EMERGING CAUSES AND DETERMINANTS OF MATERNAL MORTALITY IN INDIA: BASED ON LARGE SCALE SURVEYS SINCE THE 1990s

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Abstract

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Data from various large scale surveys are examined to understand the emerging level of maternal mortality in India, its clinical causes, the differentials by state, region, and socio-economic characteristics of households and to identify the proximate indicators that explain such differentials for programmatic intervention. Data reveal a high level of maternal mortality, despite substantial reduction, with large differentials by region and socio-economic characteristics of the household. The observed socio-economic differentials in maternal mortality are primarily found to be a function of the nutritional status of women and their utilization of antenatal and natal services. Analysis of the clinical causes and the proximate determinants also reiterate the critical role of institutional delivery and improved nutrition for further reduction in maternal mortality, both of which need to be addressed urgently if the country is to realize its commitment to reduce maternal mortality by three-fourths by 2015 under the Millennium Development Goal.

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The prevailing high rates of maternal mortality, despite the implementation of safe motherhood initiatives since the 1990s, are a cause of concern worldwide and particularly in the developing countries like India. Estimates by UNFPA indicate one in four women in developing countries suffers from acute or chronic conditions related to pregnancy; 5 percent of pregnant women need surgery, most often a cesarean section but do not have access to the much needed obstetric care facilities which puts them at risk of having a vesico-vaginal fistula. It has been estimated that 90 percent of maternal deaths occur in Asia and Sub-Saharan Africa, with India alone accounting for 25 percent of such deaths worldwide. Data on causes of maternal deaths reveal that more than 80 percent of such deaths worldwide are due to five direct causes viz., haemorrhage, sepsis, unsafe abortion, obstructed labour and other disease conditions like anemia and malaria. For every woman who dies, an estimated 100 survive but suffer from serious diseases, infections, disability or physical damage caused by pregnancy related complications. Some of these morbidity conditions are infertility, severe anemia with chronic weakness, pelvic pain, impaired mobility, uterine rupture and fistula (which makes a woman permanently incontinent). Between 4 and 5 million women in India suffer from ill- health associated with childbearing (Jejeebhoy, 2000).

India's commitment to the eight Millennium Development Goals (MDG) set by the United Nations, among which is the goal of reduction in maternal mortality ratio (MMR) by three-fourths by 2015, will therefore require the necessary political will in the implementation of policy and programmes to safeguard maternal health. In fact, to steer the country towards the achievement of the six health-related MDGs, certain strategies and targets have been set as part of the country's National Population Policy (NPP), 2000, the National Health Policy (NHP), 2002, the Reproductive and Child Health (RCH) Programme (initiated since 1996) and the National Rural Health Mission (NRHM) 2005-2012.

The strategy to reduce maternal deaths (as well as to as ensure child survival), under these policies and programmes hinges on three simultaneous efforts viz., the creation of a special cadre of health activists especially in the rural areas who will identify and motivate women, particularly those below the poverty line, to avail necessary antenatal and natal care, ensuring universal institutional delivery either in government health centres/hospitals or in private nursing homes whose doctors are given a fixed fee for normal deliveries or for Caesarean operation for women living below the poverty line and increasing emergency obstetric care by ensuring that the service centres, especially primary health centres and first referral hospitals have the necessary equipment and manpower as per the Indian Public Health Standards, to provide normal and emergency services. This three pronged approach thus addresses the social determinants of health and the gaps in health delivery system. It is therefore important to have reliable data on the levels and trends of maternal mortality and its variation across the regions

and communities which can be used for planning, monitoring and evaluating programme performance.

In the absence of a reliable vital registration system (VRS) in developing countries like India, one time household level sample surveys are often used for the estimation of MMR. The major drawback of sample surveys is the large sample required to capture all maternal deaths (which is a rare event even where levels of maternal mortality are high), to provide a precise estimate, which makes this approach of direct estimation, a costly and time consuming one. Although the two rounds of National Family Health Survey (NFHS-1 & 2), conducted during 1992-93 and 1998-99 respectively have attempted to provide national level estimates of MMR, these estimates provide large confidence interval to be able to gauge any trend, despite the large sample size of both the surveys (IIPS, 1995; IIPS & ORC MACRO, 2000). The Sample Registration System (SRS) which is the largest demographic survey in India has since the last decade, initiated the conduct of special surveys to record maternal deaths, with generally consistent definitions, to provide direct estimates of maternal mortality for the major states as well as the country as a whole (Registrar General, India, 2006), although the reliability of these estimates is not yet known.

Similarly, very few studies have addressed aspects of levels and determinants of maternal mortality because of the requirement of a large sample size. An examination of differentials in MMR and causes of maternal deaths by Bhatia (1993) from data of a community based study in Anantpur district of Andhra Pradesh in South India during 1985-86, revealed a maternal mortality ratio of 830 and 545 in the rural and urban areas respectively. This study, which combined data from multiple sources (survey, clinical/ hospital records and registration), further, noted the incompleteness of records on this important aspect of women's health. It also revealed that more than three-fourths of maternal deaths could have been prevented by the provision of early antenatal care, treatment of ill-health during pregnancy and timely availability of medical care. Post abortion complication was yet another cause of maternal death identified by the study (Bhatia, 1993).

A more recent study by Bhat (2002) also examined the socio-economic differentials in maternal mortality in India, based on estimates derived by the sisterhood method applied to the data from Human Development Profile Survey, 1994, and spatial and temporal variations in maternal mortality derived by regression method developed by him, using the data on mortality and fertility rates from India's Sample Regression System (SRS). Incidentally, the level of maternal mortality (544 per 100,000 births for rural India) for the early 1980s implied by the sisterhood method was found to be 15 percent lower than the estimate for the same period derived from regression method that uses data on sex differentials in adult mortality. Nevertheless, the application of the latter method to the SRS data reveals that the level of mortality in the country declined substantially and it was about 519 around 1989 and 440 around 1994. The study further noted wide regional/state-wise variation in maternal mortality in India even during 1987-96. The survey

results also indicated that maternal mortality levels were high among scheduled tribes and scheduled castes and low among Muslims. The less-developed villages had significantly higher maternal mortality than that in either moderately developed or well developed villages, indicating that access to health care appears to be a factor in the level of maternal mortality. Its relationship with poverty and educational levels of respondents were however found to be weak.

The most recent all-India data from the second round of the National Family Health Survey (IIPS and ORC Macro, 2000), which put the level of MMR in the range of 437-540 during the last decade (NFHS-3 did not collect data on maternal deaths) also reveal the various health problems experienced by women during their pregnancy. Among these, excessive fatigue heads the list (48 percent), followed by swelling of hands, body or face (25 percent), convulsions not from fever (10 percent), night blindness (9 percent) and difficulty with vision during daylight (6 percent). These problems point to the causative role of malnutrition and inadequate health care, which continue to impact women's health during their most vulnerable stage of reproductive life. The poor nutritional status of women is borne out by the fact that more than one third of women had a body mass index below normal (less than 18.5) and as high as 58 percent of women (15-49) were found anaemic (NFHS -3, 2005-06), while the corresponding figures from NFHS- 2 were 36 and 50 percent respectively. It is thus disturbing to note that the nutritional status of women has not improved to the desired level between the two survey periods.

With regard to ante-natal care, the data reveal that only 23 percent were found to have taken adequate IFA tablets to combat anemia which improves to 48 percent of the pregnant women who reported that they had had 3 or more ante-natal check-ups and 76 percent who reported to have received two or more doses of tetanus toxoid injection (NFHS-3, 2005-06). Less than 40 percent of the births were found to have occurred in a health facility and only a small proportion of births (less than 10 percent) which took place at home were attended by a medical or paramedical person. The NFHS-3 all-India data further reveal that a large proportion of women had suffered from postpartum complications at any time during the two months after delivery. For example, women reported massive vaginal bleeding for 12 percent of births that occurred in the three years preceding the survey and very high fever in the postpartum period for 14 percent of births.

This tragic picture of maternal health is further compounded by the fact that women in the reproductive ages are repeatedly exposed to the risk of childbearing and are powerless to alleviate their suffering under the existing socio-economic and cultural setting and an inadequate medical and health system. It is therefore important to understand the underlying direct and indirect factors which prevent further reduction in maternal mortality.

Scope & objective of the study

The recent estimates of maternal mortality from the SRS reveal that maternal mortality in India has declined substantially during the recent period, although its level at about 301 maternal deaths per 100,000 live births during 2001-03 (which was about 398 during 1997-98) is still high (Registrar General, 2006). Considering the current level of MMR in major states in the country, particularly in the less developed states (MMR more than 400) and the pace of its decline in the recent past it is highly unlikely that an MMR of 100 per 100,000 live births as envisaged under the national programme and the National Rural Health Mission can be achieved (Das et al, 2007).

To improve maternal health and survival and achieve the Millennium Development Goal (MDG) by the target date, policy makers and programme implementers must make difficult choices regarding prioritization in the allocation of scarce resources in a developing country like India. To make such decisions, they not only need data on the level and trends in maternal mortality in the country, but also information on differences in the risk of maternal death between regions and communities as well as between various socio-economic groups in a country. Unfortunately, reliable and comparable data on maternal mortality are scarce because of the requirement of a very large sample of women to accurately measure the same. Apart from this large sample size requirement, such maternal deaths in a survey are often misclassified and attributed to non-maternal causes. This study has therefore examined the available large national surveys conducted since the early 1990s to establish the level of maternal mortality and its variation across the states, to assess the clinical causes of maternal deaths, the prevailing socio-economic differentials in maternal mortality and the proximate indicators that explain these differentials in India which has witnessed substantial decline in MMR during the recent past.

DATA AND METHOD

Firstly, the present study has used the recent data from the Sample Registration System (SRS) which is the largest demographic sample survey in the country. Since the late 1990s, the SRS has initiated retrospective or continuous recording of maternal deaths, with generally consistent definitions, to provide direct estimates of maternal mortality for the major states as well as for the country as a whole (Registrar General, India, 2006). The SRS data available for the periods 1997-98, 1999-2001 and 2001-03 have been used here to examine the level and trend of maternal mortality. The 2001-03 survey data from the SRS have been used here to understand the causes of maternal deaths, inferences of which were made by the SRS, based on examination of household reports and their medical evaluation by two trained physicians, besides adopting other quality control methods. The conventional definition of maternal death, as given in the International Classification of Diseases, was adopted by the SRS. Accordingly, “maternal

death is the death of a woman while pregnant or within 42 days of termination of pregnancy, irrespective of the duration and the site of the pregnancy, from any cause related to or aggravated by the pregnancy or its management but not from accidental or incidental causes" (WHO, 1977).

The study has next examined the differentials in maternal mortality by state, region as well as by the socio-economic characteristics of households and individuals. Since the data from SRS do not provide information on maternal mortality by background characteristics, the available maternal mortality data from the DLHS-RCH-2 (2002-04), which has a reasonably large sample at the national level, were analysed to understand differentials in maternal mortality. To study the differentials in maternal mortality a new index viz. Crude Maternal Mortality Rate (CMMR), is used in the absence of data to compute conventional indices of mortality such as maternal mortality rate and maternal mortality ratio for various sub groups of the population. The CMMR is defined here as the number of maternal deaths to women age 15-44 per 10,000,00 population. The measure is based on the annual number of female deaths to usual residents of the sample households that occurred during pregnancy, childbirth or within 42 days after the termination of a pregnancy and which was due to a complication of the pregnancy or childbirth.

To meet with the final study objective, analysis of three rounds of NFHS data collected over 14 years since 1992 was carried out to assess the role of various proximate indicators, over time, in the reduction of maternal mortality in India.

RESULTS AND DISCUSSION

This section first presents the level of maternal mortality rate by state in the country based on direct estimates from the SRS (2001-03) and compares with that based on DLHS-2 (2002), which will help not only to understand level of maternal mortality but also help to assess completeness of DLHS-2 data for further analysis. Clinical causes of maternal mortality and the differentials in CMMR (as defined earlier) by region, residence as well as by the socio-economic characteristics of the households are presented next. Finally, the different programme variables and other proximate indicators which play a crucial role in reducing maternal mortality in the country have been identified to be able to suggest action under the national programme.

Level of maternal mortality rate

The maternal mortality rate is the number of maternal deaths to women age 15-44/15-49 per 1,00,000 women of the respective age group, during pregnancy, childbirth or within 42 days after termination of pregnancy due to complication of pregnancy or childbirth. As is evident from Table 1, the level of maternal mortality rate is about 27.4 per 1,00,000 women age 15-49 years during the period 2001-03, as per the estimate by SRS. The corresponding level was about 34.8 (data not shown in Table 1) during 1997-98, indicating a

Table 1: Estimates of Maternal Mortality Rate* by States, India, 2001-04

State	DLHS - RCH – 2, 2002-04		SRS, 2001-03	
	Female population, age 15-44 years	Maternal mortality rate+ per 100,000 women age 15-44 years (2002)	Female population, age 15-49 years	Maternal mortality rate per 100,000 women age 15-49 years
North				
Jammu & Kashmir	20484	5.2	-	-
Himachal Pradesh	15771	3.1	-	-
Punjab	24031	15.1	142595	13.8
Haryana	27216	25.7	163710	16.9
Central				
Uttar Pradesh	95339	41.8	462547	70.01[1]
Uttaranchal	16030	13.7	-	-
Madhya Pradesh	58184	47.1	220269	47.42[2]
Chhattisgarh	19954	19.6	-	-
East				
Bihar	53321	60.8	321721	48.63[3]
Jharkhand	24419	43.0	-	-
Orissa	39624	41.2	254176	29.5
West Bengal	22793	7.1	390702	14.8
Assam	30423	17.8	202943	47.4
West				
Rajasthan	47221	21.9	248891	56.1
Gujarat	32416	27.8	219783	16.6
Maharashtra	44414	15.4	266750	11.7
South				
Andhra Pradesh	27907	28.3	251511	14.8
Karnataka	37174	15.5	299571	18.9
Kerala	17186	3.6	274990	6.6
Tamil Nadu	36247	14.0	298726	8.8
Total	**795822**	**25.8**	**5039583**	**27.4**

* The maternal mortality rate is defined here as the number of maternal deaths to women age 15-44/15-49 per 1,00,000 women age 15-44/15-49. The measure is based on the annual number of female deaths to usual residents of the sample households that occurred during pregnancy, child-birth or within 42 days after the termination of a pregnancy or childbirth and which was due to a complication of the pregnancy or childbirth.

+ Weighted by state

[1] Includes Uttaranchal [2] Includes Chhattisgarh [3] Includes Jharkhand

Source: (1) Computed from DLHS-RCH-II (2002-04) data file, obtained from IIPS, Mumbai.

(2) SRS estimates are obtained from the study on "Maternal Mortality in India: 1997-2003 Trends, Causes and Risk Factors", Registrar General, India, New Delhi, October 2006.

decline in maternal mortality since 1997. When the same index is computed from the available data on maternal deaths from DLHS-RCH-2 (2002-04), it was found to be about 25.8, which, although slightly lower approximates the SRS estimate (27.4) of 2001-03. However, differentials are evident when the estimates from the two different sources are compared for the major regions and states in the country. The estimates of MMR at the state level, when derived from DLHS-RCH-2 data, may not be as stable as that of the SRS, sample size covered under the DLHS-RCH-2 is much smaller compared to

that under the SRS (Table1). Nevertheless, Table 1 does reveal the variation in maternal mortality across the states, with a relatively lower rate of mortality in some of the southern states (Kerala, Tamil Nadu) as well as in parts of the north (Himachal Pradesh, Jammu & Kashmir and Punjab) while it is much higher in the eastern region (Bihar, Orissa) and central India (Uttar Pradesh, Madhya Pradesh).

Level of Maternal Mortality Ratio

Table 2 presents the direct estimate of maternal mortality ratio (MMR) based on SRS for the period 1997-98 to 2001-03, which also reveals that maternal mortality has shown a decline over time in a number of states as well as in the country as a whole. However, estimates of MMR for certain states during the period 1997-2003 appear to be inconsistent, and unexpectedly indicate a rise in the level of maternal mortality during the period. Nevertheless, the decline at the national level during 1997-98 and 2001-03 is statistically significant. It is further evident from Table 2 that there are wide differentials in the level of maternal mortality across the states even during the recent period. The maternal mortality ratio is relatively lower (< 200) in some of the southern states like Kerala and Tamil Nadu as well as in certain northern states like Punjab and Haryana, while it is much higher (> 350) in the central and eastern region (except West Bengal). At the all-India level, the SRS estimates MMR at 301 (95% CI ranging from 285 to 317) during 2001-03, which declined from 398 (378-417) prevailing during 1997-98. This national level estimate appears to be under-estimated in view of the NFHS – 2 (1998-99) estimate of 540 with a 95% confidence interval ranging from 428 to 653, at the national level. However, this estimate is much higher than that observed about 6 years ago during NFHS-1 (1992-93) which gave an estimate of 437 maternal deaths per 100,000 live births (with 95% CI ranging from 384 to 540). Nevertheless, the adequate the sample base even at the state level and the regularity of the surveys under SRS makes them a valuable source to monitor maternal health in the country, provided certain gaps in the data are addressed.

Clinical causes of maternal mortality

A special survey of maternal deaths undertaken by SRS during 2001-03 provides information on causes of maternal mortality based on the method of verbal autopsy and verified by physicians trained for the purpose (Registrar General, India, 2006). Based on the International Classification of Diseases as per the WHO guidelines, the major causes of maternal death reported by SRS are summarised in Table 3. It is evident from this table that haemorrhage and a host of other conditions (such as infection of the genitourinary tract, diabetes, malnutrition, placenta disorder, umbilical cord complication etc.) account for 38 and 33 percent of maternal deaths respectively, indicating that the majority of maternal deaths occur as a result of malnutrition and lack of medical attention during childbirth and in the post partum period. Another large proportion of maternal deaths (11 percent) were reported have occurred as a result of sepsis (puerperal related infection) followed by 8 percent of deaths due to abortion and its complications and about 5 percent each due to

Table 2: Estimates of Maternal Mortality Ratio (MMR)[+] and its Trend for Major States of India, 1997-2005

Region/ State	Maternal Mortality Ratio (maternal deaths per 100,000 live births)[++]		
	1997-1998	1999-2001	2001-2003
North			
Jammu & Kashmir	-	-	-
Himachal Pradesh	-	-	-
Punjab	280 (185-376)	177 (99-254)	178 (100-257)
Haryana	136 (82-191)	176 (113-239)	162 (102-223)
Central			
Uttar Pradesh[*]	606 (544-668)[1]	539 (481-596)[1]	517 (461-573)[1]
Madhya Pradesh	441 (370-512)[2]	407 (332-482)[2]	379 (306-452)[2]
East			
Bihar[*]	531 (464-597)[3]	400 (340-461)[3]	371 (313-430)[3]
Orissa	346 (264-427)	424 (336-512)	358 (277-439)
West Bengal[*]	303 (240-366)	218 (165-271)	194 (111-243)
Assam	568 (460-677)	398 (309-486)	490 (393-588)
West			
Rajasthan	508 (425-590)	501 (423-580)	445 (371-519)
Gujarat	46 (19-74)	202 (141-262)	172 (116-228)
Maharashtra	166 (117-216)	169 (114-224)	149 (97-201)
South			
Andhra Pradesh	197 (132-261)	220 (155-286)	195 (132-257)
Karnataka	245 (185-305)	266 (202-311)	228 (169-287)
Kerala	150 (90-210)	149 (91-207)	110 (59-161)
Tamil Nadu	131 (81-182)	167 (111-224)	134 (83-185)
All India[*]	398 (378-417)[@]	327 (311-343)	**301 (285-317)**

[1] Includes Uttaranchal [2] Includes Chhattisgarh [3] Includes Jharkhand

[+] Based on SRS Special Retrospective surveys on Maternal Mortality in India: 1997-2003 (Registrar General India, 2006)

[++] The maternal mortality ratio is defined here as the number of maternal deaths to women age 15-49 years per 100,000 live births, that occurred during pregnancy, child-birth or within 42 days after the termination of a pregnancy or childbirth and which was due to a complication of the pregnancy or childbirth.

[@] Figures within parenthesis indicate 95 percent confidence interval,

[*] The decline in MMR during 1997-98 and 2001-03 is significant at least at .01 level

Source: (1) Computed from DLHS-RCH-II (2002-04) data file, obtained from IIPS, Mumbai.

(2) SRS estimates are obtained from the study on "Maternal Mortality in India: 1997-2003 Trends, Causes and Risk Factors", Registrar General, India, New Delhi, October 2006.

hypertensive disorder and obstructed labour. Direct causes of maternal death are similar to those in several developing countries and they include haemorrhage/excessive bleeding, infections, pregnancy related hypertension, obstructed labour and unsafe abortion (Biswas, 2003).

While nutritional deficiency, largely influenced by poverty, socio-cultural related factors and poor reach of the nutritional programme, appears to be one of the major causes of maternal mortality, timely medical care and management of complications arising out of nutritional deficiency, and other

Table 3: Causes of Maternal Deaths in India, 2001-03*

Clinical Causes	Percentage of deaths	95% CI
Haemorrhage (during or after delivery)	38	34-41
Sepsis (Puerperal related infections)	11	9-14
Hypertensive disorders (during pregnancy, childbirth & puerperium, eclampsia, gestational oedema & proteinuria without hypertension)	5	3-6
Obstructed labour (caused by malposition of fetus at onset of labour, obstruction by bony pelvis/ abnormal pelvic soft tissues, shoulder dystocia, locked twins)	5	3-6
Abortion (complicated by genital tract & pelvic infection, by delayed or excessive haemorrhage, renal failure, shock retained products of conception during spontaneous or induced abortion)	8	6-10
Other conditions (haemorrahage in early pregnancy, infections of genitourinary tract, diabetes, malnutrition, obstetric trauma, labour & delivery complicated by fetal stress, long labour, placenta disorder, umbilical cord complications, multiple gestation/ multiple delivery)	33	30-37
Total	**100.0**	

***Source**: (1) SRS, Registrar General of India, 2006.
(2) Elaborated from International Classification of Diseases, Manual of the International Statistical Classification of Diseases, Injuries and Causes of Death, 9th and 10th Revision, World Health Organisation, Geneva.

health conditions noted during pregnancy, delivery or after delivery, could have prevented a large proportion of maternal deaths in India. We will come back to these programme variables a little later.

Differentials in Maternal Mortality

The understanding of differentials in maternal mortality by region, residence and other background characteristics is important to inform programmatic action. In the absence of required data to compute the conventional measure of maternal mortality, a new index namely, crude maternal mortality rate (CMMR) as defined in the section on methodology, was computed from the recent DLHS-RCH data. The results of the analysis are presented in Table 4.

As is evident from Table 4, the level of CMMR is found to be 59 maternal deaths per 10,000,00 population which also appears to be an underestimate as noted earlier in case of MMR. Nevertheless, this index will suffice to study the differentials in maternal mortality. It is once again evident from Table 3

Table 4: Differentials in Crude Maternal Mortality Rate (CMMR) by Region and Socio-Economic Status of the Households, India, 2002-04

Region/SES of the head of the household	No of HHs covered	Population covered	CMMR [a]	SE (CMMR)	Results of ANOVA	Results of Scheffe's test: Mean difference significant at least at .01 level between ith and jth group:
Education						
1. Illiterate	229169	1279941	76.71	7.74	F = 18.62*	1 vs. 3,4
2. Primary(1-7)	153916	887011	61.21	8.31		2 vs. 4
3. Secondary(8-10)	140571	792326	50.30	7.97		3 vs. 4
4. Higher secondary & above (11+)	96353	505747	25.77	7.14		-
Religion						
1. Hindu	477565	2631412	66.32	5.02	F = 12.86*	1 vs. 3
2. Muslim	67897	429380	43.60	10.08		-
3. Others	74546	404232	30.03	8.62		-
Caste						
1. Scheduled caste	106919	585968	94.52	12.70	F = 15.56*	1 vs. 2,3,4
2. Scheduled tribe	101263	552790	61.90	10.58		-
3. Other backward castes	224785	1288739	54.35	6.49		-
4. Others	187041	1037528	44.07	6.52		-
SLI						
1. Low	287087	1545043	82.79	7.32	F = 33.46*	1 vs. 2. 3
2. Medium	187893	1079947	46.42	6.56		-
3. High	145027	840027	32.52	6.22		-
Place of residence						
1. Rural	414967	2349079	67.90	5.38	F = 31.62*	1 vs. 2
2. Urban	205041	1115947	41.11	6.07		-
Region						
1. North	76552	423128	38.56	9.55	F = 20.36*	1 vs. 2,3
2. Central	147651	888565	77.42	9.33		2 vs. 4,5,6
3. East	107479	625634	87.66	11.84		3 vs. 4,5,6
4. Northeast	80946	435674	34.51	8.90		-
5. West	101175	566411	55.27	9.88		-
6. South	106203	525613	36.28	8.31		-
Total	**620008**	**3465025**	**59.27**	**4.14**		

[a] The Crude Maternal Mortality Rate (CMMR) is defined here as the number of maternal deaths to women age 15-44 per 10,000,00 population. The measure is based on the annual number of female deaths to usual residents of the sample households that occurred during pregnancy, childbirth or within 42 days after the end of a pregnancy or childbirth, and it was due to a complication of the pregnancy or childbirth.

* Significant at least at .001 level.

Source: Computed from DLHS - RCH – II (2002-04) data file obtained from IIPS, Mumbai.

that there is a large regional differential in maternal mortality across the country, with the eastern and central regions recording the highest rate while the southern, northern and northeastern regions have recorded a relatively much lower rate of maternal mortality. Similarly, as expected, women in rural households have a relatively greater susceptibility to die due to maternal causes. When other characteristics of the household are examined, the results are in the expected direction. For example, education, religion, caste and standard of living of the head of the household have an important bearing on maternal mortality. In fact, all the selected variables are found to be significantly related to maternal mortality. However, the results also show some interesting findings. For example, education of head of the household beyond secondary level is found to be critical for ensuring survival of women during their childbearing period. As regards religion and caste, women belonging to households having affiliation to religions other than non-Hindu and non-Muslim households were found to have least risk of dying during their childbearing period as were women belonging to castes other than lower castes and tribes.

While it is well known that non- Hindu and non-Muslim households and those belonging to upper caste group are expected to experience a lower level of maternal mortality, one needs to explore the reason for the relatively lower level of mortality among Muslims (compared to Hindus) and tribal (compared to scheduled caste) women. Incidentally, a similar result with respect to differentials in MMR by caste and religion has also been noted by Bhat, 2002.

The observed differential in MMR by region, residence and various background characteristics is in fact, basically a function of utilization of antenatal and natal services as well as the level of anemia and nutritional status of women. For example, data from the NFHS – 2 and 3 clearly indicate a high prevalence of nutritional deficiency (both in terms of BMI and anemia) noted particularly among Hindu women, those residing in rural areas, are not literate, belong to scheduled caste and scheduled tribe groups and those who reside in households with a low standard of living. Similarly, as expected, full antenatal care (such as at least three ANC check-ups, at least one tetanus toxoid injection and adequate amount of iron folic acid supplementation during pregnancy) and institutional delivery is once again relatively very low among women in rural areas, who are not literate, belong to scheduled caste and scheduled tribe communities and reside in households with a low standard of living. With regard to religion, the data indicate that both Hindu and Muslim women fare much lower than women from other religions on both these indicators (DLHS-RCH-2 (2002-04) IIPS, 2006; NFHS– 3, (2005-06), IIPS & Macro International, 2007).

The large observed socio-economic differentials in MMR thus suggest that the health and nutrition programmes are not reaching all class and caste groups of women equally in the rural and urban areas of the country. If the reach of the programme had been effective, such large differentials would not have been evidenced.

Proximate factors of maternal mortality

In order to better understand the role of the above four identified proximate indicators that influence maternal mortality, the available national level survey data are examined in detail in this section.

Considering the nature of data available, a macro level analysis, using state as a unit of analysis, was carried out. The MMR of each state is considered as the dependent variable whereas nutritional status (as measured by proportion of women with BMI <18.5), anemic condition (proportion of pregnant women 15-49 who are anemic), antenatal care status as measured by proportion of women who received at least two TT injections, as a proxy for full ANC (proportion of women who received at least 3 antenatal visits, atleast one TT injection and adequate amount of IFA tablets) and institutional delivery (proportion of births that took place at a medical facility during the three years preceding the survey), are the independent variables. This analysis was repeated for three data sets obtained from the individual rounds of NFHS which were conducted over three points of time to assess the relative importance of the identified proximate indicators when MMR falls over time.

The data for the estimate of MMR were mainly taken from various rounds of SRS after their adjustment based on a method developed by Das et. al (2007), and the data used for the measurement of the above four identified proximate indictors that influence maternal mortality, were obtained from the three rounds of NFHS. The data thus finally used for the present analysis are summarised in Table 5.

It may be noted that out of the two variables used for assessing the nutritional status of women viz. “BMI” and “Anemia” (proportion of women age 15-49 who are anemic), “Anemia” was finally dropped from the present analysis to minimize multi-co-linearity problem in the multi-variate analysis, since our preliminary analysis of NFHS data suggests that there is consistently a very high correlation (above 0.75) between anemia and BMI of women (data not shown). The high correlation between these variables seems to suggest that in a state where women are taking care of their calorie requirements are also able to combat anemia among them. As can be seen from Table 4, the nutritional status of women as measured through BMI has slightly improved overtime, as proportion of women whose BMI is below normal (that is, less than 18.5), which was about 38 percent during the early 1990s reduced to 30 percent during the year 2005-06, although nutritional deficiency is still an important issue in a number of states and varies widely across the states particularly during the recent period. Similarly, the status of institutional delivery, which has also improved over the last decade, is still far from satisfactory and varies very widely across the states (Table 5). For example, the proportion of births that take place at a medical facility which was about 29 percent during the early 1990s, increased to 49 percent during 2005-06, indicating that more than half of the births are yet delivered at home and a large number of them are delivered without the required medical assistance. Regarding another important proximate indicator viz. antenatal care status, it is evident from Table 5 that the situation is relatively much

Table 5: Summary of the State-wise Data used for the Study of Proximate Determinants of Maternal Mortality in India, 1992-2005

	Variables	Year					
		1992		1998		2005	
		Mean[4]	SE	Mean[4]	SE	Mean[4]	SE
1	Maternal mortality ratio (per 100,000 live births)[1]	509	62	414	47	310	35
2	Antenatal care[2] (percentage of women who received two or more doses, TT injection for their births during three years preceding the survey as a proxy for full ANC, as there is high correlation between those received two TT injections and those who received adequate among of IFA or those who received atleast 3 ANC check-ups)	59.4	4.8	70.5	3.5	77.1	3.1
3	Institutional delivery[2] (percentage of births that took place at a medical facility among the last two live births during three years preceding the survey)	28.8	4.9	37.9	5.1	48.8	5.3
4	Nutritional status of women[3] (measured by proportion of women whose body mass index is below normal, that is, less than 18.5)	37.8	1.7	32.0	2.3	29.5	2.2

[1] Computed from SRS data after adjustment by present authors (Das et al., 2007) for the period 1998 and onwards, while the rate for 1992 was computed from a study by Bhat (2002)

[2] Computed from the three rounds of NFHS conducted during 1992-93, 1998-99 and 2005-06 in various states of India.

[3] Body mass index (BMI) is defined as weight in kilograms divided by height in meters squared (kg/m^2). This index was computed for all women age 15-49 except those women who were pregnant at the time of the survey and those who gave birth during the two months preceding the survey. A cut off point of 18.5 is used to define thinness of acute under-nutrition among women.

[4] The means may not match with the observed all- India estimates since these are based only on states for which complete information on MMR and other proximate indicators are available. Moreover, smaller states have also been excluded to ensure stability of results.

better compared to that of the other two indicators, as the proportion of women who received two doses of TT injection as a part of antenatal care for their last birth that occurred during three years preceding the survey, which was about 59 percent during the early 1990s, increased to more than 77 percent during 2005-06, thereby reducing the variation across the states in availing antenatal care. Incidentally it may be noted that other components of ANC such as regular antenatal check-ups and consumption of adequate amount of IFA, are highly correlated with the mother's TT status (widely publisied NFHS data used for analysis not shown), indicating that the women who are receiving two doses of TT injections, are also likely to receive other antenatal care needed for complete protection.

Finally, regarding the consequent (dependent) variable viz. maternal mortality ratio (MMR), as can be seen from Table 6, the pooled level of MMR which was about 509 ($\pm$ 62) per 100,000 live births during 1992, reduced to about 414 ($\pm$ 47) during 1998, which further reduced to about 310 ($\pm$ 34) during 2005. It is therefore important to understand the role of various proximate indicators over this period so that necessary programmatic interventions are made in an effort to achieve the desired reduction in MMR by the targeted date.

Table 6: Correlation Between Maternal Mortality Ratio and Its Proximate Factors, India, 1992-2005

	Variables	Year		
		1992	**1998**	**2005**
1	Antenatal care (proportion of women who received 2 doses of TT injection for their last live births/still births during three years preceding the survey as a proxy for full ANC, as there is high correlation between those received two TT injections and those who received adequate among of IFA or those who received atleast 3 ANC check-ups)	-0.52**	-0.49**	-0.31
2	Institutional delivery (proportion of births that took place at a medical facility among the last two live births three years preceding the survey)	-0.67**	-0.70**	-0.72**
3	Nutritional status of women (measured by proportion of women whose body mass index is below normal, that is, less than 18.5)	0.54*	0.54*	0.70**

Note: The correlation between MMR and its three identified proximate variables is computed taking 20 major states as the units of analysis

* Significant at the 0.05 level (2 – tailed)

** Significant at the 0.01 level (2 – tailed)

As a first step, to assess the extent of relationship between the dependent and the independent variables, a zero order correlation was derived for the three reference years, mentioned earlier, which is presented in Table 6. It is evident from this table that all the three proximate variables finally selected are significantly correlated with maternal mortality indicating that the nutritional status of the women (including anemia) as well as utilization of the required antenatal and natal services are crucial to enable them to go safely through pregnancy, childbirth and the post partum period.

It is further interesting to note from Table 6 that antenatal care which appears to be a significant factor for the reduction of MMR in the early and late 1990s, is no longer an important determinant of maternal mortality, while the nutritional status of the women, measured through BMI is emerging as a stronger determinant of maternal mortality during the recent period, it being harder to address under the national health programme. On the other hand, institutional delivery which ensures safe delivery, continued to be a most important determinant of maternal mortality. The results thus seem to suggest that the national health programme is able to ensure minimum antenatal care needed to protect women during pregnancy in most of the states, while the programme failed to improve institutional delivery to the desired extent in majority of the states. Similarly, the nutritional status of women is still very poor because of their poor socio-economic condition and inadequate reach of the nutritional programmes in the country. Nevertheless, in order to understand the net effect and finally to determine the most important predictor(s) overtime, a stepwise regression analysis was carried out with MMR as the dependent variable for the three sets of data referring to

three time periods. The results of this analysis, presented in Table 7 reveal that the variable which finally remained in the regression equation for the year 1992, was institutional delivery, which was found to be highly significant and explained about 44 percent of the variance in MMR during the early 1990s, indicating that delivery at a medical or health facility is the single most important variable to ensure women's survival.

Table 7: The Results of Stepwise Regression Analyses Using Maternal Mortality Ratio as the Dependent Variable for the Year 1992,1998 and 2005

Dependent Variable: Maternal Mortality Ratio					
Variable(s) finally entered in the equation:					
	Regression Coefficient (b)	**SE (b)**	**Standardized coefficients**	**Adjusted R^2 (%)**	**Value of F**
Model 1(1992)				44.4	11.972**
Institutional delivery	-8.020*	2.32	-0.67		
(Constant)	742.502*	82.75	-		
Model 2 (1998)				64.8	
Institutional delivery	-5.73*	1.46	-0.61	-	13.810**
Nutritional status of women (BMI)	8.337*	3.23	0.40	-	-
(Constant)	363.396*	130.87			
Model 3(2005)				65.6	14.281**
Institutional delivery	-3.112*	1.16	-0.48		
Nutritional status of women (BMI)	7.046*	2.83	0.45	-	-
(Constant)	254.245	124.97	-		

Note: All the three proximate variables defined in Table 6, being significantly related to maternal mortality ratio, are considered in the stepwise regression analysis with MMR as the dependent variable.

* Value of t significant at least at .001 level

** Significant at least at .001 level

This, however, does not lessen the importance of the other variables included in the analysis. For example, since the correlation between institutional delivery and ANC is very high (0.78), during the early 1990s which infact remained so during the late 1990s and also during the recent period (2005), antenatal care variable gets therefore excluded from the final regression equation of 1992, 1998 and 2005. These results therefore do not undermine the importance of antenatal care for the further reduction in MMR in the country. This is because of the fact that the states in which women are

availing the complete range of antenatal services, are also highly likely to deliver at a medical facility.

It is however interesting to note from the results of 1998 and 2005 models that the nutritional status of women as measured through BMI, which was not noted to be important under the 1992 model (because of relatively high prevalence of nutritional deficiency among women, with relatively very low variation across the state), emerged as one of the most important predictors of maternal mortality. This variable along with the variable – "institutional delivery" explains about two-thirds of the variance in MMR during the recent period. The results thus indicate that nutritional status of women and institutional delivery are still the most important determinants of MMR in the country which are also consistent with our earlier results on the leading causes of maternal mortality evidenced from clinical data.

The non-institutional delivery (noted in case of more than fifty percent of the women) is likely to give rise to complications during or after delivery or induced abortion such as, genital tract and pelvic infection, haemorrhage, obstetric trauma, obstructed labour and delivery complicated by fetal stress, long labour, placenta disorder and umbilical cord complications which, in turn are leading causes of maternal mortality. In addition, poor socio-economic condition of the women which impinge on their health, as a result of adolescent marriage, large family size norms which encourage frequent and closely spaced pregnancies, nutritional deficiency and lack of awareness of other health care, give rise to such complications during or after delivery, which are fatal in many situations.

CONCLUDING REMARKS

The estimates of maternal mortality, as measured through maternal mortality rate and maternal mortality ratio, from the Sample Registration Scheme, other national level survey data and those derived under the present study, have clearly revealed a decline in the level of maternal mortality in majority of the states and therefore at the national level during the last decade, although the level of MMR is still high (atleast 301 per 100,000 live births) in the country with a wide variation across the states from about 110 in Kerala to more than 500 in Uttar Pradesh, as per the latest estimate of SRS (2001-03).
Data from the special survey on the clinical causes of maternal deaths undertaken by SRS during 2001-03 have shown that haemorrhage and a host of other conditions (such as infection of the genitourinary tract, diabetes, malnutrition, placenta disorder, umbilical cord complication etc.) account for 38 and 33 percent of maternal deaths respectively, indicating that the majority of maternal deaths occur during childbirth.

A large regional differential in maternal mortality across the country was noted with the eastern and central regions recording the highest rate while the southern, northern and northeastern regions had the lowest rate of maternal mortality. Similarly, as expected, women in rural households had a relatively greater susceptibility to die due to maternal causes.

In fact, as expected, all the selected variables viz., education, religion, caste and standard of living of the head of the household were found to be significantly related to maternal mortality. However, the results also show some interesting findings. For example, education of head of the household beyond secondary level is found to be critical for ensuring survival of women during their childbearing period. While it is well known that households belonging to religions other than Hindu and Muslim and those belonging to upper caste group are expected to experience a lower level of maternal mortality, one needs to explore the reason for relatively lower level of mortality among Muslims (compared to Hindus) and tribal (compared to scheduled caste) women.

These socio-economic differentials in MMR observed in the country are primarily a function of utilization of antenatal and natal services and nutritional status of women. The recent NFHS data also indicate that better utilization of such maternal health-care services and better nutritional status of women are noted in those states which are found to have relatively better socio-economic development, including women's literacy, which plays a catalytic role in ensuring their survival during the childbearing period. Therefore to offset the deficit of socio-economic development, programmatic efforts must be targeted to all women but especially to those who are educationally and socially marginalised so that they are brought within the fold of the national programme and are motivated to utilize the required health services. In this regard, proximate indicators of MMR identified in our study suggest that there is a need to combat nutritional deficiency during pregnancy and after childbirth as well as to ensure institutional delivery or atleast safe delivery at home under the national health programme.

Therefore, programme initiatives by the central and state governments under the NRHM, such as Janani Suraksha Yojana, Chiranjeevi Yojana, and PHC services 24 X 7, EmOC (including referral and transport services), upgrading CHCs & FRUs to IPHS etc. are indeed laudable and need to be implemented on a priority basis to ensure institutional delivery. It is needless to say that early registration of pregnant women and providing the complete range of ANC services is not only important to manage women's health during pregnancy but also sets the stage to counsel for and ensure institutional delivery. Another important component which has a large bearing on MMR is anemia and underweight. This should be addressed under the iron prophylaxis and ICDS programmes. In fact, special focus needs to be on those under-developed states where MMR is high (such as Orissa, Madhya Pradesh, Bihar, Uttar Pradesh, Rajasthan, Chhattisgarh and Assam) to improve the reach of antenatal, natal and nutrition services under the RCH programme if the reduction in MMR by three-fourths is to be achieved by 2015 as envisaged under the Millennium Development Goal.

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