ORIGINAL ARTICLE

Estimates of Maternal Mortality Ratio and the associated medical causes in Orissa and Rajasthan States - A cross sectional study

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Abstract

Background: Maternal Mortality Ratio (MMR) is an important indicator of reproductive health and its reduction remains a challenge in India. **Aims & Objective:** To estimate MMR in two states, Orissa and Rajasthan having high MMR as well as to identify the associated medical causes of maternal mortality. **Material Methods:** This survey was conducted from October 2010-June 2012 on a sample of 13 Primary Health Centres (PHCs) in Orissa and 15 PHCs in Rajasthan. These numbers have been derived after estimating the total number of live births using MMR and birth rate from Sample Registration System. 1997-2003.An adapted snowball technique was adopted wherein maternal deaths were captured by snowball technique and the numbers of live births were taken from the available records from the various health facilities in the study. **Results**: The overall birth rate in Orissa was found to be 19 per 1000 population while in Rajasthan it was 24 per 1000 population. The study revealed that 17% additional maternal deaths could be captured by snowball technique as against the official record. The overall weighted estimate of MMR was 252 per one lakh live births (95% CI: 246-259 per 1,00,000 live births) in Orissa and 209 per one lakh live births (95% CI: 207-211 per one lakh live births) in Rajasthan. The main causes of maternal deaths were post-partum haemorrhage, anaemia and septicaemia. More than 25% maternal deaths could be attributed to indirect causes including suicide, accident and infectious diseases. **Conclusion**: There appears to be a positive trend towards reduction of maternal mortality in Orissa and Rajasthan. Greater care is essential to reduce medical as well as incidental causes of death during pregnancy.

Introduction

Maternal mortality ratio is an important indicator of the nation's reproductive health. Though India has made an appreciable progress in improving its overall health status yet reduction in the maternal mortality ratio (MMR) is far from the goal set by the Millennium Development Goals (MDG) of 109 per one lakh live births by 20151, (2). As per sample registration system, GOI during 2007-2009, a fall of 42 points or 17 % decline was found3 and it has further declined to 178 as per the latest results of SRS 4 As expected, the decline in MMR has been significant in Empowered Action Group of States and Assam from 375 to 308, a fall of 18 per cent according to recent Annual Health Survey (AHS) conducted by RG Office, Government of India (4). There has been reported 4.7% annual decline in MMR (5,6,7) and 3.5% annual increase in skilled birth attendance since 1990. (4) In order to meet the United Nations' Millennium Development Goal (MDG), India's needs to achieve the MMR of 109 by

2015, a feat already achieved by Kerala, Tamil Nadu and Maharashtra. Four other states - Andhra Pradesh, West Bengal, Gujarat and Haryana – are close to the MDG target (4).

During 2007 the snowball technique was successfully evolved by us for capturing maternal deaths in five states8. Based on the findings of the study it was found that total number of births during last three years together amounted to one-third of households reporting births when applied snowball technique. The snowballing of recorded births thus amounted doing house-to-house survey (9). During 2005-2006 application of snowball technique was replicated in Gujarat state by Population Research Centre, Baroda, and Gujarat but due to improper implementation state level estimate could not be generated, however indirect estimates have been projected. (10)

For replication of snowball sampling, a study was approved by ICMR Taskforce to estimate the level of MMR in Orissa and Rajasthan using adapted snowball technique wherein maternal deaths were captured by the snowball technique described earlier (8) while the number of live births was enumerated from the records of the system. This would save the time for data collection on births as well as economical. Because of high MMR in Orissa and Rajasthan, these two states were selected for the study.

Aims & Objectives

This manuscript presents the findings of the study for level of maternal mortality ratio in Orissa and Rajasthan states and the associated causes of maternal deaths using adapted snowball technique. This may be useful to policy managers to fill up the gap in the knowledge and to redefine strategies to attain the target set under MDG-5 by 2015.

Material and Methods

Sample Size: A cross sectional study was designed to estimate the levels of maternal mortality ratio and its associated causes of maternal deaths in two states Orissa and Rajasthan. A sample of 13 Primary Health Centre (PHC) in Orissa and 17 PHCs in Rajasthan were worked out with 95% level of confidence and 15% margin of error. At the first stage number of live births was estimated, assuming 24.3 & 31.4 per thousand population respectively in Orissa and Rajasthan State and then using the available levels of MMR 358 /100,000 in Orissa and 445/1,00,000 in Rajasthan11 the total population was estimated. In

India, there is a uniform chain of primary health centres (PHC) 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 was converted into number of PHCs/CHCs which were considered as the primary sampling unit.

Sampling Design: Cluster sampling was adopted for the selection of PHC, PHC being the cluster in rural area in each State. Five districts namely Bharatpur, Jaipur, Jodhpur, Kota, and Udaipur from Rajasthan state were selected randomly from North, South, East, West and Centre Zone. The Number of PHCs was allocated proportionally in each of the selected districts. From each of the selected district, required number of PHCs was selected through systematic random sampling as the frame for selection of PHCs was available. Similarly in Orissa state three districts namely Koraput, Sambalpur and Puri were selected randomly from southern, western and coastal zone. PHCs were allocated proportionally in the selected districts. The required numbers of PHCs were selected by systematic random sampling as the frame was also available in Orissa state. Snowball technique was adopted to capture the maternal deaths in the catchment areas of selected PHCs and the number of live births was ascertained from the available records from PHC/SC/ Aganwari workers.

Predesigned questionnaires were used for collecting the information on number of live births and maternal deaths from the record of the PHCS while details of the maternal deaths were collected through verbal autopsy questionnaire. The respondents for verbal autopsy were either husband of the deceased or any other adult member of the household. The causes of maternal deaths were ascertained by a Gynaecologist. The reference period of the study was April to March three years preceding the survey. The survey was conducted during October 2010 to June 2012. The data was collected by the SRF and monitored by the Principal investigator for correctness of the data. The study was approved by the Institutional Ethic Committee of the National Institute of Medical Statistics, ICMR. Consent was taken from the sarpunch for the community in the village. The set definition for estimation of birth rate and maternal mortality ratio were used. The study is registered in CTRI with CTRI number as ctri/2012/09/003029

Methodology for Data Collection: One SRF was appointed to collect the data in the selected PHCs in both the states. To implement the snowball technique first the SRF along with the Principal Investigator met the CMO in the district Headquarter. After the discussion about the study and snowball technique all the available records were examine and the information on births and maternal deaths were collected. The letters to Medical officer were sent to the respective medical officers of the selected PHC. Then the SRF visited the selected PHCs and sub centre to collect the information from their records and update the collected information.

To implement the snowball technique for capturing the maternal deaths the key informants like surpanch, Aganwari worker or ANM were contacted to prepare the list of all maternal deaths occurred in their area during the reference period. The detailed information of the maternal deaths was collected by visiting the particular household of the maternal deaths. Verbal autopsy was conducted to collect the information on maternal death and complete story for the death was recorded to ascertain the medical cause of the death by the Gynaecologist from AIIMS, New Delhi.

Methodology for developing weights and Estimates of Maternal Mortality Ratio.

Let P_{ij} i= 1to 3 , j= 1to 3 denotes the population of ith district in the jth region of Orissa state.

Let p_{ij} i= 1to 3 , j= 1to 3 denotes the population covered in the ith district in the jth region of Orissa state

Let b_{ij} i= 1to 3 , j= 1to 3 denotes the number of births covered in the ith district in the jth region of Orissa state

Let m_{ij} i= 1to 3 , j= 1to 3 denotes the number of maternal deaths covered in the ith district in the jth region of Orissa state

Weight for estimating the number of births in the ith district in the jth region is given as

W_{bij} =

Estimated number of births (B_{ij}) in the jth region of the ith district is given as

$b_{ij} \times W_{bij}$ i= 1 to 3, j = 1 to 3

Total Number of births (B) in Orissa State $= \sum_{(i,j=1)}^{(i,j=3)} \llbracket b_{ij} \times W_{bij} \rrbracket$

Weight for estimating the number of maternal deaths (M_{ij}) in the ith district in the jth region is given as

W_{mij} =

Estimated number of maternal deaths in the jth region of the ith district is given as

$m_{ij} \times W_{mij}$ i= 1 to 3, j = 1 to 3

Total Number of maternal deaths (MD) in Orissa State $= \sum_{(i,j=1)}^{(i,j=3)} \llbracket m_{ij} \times W_{mij} \rrbracket$

Estimated MMR in Orissa state = X 1,00,000

Similarly for Rajasthan where five districts from four regions were covered has been calculated.

Results

A total of 344289 populations in Orissa and 490488 populations in Rajasthan were covered from the selected PHCs. The overall birth rate in Orissa was estimated as 19 per 1000 populations while in Rajasthan it was 24 per 10000 population. The study found 52 maternal deaths in Orissa and 77 maternal deaths in Rajasthan during the reference period. Snowball technique captures 17% additional maternal deaths as compared to the official record Table 1.

The detailed information of the identified maternal deaths was collected through verbal autopsy schedule developed as a part of Causes of Death study (ICMR, 2004, Singh *et al* 2007)8. The socio economic characteristics of maternal deaths are presented in Table 2.

The respondent of the deceased were either husband or any other adult member present at the time of the survey. It was observed that about 44% in Rajasthan and 81% in Orissa the respondents were husband.

The overall MMR for Orissa was estimated as 252 (95% CI: 246-259) and in Rajasthan as 209 (95% CI: 207-211). These estimates were developed by applying proper weights to obtain the number of births as well as maternal deaths. Table 3A & 3B.

The main causes of maternal deaths in Orissa were found to be PPH (24%), anemia (14.3%) and abortion (7.1%) while in Rajasthan causes were PPH (32.7%), anemia (12.7 %) and followed by Septicemia (9.1%). The indirect or non-obstructed causes of maternal deaths were about 33% in Orissa and 27% in Rajasthan. Among the non-obstetric reasons of maternal deaths were viral hepatitis, TB, suicide, road accident and heart diseases. (Table 4)

Discussion

This study was conducted during 2010-2012 two states Orissa and Rajasthan, both having high MMR.

The study aimed to estimate the level of maternal mortality ratio and its associated medical cause of maternal deaths in these two states using adapted snowball technique wherein the numbers of live births were collected from the various records of PHCs, sub centres, Anganwari workers and from record of ASHA while the maternal deaths were detected via snowball technique in the selected PHC area. The study found that the maternal deaths which were missed in the records were also captured by snowball technique while interviewing the key informants like ANMs & ASHAs in the village.

Our study found the level of MMR in Orissa to be in between the levels reported by AHS and SRS. When compared statistically, the difference between the estimate was non-significant with overlapping confidence interval. It indicates that our estimate of MMR in Orissa though on smaller sample is reliable having small standard error of about 1% or 3 maternal deaths per one lakh live births. This shows that our estimates are closed to the Government estimates.

Similarly our study found the level of MMR in Rajasthan to be lower when compared with AHS and SRS. (3,11)   We obtained a narrow 95% CI as compared to SRS or AHS. A reduction of about 11% in MMR was found in Rajasthan as compared to SRS findings. Government of India has already observed a decline of 17% in 2004-2006 (2,11,12,13). A further decline indicates a good move to attain the goal of MDG5.

While the Sisterhood method (14) is an alternative indirect method for estimating the maternal mortality ratio where there is high fertility and mortality rate. In our country, the sisterhood method was used by Mari Bhat (1995) to provide levels and differentials in maternal mortality in Rural India when the MMR rates were high   Further Mari Bhat (2002) updated these estimates for India and its major states for the period 1987-9615-16. These indirect methods used for estimating maternal mortality ratio have their own limitations. The direct estimation methods are always prefer to used for policy decision though expensive in terms of cost and time.   Further direct estimates could provide 95% CI. Therefore, our study is based on the direct method of estimation.

The probable cause of lower estimates of MMR in Rajasthan found from the study may be due to increase in institutional deliveries with the implementation of JSY in the State.17-18 It was observed during the survey that certain PHCs in both the states have 100% institutional deliveries thereby safe guarding the life of the women As per the special bulletin on maternal mortality of sample registration system (SRS) 2007-2009, three states have already realized the MDG target while other two Tamil Nadu and Maharashtra are the new entrants. (4)

The Millennium Development Goals report of 2011 indicates that improvement in the past two decades was also due to the proportion of deliveries attended by skilled health personnel in developing regions rising from 55 per cent in 1990 to 65 per cent in 2009. It seems that Government of India's policy shift from home delivery conducted by traditional birth attendants to universal professional skilled births attendance is effective. (19)

The findings of this study suggest that Rajasthan which is one of the EAG state is improving and soon will be a part of target met group.

The lower estimates of MMR   indicate an improvement in reduction of maternal deaths. This progress may be due to the implementation of JSY published by Lim *et al* has suggested the program is having a significant impact on perinatal and neonatal health (18, 19) During September 2011 GOI has implemented Janani Shishu Sureshka Karyakara (JSSK) scheme   in Rajasthan20 by providing additional facility of complete reimbursement of transport. In addition all the investigations required to the beneficiaries are also free of charge. Food under KALEVA YOGNA is also provided to institutional deliveries.   Due to these schemes although the number of deliveries is increasing but it has a direct impact on the reduction of maternal deaths. Efforts may be made to avert these maternal deaths.

Our study found the major causes of maternal deaths as PPH 24% in Orissa vs. 33% in Rajasthan), Septicaemia (4.8% in Orissa vs. 9.1% in Rajasthan) and anaemia (14.3% in Orissa and 12.7% in Rajasthan) followed by abortion and hypertensive disorders. The data, particularly those of PPH and septicaemia, are comparable to those reported elsewhere (6, 9,21-22). However, as per the report of the sample registration system (SRS), haemorrhage has been reported to be 38%, which is higher than our estimates in both the states (13). About 30% of maternal deaths in our study are caused by non-obstetric causes which are higher than the recent study reported by Montogomary6 as 17%. This may

be due to the variation while recording the narration by the investigators. Based on the narration the cause of maternal deaths was assigned as indirect cause by the Gynaecologist. This shows that the first step for avoiding these 30% maternal deaths is to ensure that proper care to be provided to pregnant women to safe guard their lives.

Hence, there appears to be a positive trend towards reduction of maternal mortality in Orissa and Rajasthan. Greater care is essential to reduce medical as well as incidental causes of death during pregnancy.

Conclusion

The overall weighted estimate of MMR was 252 per one lakh live births (95% CI: 246-259 per 1,00,000 live births) in Orissa and 209 per one lakh live births (95% CI: 207-211 per one lakh live births) in Rajasthan. There is a reduction in maternal mortality ratio. More than 25% of maternal deaths due to non-obstructed reasons could be averted or saved the life of mothers.

Recommendation

It is recommended that the importance of safe delivery at institutional may be advocated to women in rural population to avoid such happenings at the last stage. Surveillance system may be introduced for reporting and registration of maternal deaths in the country. In addition, intervention for the prevention of PPH may be planned.

Limitation of the study

Since the data on number of live births have been collected from the available records there are chances of under estimation of live births in both the states. In case of maternal deaths, the deaths occurred at home after the discharge from needs to be registered. Computerize data base was in progress during the survey. May be in due course of time under reporting or under registration will improve and correct estimates could be derived

Authors Contribution

The study was planned, executed, conducted; and report written by Dr. Abha Aggrawal, as PI, National Institute of Medical Statistics, ICMR, New Delhi. The manuscript was also conceived and written by Dr. Abha Aggarwal. Under the supervision of Prof. Arvind Pandey, Director, National Institute of Medical Statistics. Dr. Ranajana Kar supported in the data collection in Orissa state.

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Tables

TABLE 1 NUMBER OF MATERNAL DEATHS BY SNOWBALL TECHNIQUE VS. RECORDS AVAILABLE FROM PHCs

State	District	Records	Snowball Technique
Orissa	Puri	17	20
	Sambalpur	8	10
	Koraput	18	22
Total		43	52
Rajasthan	Jaipur	16	18
	Bharatpur	13	16
	Udaipur	17	22
	Kota	10	12
	Jodhpur	8	9
Total		64	77

TABLE 2 SOCIO ECONOMIC CHARACTERISTICS OF THE MATERNAL DEATHS (PERCENTAGE)

Variables		Orissa (N=52) %	Rajasthan (N=77) %
Type of House	Kutcha	77.4	25.5
	Pucca	11.3	41.8
	Semi Pucca	11.3	32.7
Separate Room as Kitchen	Yes	43.4	25.5
	No	56.6	74.5
Type of fuel mainly used for cooking	Wood	96.2	80.0
	Dung cakes	3.8	9.1
	LPG	0.0	10.9
Toilet facility available	Open field	96.2	92.7
	Own flush toilet	0.0	7.3
	Own pit toilet	3.8	0.0
Electricity connection available	Yes	39.6	83.6
	No	60.4	16.4
Source of Drinking Water	Well	18.9	18.2
	Handpump	62.3	56.4
	Tapwater	15.1	25.4
	River Water	3.8	0.0
Source of Drinking water inside Home	Yes	1.9	3.6

	No	98.1	96.4
Drainage in front of the house	Open and stagnant	1.9	14.5
	Open and running	5.7	43.6
	Closed	5.7	7.3
	No drainage system	86.8	34.5
Others facility	Refrigerator	0	4.2
	T.V	17.0	19.9
	Radio	24.6	16.3
	None	50.6	55.8
	Others	7.5	3.8

TABLE 3A ESTIMATES FOR RAJASTHAN STATE

District	Region	Population Covered	No. Of births Covered	No. of Maternal deaths covered	Population Region	Wt. Estimated births	Wt. Estimated Maternal deaths
Jaipur	NE	144750	9534	18	98381673	6479937	12234
Bharatpur	NE	112329	7512	16	98381673	6579273	14013
Udaipur	Southern	110062	9475	22	7412932	638163	1482
Kota	SE	70821	4541	12	7243856	464472	1227
Jodhpur	Western	52526	3637	9	23335332	1615783	3998
Total		490488		77		15777627	32955
Jaipur	NE	144750	9534	18	98381673	6479937	12234

Weighted estimate of MMR= 15777627 / 32955 = 0.002088709 0r 209 per one lakh live births
SE = 1.1E-05
95% CI = .00209±1.1E-05 = (207, 211)

TABLE 3B ESTIMATES OF MMR IN ORISSA STATE

District	Region	Pop. Covered	No. Of births Covered	No. of Maternal deaths covered	Population Region as per Census 2011	weighted. Estimated births	Estimated Maternal deaths
Puri	coastal	175155	8931	20	19847989	1012032	2266
Sambalpur	Northern	73750	3980	10	14577574	786695	1977
Koraput	Southern	95384	7257	22	7521795	572273	1735
Total		344289		52		2370999	5978

Weighted Estimate of MMR in Orissa= (5978 / 2370999) X 1,00,000 = 252 per one lakh live births
95% CI = .00252± 1.96 * 3.3E-05 where 3.3E-05 is the SE of the estimate=(246, 259)

TABLE 4 CAUSES OF MATERNAL DEATHS

Causes of Maternal Death	Orissa	Rajasthan
Direct causes		
PPH	23.8	32.7
Septicemia	4.8	9.1
Anemia	14.3	12.7
Hypertensive disorder	4.8	5.5
APH	2.4	3.6
Obstructed labour	4.8	3.6
Abortion	7.1	3.6
Indirect causes		
Retain Placenta	4.8	1.8
Other*	33.3	27.3
Total	100.0	100.0