September 14, 2009

USING A POST- CENSUS SURVEY TO MEASURE MATERNAL MORTALITY

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Paper prepared for the 2009 International Population Conference of the IUSSP

Marrakesh, Morocco. October.

Introduction

Despite some advances in health, most developing countries continue to suffer from high levels of maternal mortality. Addressing maternal health and mortality concerns has been the focus of several national and international initiatives, such as the Millennium Development Goals (MDGs), which have well defined benchmarks to monitor and evaluate interventions. Assessing progress of these initiatives has been a challenge due to weak and fragmented health information systems as well as a lack of reliable data.

Most of the methodologies available to measure and monitor maternal mortality do not provide representative estimates (at either the national or subnational level). In fact, among maternal mortality estimates for sub-Saharan Africa provided by a recent summary report, 44 percent of country estimates were not based on data at all but rather statistical models (WHO, et al., 2007).[1] Moreover, even when maternal mortality data are more readily available, they typically do not indicate direct and indirect causes of mortality nor is the underlying cause of maternal death based on internationally comparable procedures. In order to measure maternal mortality accurately it is important to know all of the following: total number of deaths over a given period by age and sex, number of deaths among women aged 15-49 due to maternal causes, number of live births by sex over the same period, and population distribution by age and sex (ibid.). Existing widely used methodologies for measuring maternal mortality, such as

[1]WHO, UNICEF, UNFPA, The World Bank. 2007. *Maternal Mortality in 2005*. Geneva: The World Bank. For most other countries of sub-Saharan Africa in this report (53%), maternal mortality estimates were based on sisterhood methods typically applied to Demographic and Health Survey data.

household-based surveys and hospital-based methodologies, have several limitations and cannot provide these measures.

This paper presents results from an innovative approach for generating such information – including the measurement of maternal mortality – using the 2007 Mozambique national census. A post-census mortality survey, using resources from the Sample Vital Registration with Verbal Autopsy (SAVVY) toolkit,[2] was conducted to ascertain leading causes of death by sex and age group at the national and provincial levels. The survey was designed with input from national and provincial health planning systems to ensure that the resulting data would be appropriate for use in an evidence-based decision making process.

This paper addresses the number, distribution, and causes of maternal and other deaths in Mozambique, as well as other characteristics of these deaths. Death rates and ratios will be presented in the next phase of this project once census counts are available.

Identification and Classification of Deaths

The 2007 national census of Mozambique provided the frame for the post-census mortality survey sample. Each province was divided into rural and urban strata, then 32-48 clusters were randomly selected in each province. Urban areas were oversampled in order to have sufficient numbers of deaths in both urban and rural strata in each province. The urban shares across the provinces were otherwise roughly proportionate to those recorded in the prior census. Overall, this design called for approximately a five-percent sample of all households in Mozambique.

The 2007 census form contained questions regarding deaths that occurred in the household within the prior year. Once specific clusters were chosen in each province, all households in which a death was reported within the cluster during the census interview were identified for a follow-up verbal autopsy (VA) interview. Three separate verbal autopsy forms, corresponding to newborns, infants and children, and adults, were developed based upon the WHO international standardized versions. Trained interviewers visited the household and filled out the forms. When forms were completed, they were turned over to a team of physicians, who had received training on the application of ICD-10 certification and coding. The physicians used the information on the forms, their medical expertise, and ICD-10 certification and coding guidelines to complete a death certificate indicating the immediate and underlying causes of each death.

[2] http://www.cpc.unc.edu/measure/tools/monitoring-evaluation-systems/savvy

For indicators of maternal mortality,[3] as well as for deaths due to other causes, the causes of death were coded according to procedures and definitions described in the WHO ICD-10 volumes 1-3 for establishing a single underlying cause of death. We classified all maternal deaths according to the WHO ICD-10 volumes 1-3-10 index, Chapter XV Pregnancy, childbirth and the puerperium (O00–O99[4]) which excludes human immunodeficiency virus [HIV] disease (B20–B24), injury, poisoning and certain other consequences of external cause (S00–T98) and normal pregnancy (Z34.-). However, we identified all maternal deaths caused by HIV and included these deaths in the maternal mortality measures where appropriate.

We defined a maternal death as 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 causes.

We classified direct Obstetric deaths (O00-O97) as maternal deaths resulting from obstetric complications of the pregnant state, from interventions, omissions, incorrect treatment, or from a chain of events resulting from a maternal cause of death. Likewise we classified Indirect Obstetric deaths (O98-O99) as maternal deaths resulting from previous disease that developed during pregnancy and which were not due to direct obstetric causes but were aggravated by physiologic effects of pregnancy. We included deaths which were not otherwise classified as direct obstetric deaths, but where the underlying cause was HIV infection, as indirect obstetric deaths.

We determined the timing of adult female deaths relative to pregnancy from the adult verbal autopsy form that contains a question to identify all women who died and were pregnant at time of death, within 42 days of death and 43 days to 1 year before death (O96). This information allowed us to calculate pregnancy-related deaths.

Findings

There were 213 maternal deaths recorded in the Mozambique post-census mortality survey. Table 1 and Figure 1 show the distribution of these deaths based on whether they were due to direct obstetric causes or indirect causes. Although ICD-10

[3]The most commonly used indicator is the maternal mortality ratio (MMRatio), which refers to the number of maternal deaths per live birth, multiplied by a conventional factor of 100,000:
MMRatio = Number of maternal deaths/ Number of live births * 100,000.
The MMRate is usually multiplied by a factor of 1,000:
MMRate = Number of maternal deaths/ Number of women aged 15-49* 1000
A third indicator is the proportion of adult female deaths due to maternal causes (PMFD), or proportion maternal:
PMFD = Number of maternal deaths/Number of deaths among women 15-49

[4]Ranges of codes from ICD-10 are indicated here in order to clarify which specific causes are included in each definition.

coding excluded HIV as an underlying direct or indirect cause of maternal death, we assume here that it is an indirect cause. There were, however, 10 instances where mothers were HIV positive yet died of direct obstetric causes; we counted these deaths in the direct category.[5]

Almost 54 percent of maternal deaths were due to direct obstetric causes. About 19 percent were AIDS-related, and the remaining 27 percent were due to indirect causes other than AIDS. To our knowledge, this post-census mortality survey in Mozambique may be the most broad-based in a developing country to determine the share of maternal deaths due to direct vs. indirect obstetric causes, as well as the share due to HIV – nearly one fifth.

In addition to the 213 maternal deaths just described, another 8 were due to accidents or incidental to pregnancy. Thus, there were 221 deaths that were pregnancy-related. The post-census survey also recorded 46 late maternal deaths (more than 42 days after the pregnancy ended). In the tables and figure that follow, unless otherwise indicated, we exclude these two latter categories, focusing instead on the 213 maternal deaths.

Table 1 presents the basic frequency distributions (numbers and percentages) as reported in the post-census mortality survey. In all of the following tables, the numbers are also quoted as reported, yet the percentages refer instead to *weighted* distributions, which sometimes differ considerably from unweighted distributions.

Table 2 shows the distribution of all pregnancy-related deaths (maternal plus accidental) in relation to the duration of the pregnancy or time since childbirth. Among all these deaths, 42 percent occurred within 1 to 42 days after birth (24.1 percent from 1 to 7 days and 18.3 percent from 8 to 42 days). Most pregnancy-related deaths occurred within the first 28 weeks of pregnancy (21.4 percent) or within the 1 to 7 days after birth (24.1 percent). When comparing maternal deaths due to direct versus indirect (non-AIDS) obstetric causes, the percent occurring between 28 weeks of pregnancy and the time of delivery was far higher for direct causes (28.2 percent vs. 5.2 percent). In contrast, the percent occurring within 28 weeks of pregnancy was higher for indirect causes than for direct causes (40.9 percent vs. 9.7 percent).

One other notable finding was that indirect obstetric deaths due to HIV tended to be more spread out across the entire risk interval, perhaps reflecting the ongoing risk to maternal health associated with HIV. Nevertheless, pregnancy-related deaths due to

[5] ICD-10 generally assigns HIV as the underlying cause of death in deaths which occur in HIV positive persons. In the case of known or suspected HIV positive maternal deaths, they were classified here as indirect obstetric deaths with one exception: if they would have been otherwise classified as direct obstetric deaths had they not been HIV positive they were still classified as direct obstetric deaths.

AIDS were more prevalent within 8-42 days after birth (32.6 percent) compared to at 1-7 days (13.5 percent), the reverse of what one finds among maternal deaths due to other causes. It is possible that the impact of AIDS becomes most serious after the first week following a birth. On the other hand, it could be an artifact of the coding process if the physicians certifying the deaths assumed that maternal deaths after the first week following birth were more likely due to AIDS.

Table 3 shows the distribution of maternal deaths occurring to women who gave birth by type of delivery. Over 87 percent of such deaths occurred to those having normal vaginal deliveries. Around 8 percent occurred in cases of cesarean sections. Yet since cesareans are rare – the 2003 Mozambique DHS found that just under 2 percent of all births occurred by cesarean – the risk of maternal death after a cesarean is likely to be about four times higher than that of vaginal delivery (roughly, 8 percent/2 percent).

Table 4 shows the distribution of maternal deaths and non-maternal female deaths by age. Distributions in the third column indicate that between 19 and 25 percent of maternal deaths occurred at each age group 15-19, 20-24, 25-29 and 30-34. Only 9 percent occurred at ages 35-39. In addition, the proportion of all deaths among women aged 15-49 that was due to maternal causes was highest in younger women and decreased monotonically with age (24.1 percent in 15-19 year olds compared with 0.6 percent in 45-49 year olds). The latter findings contrast sharply with the 2003 Demographic and Health Survey, which suggests far less of a decline by age in the proportion of female deaths due to maternal causes.[6]

We think our results are reasonable, as they reflect in part the proportion of women who become pregnant (and thus are at risk of death) within each age group. Since pregnancies are far less common among women in their 40s, one would expect a far lower proportion of female deaths at these ages to be due to maternal causes. Once we consider information on pregnancies by age, we can better identify the ages at which pregnant women are most likely to die from maternal causes.

The distributions on Table 5 and Figure 2 show that 45.2 percent of maternal deaths among those giving birth occurred to mothers who delivered at home, with 47.8 percent occurring at a hospital or medical facility. This latter finding is roughly comparable to findings in Table 6, which shows that almost half of all maternal deaths occurred when there was a doctor (6.4 percent) or nurse (43.3 percent) assisting with the birth. Despite the closeness of the frequencies of maternal deaths occurring at home and at medical facilities, we cannot conclude that the risk of maternal death is relatively similar in both places. To determine appropriate death rates in each area, we would need to know where women typically give birth. And even after such rates are calculated,

[6] The 2003 DHS used the sisterhood method for collecting information on maternal mortality.

there might still be questions about how to interpret the results. Since women who are ill may choose to give birth in medical facilities rather than at home, births at such facilities are likely "selected" to be those at greatest risk.

Tables 7 and 8 show care seeking prior to death for various age and sex groups. Table 7 indicates that 66.5 percent of maternal deaths were preceded by attempts at medical treatment, notably below the percentages seeking treatment prior to non-maternal female deaths at ages 15-49 (78.9 percent) and male deaths at 15-49 (75.9 percent). Table 8 indicates that for every maternal death at ages 15-49, there were seven non-maternal deaths to women at this age group. As might be expected given the causes of death involved, a higher proportion of maternal deaths took place at a health facility (37.1 percent) than for non-maternal deaths at ages 15-49 (27.8 percent).

Conclusion

A national census offers a unique opportunity to address the challenge of measuring maternal mortality and related socio-economic determinants. The advantage of a post-census mortality survey is that it can generate estimates with a high level of precision as well as data that can be disaggregated at the national and sub national levels, and by cause of death (including direct and indirect causes). The use of ICD-10-compatible lists of causes, through the standardized verbal autopsy tool, permits systematic recording, analysis, interpretation and comparison of mortality in different countries at different times.

Among highlights of the Mozambique post-census mortality survey:

About 54 percent of all maternal deaths were due to direct obstetric causes. About 19 percent were due to indirect causes related to HIV.

Based on supplemental findings from the DHS, risk of maternal mortality after cesarean is roughly four times that of vaginal birth.

Over 42 percent of all maternal deaths occur between 1 full day and 42 days after childbirth.

Maternal deaths are more likely to take place at a health facility than non-maternal deaths for women at ages 15-49.

Again, we will refine our analysis of these data once the full results of the 2007 census have been processed. The census will provide appropriate denominators for the

numerators discussed herein, allowing us to construct death rates of for various demographic and social groups.

ANNEX OF TABLES

Table 1. Distribution of Maternal Deaths Along With Number of Accidental and Late Maternal Deaths

Pregnancy Related Deaths						
Maternal Deaths						
Direct Obstetric Deaths[1]	Indirect Obstetric Deaths		Total Maternal Deaths	Accidental/ Incidental	Total Pregnancy-Related Deaths	Late Maternal Deaths
	Indirect Causes	HIV[2]				
114	58	41	213	8	221	46
53.5%	27.2%	19.2%	100.0%			

[1] Ten cases were HIV+ but the underlying cause of death was a direct obstetric death..

[2] Although ICD-10 codes exclude HIV as either a direct or indirect cause of maternal deaths, it is classified here as an indirect cause.

Table 2. Distribution of Maternal Deaths By Type of Death and Time of Death Relative to Pregnancy[1]

Time of Death	Indirect Obstetric – HIV		Indirect Obstetric - No HIV		Direct Obstetric	
	Frequency	Percent (weighted)	Frequency	Percent (weighted)	Frequency	Percent (weighted)
Total	41	100.0	58	100.0	114	100.0
No Information	2	3.1	1	2.9	6	4.2
Within 28 weeks of pregnancy	8	20.0	23	40.9	11	9.7
After 28 weeks of pregnancy	5	8.0	4	5.2	23	28.2
During or within 24 hours after delivery	0	0.0	0	0.0	3	2.7
1-7 days after birth	7	13.5	14	24.4	36	27.4
8-42 days after birth	8	32.6	11	16.9	19	15.4
During or within 24 hours after abortion	2	3.7	2	5.0	3	2.6
1-7 days following abortion	2	6.9	0	0.0	7	5.6
8-42 days after abortion	7	12.3	3	4.8	6	4.4

[1] Weighted percent distributions are for Mozambique as a whole and differ from those implied by unweighted reported deaths.

Table 2. Distribution of Maternal Deaths By Type of Death and Time of Death Relative to Pregnancy (continued)

Time of Death	Accidental/Incidental		Pregnancy Related	
	Frequency	Percent (weighted)	Frequency	Percent (weighted)
Total	8	100.0	221	100.0
No Information	0	0.0	9	3.5
Within 28 weeks of pregnancy	5	60.4	47	21.4
After 28 weeks of pregnancy	1	13.8	33	18.1
During or within 24 hours after delivery	0	0.0	3	1.4
1-7 days after birth	2	25.8	59	24.1
8-42 days after birth	0	0.0	38	18.3
During or within 24 hours after abortion	0	0.0	7	3.3
1-7 days following abortion	0	0.0	9	4.1
8-42 days after abortion	0	0.0	16	5.7

Table 3. Distribution of Maternal Deaths Among Those Who Delivered By Type of Delivery[1]

Type of Delivery	Frequency	Percent (weighted)
Total	151	100.0
Vaginal/normal	131	87.4
Suction/vacuum	2	1.8
Cesarean	13	8.0
Other	1	0.7
Don't Know	4	2.2

[1]Among 213 reported maternal deaths, only 151 delivered. Weighted percent distributions are for Mozambique as a whole and differ from those implied by unweighted reported deaths.

Table 4. Distribution of Maternal and Non-Maternal Female Deaths By Age, Percent Maternal Deaths, and DHS comparisons[1]

Age	Frequency, maternal deaths	Percent (weighted)	Frequency, non-maternal female deaths	Percent Maternal Deaths Among Female Deaths	Percent Maternal Deaths Among Female Deaths DHS 2003 [3]
Total	209 [2]	100.0	1434	12.7	18.5
15-19	38	20.3	120	24.1	23.9
20-24	44	21.8	197	18.3	11.6
25-29	54	25.3	291	15.7	20.1
30-34	46	19.1	273	14.4	21.6
35-39	18	8.9	208	8.0	18.3
40-44	8	4.4	190	4.0	17.3
45-49	1	0.3	155	0.6	16.8

[1] Weighted percent distributions are for Mozambique as a whole and differ from those implied by unweighted reported deaths.
[2] There are 213 maternal deaths. Four deaths did not fall between 15-49 years of age.
[3] Mozambique 2003 Demographic and Health Survey (report available in Portuguese). Percentages are based on 293 maternal deaths identified in the survey through the sisterhood method.

Table 5. Distribution of Maternal Deaths By Place of Delivery[1]

Place of Delivery	Frequency	Percent (weighted)
Total	151	100.0
Hospital/Clinic	86	47.8
House	54	45.2
Other	10	5.5
Don't Know	1	1.5

[1] Among 213 reported maternal deaths, only 151 delivered. Weighted percent distributions are for Mozambique as a whole and differ from those implied by unweighted reported deaths.

Table 6. Distribution of Maternal Deaths Among Those Who Delivered by Who Assisted During Delivery[1]

Who assisted with the delivery	Frequency	Percent (weighted)
Total	151	100.0
Doctor	14	6.4
Nurse	71	43.3
Midwife	19	17.3
Parent	22	16.9
Mother alone	10	8.4
Other	7	3.8
Don't Know	8	3.9

[1] Among 213 reported maternal deaths, only 151 delivered. Weighted percent distributions are for Mozambique as a whole and differ from those implied by unweighted reported deaths.

Table 7. Distribution of Maternal Deaths by Treatment Sought, Compared to Non-Maternal Deaths[1]

Population Group	Frequency	Sought or obtained any treatment for the disease	Treated at home by family members or others	Treated by visiting caregiver, community health agent	Treated by traditional healer	Treated at health center	Treatment (medicines) from pharmacy or shop
Women aged 15-49, maternal deaths	209	66.5	6.3	4.7	23.7	60.8	4.7
Women aged 15-49, non-maternal deaths	1,434	78.9	10.0	4.7	30.8	72.4	4.9
Men aged 15-49	1,810	75.9	9.5	4.0	33.1	68.6	4.1
All deaths	10,080	69.2	7.9	3.6	26.5	61.8	3.3

[1] Weighted percent distributions are for Mozambique as a whole and differ from those implied by unweighted reported deaths.

Table 8. Distribution of Maternal Deaths by Location of Death, Compared to Non-Maternal Deaths[1]

Population Group	Frequency	Total	No Information	Medical Facility	House	Other	Don't Know
Women aged 15-49, maternal deaths	209	100.0	0.0	37.1	60.5	2.4	0.0
Women aged 15-49, non-maternal deaths	1,434	100.0	0.5	27.8	68.6	3.1	0.0
Men aged 15-49	1,810	100.0	0.6	25.7	67.0	6.3	0.5
All deaths	10,080	100.0	0.9	21.2	73.9	3.8	0.1

[1] Weighted percent distributions are for Mozambique as a whole and differ from those implied by unweighted reported deaths.

Figure 1. Distribution of Maternal Deaths

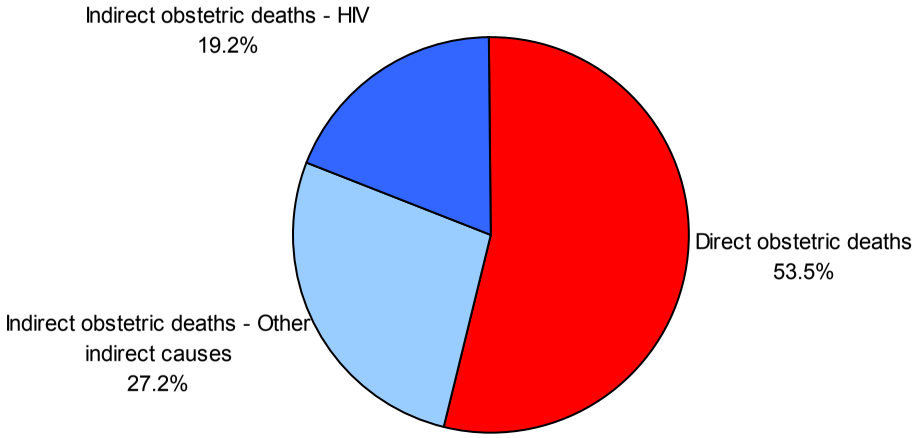

Figure 2. Distribution of Maternal Deaths by Place of Delivery (weighted)