

House-to-house survey vs. snowball technique for capturing maternal deaths in India: A search for a cost-effective method

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Background & objectives: Estimation of maternal mortality has been difficult because of large sample size requirement. A study using snowball technique for identification of households where maternal death has taken place and its related causes was conducted. We present here the feasibility of carrying out the snowball technique for capturing maternal deaths as against house-to-house survey and to obtain the estimates of maternal mortality ratio (MMR) in some selected States of India.

Methods: Five states representing high MMR (Uttar Pradesh), medium MMR (Maharashtra, Karnataka, Uttranchal) and low MMR (Delhi) were selected. A total of 8 PHCs and 3 (UFS) were covered. Study used both house-to-house survey and snowball technique to enumerate the maternal deaths in the selected PHCs in rural area and urban frame survey (UFS) in urban area.

Results: In all, 94 maternal deaths were captured through snowball technique as against 83 through house-to-house survey. The estimate of MMR for the five States combined was 356 per 100,000 live births, as compared to assumed 400 per 100,000 live births for the country as a whole. The relative standard error of the estimate of MMR was about 10 per cent.

Interpretation & conclusion: Snowball technique captured more maternal deaths than those in house-to-house survey particularly in rural areas. The estimates also indicated the feasibility of replicating the proposed methodology for estimation of MMR as a time and cost-effective methodology.

Key words House-to-house survey - live births - maternal death - snowball sampling

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In developing countries including India, reduction in maternal mortality has been the key developmental goal for monitoring the progress of reproductive and child health in the population. The need of setting such goals has been discussed and documented in various national and international deliberations¹⁻⁷. However, concerns are shown about the availability of reliable data on this aspect. It is said that maternal deaths are crucial but complex to measure both for conceptual and practical reasons. Though the Office of the Registrar General of India (through sample registration system, SRS) has provided estimates of the maternal mortality ratio (MMR) for India and its States^{8,9}. These estimates have large standard errors and for some States, the estimates are not reliable because of the inadequate sample size. As such, household surveys using direct estimation are expensive and complex to implement because large sample sizes are needed to provide a statistically reliable estimate. Estimation of MMR at national level has always been an issue due to large sample size and huge cost involved. In this context, the Ministry of Health & Family Welfare (MOHFW), Government of India, has commissioned the National Institute of Medical Statistics (ICMR), New Delhi, to conduct a pilot study to estimate the maternal mortality ratio in five selected States, which were representative of high, moderate and low maternal mortality. The study was conducted in 2003. House-to-house survey was conducted to enumerate live births and maternal deaths. Snowball sampling was adopted for capturing maternal deaths in addition to house-to-house survey. Snowball sampling is a non probability method and may be used when the desired sample characteristic is rare, *i.e.*, when it is extremely difficult or cost-prohibitive to locate respondents in the study population such as maternal deaths. This technique involves first to identify the key informants in the study population, then the first subject is identified through key informant who gives the names of the another subject, who in turn provides the name of third, and so on¹⁰. Snowball sampling relies on referrals from initial subjects to generate additional subjects. This technique can be used for the populations such as criminals,

prostitutes¹¹, drug users¹²⁻¹⁴ and people with unusual or stigmatized conditions (*e.g.*, AIDS patients)¹⁵. While this technique can dramatically lower search costs, it comes at the expense of introducing bias because the technique itself reduces the likelihood that the sample will represent a good cross-section from the population. The snowball technique is advantageous over the house-to-house survey as the latter is associated with a largely quantitative tradition of measuring the rare event that often suffers from a lack of responses from the particular rare event such as maternal death in this study, whereas snowball sampling involves in locating the household with the rare event through key informant approach. Therefore, snowball sampling has been found to be economical, efficient and effective^{12,16}.

This pilot study was conducted to estimate the MMR at the national and State level along with major causes of such deaths. It was also proposed to use snowball sampling technique for rare event like maternal deaths as a cost-effective tool to estimate MMR in the population. We present here the feasibility of carrying out the snowball sampling for capturing maternal deaths as against house-to-house survey and to obtain the estimates of MMR in some selected States of India.

Material & Methods

In order to provide the estimate of MMR at national and State level, there was a need to set up the required sample size, approach for enumeration and the instruments for the survey. For sample size, assuming the estimate of the MMR as 400 per hundred thousand live births⁸, a sample of 3.8 lakhs live births was required to provide an estimate of MMR at all India level with 95 per cent confidence level, 10 per cent margin of error and a design effect of 2 for the cluster sampling. Assuming birth rate of 28.5 per thousand population, this would amount to covering about 0.19 million population. In India, there is a uniform chain of primary health centres (PHC) in rural area and Health Centre (HC) or Urban Health Post (UHP) to

cater the service need of every 30,000 population in the country, which over time has experienced the local population growth and thereby contained a population more than 30000. The estimated population is converted into number of PHC/HC which was considered as the primary sampling unit. All the households covered under the PHCs were enumerated under the assumption that the design effect would be bare minimum.

House-to-house survey was conducted to enumerate the number of live births and maternal deaths. In addition, snowball technique was used for the completeness of maternal deaths.

A pilot study was conducted in five selected States representing high MMR (Uttar Pradesh), medium MMR (Maharashtra, Karnataka and Uttaranchal now Uttarakhand) and low level of MMR (Delhi). One district each was selected in the States of UP, Karnataka, Maharashtra and Uttaranchal and from the selected district, two PHCs were selected randomly. Further, three urban-frame-sample (UFS), one each in the States of Delhi, Karnataka and Uttar Pradesh were randomly selected. Hence, in total, 8 PHCs and 3 UFS were covered in the survey.

Two sets of instruments, one for house-to-house survey and another for snowballing was developed to identify the households where maternal deaths have taken place in the last three years preceding the survey between 1 April 2000 to 31 March 2003. In addition, a verbal autopsy schedule was developed¹⁷ to collect information on maternal death from the respondent available in the house as husband or the other members of the family. While a trained field investigator administered verbal autopsy instrument, a gynaecologist assigned the causes of maternal deaths based on the information collected through verbal autopsy.

Two independent approaches, one house-to-house survey and another snowballing were employed. The

house-to-house survey was conducted by visiting each and every household to enumerate live births and maternal deaths in the study population. The snowball sampling was employed by identifying the key informants like *Basti Sevika* in Delhi and auxiliary nurse midwife (ANM), *Dai* and *Sarpunch* in rural areas. They were asked to identify the houses where a maternal death had occurred. The first household was contacted and the respondent of that house was asked to provide the name of the other household where the similar event had taken place and so on. Thus, the list of maternal deaths in the study area was prepared and updated by cross-verification.

Two independent teams were formed to carry out the survey under the two approaches. The former team consisting of 6 field investigators and one field supervisor was employed to conduct the house-to-house survey. To start with, the selected PHCs were visited and the records available at PHCs were reviewed by this team for the collection of data on live births and maternal deaths. The information collected from PHC was used to make sure that all the births and deaths recorded in the records of the PHC were covered. The second team consisting of one field investigator and one field supervisor conducted snowball sampling. The team identified key informants such as *dai*, teacher, *sarpanch*, etc., to collect information on maternal deaths. The identification of maternal deaths obtained through house-to-house survey was matched with the identified maternal deaths by snowball technique for duplication and omission of maternal deaths. Then the field supervisor conducted the verbal autopsy for all the maternal deaths reported in that PHC area. The gynaecologist assigned the cause of death based on the verbal autopsy.

Results & Discussion

Two approaches were employed to collect data on maternal deaths in the catchment's area of 8 PHCs

3 urban health centres enumerating 26416 births from 92670 households in the population of 371480. The snowball technique enumerated 94 maternal deaths as against only 83 under the house-to-house survey (Table I).

In order to draw statistical significance, McNemar test has been used to see the change in the response due to snowball sampling and house-to-house survey. The test provides number of matched pairs of maternal deaths obtained through snowball sampling and house-to-house survey. There were 83 maternal deaths, which were common by two procedures. Also, snowballing identified all the maternal deaths, which were missed in house-to-house survey. The value of McNemar's χ^2 statistic was 9.1 ($P < 0.01$) and the value of the relative difference was 1

indicating that the maternal deaths which were missed under house-to-house survey, were all captured by snowball technique. The analysis revealed that house-to-house survey might be resulting in under-enumeration of maternal deaths as compared to snowballing and such omissions were over 10 per cent. It indicates that the information on maternal deaths was not revealed by some households for fear or otherwise while the key informants have reported the maternal deaths. Hence, the snowball technique may be considered more appropriate especially in rural areas for capturing the maternal deaths and could be used as an effective methodology for enumerating maternal deaths.

The house-to-house survey was completed in 15 days with 7 field staff resulting into 105 man-days per PHC. In case of snowballing, only two field staff completed the enumeration of maternal deaths in seven days, *i.e.*, 14 man-days per PHC. Therefore, the ratio was 1:7. It indicates that snowball technique is cost-effective over the house-to-house survey.

Although the sample covered in the survey was below the size required for estimating the maternal mortality ratio in the population, it was proposed to provide the estimates of MMR based on a pilot survey along with its standard error and confidence interval for the selected States and for all the States combined (Table II). The standard errors are calculated on the

Table I. Maternal deaths recorded by snowballing vs house-to-house survey

State	Maternal deaths	
	Snowballing	House-to-house
Uttar Pradesh	57	51
Uttaranchal	13	11
Maharashtra	10	10
Karnataka	9	7
Delhi (slum)	5	4
Total	94	83

Table II. Estimates of maternal mortality ratio based on a pilot survey

State	Population covered	Maternal deaths (for 3 yr)	Births (for 3 yr)	Birth rate (per 1000/yr)	MMR per 100,000 live births	SE (maternal deaths)	Relative precision (MMR) (%)	95% CI	
								Lower	Upper
Uttar Pradesh	104495	57	9514	30	599	79	13.2	444	754
Uttaranchal	74547	13	4377	20	297	82	27.6	136	458
Maharashtra	80928	10	5466	22	183	58	31.6	70	296
Karnataka	71744	9	4152	19	217	72	33.3	76	358
Delhi (slum)	39766	5	2907	24	172	77	44.7	21	323
Total	371480	94	26416	24	356	37	10.3	284	428

basis of proportion for simple random sampling. The estimate of MMR for the selected States as a whole was 356 per 100,000 live births, which was comparable with 400 per 100,000 live births for the whole country¹⁸. The relative standard error of the estimate of MMR is also 10 per cent as assumed. The estimate of 599 maternal deaths for Uttar Pradesh is also comparable. The relative standard error for the States covered ranged between 28-45 per cent except for Delhi, which may be lower when more population will be covered. These estimates indicated the feasibility of the proposed methodology.

The main causes of maternal deaths included post-partum haemorrhage (PPH) (17%) followed by post partum septicaemia (13%) and anaemia (12%). There were some maternal deaths due to retained placenta (8%) and non-obstetric reasons (9%) (Fig).

The details on socio-economic variables and obstetric profile of the maternal deaths were ascertained in the verbal autopsy schedule. Majority of the maternal deaths enumerated from the survey

belonged to low socio-economic households, occupation as housewives, illiterate, and more than one-third belonged to either schedule caste or schedule tribe.

About half of the maternal deaths occurred in women below age 25 yr, of which 40 per cent were of parity one or two and about one quarter died during antenatal stage¹⁸. About half of these delivered at home and 45 per cent of these deliveries were conducted by untrained *dais*. In more than 50 per cent of deaths, the health facilities were 4-5 km away from home; women could not reach health facility because of inadequate transport facility. About 15 per cent of maternal deaths occurred on the way to health facility. In the hilly areas of Uttaranchal, for some villages health facility was as far as above 20 km away and there was no transport facility available in the village. About one-third of women who died, did not receive antenatal care and tetanus toxoid (TT) and a large percentage (47%) did not consume iron folic tablet during ante-partum period. About 59 per cent woman stayed in the hospital for one to two days before the death indicating that after the delivery woman suffered complications and rushed to

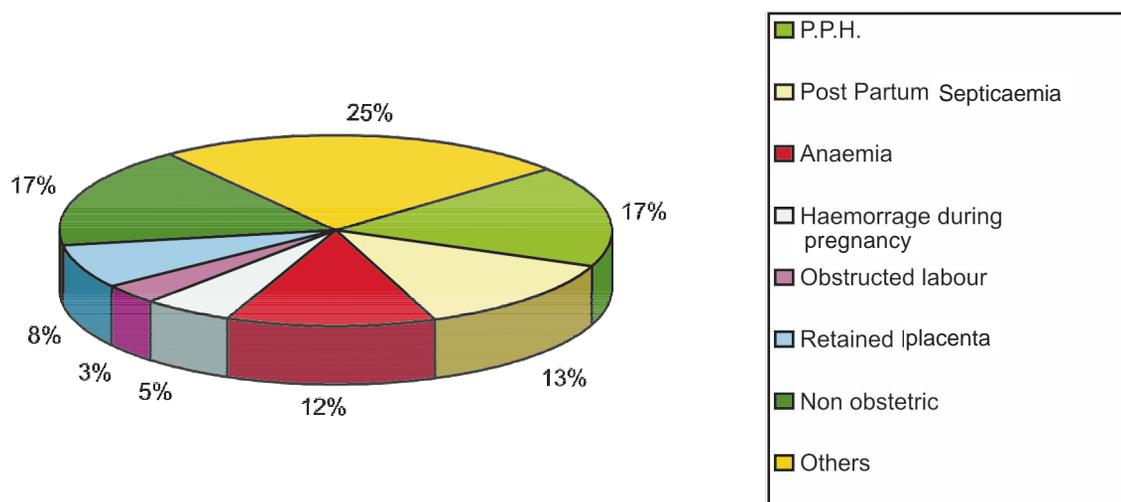


Fig. Causes of maternal deaths.

the hospital. It was observed that among home deliveries (47%) about one third had haemorrhage after the delivery and they died either on the way or at hospital within 24 h, indicating higher institutional deaths. About one fourth of the maternal deaths were found to be during antenatal period, about 70 per cent in postnatal period and 7 per cent were found to be during delivery¹⁸.

In conclusion, our study shows that snowball technique for capturing maternal deaths is feasible, rapid, cost-effective and better as compared to house-to-house survey particularly in rural areas. It captured all maternal deaths, which were missed in the house-to-house survey. The majority of maternal deaths occurred to women who were relatively young and during their first or second delivery.

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