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SAMPLE REGISTRATION SYSTEM

MATERNAL MORTALITY IN INDIA: 1997-2003

TRENDS, CAUSES AND RISK FACTORS

REGISTRAR GENERAL, INDIA
NEW DELHI

MATERNAL MORTALITY IN INDIA: 1997-2003

TRENDS, CAUSES AND RISK FACTORS

REGISTRAR GENERAL, INDIA, NEW DELHI
in collaboration with
CENTRE FOR GLOBAL HEALTH RESEARCH
UNIVERSITY OF TORONTO, CANADA

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FOREWORD

Deaths due to pregnancy and child birth are common among women in the reproductive age groups. Reduction of mortality of women has thus been an area of concern and governments across the globe have set time bound targets to achieve it. The International Conference on Population and Development in 1994 had recommended reduction in maternal mortality by at least 50 per cent of the 1990 levels by the year 2000 and further one half by the year 2015. The Millennium Development Goals (MDG) have set the target of achieving 200 maternal deaths per lakh of live births by 2007 and 109 per lakh of live births by 2015.

2. Earlier, efforts have been constantly made by the Government to meet the challenge of rapid reduction in maternal mortality by launching appropriate interventional strategies. The programme on Reproductive and Child Health (RCH) initiated in 1997 has been one such effort to ensure that women have access to information and services for reproductive health care.

3. The Office of the Registrar General, India under the Ministry of Home Affairs, apart from conducting population census and monitoring of registration of births and deaths, has been evaluating indirectly the impact of governmental programmes/schemes on fertility and mortality using the Sample Registration System (SRS). SRS is the largest demographic sample survey in the country and is being used to provide direct estimates of maternal mortality through a nationally representative sample. The present Report provides estimates of maternal mortality for the period 1997-2003. Nearly two-third of the maternal deaths in the country are reported to occur in the EAG states and in Assam.

4. The study shows that overall MMR which was in the vicinity of 400 in 1997-98, has come down to about 300 in 2001-03, thus registering a decline of 24 per cent during this period based on SRS data. The decline is impressive but still a lot would need to be done to achieve the time bound target of 200 maternal deaths per lakh of life births by 2007 and 100 by 2012. Unlike now when estimates of MMR have been brought out after ten years, the Office of the RGI will be working to provide such estimates at the state and national level from SRS regularly hereafter. This will be helpful not only for evaluation of the health schemes/programme but also for corrective measures for their better targeting.

5. I must place on record the extensive efforts put in by the team led by Additional Secretary and Registrar General, India & Census Commissioner in bringing out this Report.

New Delhi
October, 2006

V.K. Duggal
Home Secretary

FOREWORD

Since its inception in 1971, the Sample Registration System (SRS) has been a continuous source of information on fertility and mortality indicators including inter alia infant, child and female mortality. There has been significant reduction in each of these indicators. About a sixth of the world's population lives in India and thus, the progress on priority health outcomes in the country as well as in the world depend to a large extent on the progress of health standards at the district and state levels in India. The government's commitment to the new National Rural Health Mission underscores the importance assigned to improving health at a grassroots level.

2. Maternal death is an important indicator of the reach of effective clinical health services to the poor, and is regarded as one of the composite measure to assess the country's progress. Reliable estimation of levels and trends of maternal mortality is thus extremely essential. This Report attempts to estimate this based on a larger study of maternal deaths, covering near 4,500 maternal deaths among 13 lakh births in over 11 lakh homes. The addition of an innovative method called the RHIME (routine, representative, re-sampled household interview of mortality with medical evaluation) has helped enhance the quality of information on the causes of death.

3. The key finding of the Report that maternal mortality ratios (MMR) per 100,000 live births have fallen from about 400 in 1997-98 to about 300 in 2001-03 gives satisfaction but tells at the same time that reducing MMR to 109 by 2015 envisaged by Millennium

Development Goals is going to be a real challenge. Particularly, when most of these deaths occur in the states included in the "Empowered Action Group" (EAG) of states namely Bihar and Jharkand, Orissa, Madhya Pradesh and Chattisgarh, Rajasthan, Uttar Pradesh and Uttaranchal and in Assam. For further decline, rapid progress in health sector schemes would be needed in these states. And, these states are thus the focus of the National Rural Health Mission (NRHM).

4. We are thankful to Additional Secretary and Registrar General, India & Census Commissioner, Additional Registrar General and other officers/officials for bringing out these results successfully in collaboration with the Centre for Global Health Research (CGHR), University of Toronto.

New Delhi
October, 2006

P.K. Hota
Secretary, Ministry of
Health and Family Welfare

PREFACE

Reduction of maternal mortality (MMR) is one of the major challenges to improve the overall quality of life. The absence of reliable estimates of MMR makes the process both difficult and complex. An attempt has been made through the Sample Registration System (SRS) - a large, ongoing, low-cost and long-term measurement system to provide the levels and trends in maternal mortality across the country during the period 1997-2003. This Report will, hopefully, help bridge the data gap on the estimates of maternal mortality and will be of use for policy planners, programme managers, academicians and demographers.

2. The findings brought out in the Report suggest that level and trend of maternal mortality in the country has substantially declined by nearly 24 per cent during 1997-2003. However, a lot will need to be done to achieve the ultimate goal set in this regard.

3. The SRS has been a joint effort of the Centre and State Governments and the field work for the present study has become possible with the active support of the staff and officers in the Directorates of Economics and Statistics of Kerala and Maharashtra and the Directorates of Census Operations and the SRS Wing of the Vital Statistics Division at Delhi headquarters. The analytical work on causes of death and risk factors has been done in close collaboration with the Centre for Global Health Research (CGHR), University of Toronto, as part of the 'Prospective Study of 1 Million Deaths'. In particular, I must acknowledge the efforts of SRS staff under the leadership of Shri R.C. Sethi, Additional Registrar General, including Shri A. K. Saxena, Dr. D. K. Dey, Deputy

Directors, Shri Sidhil Sasi, Research Officer, Smt. Gracy James, Investigator, Shri Brijesh Kumar, Sr. Compiler, Ravi Kant, Compiler and Km. Prabha, Shri R.S. Kar and Smt. Sunita Bhatnagar, Data Entry Operators. I must also thank Dr. Prabhat Jha, Dr. Binu Jacob, Dr. Leena Sushant, other colleagues at CGHR and Dr. Rajesh Kumar from the School of Public Health, PGIMER, Chandigarh. We thank the collaborators for their active support and encouragement of improved mortality statistics in India.

New Delhi
October, 2006

Devendra Kumar Sikri
Additional Secretary and
Registrar General, India
& Census Commissioner

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DEFINITIONS

$$\text{Maternal Mortality Ratio (MMR)} = \frac{\text{Number of maternal deaths to women (15-49 years)}}{\text{Number of live births to women (15-49 years)}} \times 100000$$

$$\text{Maternal Mortality Rate (MM\_rate)} = \frac{\text{Number of maternal deaths to women (15-49 years)}}{\text{Number of living women (15-49 years)}} \times 100000$$

$$\text{Lifetime Risk of Maternal Death} = 1 - (1-\text{MM\_rate}/1{,}00{,}000)^{35}$$

SUMMARY

Background: Indirect estimates of maternal mortality or those based on small studies in India have been unable to establish, reliably, existing levels, trends and differences in maternal deaths. Similarly, the data on the causes of maternal death remains scant.

Methods: The study has investigated 4,484 maternal deaths among over 1.3 million births occurring in a nationally-representative continuous demographic survey called the Sample Registration System. The surveys in 1997-1998, 1999-2001, and 2001-2003 have used retrospective or continuous recording of maternal deaths, with generally consistent definitions. But unlike previously, when different methods were used to classify the causes of maternal deaths, the inferences from the 2001-2003 survey are based on examination of household reports and their medical evaluation by two trained physicians, besides adopting for other quality control methods.

Results: The results of the study are as under:

- About two-thirds of maternal deaths occur in a handful of the states - Bihar and Jharkand, Orissa, Madhya Pradesh and Chhattisgarh, Rajasthan, Uttar Pradesh and Uttaranchal (the Empowered Action Group or EAG states) and in Assam.
- The maternal mortality ratio (MMR) - the number of maternal deaths per 100,000 live births has declined from 398 (95%CI 378-417) in 1997-1998 to 301 (95%CI 285-317) in 2001-2003.
- The overall relative decline of nearly 24 per cent during 1997-2001 includes a 16 per cent relative decline in the EAG states and in Assam. In contrast MMR has fallen by 7 per cent in the

southern states of Andhra Pradesh, Karnataka, Kerala and Tamil Nadu.

- In 2001-03, the lifetime risk of a women dying of in childbirth is 1.8 per cent in the EAG states and in Assam, 0.4 per cent in southern states and 0.6 per cent in other states.
- Based on about 26 million births in 2004, nearly 78,000 maternal deaths are estimated (95%CI 74,000-82,000) in India in that year.
- The leading causes of maternal death have been, haemorrhage (38%), sepsis (11%), and abortion (8%).
- The risk of a female dying of maternal and non-maternal causes is higher in the rural areas or in an EAG state or in Assam. Low level of education among females specifically enhances the risk of maternal death appreciably.
- Only about 28 per cent of all births at 2003 occur in private or public institutions and increases in proportion have been slow from 1990.

Conclusion: There has been substantial decline in maternal mortality ratio (MMR) during 1997-2003. However, in order to achieve the target set by Millennium Development Goals (MDG), National Commission on Population (NCP) and National Rural Health Mission (NRHM), rapid expansion of institutional births with skilled attendance, especially in the EAG states and in Assam would be needed. Based on the conservative estimates, it has been projected that the MMR would be 195 by 2012. However, using the Log-linear model, the projected MMR would be 231 by 2012. A stronger programme to increase institutional delivery in low performing states and in communities having high MMR can, however, make a difference. States having higher percentage of institutional deliveries generally have lower maternal mortality and vice versa.

C H A P T E R - 1

INTRODUCTION

Statistics on maternal mortality form a part of vital statistics system and have a great value for health planners, administrators and medical professionals. Data on maternal mortality being scarce, efforts have been made in the past to make indirect estimates. Indirect estimates by the World Health Organisation (WHO) show that India had about 120,000 to 140,000 maternal deaths in 2002. The indirect estimates rely on vital registration deaths and econometric models; these are then likely to be approximately correct. Against this, direct estimation from household interviews of causes of death is better and more reliable even though precise levels of maternal deaths are difficult to estimate due to overall limitations resulting from the fact that maternal deaths are a small percentage of total births in the country.

1.2. In a country of the size of India, levels of maternal mortality vary greatly across the regions, due to variation in underlying access to emergency obstetrical care, prenatal care, anemia rates among women, education levels of women, and other factors. Large studies with several hundred maternal deaths will be needed to estimate the reasons for variation across the regions.

1.3 There has been a general consensus that maternal deaths are declining in most developing countries including India. The past estimates for India which used indirect methods, (such as those using age-specific mortality rates among women) suggested that maternal mortality ratio (MMR; defined as maternal deaths per 100,000 live births) had declined from over 750[1] in the 1960s to about 400 in the

[1] Bhat PNM, Navaneetham K, Rajan SI. Maternal Mortality in India: Estimates from a regression model. *Studies in Family Planning* 1995; **26**: 217-232.

1990s. However, a doubt had been cast on the decline continuing in the 1990s by two relatively small demographic surveys which suggested that the MMR had not changed significantly from 424 (95% C.I: 324-524) in 1992-1993 (NFHS-1) to 540 (95% C.I: 428-653) in 1998-1999 (NFHS-2). The confidence intervals were large due to inclusion of only a few dozen maternal deaths in these surveys. Moreover, estimates by lower geographical level, could not be generated. Further, there has been little direct evidence from various regions of India on the possible causes of maternal mortality. The contribution of hemorrhage to maternal deaths has been a matter of incessant debate. A recent WHO review of 34 datasets[2] has found that the percentage of maternal deaths from hemorrhage was higher than that previously estimated by WHO.

1.4 In this backdrop, the present Report lends itself a unique position. Based on nearly 4500 maternal deaths for the periods 1997-1998, 1999-2001 and 2001-2003, the Report gives trends in maternal mortality in recent years, examines the major causes of maternal mortality, and provides estimates of current and future burden from maternal deaths. The analysis in the Report is the result of largest series of maternal deaths studied in any single country over the seven-year period from 1997 to 2003. The Sample Registration System (SRS) estimates of maternal mortality for 1997 and 1998 varied widely at the state level, being based on a single year each and relatively small number of maternal deaths. The data has subsequently been pooled for three years each and the estimates of the overall levels of maternal mortality and trends have been presented for 1999-2001 and 2001-2003. The pooling of the data accounting for the overlapping years 1997 and 2001, have been done since the data are based on independent surveys though pertaining to the same sample.

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[2] Khan KS, Wojdyla D, Say L, Gulmezoglu AM, Van Look PF. WHO analysis of causes of maternal death: a systematic review. *Lancet* 2006; **367**: 1066-74.

These results are reasonably stable. A system of 'post death verbal autopsy' has been adopted to arrive at the causes of death. Upto 2001, the field supervisor would arrive at the cause of death based on the most common signs and symptoms reported. To enhance the objectivity of the system, role of the field staff was redesigned and restricted to investigating and recording faithfully the chain of events, circumstances, symptoms and signs of death through an interview of close relatives or associates of the deceased. For ascertaining the probable cause of death, a system of double assignment of cause of death by two independent trained physicians based on examination of the field reports was adopted. Disagreement, as to the assigned cause of death was resolved by adjudication through a senior third physician to arrive at an unambiguous cause of death.

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C H A P T E R - 2

SURVEY DESIGN AND ESTIMATION PROCEDURE

The Office of the Registrar General, India, since 1969-70, has been conducting a continuous demographic survey known as the Sample Registration System (SRS) in the randomly selected sample units (village/ segment of a village in rural areas and census enumeration block in urban areas) spread across the country to provide reliable annual estimates of fertility, mortality and other advanced indicators at the state and national level. To capture change in the age structure, marital status, literacy and other demographic variables, the SRS sample is replaced every ten years based on the latest census frame. The sample size used in this study was based on the 1991 census frame and covered over 6 million people, living in about 1·1 million households in 28 states and 7 union territories. The overall sample at the national level comprised 6671 (4436 rural and 2235 urban) sample units, each comprising nearly 150 households and about a 1,000 population. On an average, this accounted for nearly 20–25 births and 9 deaths annually per unit. SRS is a dual-record system wherein a resident part-time enumerator continuously records births and deaths in each household within the sample unit every month. A full-time SRS supervisors thereafter independently collects the vital events along with other related details for each of the preceding two six month periods during the calendar year. The two sets of figures are matched. Partially matched/un-matched events are re-verified in the field to get an unduplicated count of events. Details of the SRS sample design and field methods are published elsewhere[3].

2.2 Until 1997, indirect estimates of maternal mortality or those based on small studies in the country were unable to establish

[3] Sample Registration System, 2003 – Annual Report, Office of the Registrar General, India

reliably the levels, trends and differences in maternal deaths. Estimates of maternal mortality along with the most probable causes of death at the national and state level was attempted for the first time using SRS in 1997, to fill the data gaps as the estimates were in demand from both the policy planners and researchers. Subsequently, estimates of maternal mortality were released for 1998, following the procedure of 1997. During 1998, an independent Special Fertility and Mortality Survey was undertaken in SRS units using single round retrospective approach with 1997 as the reference year.

2.3 Maternal deaths are rare events. That is why wide fluctuations in the estimates of maternal mortality at state level were estimated in the SRS for the years 1997 and 1998 suggesting that single year data would not be able to provide reliable estimates of maternal mortality due to small number of events. The methodology was changed and data was subsequently pooled for three years. The pooled estimates of maternal mortality and trends for 1999-2001 and 2001-2003 have been reasonably stable. All the pooled surveys were, however, conducted within the domain of SRS.

2.4 Statement 1 summarises features of the specific maternal surveys which were carried within the SRS since 1997. Aside from sample size, the other key considerations of study design included information on (a) cause of deaths recorded continuously in the dual record system or through a special retrospective survey; (b) causes of maternal death covered - these include ***direct*** obstetrical causes (chiefly haemorrhage, obstruction, abortion, sepsis, and pre-eclampsia), ***indirect*** causes (malaria, anaemia, viral hepatitis etc.) and ***unrelated causes*** that have no relation to pregnancy; and (c) field methods used to establish cause of maternal or non-maternal death. The time period for maternal death was standard across the studies - deaths of women on account of pregnancy or abortion or within 42 days of childbirth.

Statement 1: Design of Maternal Mortality Surveys

Year	Name of the Surveys	No. of Maternal Deaths netted	Causes Considered	Retrospective/ Concurrent	Method of Determination of Causes of Deaths
1997-1998	SRS Special Maternal Mortality; Special Fertility & Moratlity Survey	1,589	Direct, Indirect and Others	Continuous and Retrospective	Post Death Verbal Autopsy and recording causes of death for females ages 15-49.
1999-2001	Cause of Deaths through Verbal Autopsy in SRS	1,512	Direct, Indirect and Others	Continuous and Retrospective	Post death enquiry based on symptoms, conditions, duration and anatomical site of the disease as reported by family members of the deceased and assignment of causes of death by SRS supervisors.
2001-2003	Special Survey of Deaths	1,383	Direct, Indirect and Others	Retrospective	Post death enquiry based on symptoms, conditions, duration and anatomical site of the disease as reported by family members of the deceased. These were recorded in specifically designed forms along with brief narratives. Assignment of cause of death by two independent trained physicians.
	Total	**4,484**			

2.5 Some of relevant details of these surveys are discussed in the subsequent paragraphs.

A. Special Maternal Mortality Surveys – 1997 & 1998

2.5.1 The Office of the Registrar General, India had for the first time in 1997, conducted on a pilot basis the special survey of all female deaths in the age group, 15-49 within the domain of SRS. Households

were interviewed by the SRS supervisors, about the causes of death during the reference year. The causes of maternal death included 'direct', 'indirect' and 'other' unrelated causes. A 'post-death verbal autopsy' that used a simple algorithm to arrive at one of the following direct causes was used: pregnancy with abortion outcome, oedema, proteinuria and hypertensive disorders, haemorrhage, obstructed labour due to mal-position and mal-presentation of the foetus, and complications predominantly relating to the puerperium. Indirect causes included: tuberculosis, viral hepatitis, malaria and anaemia and 'other' unrelated causes: that which were not related with pregnancy. The SRS supervisors assigned the cause of death as per International Classification of Diseases, 9th Revision (ICD-9). The special survey continued in SRS for 1998 as well. However, the state of Jammu and Kashmir for 1997, and rural units of Nagaland for 1997 and 1998 were not covered for administrative reasons.

B. Special Fertility and Mortality Survey (SFMS), 1998

2.5.2 In the Special Fertility and Mortality Survey (SFMS), 1998, a separate questionnaire was used to collect data on all deaths that had occurred in the households during the calendar year 1997. A specific question on the causes of death of female's in age group 15-49 years (maternal or non-maternal) was included. Fieldwork was carried out by a SRS supervisors who assigned the cause of death based on the response to one of the direct causes viz. toxaemia or preclampsia, anaemia, bleeding of pregnancy or puerperium, malpositioning of child and puerperal sepsis. The state of Jammu and Kashmir, and rural units of Nagaland were not covered for administrative reasons. The findings on maternal mortality rate and causes of maternal mortality from the SFM Survey, have been published separately[4].

C. Cause of Death through Verbal Autopsy in SRS, 1999-2001

[4] Special Fertility & Mortality Survey, 1998 – Office of the Registrar General, India

2.5.3 The scope of SRS was enhanced from January, 1999 for collection of data on all causes of death. The SRS supervisors were imparted training on medical terminologies, symptom of diseases and interview techniques. The causes of death were drawn from a list of 79 common causes, and were based on the 10th revision of the International Classification of Diseases (ICD-10). The supervisors were trained to assign the cause of death based on the most common symptoms reported. For recording of causes of maternal deaths, the direct maternal causes and the accompanying ICD-10 codes used were: abortion (O03-O06); haemorrhage (O20); anaemia of pregnancy (O25), malpositioning of the child (O64), puerperal sepsis (O85), and unclassified maternal deaths (O90). Indirect maternal causes were included only to the extent of being captured as unclassified maternal deaths.

D. Special Survey of Deaths - 2001-2003

2.5.4 From 2002 onwards, the SRS included a new method called the "RHIME" or **r**epresentative, **r**e-sampled, **r**outine **h**ousehold **i**nterview of **m**ortality with **m**edical **e**valuation. This is an enhanced form of "verbal autopsy" which is the key feature of a prospective study of 1 million deaths within the SRS. The RHIME method required repeated training of the SRS supervisors on how to collect the symptoms, signs and key circumstances leading to death using a two-page structured form which has also provision to record a brief narrative. Other features of RHIME include random re-sampling of field-work by an independent team for maintaining quality of data. Importantly, field-staff were instructed not to assign a cause of death, but only collect the major symptoms and narrative of the events leading up to death. The assignment of causes of death involved central medical evaluation by two independent trained physicians who would examine the field reports using a web-based system piloted for this study. Physicians undergo standardised training and have guidelines for the most

common causes, including maternal causes of death. The two physicians, based on examination of household reports, would either agree on the underlying ICD-10 code (to 3 digits) assigned for the cause of death pending which their forms would be anonymously shuffled between them for reconciliation. Continuing disagreements would be referred to a senior third physician who adjudicated the final ICD-10 code. The details of the RHIME method, quality control checks and validation results to date have been published[5]. Earlier studies[6],[7] have established reasonably high sensitivity and specificity for most of the common maternal causes of death. The RHIME method was introduced in the SRS from December 2002 as part of the continuous half-yearly survey in some states, and then a special survey of all deaths within the SRS for calendar years 2001-2003 (excluding those already covered in the routine half-yearly surveys) was conducted from May-October 2004. A total of about 140,000 deaths at all ages were included in the Special Survey of Deaths for which VA instruments were used. Due to out migration and change in households, some 25 per cent of deaths could not be surveyed, but have been included for determining the maternal mortality rate.

2.5.5 For comparability with WHO estimates for India and for other countries, the WHO's "Global Burden of Disease" categorization of maternal deaths have been used, which includes various categories with their ICD-10 codes such as : haemorrhage (O44-O46, O67, O72); sepsis (O85-O86); hypertensive disorders(O10-O16); obstructed labour (O64-O66); abortion (O00-O08); and other conditions (O20-O43, O47-O63, O68-O71, O73-O84, O87-O99) .

[5] Jha P, Gajalakshmi V, Gupta PC, Kumar R, Mony P, Dhingra N, Peto R. Prospective study of 1 million deaths in India: rationale, design, and validation results. *PLoS Med* 2005; **3**:e18

[6] Kumar R, Sharma AK, Barik S, Kumar V. Maternal mortality inquiry in a rural community of north India. *Int J Gynaecol Obstet*. 1989;29:313–319.

[7] Kumar R, Thakur J, Rao M, Singh M, Bhatia P. Validity of verbal autopsy in determining causes of adult deaths. *Indian J Public Health*. 2005

2.6 Estimation Procedure

2.6.1 For the purpose of this Report, the states have been grouped into three categories (regions); the first category (region) comprises the "Empowered Action Group" (EAG) states of Bihar and Jharkand, Madhya Pradesh and Chattisgarh, Orissa, Rajasthan, Uttar Pradesh and Uttaranchal. The state of Assam too has been added to this list. These states have had, historically higher child mortality indicators, higher poverty levels and lower life-expectancy and other indictors than most other states. The second category (region) covers the "Southern" states and includes the states of Andhra Pradesh, Karnataka, Kerala and Tamil Nadu. These states traditionally have had better child mortality and other health indicators. The remaining major states formed the third category (region) and have been classified as 'Others'.

2.6.2 The number of births and deaths reported in regular SRS is higher than that recorded in the Special Surveys (Special Fertility & Mortality Survey, 1998 and Special Survey of Deaths, 2001-2003) because of dual (continuous and retrospective) recording, shorter recall period, and prospective follow-up. To correct for the undercount, the actual number of maternal deaths for each state has been multiplied by a correction factor which corresponds to the ratio of total female deaths in the age group 15-49 in SRS (as derived from the routine half-yearly surveys) to the counts for the corresponding age-group in the special surveys.

2.6.3 Data from the 1997 and 1998 Special Maternal Mortality Surveys and 1998 Special Fertility & Mortality Survey have been combined for two reasons : first, all three are independent surveys having used similar methods to ascertain maternal deaths and

second, the pooled numbers of deaths in each state lend stability to the overall numbers for yielding more reliable estimates.

2.6.4 The chief statistic presented for relevant years (1997-1998, 1999-2001 and 2001-2003) is the maternal mortality ratio (MMR). This is derived as the proportion of maternal deaths per 100,000 of all recorded births within the SRS. Besides, the 95% Confidence Intervals (95% CI) of the estimates based on the calculated standard error have also been presented. In addition, estimates of maternal mortality rate (MM_rate) viz. maternal deaths to women in the ages 15-49 per lakh of women in that age group, and the life time risk have been presented. The life time risk is defined as the probability that at least one woman of reproductive age (15-49) will die due to child birth or peruperium assuming that chance of death is uniformly distributed during the entire reproductive span, has been worked out using the following formula:

$$\text{Life Time Risk} = 1 - \{1-(\text{MM\_rate}/1{,}00{,}000)\}^{35}$$

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C H A P T E R - 3

LEVELS AND TRENDS OF MATERNAL MORTALITY IN THE COUNTRY

Statement 2 below indicates the total of 4,484 maternal deaths from among 1,321,378 live births reported from the five surveys conducted within the domain of SRS during the period 1997-2003. Among the three categories in which the states have been grouped, 'EAG states and Assam' account for nearly 65 per cent of the maternal deaths and 47 per cent of the births in the sample during this period. This is despite the fact that these states account for about 35 per cent of the total sample adult female population. About one fourth (22.9%) of the total maternal deaths in the country are reported from Uttar Pradesh/ Uttaranchal – the states which account for nearly 14 per cent of the total live births and about 9 per cent of the adult female population in the sample. In contrast, only about 10 per cent of the total maternal deaths from among nearly 18 per cent of total births in the country have been reported by states in 'Southern' category that accounts for nearly 23 per cent of total sample adult female population.

Statement 2: Total female population ages 15-49, live births and maternal deaths, 1997-2003

India and bigger states/ Category	Sample female population (15-49)	Live births	Maternal deaths	% to total female population	% to total live births	% to total maternal deaths
INDIA*	**1,4441,259**	**1,321,378**	**4,484**	**100.0**	**100.0**	**100.0**
Assam	572,912	57,458	278	4.0	4.3	6.2
Bihar/ Jharkhand	993,945	129,006	563	6.9	9.8	12.6
Madhya Pradesh/ Chhattisgarh	699,135	88,913	365	4.8	6.7	8.2
Orissa	729,232	61,858	233	5.0	4.7	5.2
Rajasthan	709,732	90,838	440	4.9	6.9	9.8
Uttar Pradesh/ Uttaranchal	1,322,465	185,738	1,028	9.2	14.1	22.9
Sub-total (EAG & Assam)	**5,027,421**	**613,811**	**2,907**	**34.8**	**46.5**	**64.8**

India and bigger states/ Category	Sample female population (15-49)	Live births	Maternal deaths	% to total female population	% to total live births	% to total maternal deaths
Andhra Pradesh	734,144	56,967	116	5.1	4.3	2.6
Karnataka	868,588	75,356	186	6.0	5.7	4.1
Kerala	805,893	49,268	67	5.6	3.7	1.5
Tamil Nadu	887,580	59,787	86	6.1	4.5	1.9
Sub-total (Southern)	**3,296,205**	**241,378**	**456**	**22.8**	**18.3**	**10.2**
Gujarat	647,056	66,310	91	4.5	5.0	2.0
Haryana	470,854	51,731	82	3.3	3.9	1.8
Maharashtra	777,452	68,192	110	5.4	5.2	2.5
Punjab	416,918	34,169	73	2.9	2.6	1.6
West Bengal	1,116,194	89,108	212	7.7	6.7	4.7
Others	1,997005	152,063	389	13.8	11.5	8.7
Sub-total (Others)	**5,425,479**	**461,573**	**956**	**37.6**	**34.9**	**21.3**

* Includes others for 1997-98

3.2 In SRS, the usual practice is to present the estimates of vital indicators after applying multiplication factors to the sample values. Application of multipliers may affect the estimates of an indicator in case of rare events. Maternal deaths being a rare event, the number of sample maternal deaths covered have also been presented. It has been tested that the estimates based on sample statistic are approximately close to those obtained after applying multiplication factors to the sample values. The maternal mortality ratios for Uttar Pradesh and Gujarat for the period 2001-2003 have been worked out, using the two approaches. The maternal mortality ratio for Uttar Pradesh has been estimated as 517 and 519 maternal deaths per 100 thousand live births. Such estimates, for Gujarat are 172 and 169. The difference between the two set of estimates is statistically in-significant. The, estimates of maternal mortality presented in this report are based on sample values.

3.3 Tables 1-3 present the maternal mortality ratio, maternal mortality rate and lifetime risk of deaths by category of states based on the five different surveys during 1997-1998, 1999-2001 and 2001-2003. At the national level, the MMR has declined from 398 (95%CI: 378-417) in 1997-1998 to 301 (95%CI: 285-317) in 2001-2003. This translates to a

relative overall decline of about 24 per cent in the country during the period 1997-2003 (absolute decline of 97) at an annual rate of about 16 maternal deaths per 1,00,000 live births. The relative decline during this period has been 16 per cent in the EAG states and in Assam (absolute decline of 82) at an annual rate of nearly 14 maternal deaths per 1,00,000 live births.

3.4 Decline in the category 'Others' is more difficult to document, partly because of a much lower baseline rate in 1997-1998. However, the measured declines have been more modest in the southern states: relative decline of 7 per cent (absolute decline of 14), with an annual rate of decline of 2 maternal deaths per 1,00,000 live births. In the category 'Others', data for 1997 excludes Jammu & Kashmir.

3.5 During the period 2001-2003, the 'Lifetime Risk' of maternal death of women in the age group 15-49 has been reported to be 1 per cent. This is substantially higher for women in the category 'EAG states and Assam' (1.8%) compared to the women in the category 'Southern' (0.4%) or in 'Other' states (0.6%). It is comforting to note that the 'Lifetime Risk' has declined in all regions from the 1997-1998 rates.

3.6 Chart 1a puts the declines in MMR in a historical perspective with earlier studies that used indirect methods. It is apparent that over the period 1997-2003, the decline is significant. Using conservative estimates (based on the lower limit of 95 percent confidence interval of MMR for 1997-98 and upper limit for 2001-2003), the projected MMR would be 195 in 2012, whereas it would be 231 using log-linear trend (Chart 1b). Both these estimates are far above the goals of reducing MMR to 100 by 2012 set up by National Rural Health Mission (NRHM) and 109 by 2015 as per Millennium Development Goals (MDG).

3.7 Chart 2 provides the variations in 2001-2003 MMRs (with their confidence intervals) for major states and for each of the categories (regions). As would be seen, there is a marked concentration of high MMR in the central states and in Assam. The MMR is the highest in

Uttar Pradesh/Uttaranchal (517) with MM Rate 70.0 and life time risk 2.4 percent followed by Assam (490). The lowest MMR is in the state of Kerala followed by Tamil Nadu. There are three states viz. Maharashtra, Tamil Nadu and Kerala whose MMR is less than 150 maternal deaths per 1 lakh live births.

3.8 The age-distribution of maternal and non-maternal deaths from the 2001-2003 Special Survey of Deaths are given in Table 4. As would be seen from the table, more than two-third of the maternal deaths are of women in the age group 20-34. In contrast, non-maternal deaths are more evenly distributed over the reproductive age span of 15-49.

3.9 Estimates of causes of maternal death have been more reliably studied among the 2001-2003 Special Survey of Deaths (Table 5 and Chart 3) as this survey, among the five surveys held in the domain of SRS during 1997-2003, had a strict quality control on the causes of deaths consequent to the involvement of two independent physicians. As per the Special Survey of Deaths, the leading cause of death is haemorrhage (38%), followed by sepsis (11%), and abortion (8%). The patterns are similar in all the three categories namely 'EAG states and Assam', 'Southern' and 'Others', except that 'hypertensive disorders' and 'abortion deaths' are more in the category 'Southern' and 'EAG states and Assam' respectively.

3.10 Table 6 gives estimates of the trends in institutional births by state category from 1991-2003 based on the SRS routine surveys. As of 2003, 28.3 per cent of all births in India have occurred in institutions, with much lower level in the 'EAG states and Assam' (15.8%) vis-a-vis the 'Southern' (64.0%) and 'Others' states (33.8%). The growth in institutional births in most states, especially in the EAG states has also not been marked.

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C H A P T E R - 4

CONCLUSIONS

The WHO 2001 estimates suggest that of the 199,000 maternal deaths in South Asia, nearly 74% would be accounted for by India. This amounts to about 140,000 maternal deaths, which is far above the upper range of the SRS estimates for that time period. It may be pertinent to mention here that the WHO estimates are based on indirect methods whereas those of SRS are based on direct methods.

4.2 The major sources of bias including variation in maternal deaths, netting of maternal death on a continuous or retrospective basis and classification of causes of death as 'direct' or 'indirect' have been described above and detailed in Statement 1. The three study approaches are not fully comparable resulting in some year to year fluctuations at the state level. The error of recall lapse; assignment of cause of death by a medical professional instead of the SRS supervisor; recording of cause of death using specially designed and well structured VA instrument instead of being based on the most common signs and symptoms reported, etc. are some of the reasons for such variations in the data.

4.3 The overall trend in MMR, over the three periods, appears to be reasonably stable (Statements 1-3, Chart 1a). Trends among the states of the 'Southern' and 'Others' region are difficult to establish, due to a fewer number of deaths. However, 2001-2003 differences across the group of states are quite marked. Within the three regions, MMR in the 'EAG states and Assam' is about 2-3 times higher than in the states of the 'Southern' region (Statements 1-3, Chart 2).

4.4 The overall average rate of MMR decline during the period 1997-2003 has been, of 16 points per year. At this rate of decline, both the NRHM Goal of a MMR of 100 by 2012 and the MDG of 109 by 2015,

may be difficult to achieve (Charts 1a and 1b). Under the prevailing conditions and the presumption of decline being log linear, the MMR would be around 231 by 2012. Using conservative estimates, the MMR would be 195 by then. Appropriate and strong governmental policies would then be required to meet the targets of NRHM and MDG.

4.5 The strategies to reduce maternal mortality are beyond the scope of this Report. The central message is, however, to rapidly expand institutional births with a skilled practitioner (well trained midwife or doctor) who can not only manage most "low-risk" routine deliveries, but can also quickly refer for major obstetrical complications. The death rate for obstetrical complications arising within such institutional births is only a fraction of that for home births, or births at facilities without trained staff. There has been a steady increase in institutional births in the various regions, but less so in the EAG states and Assam (Table-6).

4.6 Further evidence of the importance of skilled attendance and institutional delivery is demonstrated by the causes. There are a substantial percentage of all deaths that arise from maternal haemorrhage. Some of this could reflect the easier recall of ante partum or post-partum haemorrhage versus other obstetrical causes (such as abortion). The WHO's previous estimates of maternal deaths is too high, and those that arise from maternal haemorrhage is too low. The Global Burden of Disease estimates for South Asia also suggest that the major causes in order are: haemorrhage (31%), sepsis (14%), hypertension (14%), abortion (14%) and obstruction (10%). The higher haemorrhage percentage is also consistent with the high background rates of anaemia reported among Indian women. Also, the data from urban, medically-certified deaths suggests that haemorrhage is a much less common cause of maternal death in these settings, reflecting better accesses to emergency obstetrical care.

4.7 The chief implications of this study for monitoring maternal deaths are several. Firstly, there is a need to do so periodically within the SRS, using at least 3 years of deaths to aggregate results. The new SRS sample since 2004 will, besides recording the type of institution where the birth took place and the attention received, be able to track the outcomes of individual pregnancies more efficiently. This will facilitate monitoring and recording of the maternal deaths much effectively.

4.8 To conclude, there is a substantial decline – nearly 24 percent – during the seven year period 1997-2003. However the pace of decline is insufficient to achieve the major development goals for maternal deaths. The patterns of causes of death reinforce the key finding that rapid expansion of institutional and skilled birth attendance, especially in the EAG states and Assam is needed to further reduce maternal mortality in India.

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Table 1: Live Births, Maternal Deaths, Maternal Mortality Ratio in India by State from 1997-1998 Retrospective MMR Surveys

India & Major States	Sample Female Population	Live Births	Maternal Deaths	MMR	95% CI	Maternal Mortality Rate	Lifetime risk
INDIA TOTAL*	**4 562 274**	**399 412**	**1589**	**398**	**(378-417)**	**34.8**	**1.2%**
Assam	178 779	18 474	105	568	(460-677)	58.7	2.0%
Bihar/Jharkhand	369 960	45 427	241	531	(464-597)	65.1	2.3%
Madhya Pradesh/ Chhattisgarh	267 096	33 578	148	441	(370-512)	55.4	1.9%
Orissa	232 632	19 966	69	346	(264-427)	29.7	1.0%
Rajasthan	224 230	28 557	145	508	(425-590)	64.7	2.2%
Uttar Pradesh/Uttaranchal	423 478	60 537	367	606	(544-668)	86.7	3.0%
EAG AND ASSAM SUBTOTAL	**1 696 175**	**206 539**	**1075**	**520**	**(489-552)**	**63.4**	**2.2%**
Andhra Pradesh	238 908	18 309	36	197	(132-261)	15.1	0.5%
Karnataka	280 610	25 713	63	245	(185-305)	22.5	0.8%
Kerala	261 332	16 020	24	150	(90-210)	9.2	0.3%
Tamil Nadu	292 874	19 788	26	131	(81-182)	8.9	0.3%
SOUTH SUBTOTAL	**1 073 724**	**79 830**	**149**	**187**	**(157-217)**	**13.9**	**0.5%**
Gujarat	211 076	23 773	11	46	(19-74)	5.2	0.2%
Haryana	149 373	17 633	24	136	(82-191)	16.1	0.6%
Maharashtra	250 290	25 880	43	166	(117-216)	17.2	0.6%
Punjab	135 111	11 771	33	280	(185-376)	24.4	0.9%
West Bengal	354 371	29 371	89	303	(240-366)	25.1	0.9%
Other							
OTHER SUBTOTAL	**1 100 221**	**108 428**	**200**	**184**	**(159-210)**	**18.2**	**0.6%**

* Includes others

Table 2: Live Births, Maternal Deaths, Maternal Mortality Ratio in India by State from 1999-2001 SRS Prospective Household Reports

India & Major States	Sample Female Population	Live Births	Maternal Deaths	MMR	95% CI	Maternal Mortality Rate	Lifetime risk
INDIA TOTAL	**4 839 402**	**462 335**	**1 512**	**327**	**(311-343)**	**31.2**	**1.1%**
Assam	191 190	19 365	77	398	(309-486)	40.3	1.4%
Bihar/Jharkhand	302 264	41 467	166	400	(340-461)	54.9	1.9%
Madhya Pradesh/ Chhattisgarh	211 770	27 772	113	407	(332-482)	53.4	1.9%
Orissa	242 424	20 978	89	424	(336-512)	36.7	1.3%
Rajasthan	236 611	30 910	155	501	(423-580)	65.5	2.3%
Uttar Pradesh/Uttaranchal	436 440	62 542	337	539	(481-596)	77.2	2.7%
EAG AND ASSAM SUBTOTAL	**1 620 699**	**203 034**	**937**	**461**	**(432-491)**	**57.8**	**2.0%**
Andhra Pradesh	243 725	19 506	43	220	(155-286)	17.6	0.6%
Karnataka	288 407	24 768	66	266	(202-331)	22.9	0.8%
Kerala	269 571	16 800	25	149	(91-207)	9.3	0.3%
Tamil Nadu	295 980	20 310	34	167	(111-224)	11.5	0.4%
SOUTH SUBTOTAL	**1 097 683**	**81 384**	**168**	**206**	**(175-238)**	**15.3**	**0.5%**
Gujarat	216 197	21 317	43	202	(141-262)	19.9	0.7%
Haryana	157 771	17 023	30	176	(113-239)	19.0	0.7%
Maharashtra	260 412	21 330	36	169	(114-224)	13.8	0.5%
Punjab	139 212	11 308	20	177	(99-254)	14.4	0.5%
West Bengal	371 121	29 766	65	218	(165-271)	17.5	0.6%
Other	976 307	77 173	213	276	(239-313)	21.8	0.8%
OTHER SUBTOTAL	**2 121 020**	**177 917**	**407**	**229**	**(207-251)**	**19.2**	**0.7%**

Table 3: Live Births, Maternal Deaths, Maternal Mortality Ratio in India by State from 2001-2003 Special Survey of Deaths using RHIME

India & Major States	Sample Female Population	Live Births	Maternal Deaths	MMR	95% CI	Maternal Mortality Rate	Lifetime risk
INDIA TOTAL	**5 039 583**	**459 631**	**1383**	**301**	**(285-317)**	**27.4**	**1.0%**
Assam	202 943	19 619	96	490	(393-588)	47.4	1.6%
Bihar/Jharkhand	321 721	42 112	156	371	(313-430)	48.6	1.7%
Madhya Pradesh/ Chhattisgarh	220 269	27 563	104	379	(306-452)	47.4	1.6%
Orissa	254 176	20 914	75	358	(277-439)	29.5	1.0%
Rajasthan	248 891	31 371	140	445	(371-519)	56.1	1.9%
Uttar Pradesh/Uttaranchal	462 547	62 659	324	517	(461-573)	70.0	2.4%
EAG AND ASSAM SUBTOTAL	**1 710 547**	**204 238**	**895**	**438**	**(410-467)**	**52.4**	**1.8%**
Andhra Pradesh	251 511	19 152	37	195	(132-257)	14.8	0.5%
Karnataka	299 571	24 875	57	228	(169-287)	18.9	0.7%
Kerala	274 990	16 448	18	110	(59-161)	6.6	0.2%
Tamil Nadu	298 726	19 689	26	134	(83-185)	8.8	0.3%
SOUTH SUBTOTAL	**1 124 798**	**80 164**	**139**	**173**	**(144-202)**	**12.3**	**0.4%**
Gujarat	219 783	21 220	37	172	(116-228)	16.6	0.6%
Haryana	163 710	17 075	28	162	(102-223)	16.9	0.6%
Maharashtra	266 750	20 982	31	149	(97-201)	11.7	0.4%
Punjab	142 595	11 090	20	178	(100-257)	13.8	0.5%
West Bengal	390 702	29 972	58	194	(144-243)	14.8	0.5%
Other	1020 698	74 890	176	235	(200-269)	17.2	0.6%
OTHER SUBTOTAL	**2 204 238**	**175 229**	**349**	**199**	**(178-220)**	**15.8**	**0.6%**

Table 4: Age Distribution of Maternal Deaths from 2001-03 Special Survey of Deaths

	Maternal Deaths		Non-maternal Deaths	
Age Groups	**Proportion**	**95 % CI**	**Proportion**	**95 % CI**
15-19	12%	(9-14)	14%	(12-17)
20-24	29%	(26-32)	15%	(12-18)
25-29	21%	(18-24)	13%	(11-16)
30-34	20%	(17-23)	12%	(10-15)
35-39	12%	(10-15)	14%	(11-16)
40-44	4%	(3-6)	14%	(12-17)
45-49	1%	(0-2)	17%	(14-20)
15-49	**100%**		**100%**	

Table 5: Causes of Maternal Deaths from 2001-03 Special Survey of Deaths

Maternal Causes	ICD-10 Code	India		EAG and Assam		South		Other	
		%	95% CI	%	95% CI	%	95% CI	%	95% CI
Haemorrhage	O44-O46, O67, O72	38%	(34-41)	37%	(33-42)	30%	(17-44)	40%	(33-47)
Sepsis	O85-O86	11%	(9-14)	11%	(8-14)	17%	(6-28)	10%	(6-15)
Hypertensive Disorders	O10-O16	5%	(3-6)	4%	(2-6)	13%	(3-23)	6%	(2-9)
Obstructed Labour	O64-O66	5%	(3-6)	5%	(3-7)	9%	(1-17)	4%	(1-7)
Abortion	O00-O08	8%	(6-10)	10%	(7-12)	4%	(-2-10)	3%	(1-6)
Other Conditions	O20-O43,O47-O63,O68-O71,O73-O84,O87-O99	34%	(30-37)	33%	(29-37)	26%	(13-39)	37%	(30-44)
Total		100%		100%		100%		100%	

Table 6: Type of medical attention at birth (Institutional),1991-2003

India and bigger states	1991	1996	1997	1998	1999	2000	2001	2002	2003
India	**24.3**	**25.2**	**25.4**	**25.4**	**26.6**	**25.2**	**26.3**	**27.7**	**28.3**
Assam	18.3	20.9	21.2	21.1	21.0	21.2	21.4	21.5	21.9
Bihar/Jharkhand	11.7	15.1	15.3	15.4	15.8	15.9	15.9	16.0	16.3
Madhya Pradesh/Chhattisgarh	13.2	14.2	14.5	14.7	16.4	16.5	16.3	16.4	17.1
Orissa	9.8	13.3	13.6	13.9	14.1	14.3	14.9	18.8	19.3
Rajasthan	5.0	7.8	8.0	8.0	8.1	8.4	9.0	9.1	9.9
Uttar Pradesh/Uttaranchal	4.5	7.5	7.7	7.8	8.0	8.4	8.7	9.1	10.1
EAG AND ASSAM SUBTOTAL	10.4	13.1	13.4	13.5	13.9	14.1	14.4	15.2	15.8
Andhra Pradesh	37.7	42.1	42.5	42.8	43.0	43.2	43.3	43.7	43.8
Karnataka	40.6	49.2	49.3	49.2	49.0	49.2	49.1	49.4	49.8
Kerala	91.5	97.1	97.1	97.1	97.1	97.1	97.1	97.1	97.1
Tamil Nadu	56.8	64.7	65.2	64.8	64.7	64.8	64.5	65.1	65.3
SOUTH SUBTOTAL	56.7	63.3	63.5	63.5	63.5	63.6	63.5	63.8	64.0
Gujarat	23.5	36.6	36.5	36.3	36.3	36.4	36.6	36.6	36.7
Haryana	19.9	24.3	24.6	24.7	24.8	25.1	25.1	25.2	25.5
Maharashtra	34.3	47.4	47.7	47.8	48.6	48.9	48.6	48.9	49.3
Punjab	7.3	12.5	12.6	12.7	12.8	13.1	16.2	17.0	20.2
West Bengal	30.7	35.9	36.2	36.2	35.8	35.8	36.1	36.9	37.1
OTHER SUBTOTAL	23.1	31.3	31.5	31.5	31.7	31.9	32.5	32.9	33.8

Chart 1a: Maternal Mortality Ratio (MMR) in India: Trends from 1980-2020

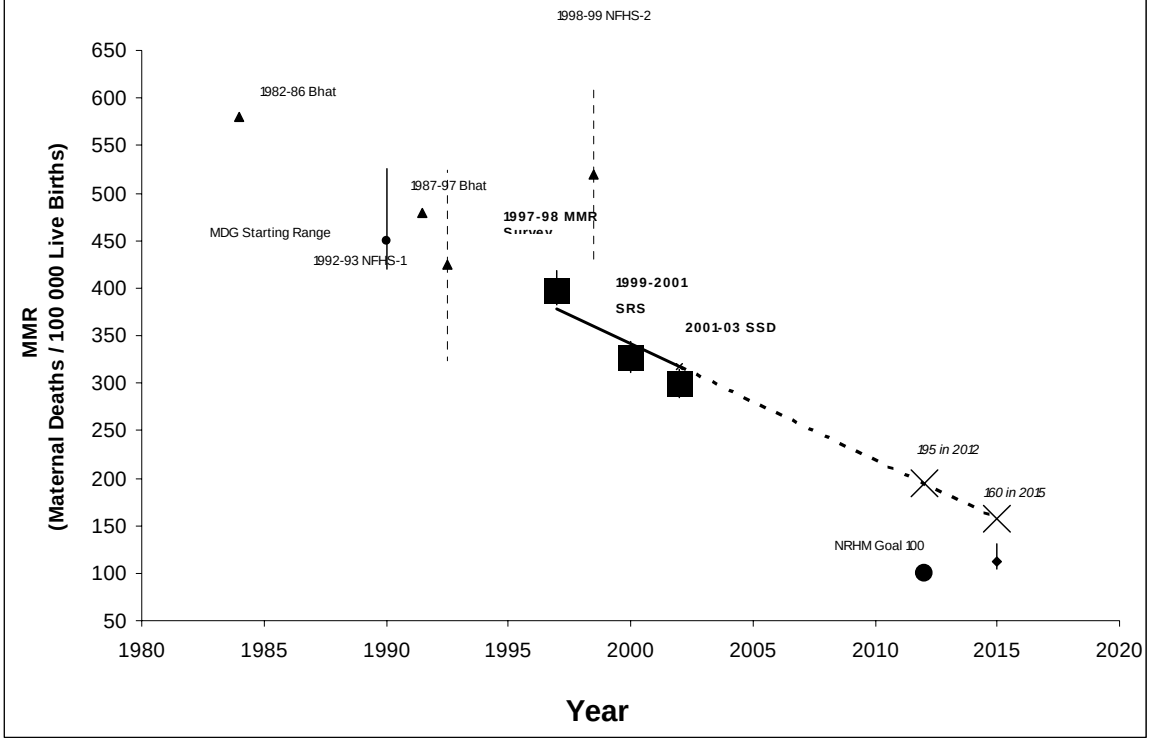

Chart 1b: Maternal Mortality Ratio (MMR) in India : Trends based on Log-Linear model, 1997-2012

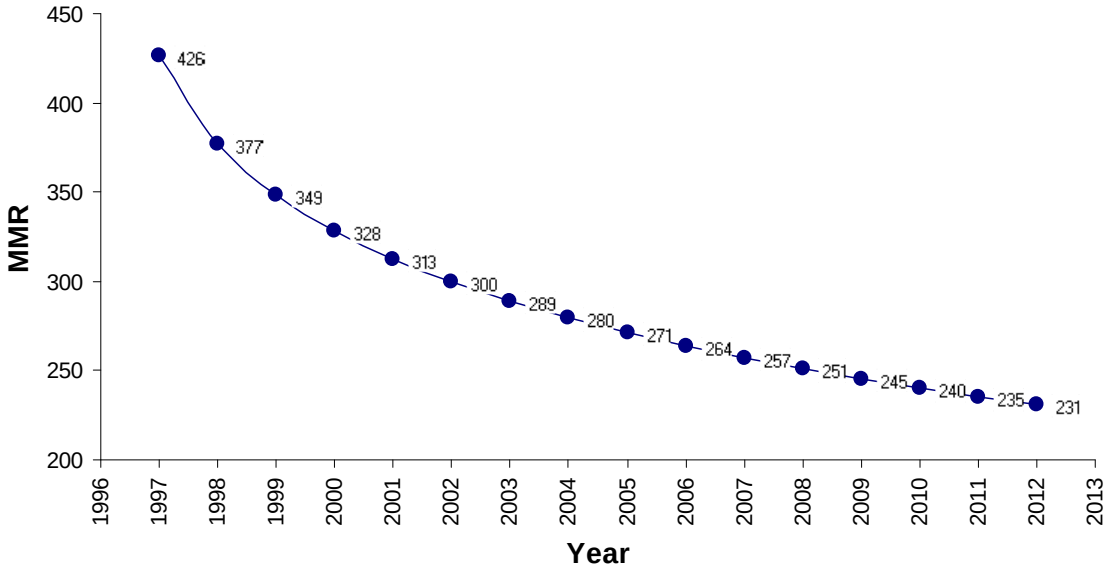

Chart 2: Maternal Mortality Ratio (MMR) along with 95% confidence interval, India and States, 2001-2003

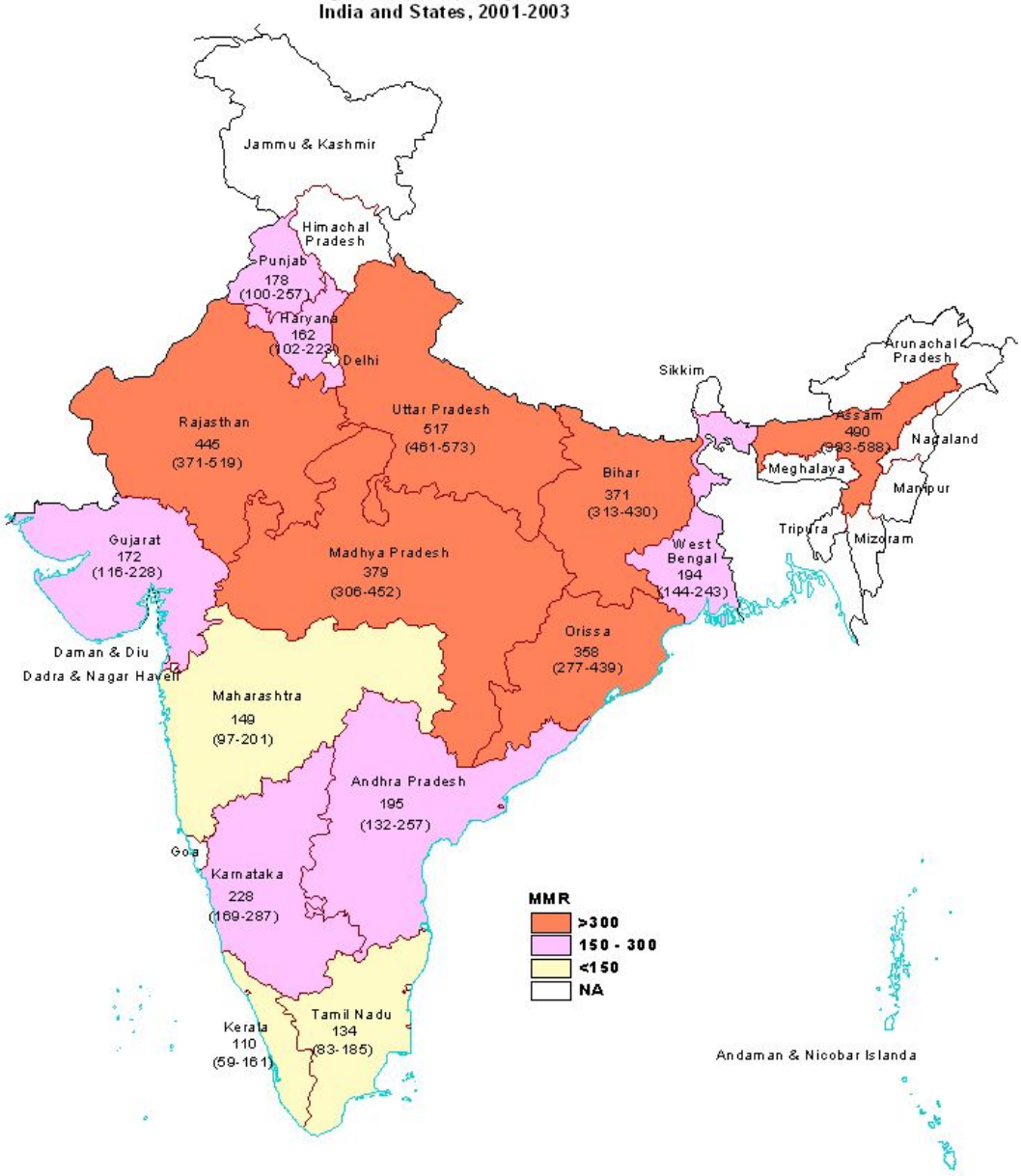

Chart 3: Causes of Maternal Death in India