]
904 What was the name given to your oldest (next oldest) brother or sister?						
905 Is (NAME) male or female?	MALE.......1 FEMALE.....2	MALE.......1 FEMALE.....2	MALE.......1 FEMALE.....2	MALE.......1 FEMALE.....2	MALE.......1 FEMALE.....2	MALE.......1 FEMALE.....2
906 Is (NAME) still alive?	YES........1 NO.........2 GO TO 908 DK.........8 GO TO [2]	YES........1 NO.........2 GO TO 908 DK.........8 GO TO [3]	YES........1 NO.........2 GO TO 908 DK.........8 GO TO [4]	YES........1 NO.........2 GO TO 908 DK.........8 GO TO [5]	YES........1 NO.........2 GO TO 908 DK.........8 GO TO [6]	YES........1 NO.........2 GO TO 908 DK.........8 GO TO [7]
907 How old is (NAME)?	GO TO [2]	GO TO [3]	GO TO [4]	GO TO [5]	GO TO [6]	GO TO [7]
908 In what year did (NAME) die?	1 9 GO TO 910 DK......9998	1 9 GO TO 910 DK......9998	1 9 GO TO 910 DK......9998	1 9 GO TO 910 DK......9998	1 9 GO TO 910 DK......9998	1 9 GO TO 910 DK......9998
909 How many years ago did (NAME) die?						
910 How old was (NAME) when she/he died?	IF MALE OR DIED BEFORE 12 YEARS OF AGE GO TO [2]	IF MALE OR DIED BEFORE 12 YEARS OF AGE GO TO [3]	IF MALE OR DIED BEFORE 12 YEARS OF AGE GO TO [4]	IF MALE OR DIED BEFORE 12 YEARS OF AGE GO TO [5]	IF MALE OR DIED BEFORE 12 YEARS OF AGE GO TO [6]	IF MALE OR DIED BEFORE 12 YEARS OF AGE GO TO [7]
911 Was (NAME) pregnant when she died?	YES........1 GO TO 914 NO.........2	YES........1 GO TO 914 NO.........2	YES........1 GO TO 914 NO.........2	YES........1 GO TO 914 NO.........2	YES........1 GO TO 914 NO.........2	YES........1 GO TO 914 NO.........2
912 Did (NAME) die during childbirth?	YES........1 GO TO 915 NO.........2	YES........1 GO TO 915 NO.........2	YES........1 GO TO 915 NO.........2	YES........1 GO TO 915 NO.........2	YES........1 GO TO 915 NO.........2	YES........1 GO TO 915 NO.........2
913 Did (NAME) die within two months after the end of a pregnancy or childbirth?	YES........1 NO.........2 GO TO 915	YES........1 NO.........2 GO TO 915	YES........1 NO.........2 GO TO 915	YES........1 NO.........2 GO TO 915	YES........1 NO.........2 GO TO 915	YES........1 NO.........2 GO TO 915
914 Was her death due to complications of pregnancy or childbirth?	YES........1 NO.........2	YES........1 NO.........2	YES........1 NO.........2	YES........1 NO.........2	YES........1 NO.........2	YES........1 NO.........2
915 How many children did (NAME) give birth to during her lifetime?	GO TO [2]	GO TO [3]	GO TO [4]	GO TO [5]	GO TO [6]	GO TO [7]

IF NO MORE BROTHERS OR SISTERS, GO TO 916

	[7]	[8]	[9]	[10]	[11]	[12]
904 What was the name given to your oldest (next oldest) brother or sister?						
905 Is (NAME) male or female?	MALE.......1 FEMALE.....2	MALE.......1 FEMALE.....2	MALE.......1 FEMALE.....2	MALE.......1 FEMALE.....2	MALE.......1 FEMALE.....2	MALE.......1 FEMALE.....2
906 Is (NAME) still alive?	YES........1 NO.........2 GO TO 908 DK.........8 GO TO [8]	YES........1 NO.........2 GO TO 908 DK.........8 GO TO [9]	YES........1 NO.........2 GO TO 908 DK.........8 GO TO [10]	YES........1 NO.........2 GO TO 908 DK.........8 GO TO [11]	YES........1 NO.........2 GO TO 908 DK.........8 GO TO [12]	YES........1 NO.........2 GO TO 908 DK.........8 GO TO [13]
907 How old is (NAME)?	GO TO [8]	GO TO [9]	GO TO [10]	GO TO [11]	GO TO [12]	GO TO [13]
908 In what year did (NAME) die?	1 9 GO TO 910 DK......9998	1 9 GO TO 910 DK......9998	1 9 GO TO 910 DK......9998	1 9 GO TO 910 DK......9998	1 9 GO TO 910 DK......9998	1 9 GO TO 910 DK......9998
909 How many years ago did (NAME) die?						
910 How old was (NAME) when she/he died?	IF MALE OR DIED BEFORE 12 YEARS OF AGE GO TO [8]	IF MALE OR DIED BEFORE 12 YEARS OF AGE GO TO [9]	IF MALE OR DIED BEFORE 12 YEARS OF AGE GO TO [10]	IF MALE OR DIED BEFORE 12 YEARS OF AGE GO TO [11]	IF MALE OR DIED BEFORE 12 YEARS OF AGE GO TO [12]	IF MALE OR DIED BEFORE 12 YEARS OF AGE GO TO [13]
911 Was (NAME) pregnant when she died?	YES........1 GO TO 914 NO.........2	YES........1 GO TO 914 NO.........2	YES........1 GO TO 914 NO.........2	YES........1 GO TO 914 NO.........2	YES........1 GO TO 914 NO.........2	YES........1 GO TO 914 NO.........2
912 Did (NAME) die during childbirth?	YES........1 GO TO 915 NO.........2	YES........1 GO TO 915 NO.........2	YES........1 GO TO 915 NO.........2	YES........1 GO TO 915 NO.........2	YES........1 GO TO 915 NO.........2	YES........1 GO TO 915 NO.........2
913 Did (NAME) die within two months after the end of a pregnancy or childbirth?	YES........1 NO.........2 GO TO 915	YES........1 NO.........2 GO TO 915	YES........1 NO.........2 GO TO 915	YES........1 NO.........2 GO TO 915	YES........1 NO.........2 GO TO 915	YES........1 NO.........2 GO TO 915
914 Was her death due to complications of pregnancy or childbirth?	YES........1 NO.........2	YES........1 NO.........2	YES........1 NO.........2	YES........1 NO.........2	YES........1 NO.........2	YES........1 NO.........2
915 How many children did (NAME) give birth to during her lifetime?	GO TO [8]	GO TO [9]	GO TO [10]	GO TO [11]	GO TO [12]	GO TO [13]

IF NO MORE BROTHERS OR SISTERS, GO TO 916

916	RECORD THE TIME.	HOUR.................... MINUTES.................

Appendix B

Calculation of Exposure for Adult and Maternal Death Rates

Adult and maternal death rates are calculated for five- year age groups (15-19, 20-24, etc.) for the periods 0 to 6 and 7 to 13 years before the survey. The sibling history data allow the analyst to define the reference period of interest. Seven-year periods were selected for this report as a means of diminishing the effect of heaping on 5 and 10 years when responding to the question: How many years ago did (NAME) die?

The adult and maternal death rates are simply the result of dividing the number of deaths occurring in a specific age group during the time interval by the corresponding number of person-years of exposure for that age group and time interval. Months of exposure are calculated for every individual for each age group to which the individual was exposed during the interval. Given a seven-year interval and five-year age groups, this implies that a person may contribute exposure time to a maximum of three age groups.

The sibling history module does not ask for a date of birth. Dates of birth are calculated based on the responses to the questions on current age (for living siblings) and on age at death and years since death for dead siblings. Dates of birth and death are generated by randomly assigning a month within the calculated year of the event. Once a month of birth, and/or death has been assigned, the calculation of exposure is straightforward. Exposure for living siblings is the sum of all the months contributed to the specific age groups through which each individual passed during the time interval. Exposure for dead siblings is the sum of all the months contributed to the specific age groups through which each individual passed during the time interval up to the assigned month of death. The month of interview is not included in the calculation. To arrive at an annual rate, the denominator for the death rates is the sum of the number of person-months of exposure divided by 12 for all individuals in a specific age group during the relevant time period.

Appendix C

Imputation Procedures

The process of calculating a date of birth follows several steps:

- Calculate initial range for the date of birth from reported information.
- Adjust ranges to avoid overlaps, while allowing twins.
- Place the respondent in the list of siblings and further constrain the ranges.
- Impute final dates of birth within the constrained ranges.

Initial Ranges

To calculate a date of birth of the respondent, minimum and maximum dates are initially constructed. For living siblings with a reported age, the minimum and maximum cover a range of 12 months. If they have no reported age, the range is left open at this stage. For dead siblings with both a reported age at death and number of years since death, the minimum and maximum cover a 24 month range. If only the age at death or the years since death are known, an upper bound can be calculated for the date of birth, but no lower bound. If neither is known, the range is left open as for living siblings with no age reported.

Adjusted Ranges and Inclusion of Respondent

The initial ranges are then adjusted to avoid overlaps in the ranges for the dates of birth, assigning minimum and maximum dates to those previously left open, while also checking for siblings listed out of order and for probable twins. If siblings are found out of order, they are reordered and the adjustments recalculated. After the adjustment of the ranges, the respondent (for whom an exact date of birth is available) is included in the ordered list of siblings. In some cases the list of siblings contains runs of unknown information into which the respondent was to be placed. In these circumstances a fixed birth interval (calculated median birth interval of 27 months) is used to estimate the probable placement of the respondent. In a few cases, there is no date information for any sibling and the respondent is then placed at the midpoint of the list.

Imputation of Final Dates of Birth

The imputed dates of birth are calculated by taking the midpoint of the final adjusted ranges. For a small number of cases where a run of unknown dates is at the beginning or the end of the list of siblings, the fixed birth interval is used to impute the dates of birth for these siblings.

Imputing Date of Death

Having imputed a date of birth of each sibling, the date of death can be imputed easily from either the age at death or the years since death. The imputation is performed in a similar manner to the imputation of the dates of birth. If both pieces of information are known, the range for the date of death of the sibling covers less than 12 months and usually no more than six months. If only one of the two is known, the date is restricted to a 12-month period. If neither is known, other information is needed to constrain the range.

The distribution of age at death for siblings where the years since death is unknown, but age at deaths is reported, is used as the basis for imputing the age at death of each sibling where no information is known. For each sibling, an age at death is randomly assigned based on this probability distribution. From this information, it is then possible to impute a final date of death.

Appendix D

Sibling Estimates of $_{35}q_{15}$ by Sex

Table D.1 presents the sibling estimates of $_{35}q_{15}$ by sex which are used in Figures 3.8-3.11. Five additional countries are included in these graphs that were not considered in other sections of this report. These are: Guatemala, Mali, Uganda, Côte d'Ivoire, and Nepal. Sudan, which is included among the countries considered in this report, has been excluded from the above-mentioned graphs because it is not a national survey.

Table D.1 Sibling estimates of $_{35}q_{15}$ by sex, Demographic and Health Surveys, 1989-1996

Country	Female	Male
Africa		
Central African Republic	0.291	0.294
Cote d'Ivoire	0.291	0.294
Madagascar	0.211	0.250
Malawi	0.223	0.223
Mali	0.139	0.148
Morocco	0.063	0.067
Namibia	0.125	0.219
Niger	0.177	0.143
Senegal	0.111	0.127
Uganda	0.277	0.344
Zimbabwe	0.142	0.202
Asia		
Indonesia	0.090	0.102
Nepal	0.133	0.114
Philippines	0.067	0.132
Latin America		
Bolivia 1	0.112	0.108
Guatemala	0.064	0.113
Peru	0.073	0.099

Note: All estimates are for the period 0-6 years before the survey except for Uganda, which is 0-9 years before the survey.

Appendix E

Differences in Maternal Mortality Ratios between DHS Country Reports and This Report

Table E.1 below presents the maternal mortality ratios and the reference period as reported in DHS country reports. The table also presents the maternal mortality ratios for the period 0 to 6 years before the survey which are cited in this report. The following is a list of reasons for which the two estimates may differ:

- Reference periods may differ.

- The maternal mortality ratios in this report are age-adjusted. Not all maternal mortality estimates have been age-adjusted in DHS country reports. Although the MMRatio is not an age-standardized measure, such as the total fertility rate, the MMRates in this report have been adjusted to reflect the proportional distribution by age of the DHS respondents. The aggregate MMRate for sisters 15-49 is then used to obtain the MMRatio. This adjustment was done to compensate for the truncation effects seen in every country among sisters 15-19 and 45-49 which result from the practice of limiting the DHS sample of respondents to women aged 15 to 49.

- In most countries there were some adult female deaths with missing data on the time-of-death questions which prevented identifying them as maternal or nonmaternal deaths. In this report, the number of maternal deaths was adjusted for missing time of death data by applying the age-specific proportion maternal to the number of dead female siblings with missing time of death data.

- Calculation of exposure has evolved over time.

- Imputation routines have evolved over time.

Table E.1 Comparison of maternal mortality ratios (direct method estimates) reported in DHS country reports and reported in this analysis, Demographic and Health Surveys, 1989-1995

	MMRatio in DHS country report		
Country	MMR	Reference period: (years before survey)	MMRatio in this report[1]
Africa			
Central African Republic	1132	0-6	1451
Madagascar	660	0-6	663
Malawi	620	0-6	752
Morocco	332	0-6	380
Namibia	225	0-9	395
Niger	593	0-6	672
Senegal	555	0-6	566
Sudan	552	0-6	569
Zimbabwe	283	0-9	393
Asia			
Indonesia	390	0-5	454
Philippines	209	0-6	208
Latin America			
Bolivia 1	371	0-6	580
Bolivia 2	390	0-5	396
Peru	197	0-6	218

[1] Reference Period is 0 - 6 years before the survey.

As shown in the table, the estimates for the Central African Republic, Namibia, and Bolivia (1) are substantially higher in this report than in their respective country reports. In Bolivia (1), this is due to an increase in the number of maternal deaths identified for one or more of the reasons cited above, coupled with a decrease in the number of exposure years calculated for the recent period. In the Central African Republic and Namibia, the number of maternal deaths identified for this report exceeds that shown in the individual country reports. For the case of Namibia, the reference period (0 to 9 years before the survey) for the country report differs from the 0 to 6 year period used for this analysis.

Appendix F

Summary of DHS-I, DHS-II, and DHS-III Surveys, 1985-1996

Region and Country	Date of Fieldwork	Implementing Organization	Respondents	Sample Size	Male/Husband Survey	Supplemental Studies, Modules, and Additional Questions
SUB-SAHARAN AFRICA						
DHS-I						
Botswana	Aug-Dec 1988	Central Statistics Office	AW 15-49	4,368		AIDS, PC, adolescent fertility
Burundi	Apr-Jul 1987	Département de la Population, Ministère de l'Intérieur	AW 15-49	3,970	542 Husbands	CA, SAI, adult mortality
Ghana	Feb-May 1988	Ghana Statistical Service	AW 15-49	4,488	943 Husbands	CA, SM, WE
Kenya	Dec-May 1988/89	National Council for Population and Development	AW 15-49	7,150	1,133 Husbands	
Liberia	Feb-Jul 1986	Bureau of Statistics, Ministry of Planning and Economic Affairs	AW 15-49	5,239		TBH, employment status
Mali	Mar-Aug 1987	Institut du Sahel, USED/CERPOD	AW 15-49	3,200	970 Men 20-55	CA, VC, childhood physical handicaps
Ondo State, Nigeria	Sep-Jan 1986/87	Ministry of Health, Ondo State	AW 15-49	4,213		CA, TBH
Senegal	Apr-Jul 1986	Direction de la Statistique, Ministère de l'Economie et des Finances	AW 15-49	4,415		CA, CD
Sudan	Nov-May 1989/90	Department of Statistics, Ministry of Economic and National Planning	EMW 15-49	5,860		FC, M, MM
Togo	Jun-Nov 1988	Unité de Recherche Démographique, Université du Benin	AW 15-49	3,360		CA, SAI, marriage history
Uganda	Sep-Feb 1988/89	Ministry of Health	AW 15-49	4,730		CA, SAI
Zimbabwe	Sep-Jan 1988/89	Central Statistical Office	AW 15-49	4,201		AIDS, CA, PC, SAI, WE
DHS-II						
Burkina Faso	Dec-Mar 1992/93	Institut National de la Statistique et de la Démographie	AW 15-49	6,354	1,845 Men 18+	AIDS, CA, MA, SAI
Cameroon	Apr-Sep 1991	Direction Nationale du Deuxième Recensement Général de la Population et de l'Habitat	AW 15-49	3,871	814 Husbands	CA, CD, SAI
Madagascar	May-Nov 1992	Centre National de Recherches sur l'Environement	AW 15-49	6,260		CA, MM, SAI
Malawi	Sep-Nov 1992	National Statistical Office	AW 15-49	4,850	1,151 Men 20-54	AIDS, CA, MA, MM, SAI
Namibia	Jul-Nov 1992	Ministry of Health and Social Services, Central Statistical Office	AW 15-49	5,421		CA, CD, MA, MM
Niger	Mar-Jun 1992	Direction de la Statistique et des Comtes Nationaux	AW 15-49	6,503	1,570 Husbands	CA, MA, MM, SAI
Nigeria	Apr-Oct 1990	Federal Office of Statistics	AW 15-49	8,781		CA, SAI
Rwanda	Jun-Oct 1992	Office National de la Population	AW 15-49	6,551	598 Husbands	CA
Senegal	Nov-Aug 1992/93	Direction de la Prévision et de la Statistique	AW 15-49	6,310	1,436 Men 20+	AIDS, CA, MA, MM, SAI
Tanzania	Oct-Mar 1991/92	Bureau of Statistics, Planning Commission	AW 15-49	9,238	2,114 Men 15-60	AIDS, CA, MA, SAI
Zambia	Jan-May 1992	University of Zambia	AW 15-49	7,060		AIDS, CA, MA

DHS-III						
Benin	Jun-Aug 1996	Institut National de la Statistique	AW 15-49	5,491	1,535 Men 20-64	AIDS, CA, MA, MM, SAI
Central African Republic	Sep-Mar 1994/95	Direction des Statistiques Démographiques et Sociales	AW 15-49	5,884	1,729 Men 15-59	AIDS, CA, CD, MA, MM, SAI
Comoros	Mar-May 1996	Centre National de Documentation et de la Recherche Scientifique	AW 15-49	3,050	795 Men 15-64	CA, MA
Côte d'Ivoire	Jun-Nov 1994	Institut National de la Statistique	AW 15-49	8,099	2,552 Men 12-49	CA, MA, SAI
Eritrea	Sep-Jan 1995/96	National Statistics Office	AW 15-49	5,054	1,114 Men 15-59	AIDS, CA, MA, MM, SAI
Ghana	Sep-Dec 1993	Ghana Statistical Service	AW 15-49	4,562	1,302 Men 15-59	CA, MA
Kenya	Feb-Aug 1993	National Council for Population and Development	AW 15-49	7,540	2,336 Men 15-54	AIDS, CA, MA, SAI
Malawi (KAP)[a]	Jun-Oct 1996	National Statistical Office	AW 15-49	2,683	2,658 Men 15-54	AIDS
Mali	Nov-Apr 1995/96	CPS/MSSPA et DNSI	AW 15-49	9,704	2,474 Men 15-59	AIDS, CA, MA, MM, SAI
Tanzania (KAP)[a]	Jul-Sep 1994	Bureau of Statistics, Planning Commission	AW 15-49	4,225	2,097 Men 15-59	AIDS, PC
Tanzania (In-depth)	Jun-Oct 1995	Bureau of Statistics, Planning Commission	AW 15-49	2,130		Adult and childhood mortality estimation
Tanzania	Jul-Nov 1996	Bureau of Statistics, Planning Commission	AW 15-49	8,120	2,256 Men 15-59	AIDS, CA, MA, MM
Uganda	Mar-Aug 1995	Statistics Department, Ministry of Finance and Economic Planning	AW 15-49	7,070	1,996 Men 15-59	AIDS, CA, MA, MM, SAI
Uganda (In-depth)	Oct-Jan 1995/96	Institute of Statistics and Applied Economics, Makerere University	AW 20-44	1,750	1,356 Partners	Negotiating reproductive outcomes
Zambia	Jul-Jan 1996/97	Central Statistics Office	AW 15-49	8,021	1,849 Men 15-59	AIDS, CA, MA, MM
Zimbabwe	Jul-Nov 1994	Central Statistical Office	AW 15-49	6,128	2,141 Men 15-54	AIDS, CA, MA, MM, PC, SAI
NEAR EAST/NORTH AFRICA						
DHS-I						
Egypt	Oct-Jan 1988/89	National Population Council	EMW 15-49	8,911		CA, CD, MM, PC, SAI, WE, WS
Morocco	May-Jul 1987	Ministère de la Santé Publique	EMW 15-49	5,982		CA, CD, S
Tunisia	Jun-Oct 1988	Office National de la Famille et de la Population	EMW 15-49	4,184		CA, S, SAI
DHS-II						
Egypt	Nov-Dec 1992	National Population Council	EMW 15-49	9,864	2,466 Husbands	CA, MA, PC, SM
Jordan	Oct-Dec 1990	Department of Statistics, Ministry of Health	EMW 15-49	6,461		CA, SAI
Morocco	Jan-Apr 1992	Ministère de la Santé Publique	AW 15-49	9,256	1,336 Men 20-70	CA, MA, MM, SAI
Yemen	Nov-Jan 1991/92	Central Statistical Organization	EMW 15-49	5,687		CA, CD, SAI
DHS-III						
Egypt	Nov-Jan 1995/96	National Population Council	EMW 15-49	14,779		CA, FC, MA, WS
Morocco (Panel)	Apr-May 1995	Ministère de la Santé Publique	AW 15-49	4,753		

ASIA						
DHS-I						
Indonesia	Sep-Dec 1987	Central Bureau of Statistics, National Family Planning Coordinating Board	EMW 15-49	11,884		PC, SM
Nepal (In-depth)	Feb-Apr 1987	New Era	CMW 15-49	1,623		KAP-gap survey
Sri Lanka	Jan-Mar 1987	Department of Census and Statistics, Ministry of Plan Implementation	EMW 15-49	5,865		CA, NFP
Thailand	Mar-Jun 1987	Institute of Population Studies Chulalongkorn University	EMW 15-49	6,775		CA, S, SAI
DHS-II						
Indonesia	May-Jul 1991	Central Bureau of Statistics, NFPCB/MOH	EMW 15-49	22,909		PC, SM
Pakistan	Dec-May 1990/91	National Institute of Population Studies	EMW 15-49	6,611	1,354 Husbands	CA
DHS-III						
Bangladesh	Nov-Mar 1993/94	Mitra & Associates/NIPORT	EMW 10-49	9,640	3,284 Husbands	PC, SAI, SM
Bangladesh	Nov-Mar 1996/97	Mitra & Associates/NIPORT	EMW 10-49	9,127	3,346 EMM	CA, MA, SM
Indonesia	Jul-Nov 1994	Central Bureau of Statistics/ NFPCB/MOH	EMW 15-49	28,168		MM, PC, SAI, SM
Kazakstan	May-Aug 1995	Institute of Nutrition, National Academy of Sciences	AW 15-49	3,771		CA, MA
Nepal	Jan-Jun 1996	Ministry of Health/New ERA	EMW 15-49	8,429		CA, MA, MM
Philippines	Apr-Jun 1993	National Statistics Office	AW 15-49	15,029		MM, SAI
Turkey	Aug-Oct 1993	General Directorate of MCH/FP Ministry of Health	EMW <50	6,519		CA, MA
Uzbekistan	Jun-Oct 1996	Research Institute of Obstetrics and Gynecology	AW 15-49	4,415		CA, MA
LATIN AMERICA/CARIBBEAN						
DHS-I						
Bolivia	Feb-Jul 1989	Instituto Nacional de Estadística	AW 15-49	7,923		CA, CD, MM, PC, S, WE
Bolivia (In-depth)	Feb-Jul 1989	Instituto Nacional de Estadística	AW 15-49	7,923		Health
Brazil	May-Aug 1986	Sociedade Civil Bem-Estar Familiar no Brasil	AW 15-44	5,892		CA, S, SM, abortion, young adult use of contraception
Colombia	Oct-Dec 1986	Corporación Centro Regional de Población, Ministerio de Salud	AW 15-49	5,329		CA, PC, S, SAI, SM
Dominican Republic	Sep-Dec 1986	Consejo Nacional de Población y Familia	AW 15-49	7,649		CA, NFP, S, SAI, family planning communication
Dominican Republic (Experimental)	Sep-Dec 1986	Consejo Nacional de Población y Familia	AW 15-49	3,885		S, SAI
Ecuador	Jan-Mar 1987	Centro de Estudios de Población y Paternidad Responsable	AW 15-49	4,713		CD, SAI, employment
El Salvador	May-Jun 1985	Asociación Demográfica Salvadoreña	AW 15-49	5,207		CA, S, TBH
Guatemala	Oct-Dec 1987	Instituto de Nutrición de Centro América y Panamá	AW 15-44	5,160		CA, S, SAI
Mexico	Feb-May 1987	Dirección General de Planificación Familiar, Secretaría de Salud	AW 15-49	9,310		NFP, S, employment

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