Maternal Mortality Estimation from House-Listing Operation of National Level Surveys

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Paper presented at XXVII International Population Conference

26-31, Augusr, 2013, Busan, Republic of Korea

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Abstract

Maternal mortality remained as one of the indicators of health and development goal. Many countries lack the estimate of maternal mortality, and in some countries, estimates are not very reliable. In case of India, Sample Registration System (SRS) estimates of maternal mortality based on three year pooled data are considered reliable in comparison to other sample survey. It may be noted that, in many sample surveys, rare events are not studies as it required large sample size. However, if the operation of house-listing can be used meaningfully to identify a rare event like maternal mortality and there is a high probability that all the members of household will remember this event. It may be noted that, around 5 to 20 percent of project expenditure is devoted for this operation, and this operation should be utilized to identify maternal deaths. Number of deaths covered during house-listing operation of any large scale survey will be certainly more than SRS. This will also help to get reliable estimates at the state level especially for those high focused states, where immediate attention is required for maternal care programme in India. The causes of deaths obtained from the nationally representative sample will be much more useful than localized oral autopsy survey.

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Introduction

Maternal mortality remained as one of the indicators of health and development goal. Safe Motherhood initiative in 1987 was a response to the growing recognition that maternal health care programmes in many developing countries were not adequate (Starrs, 2006). One of the issues in many population and health conferences that are widely discussed is to find the ways and means of reduction of maternal mortality (Obaid, 2009). This has been included as one of the goal in Millennium Development Goals (MDGs 5). The target of MDG5 is to reduce maternal mortality ratio (MMR) by three-quarter from 1990 to 2012 (UN, 2000; UN, 2009). Despite increased attention to the reduction of maternal mortality, it remains difficult to assess whether the objective has been reached (Hill et al., 2001). Many developing countries do not have a reliable estimate of mortality to examine the progress over the period

(Yazbeck, 2007; Campbell, 1999). In developed countries, annual estimates of levels of maternal mortality are generally made from civil registration (Leete, 1998). However, most developing countries do not have reliable systems of civil registration in terms of birth and death registration. Situation of civil registration in many developing countries has not improved over the period. It is due to the resources constraints of the countries as well as rural people often have no incentive, and may indeed incur costs, to register a household member's death (Leete, 1998). Moreover, in the countries where death registration is complete the cause-of death certification is generally not sufficiently accurate to capture all maternal deaths. Hence, many countries lack the estimate of maternal mortality, and in some countries, estimates are not very reliable. Several efforts have been made to improve the quality of information of maternal mortality. These efforts can be divided into three main areas: mathematical model based estimates, census; and surveys.

Model-Based Estimates

Survey based indirect estimates were used when sample size was small(Graham et al., 1989). The approach is similar to the well established Brass technique for estimating child mortality from children ever born and surviving (Brass, 1975). The sisterhood method uses the proportion of adult sisters dying due to maternal causes to derive an estimate, based on a set of underlying modelling assumptions, of the lifetime risk of maternal mortality (Graham et al., 1989). Demographic and Health Surveys (DHS) and similar surveys made an efforts to estimate maternal mortality by including module of sibling history model (Graham et al., 1989; Garenne and Friedberg, 1997; Bhat 2002b; Gakidou et al, 2006). Attempts were also made to do corrections in maternal mortality estimates based on sibling history data using known biases (Gakidou et al, 2006).

Table 1: Approximate Number of Respondents for Sisterhood Method According to Level of Maternal Mortality Ratio and Desired Margin of Error

Maternal Mortality Ratio	Reported Deaths Per 1000 Respondent	Respondent Needed by Margin of Error[a]		
		(+ or -) 30%	(+ or -) 20%	(+ or -) 10%
750	45	1000	2100	8000
500	30	1500	3200	13000
250	15	3000	6400	25000

Note: [a] Assumption of crude birth rate of 40 per 1000 live births.
Source: Adopted from Table 2 in Hanley et al.,(1996)

The advantage of sisterhood method is its simplicity and sampling efficiency. However, there are a number of technical problems that limit the usefulness of the sisterhood method for programmatic purposes. The sisterhood method, using respondent aged 15-49, produces an estimate of the maternal mortality ratio that relates on average to approximately 10-12 years prior to the date of the survey and the sample size is also relatively large.

In the recent years international organization working on maternal health namely WHO, UNICEF, UNFPA and World Bank have started an initiative to give maternal deaths figure globally (UNICEF, UNFPA, WHO, 2004; WHO, UNICEF, UNFPA, World Bank, 2007; Hill et al, 2001). In order to contribute to mapping the global burden of reproductive ill-health, many of these studies conducted a systematic review of national or sub-national level estimates from developed and developing countries (WHO, 2004; Gulmezogulu et at., 2004). The main method for the estimation of maternal mortality in these models has been to use regression based on data for countries from developed and developing regions. Maternal mortality estimates obtained by the advances of methodology have improved the reliability. In the recent years based on these advances, global estimates of maternal mortality for most of the countries are made available (WHO ,2012; Lozano et al., 2011; Hogan et al.,2010). However, these estimates are useful at the national level and many countries required sub-national level estimates.

Census Based Estimates

Estimates at the sub-national level would require a large number of households and would not be cost effective. The most important advantage of using the census is to disaggregate analysis of maternal mortality, such as by sub-national region, rural-urban or household socio-economic group. The census offers a number of advantages for estimating maternal mortality over alternative measurement methods (Hill et al., 2001). In most of the countries census is planned activity. The inclusion of questions on recent household deaths, and the additional cost of identifying pregnancy related deaths will be small. On an average, the extra questions will be in less than one per cent household on timing of an adult female deaths relative to pregnancy, childbirth and the postpartum period. Thus, it will require little interviewer or data processing time. Some of the African countries used census to estimates maternal mortality, but the questions are raised about the quality of data, and in some places it is not published. As census is doing a quality check of the data it can be validated and

published so that at least within an interval of 10 years, it will be possible to get reliable maternal mortality estimates.

Survey Based Estimates

Sample surveys offer an important potential means for collecting data to estimate levels of maternal mortality in countries lacking reliable civil registration systems. A basic survey approach for collecting information about maternal death is through a retrospective enquiry about deaths in a household. In practice, there are a number of problems that limit the potential of this type of approach for estimating levels of maternal mortality. Data collected through community-based household surveys to identify maternal deaths in the household is problematic, given the relative rarity of the event. The relatively small sample size of most household surveys tends to lead to unacceptably high standard errors of estimates of levels of maternal mortality.

Table 2: Sampling Error Associated with a Survey of 5,000 Households with an Average of 4 Persons per Household at given Levels of MMR and CBR in a Population of one Million

MMR (per 100,000 live births)	CBR (per 1,000 population)	Expected Maternal Deaths (per million population)	Expected Maternal Deaths in Sample [a]	Standard Error [b]	Margin of Error (+ or -) %[c]
500	40	200	4	99	99
500	30	150	3	86	114
500	20	100	2	70	140
250	40	125	2	70	140
250	30	100	1.5	61	162
250	20	75	1	49	198

Notes: [a] Expected maternal deaths in sample= EMD*(20,000/1,000,000).
[b] Stand error = SQRT(N* (N-n)* p* (1-p)/(n-1)) where N is population, n is sample size and p is EMD/1,000,000.
[c] Margin of error = (2*SE/EMD) * 100.
Source: Adapted from Leete (1998).

Table 2 shows the expected number of maternal deaths and associated minimum margin of error that would result in a probability survey of 5,000 households with an average of 4 persons per household in a population of one million. Form this table it may be noted that if the prevailing maternal mortality ratio was 500 per 100,000 live births and the crude birth rate 40 per 1000 population the survey would be expected to get just 4 maternal deaths. The 95 percent confidence interval around this figure is plus, or minus, almost 100 per cent. In

other words random errors alone can render meaningless or very seriously distort, estimates of the maternal mortality ratio obtained by this type of survey approach.

There is an urgent need for maternal mortality data at sub-national levels in the countries where large variation in fertility and mortality exist. In case of India, National Family Health Survey(NFHS) -1 (IIPS, 1995) was the first to provide the national level estimate of MMR as 424 per 100,000 live births for the reference period of 24 months from the survey. However, state level estimates were not provided in NFHS due to small sample size for the states. Maternal mortality estimate was derived from Sample Registration System(SRS) data on sex differentials in mortality in reproductive ages by Bhat et al., (1995). Bhat (2002a) also estimated maternal mortality ratio from sisterhood method. The Office of the Registrar General of India has provided estimates of maternal mortality ratio for all India and its states. IRMS (2003) also made an attempt to estimate maternal mortality ratios in India and its states using snowball technique of data collection. However, standard error of NFHS, SRS and AHS(2013) estimates were very large. Estimates of AHS are given below:

Table 3: Maternal Mortality Ratio of Some Selected States of India, Annual Health Survey, 2013

State/	Administrative Division	Maternal Mortality Ratio	95% Confidence Interval	
			Lower limit	Upper limit
Bihar		294	272	315
	Patna	241	192	290
	Purnia	368	290	445
	Bhagalpur	317	215	419
Uttar Pradesh		300	281	318
	Lucknow	346	276	416
	Aligarh	314	216	412
	Jhansi	207	121	293

Source: Annual Health Survey, 2013(www.censusindia.gov.in/2011-common/AHSurvey.html)

In case of India, Sample Registration System (SRS) estimates of maternal mortality based on three year pooled data are considered reliable in comparison to other sample survey (NFHS and DLHS estimates have large confidence interval (SRS,2009, 2011; NFHS-1, NFHS- 2)). The numbers of SRS live births for recent estimates is 436 thousand (SRS, 2009, 2011). Number of maternal deaths are recorded in these rounds are 1110 and 926 respectively. Number of deaths is not enough to give reliable estimates for states as maternal mortality ratio has very large confidence interval. Moreover, verbal autopsy studies are sporadic, and these studies are mostly based on backward areas of India or project area of some NGOs. In the large scale surveys like National Family Health Survey (NFHS-3) and District Level Household Survey (DLHS), maternal mortality estimates are not given due to the

apprehension of getting a small number of maternal deaths. However, these surveys can be enhanced in such a manner that it will cover more deaths than SRS.

Identification of Maternal Deaths in House-listing Operation

It may be noted that large scale demographic surveys do complete census of selected Primary Sampling Unit i.e., house-listing operation for creating sampling frame for selection of households. The objective of mapping and listing operation is to ensure that all households in the PSU are covered with the list. When the sample is selected from the list of households in the dwellings, all persons in the PSU get a proper chance of being selected for the survey. In this operation, only number of households and name of the head of the household is noted. This is a massive exercise, and it is carried out in all the selected primary sampling units (PSUs). It may be noted that around 5 to 20 percent of project expenditure is devoted for this operation. This much expenditure is made only to prepare sampling frame and it is not utilized for any other purposes. The approximate budget of these large scale surveys in Indian rupees is 100 million (DLHS), and around 10 -15 million are spent on house-listing operation.

It may be noted that in many sample survey, rare events are not studied as it required large sample size. However, the operation of house-listing is to be used meaningfully to identify a rare event like maternal mortality in many surveys. This type of exercise is found quite useful in identify rare event like infertile women or female migration for work (Unisa, 1999; Reshmi, 2009). Maternal death is a rare event, and there is a high probability that all the members of the household will remember this event as it is death of a woman during pregnancy, abortion delivery or after the termination of pregnancy. Those who are doing the house-listing operation with little more training and effort can cover this event during the operation.

The collection of information on household deaths involves the identification of all household members who have died within a specified time period, as well as sex and age, in completed years of each deceased person. It is important to ensure that the period defined is long enough for sufficient numbers of events to be recorded. In case of rare event, the reference period could be extended to 24-36 months in order to increase the number of events. However, longer periods than this are likely to suffer increased omission or date displacement due to respondent recall errors. Information collected during the house listing operation on

household deaths should identify: All deaths in the household with a specified time period, and the age and sex of each deceased person. Also, the timing of an adult female by one single question such as "Was the woman pregnant, giving birth, or within two months of the end of a pregnancy or childbirth at the time of her death?"

The main investigators teams followed after the house-listing operation can collect data from the household wherever maternal death is found using oral autopsy about the timing of death and place of death along with causes. This exercise can be held along with the main survey of maternal and child health questionnaires. An example is given below to get a rough estimate of maternal deaths which can be covered in DLHS house listing operation.

In the DLHS, all the districts are covered, and from each district, 50 PSUs are selected. According to 2011 census, we have 640 districts in India. One an average number of households per PSU are 200. Hence, house-listing operation in all the districts will cover 64 million households (640*50*200). Considering average family size of five, DLHS is covering a population of thirty-two million. According to SRS 2010 estimates for all India, birth rate is 22.1 (RGI, 2011a) and maternal mortality rate is 212(RGI, 2011b). Hence, we will get around 773 thousands live births and 1650 maternal deaths per year. In case, the reference period of deaths is spread to three years then the number of deaths will be 4920. Live births during last three years can be collected in the survey like it is currently done for comprehensive nutritional survey in Maharashtra and live births can be estimated using SRS birth rates. A table showing estimated number of deaths during house-listing operation for all India and some selected states is given below:

Table 4: Estimated Maternal Deaths from House Listing Operation in Selected States of India

	No. of District	No. of PSUs (50 [a] per district)	Population (Dist.*PSUs *200*5)	Birth rate, 2010 (SRS)	Estimated live births	MMR (SRS) - 2007-2009	Estimated maternal deaths	
							During last one year	During last three years
India	640	32000	32000000	22.1	773500	212	1640	4920
Uttar Pradesh	70	3500	3500000	28.3	99050	359	356	1068
Bihar	37	1850	1850000	28.1	51985	261	136	408
Madhya Pradesh	45	2250	2250000	27.3	61425	269	165	495
Rajasthan	32	1600	1600000	26.7	42720	318	136	408

Notes: [a] No. of PSUs can vary from state to state depending upon the mortality situation.
Average number of households in PSUs is considered here as 200 and average family size as 5

Number of deaths covered during house-listing operation in DLHS will be certainly more than SRS. In case, number of maternal deaths are less than expected (less than 5% of deaths of women in reproductive ages), adjustment of completeness and age adjustment can be done by visiting households where the death of women is reported, but it is not classified as maternal death. Similar to deaths number of live birth during the specified period may be collected for the estimation of maternal mortality ratio. However, it is possible to obtain the births for all the households in the PSU during the specified period by projecting the information obtained from the selected households for the main survey purpose (See flow chart for details).

Identification of maternal deaths during house listing operation will increase the number of deaths and reduce the cost of data collection form very large number of household for estimation of maternal mortality. Moreover, one survey will give all the important indicators of maternal and child health care. It will also help to get reliable estimates at the state level especially for those high focused states where immediate attention is required for maternal care programme (Currently fourth round of DLHS survey is in progress, and NFHS 4 is expected to start with district level survey). This can also be implemented with Annual Health Survey that is carried out by the Registrar General of India in the high focused states of India.

The causes of deaths obtained from the nationally representative sample will be much more useful than localized oral autopsy surveys. Similar exercise can also be carried out in the large scale surveys especially in the DHS type of surveys in other developing countries. This will reduce the gap of non-availability of maternal mortality estimates for some of the developing countries. Information on maternal mortality will help to strengthen the health system, and it will reduce the maternal mortality substantially with better programmes.

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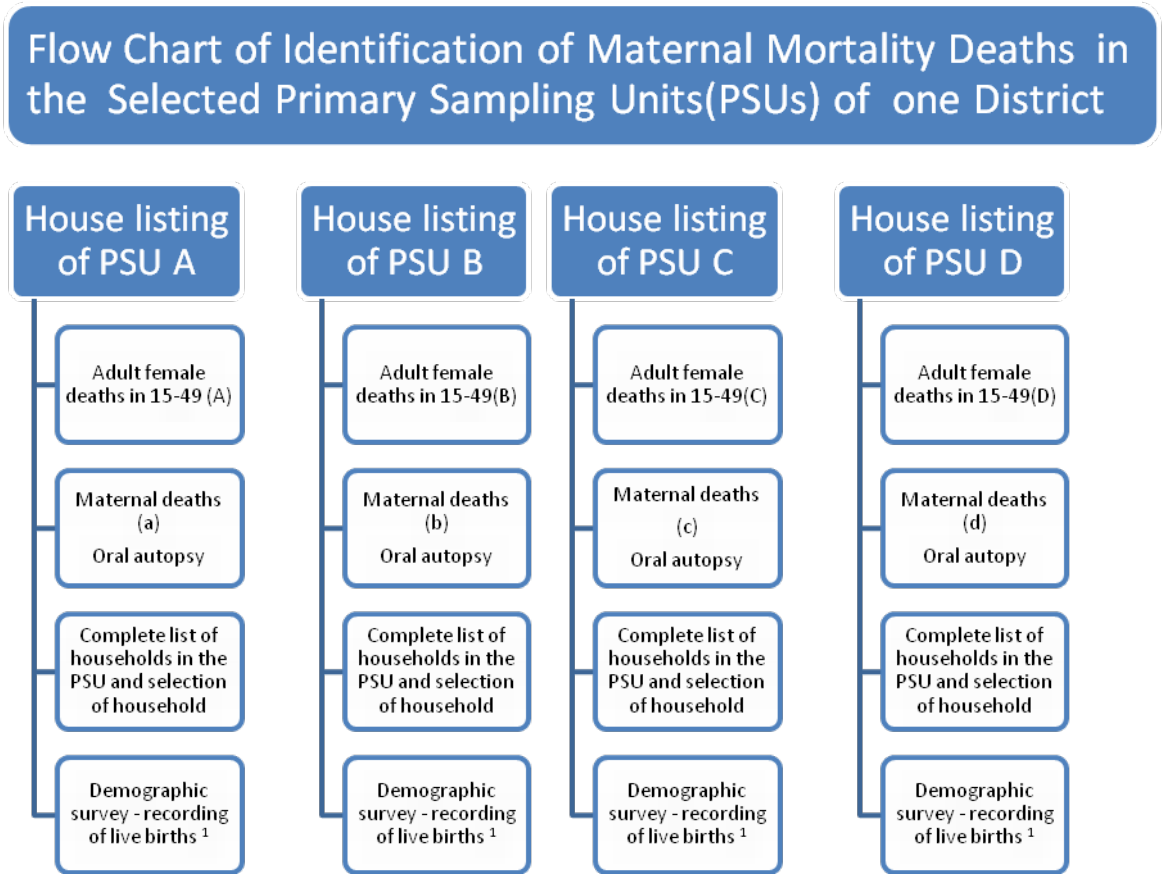
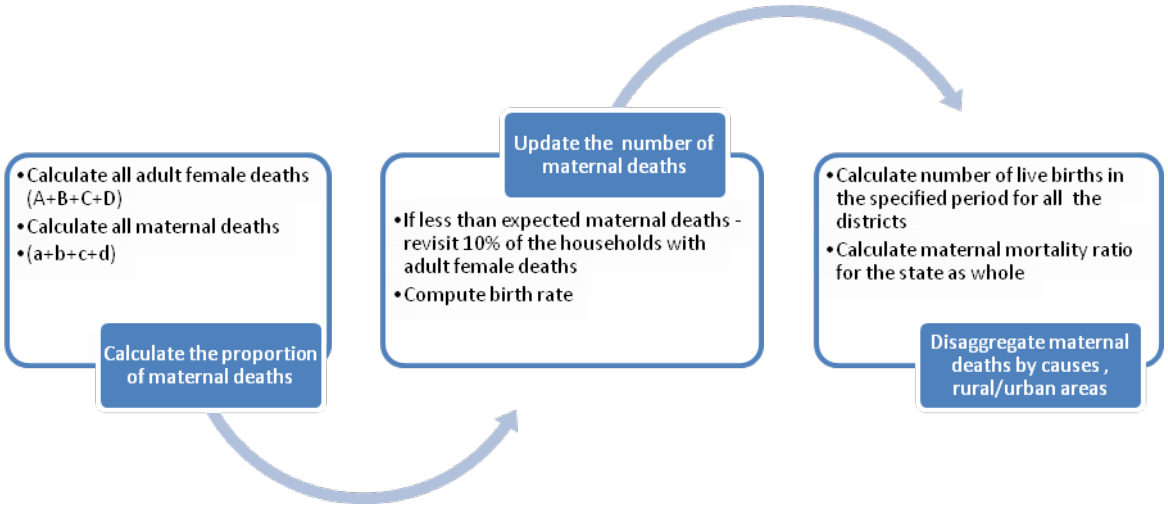


- Validation of maternal deaths and calculation of Maternal Mortality Ratio at state level



[1] Selection of the household for demographic survey will be independent of the list of households with adult deaths or maternal death. Household with maternal death may or may not be selected for the detailed demographic survey according to the specified sampling procedure. However, all households with maternal death will be visited for oral autopsy by a trained investigator in oral autopsy.