Applying the Sisterhood Method for Estimating Maternal Mortality to a Health Facility-Based Sample: A Comparison with Results from a Household-Based Sample

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Background. The sisterhood method is an indirect technique used to estimate maternal mortality in developing countries, where maternal deaths are often poorly registered in official statistics. It has been used successfully in many community-based household surveys. Because such surveys can be costly, this study investigated the suitability of using data collected in outpatient health facilities.

Methods. Adults visiting any one of 91 health centres or posts in a rural region of Nicaragua were randomly sampled and interviewed by health personnel. A sample size, proportional to the population served, was assigned to each facility and 9232 adults were interviewed. Characteristics of health facility users were compared with the general population to identify factors that would allow generalization of results to other settings.

Results. Based on these data, the lifetime risk of maternal death was 0.0144 (1 in 69). This estimate is essentially identical to that from a household-based survey in the same region 8 months earlier, which obtained a lifetime risk of 0.0145 (1 in 69). These findings correspond to a maternal mortality ratio of 241 and 243/100 000 livebirths, respectively.

Conclusions. This is the first report comparing results of the sisterhood method from household and health facility-based samples. The sisterhood method provided a robust estimate of the magnitude of maternal mortality. Results from the opportunistic health facility-based sample were virtually identical to results from the household-based study. Guidelines need to be developed for applying this low-cost and efficient approach to estimating maternal mortality in suitable opportunistic settings at subnational levels.

Keywords: maternal mortality, sisterhood method, health surveys, Nicaragua.

The call to action by the Safe Motherhood Initiative in the late 1980s stimulated a search for improved methods of estimating maternal mortality. Much has been written on the inadequacies of routine sources of information. Vital statistics often poorly register maternal deaths, and hospital data are not reliable for births and deaths that occur at home. Population-based estimates are thus a priority; however, measuring maternal mortality is not straightforward, especially at the subnational level. The comparative rarity of maternal deaths over short (1 or 2 year) intervals requires huge prospective surveys to yield reliable current estimates. Since such surveys are beyond the technical, logistic, and financial means of most developing countries, the sisterhood method was devised as a low-cost and simple alternative for estimating maternal mortality.

Since its first trial in 1987 in The Gambia, the sisterhood method has been applied in many settings and several evaluations of its reliability have been undertaken. The method provides a framework for both collection and analysis of data. Four simple questions are asked of all adults interviewed during a census or survey; these questions focus on deaths among the adult sisters of the survey respondents. Aggregate data are used to calculate the proportion of sisters dying during pregnancy, childbirth, or up to 6 weeks after the end of pregnancy (puerperium), and standard adjustment

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factors are used to convert these proportions into estimates of maternal mortality. The principal indicator obtained is the lifetime risk of maternal death (LTR), which is converted to an estimate of the maternal mortality ratio (MMR) by using the appropriate total fertility rate (TFR).

The major advantages of the sisterhood method include its minimal data requirements (four questions) and analytical simplicity, as well as its lower sample size requirements relative to other estimation procedures. Nevertheless, any data collection by household interviews involves considerable financial and personnel resources. Furthermore, home visits are not feasible in many settings. This problem is not unique to maternal mortality data collection. For child mortality estimation, a number of innovative approaches have been developed to minimize some of these difficulties. One approach is the modified clustered sample design. Another, is the Preceding Birth Technique (PBT) which takes advantage of a ‘captive’ population of women delivering in maternity wards. A drawback of such opportunistic samples is possible selection bias. In the case of the PBT, if significant proportions of women deliver outside maternity units, the resulting child mortality estimates will be biased. The issue of selectivity is somewhat different for the sisterhood method. Even though an opportunistic sample may not itself be representative of all women at risk of maternal mortality, the survey respondents’ sisters are more likely to be representative of the general population of women at risk. To test this theory, a study was carried out comparing maternal mortality estimates using the sisterhood method in a population-based household survey and in a captive population of adults attending outpatient health facilities in Region 1 of Nicaragua in July 1992.

METHODS
Region 1 is a predominantly rural, mountainous area in northern Nicaragua with approximately 450 000 inhabitants. Based on the officially registered number of maternal deaths in the region, the MMR is around 30/100 000 livebirths. However, it is widely acknowledged that maternal deaths are underreported. In 1990, the Ministry of Health estimated that the national MMR was 180/100 000 livebirths. In November 1991, a household-based survey using the sisterhood method was conducted in Region 1. Several factors suggested that this region was an appropriate site to study the reliability of opportunistic sampling. Many free or low-cost public sector health facilities were created during the 1980s, and it has a relatively high outpatient health facility-to-population ratio of 1:5000 (1:3800 in rural areas and 1:15 000 in urban areas). Theoretically, in areas with similar population densities, the higher this ratio, the better the access to health services and the more representative health facility users are of the general population.

Another advantage was that the 1992–1993 Nicaragua Reproductive Health Survey (NRHS), a national household-based survey of women of reproductive age, was underway around the same time as this health facility-based study.

Health Facility-Based Sisterhood Method Study
Sample size and study design. Using a TFR of 6.0, an estimated MMR of 230/100 000 livebirths, and a tolerated error of 15%, the estimated sample size for the health facility-based study was 8500. A target sample size of 10 000 was set to allow for incomplete interviews and other problems.

This study involved public sector health facilities operated by the Ministry of Health including ten large health centres staffed by physicians, seven smaller urban health posts, and 77 rural health posts staffed by nurses. Health centres provide a full range of ambulatory services. Health posts provide antenatal care, immunizations, child development, first aid, and treatment of malaria, tuberculosis and minor illnesses.

Each of the 26 municipalities in the region was assigned a sample size proportional to its population. Health facilities within each municipality were then assigned a sample size proportional to the size of the catchment area. Systematic sampling of adults seeking care for themselves or their children was carried out in all the health facilities for 1 or 2 weeks until the designated sample size was reached.

Questionnaire. The basic sisterhood method questions used were identical to those in the previous household-based study: 1) How many sisters have you ever had who were born to your mother and who reached the age of 15 years? 2) How many of these sisters who reached the age of 15 are still living? 3) How many of these sisters who reached the age of 15 have died? 4) How many of these dead sisters died while pregnant, in childbirth or in the 6 weeks after a pregnancy ended?

To assess the comparability of the household-based and health facility-based study populations, questions were included to evaluate the socioeconomic status of the health facility users. Because the 1991 household-based sisterhood survey did not ask this information, questions identical to those in the 1992–1993 NRHS were used.
Personnel, training and data collection. Health personnel, mostly nurses, at each facility were taught to administer the sisterhood method questionnaire during a one-day training session. Most of the interviewers were nurses, but a few were physicians or health educators. Data were collected in June and July of 1992. Three rural health posts were unattended and did not participate: two due to violence in the area and one due to staff illness. People who came to a health facility for follow-up and had previously been interviewed were not reinterviewed. Response rates were greater than 95%. Approximately 1% of the interviews were repeated by supervisors for quality control.

Analysis. Questionnaires from adults over 50 years of age were excluded from analysis for greater comparability with the NRHS which included only respondents aged 15-49. In addition, the majority of maternal deaths reported by older adults occurred many years in the past, making reports more prone to recall error and the time location for the estimate more distant. For the analysis of socioeconomic characteristics, only data from female respondents are used to increase comparability with the NRHS.

Household-Based Sisterhood Method Study. A household survey using the sisterhood method, carried out in November 1991, obtained a population-based estimate of maternal mortality for Region I. A total of 228 communities were randomly selected using probability proportional to population size. Households within each community were then randomly selected. Any adults present in the selected household at the time of the visit were interviewed. Return visits were made only if no one was home at the initial visit. Information collected during this survey was limited to the sisterhood questions.

1992–1993 NRHS

The NRHS obtained a wide variety of information from women of reproductive age and thus permitted a comparison of the general population with that of the users of health facilities sampled in this study. Field work for the NRHS took place between November 1992 and February 1993. A three-stage probability sample was designed: 1) selection of census tracts proportional to population size, 2) random selection of households in each census tract, and 3) random selection of one woman of reproductive age in each household. Although 7130 women were interviewed in the NRHS, the results presented here are only for the 692 women who lived in Region I. The response rate was 96%.

Table 1 Comparison of household-based and health facility-based sisterhood method estimates of lifetime risk and maternal mortality ratio, Region I, Nicaragua

<table>
<thead>
<tr>
<th></th>
<th>Household based</th>
<th>Health facility based</th>
</tr>
</thead>
<tbody>
<tr>
<td>Lifetime risk of maternal death</td>
<td>0.0145 (1 in 69)</td>
<td>0.0144 (1 in 69)</td>
</tr>
<tr>
<td>Maternal mortality ratio*</td>
<td>243</td>
<td>241</td>
</tr>
</tbody>
</table>

* Per 100 000 livebirths.

RESULTS

Of 9725 interviews conducted, 342 questionnaires from adults >49 years of age, and 151 questionnaires with incomplete data, were excluded. Thus, 9232 interviews were included in the final analysis.

The estimated LTR for women in Region I, obtained using information from health facility users, was 0.0144, i.e. 1 in every 69 women who reached reproductive age (defined as 15 years) died during pregnancy, childbirth or the puerperium. The corresponding MMR was 241/100 000 livebirths. These results are virtually identical to those of the household-based study (LTR = 0.0145; MMR = 243/100 000 livebirths) (Table 1).

Age-Adjusted Results

The sisterhood method obtains the overall LTR by calculating units of risk exposure for 5-year respondent age groups and then summing these risks. Differences in the age distribution of respondents from the two different data collection strategies could affect the overall estimate. Table 2 summarizes the age distributions of respondents in the two sisterhood surveys and compares them to the age distribution found in the NRHS. The NRHS sample was considered the most representative of the regional population because the interviewers were required to make repeated household visits until the selected woman was encountered. The household-based sisterhood study sample was considerably older, and the health facility-based sample was slightly younger than the NRHS sample.

Because of the differences in the age distributions of the household-based and health facility-based study populations, the results were standardized using the NRHS age distribution (Table 3). The LTR increased slightly in each of the sisterhood studies but remained essentially identical (0.0148 in the household-based study and 0.0149 in the health facility-based study).

Urban and Rural Results

The urban/rural distribution of the household-based and health facility-based study populations was similar.
TABLE 2  Selected characteristics of respondents: household-based, health facility-based and Nicaragua Reproductive Health Survey (NRHS) samples, Region I, Nicaragua

<table>
<thead>
<tr>
<th>Sisterhood method</th>
<th>Household-based study</th>
<th>Health facility-based study</th>
<th>NRHS</th>
</tr>
</thead>
<tbody>
<tr>
<td>No. of respondents</td>
<td>8745</td>
<td>9232</td>
<td>692</td>
</tr>
<tr>
<td>Age distribution (years):</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>15-29</td>
<td>50.9%</td>
<td>67.5%</td>
<td>63.7%</td>
</tr>
<tr>
<td>30-39</td>
<td>29.0%</td>
<td>23.0%</td>
<td>22.1%</td>
</tr>
<tr>
<td>40-49</td>
<td>20.1%</td>
<td>9.5%</td>
<td>4.2%</td>
</tr>
<tr>
<td>Urban/Rural:</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Urban</td>
<td>30.0%</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Rural</td>
<td>70.0%</td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

TABLE 3  Age-standardized estimates of life-time risk of maternal death, Region I, Nicaragua

<table>
<thead>
<tr>
<th>Age-standardized estimates*</th>
<th>Household-based</th>
<th>Health facility-based</th>
</tr>
</thead>
<tbody>
<tr>
<td>Overall</td>
<td>0.0148 (1 in 68)</td>
<td>0.0149 (1 in 67)</td>
</tr>
<tr>
<td>Urban</td>
<td>0.0129 (1 in 78)</td>
<td>0.0136 (1 in 74)</td>
</tr>
<tr>
<td>Rural</td>
<td>0.0156 (1 in 64)</td>
<td>0.0152 (1 in 66)</td>
</tr>
</tbody>
</table>

*Age adjustment was based on the Nicaragua Reproductive Health Survey age distribution.

(Table 2). Age-adjusted estimates were calculated separately for urban and rural areas (Table 3). The two studies obtained similar estimates for LTR in urban areas (0.0129 versus 0.0136) as well as in rural areas (0.0156 versus 0.0152). The lower LTR in urban areas is not surprising given that access to health care and family planning is generally better for women in urban areas.

Comparison of Respondent Socioeconomic Characteristics

One explanation for the similarity in the two estimates is that health facility users in Region I are, indeed, representative of the general population. To assess this possibility, selected socioeconomic characteristics of women from the health facility-based study are compared with data from the general population obtained by the NRHS.

The percentage of respondents from rural areas living in households with no piped water, no flush toilet or a dirt floor was very similar for rural health facility users compared with the rural general population as represented by the NRHS sample (Figure 1). In contrast, in urban areas, the percentage of respondents with these indicators of low socioeconomic status was strikingly higher among health facility users than among the general population (Figure 2). Despite these differences in socioeconomic status, however, the maternal mortality estimates for urban areas using the two data collection strategies were very similar.
DISCUSSION

In this study, the sisterhood method provided a robust estimate of maternal mortality comparing an opportunistic sample to a probability sample. The estimates of the LTR and MMR were virtually identical in health facility-based and household-based samples. If generalizable, this suggests that a simple survey of health service users that includes the sisterhood questions could provide an efficient and cost-effective alternative for obtaining information about maternal mortality.

These results were unexpected. Our original hypothesis was that health service users would generally receive better health care and have better health outcomes. Access to health services would be related to socioeconomic status. Health service users would tend not to include the poorest sections of the population and their sisters would also tend not to be disadvantaged and have better health outcomes. With this reasoning, data from health service users would underestimate maternal mortality. However, this was not the case in this study.

We then hypothesized that users of public health services from urban areas have a lower socioeconomic status than the general population while those from rural areas have a higher socioeconomic status. Estimates of maternal mortality would be higher for health facility users in urban areas than for the general population, while estimates from rural areas would be lower. Could these two biases be cancelling each other out? This was not the case because both studies obtained similar estimates for the rural and urban subsamples.

Another explanation for the findings is that the two study samples were, in fact, very similar. Since access to health facilities is good for much of the population in Region I, the possibility existed that health service users were representative of the general population.

The age distribution of the two study samples was, indeed, very different. This was due to two factors. 1) The health service users were younger than the household-based study population. Demand for public health services is highest during periods of greater fertility when women are younger. They use health services for antenatal care and bring their children for routine monitoring and immunization. 2) The household-based sample was older than the general population. Although households were randomly selected, only those adults present at the time of the visit were interviewed. Generally, adults who stay at home are those who are not employed or do not go to school and thus tend to be older than the general population. Nevertheless, even when the results were standardized for age, the estimates remained virtually identical.

The similarity of the general population and health facility-based population was also assessed using general indicators of socioeconomic status. Rural health service users were similar to the general rural population but in urban areas, health service users had a lower socioeconomic status than the general population. This finding is supported by data from the NRHS which showed that a high percentage of both urban and rural respondents had ever used public health services (92 versus 94%), but that a much higher percentage of urban respondents had ever used private health services (42 versus 22%). The increased access to and use of private health services in urban areas would almost certainly be limited to those with greater financial means, since these services are much more expensive than public health services.

Urban dwellers also tend to have much greater disparities in socioeconomic status and fertility than rural dwellers. Fertility, an important indicator of health facility utilization, is higher among women with a lower socioeconomic status. To the extent that fertility drives health service utilization, this would explain some of the differences found in the socioeconomic status among urban users. In contrast, in rural areas, fertility is high among all groups and socioeconomic status is more homogeneous.

However, despite differences between urban health facility users and the general urban population, the sisterhood method produced similar estimates for maternal mortality from both groups of respondents leading us to conclude that, in this setting, the sisterhood method was robust and provided similar results using two different sampling techniques. Maternal mortality information from the sisterhood method is based on the experiences of respondents' sisters and not the respondents themselves. Respondents' sisters appear to be more representative of the general population than are the respondents.

How applicable are these conclusions to other locations within Nicaragua and in other countries? It is reasonable to suggest that this methodology would be useful in locations with access to health facilities and utilization rates similar to those in Region I. Further studies are necessary to assess the validity of this approach in other situations with less access, lower utilization, and greater differences between health service users and the general population. The key question is at what point are differences between health service users and the general population so great that estimates of maternal mortality from the former are no longer representative of the latter.

Limitations of the sisterhood method should be considered before using it to estimate maternal mortality.
The most important limitation is that this method estimates maternal mortality for a period about 10–12 years before the study and therefore is not appropriate for assessing the immediate effect of interventions to lower maternal mortality. Similarly, estimates from the sisterhood method cannot be extrapolated to the present in countries with recent rapid changes in the population's health, especially in fertility or in health services to reduce maternal mortality. However, if the sample size is large enough, a trend over time can be obtained by analysing data for specific age groups.

Despite these disadvantages, in many places where maternal mortality surveillance is inadequate, no alternative currently exists for collecting population-based information on maternal mortality, and the advantages outweigh the disadvantages. Health facility-based studies using the sisterhood method may be the only feasible way to estimate maternal mortality in many areas, especially at subnational levels. In the majority of developing countries, officially reported maternal deaths are relatively rare events over a short period and thus are usually reported only at a national level, if at all. However, there may be large regional differences in maternal mortality within a country, depending on access to and quality of emergency obstetric services, cultural differences among the population, etc. Surveillance and reporting of maternal deaths is often most deficient and maternal mortality most underestimated in the very areas where rates are highest and where resources are most needed. The possibility of obtaining reliable and inexpensive subnational estimates would allow health planners to prioritize maternal health programmes in areas where the problem of maternal mortality is greatest.

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