Original research

India's progress towards the Millennium Development Goals 4 and 5 on infant and maternal mortality

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Background: India is in a race against time to achieve the Millennium Development Goals (MDGs) 4 and 5, to reduce Infant Mortality Rate (IMR) to '28' and Maternal Mortality Ratio (MMR) to '109', by 2015. This study estimates the percent net-contribution of the states and the periods in shaping India's IMR/MMR, and predicts future levels.

Methods: A standardized de-composition technique was used to estimate each state's and period's percent share in shaping India's decline in IMR/MMR between two time points. Linear and exponential regression curves were fitted for IMR/MMR values of the past two decades to predict IMR/MMR levels for 2015 for India and for the 15 most populous states.

Results: Due to favourable maternal mortality reduction efforts in Uttar Pradesh (33%), Bihar/Jharkhand (19%) and Madhya Pradesh/Chhattisgarh (11%) - India is predicted to attain the MDG-5 target by 2016, assuming the pace of decline observed in MMR during 1997-2009 continues to follow a linear-trend, while the wait may continue until 2023-24 if the decline follows an exponential-trend. Attaining MDG-4 may take until 2023-24, due to low acceleration in IMR drop in Bihar/Jharkhand, Uttar Pradesh/Uttarakhand and Rajasthan. The maximum decline in MMR during 2004-09 coincided with the launch and up-take of the National Rural Health Mission (NRHM).

Conclusions: Even though India as a nation is not predicted to attain all the MDG-4 and 5 targets, at least four of its 15 most populous states are predicted to do so. In the past two decades, MMR reduction efforts were more effective than IMR reduction efforts.

Key words: Achievement, infant mortality rate, maternal mortality ratio, Millennium Development Goals, net-contribution, regression equation, target, India.

Introduction

Globally, maternal and child mortality are in decline, although the pace of decline is not sufficient to attain Millennium Development Goals (MDGs) 4 and 5 for 128/137 developing countries[1]. Due to slow progress in reducing infant and maternal mortality, and the moral urgency of reinvigorating efforts to tackle slow progress; the United Nations (UN) launched the Global Strategy for Women's and Children's Health in 2010[2]. As part of this strategy, India committed to spend US $ 3.5 billion annually, for strengthening maternal and child health services in 235 districts, which account for nearly 70% of infant and maternal deaths[2]. In 2010, India recorded 56 000 maternal[3] and 1.3 million infant deaths[4], the highest for any country [5, 6, 7].

India's MDG-4 target is to reduce IMR by two-thirds between 1990 and 2015, i.e., from 80 infant deaths per 1000 live births in 1990 to '28' by 2015. Under MDG-4, another target is to improve the proportion of one-year-old children immunized against measles from 42%[8] in 1992-93 to 100% by 2015[9]. India's main MDG-5 target is to reduce MMR by three-quarters between 1990 and 2015, i.e., from 437 maternal deaths per 100 000 live births to '109'[9], while it has also committed to improve the 'proportion of births attended by skilled health personnel'. With only three years left to achieve MDGs-4 and 5 targets, there is a need to understand the progress made by India and as well as its15 most populous states.

To a large extent, India shapes the global MDGs-4 and 5 targets, because of its share of the global burden of child (23%) and maternal mortality (19%)[1, 3]. Moreover, during the past two decades, the 15 most populous states, which account for 95% of India's population, have made variable progress on infant and/or maternal mortality reduction efforts[5]. State-wise

analysis of IMR/MMR decline provides us an opportunity for learning which strategies did and did not work. In this context, the specific objectives of the study are:

1. To estimate percent net-contribution of the 15 most populous states and different periods, in shaping India's IMR and MMR decline;
2. To fit linear and exponential regression curves, and understand how IMR/MMR has declined in India and in the 15 most populous states;
3. To use the fitted regression estimates, extrapolate the year by which India's MDGs-4 and 5 targets of IMR '28' and MMR '109' would be achieved by India and the 15 most populous states.

Methods

Quantifying the contribution of states' decline during a time period upon overall decline: We have partitioned the difference in IMR/MMR of a state between t_1 and t_2 into two components: Component-1 is the difference due to differences in state-specific IMR/MMR. Component-2 is the difference due to differences in state-specific distribution of live births. We made this computation for each state by using the formula developed by Fleiss[10] and refined by Buehler et al[11] (equation-1).

$$\{[(P_1 + P_2)/2] \times (R_1 - R_2)] + [(R_1 + R_2)/2] \times (P_1 - P_2)]\} \text{---------(1)}$$

Where,

P_1 and P_2 represent the proportion of live births in a state at t_1 and t_2

R_1 and R_2 represent IMR/MMR of a state at t_1 and t_2

We added two components of equation-1 to arrive at *'net-excess deaths at t_2 as compared to t_1'* for each state[10, 11]. We finally calculated what percentage of the total net-excess deaths between t_1 and t_2 in India was contributed by each of the 15 populous-states. Using Sample Registration System (SRS) data, periodic changes in IMR were measured for the following durations: 1990 and 1996; 1996 and 2001; 2001 and 2006; 2006 and 2010; and for the whole period 1990 and 2010. Using SRS data, periodic changes in MMR were measured for the following durations: 1997-98 and 1999-01; 1999-01 and 2001-03; 2001-03 and 2004-06; 2004-06 and 2007-09; and for the total period 1997-98 and 2007-09.

Estimation of trends in IMR/MMR: For understanding the trends in IMR/MMR decline, we fitted regression curves between IMR/MMR values and their reference dates using Ordinary Least Square (OLS) method, as OLS offers a greater degree of objectivity, in the absence of outliers[12]. It is globally assumed; IMR/MMR declines are non-linear and approximate to exponential[13, 14]. If the decline is exponential, it reflects the fact that mortality cannot keep

declining linearly below zero. However, there is no evidence that IMR/MMR decline is best modelled as exponential[15]. In contrast, if decline follows a linear pattern, IMR/MMR declines at a constant rate over a defined period and can decline below zero. Hence, we fitted linear and exponential regression-curves, separately for India and for 15 populous states, using SRS data. Chi-square goodness-of-fit test was used for assessing the appropriateness of the fitted regression curve.

For fitting regression curves of IMR, we used a moving-average figure of 3 consecutive years as the IMR value for mid-year. Regression curves of IMR were fitted by using moving-average IMRs for 21 years, during 1990-2010. By using regression estimates, we have predicted IMR-figure for 2015, and/or the year by which it would reach '28' per 1000 live births. As MMRs are periodic estimates, we have measured interpolated value of two consecutive periods as the MMR for the mid-period using linear interpolation[16]. Regression-curves of MMR were fit using nine MMR data-points, during 1997-2009. Using regression estimates, MMR-figure for 2015 and/or the year by which it would reach '109' were derived.

Our analysis is confined to 15 states, as SRS does not provide MMR estimates for smaller states/union territories, and these 15 states (Andhra Pradesh, Assam, Bihar/Jharkhand, Gujarat, Haryana, Karnataka, Kerala, Madhya Pradesh/Chhattisgarh, Orissa, Punjab, Rajasthan, Tamil Nadu, Uttar Pradesh/Uttarakhand, and West Bengal) cover approximately 95% of India's population, hence changes in these states will fairly change the national scenario.

Results

Changes in MDG-4: Trends in IMR of India and of the 15 most populous states - during the past four decades are shown in Figure 1. It depicts a uniform declining trend across the states, although the pace of decline was more rapid during 1976-1991 and again in 2006-10. Decline was the highest in Uttar Pradesh/Uttarakhand, followed by Gujarat and Tamil Nadu. Across all the states, excluding Kerala - two types of declining trends were visible: 1) higher decline when the rates are high (in early 1970s); and 2) a steady rate of decline during 2001-10.

Table 1 provides changes in IMR, percent net-contribution of the states and the periods to overall decline in IMR of India, and predicted levels of IMR. In the last two decades, IMR of India has declined by around 40% and infant deaths from around 2.2 million to 1.3 million[4]. Percent decline was ≥50% only in three out of 15 states (Tamil Nadu, Maharashtra and West Bengal), while absolute annual decline was above the national average in Orissa, Madhya Pradesh/Chhattisgarh, Uttar Pradesh/Uttarakhand and West Bengal.

If total net-decline in IMR of India during different periods of 1990-2010 is considered as 100% *(last row of Table-1)*: maximum decline occurred during 1990-96 (36%) followed by 2001-06 (26%). On the other hand, if total decline in IMR of India during 1990-2010 among the 15 populous states is considered as 100% *(8^{th} column of Table-1)*: Uttar Pradesh/Uttarakhand contributed maximum (20%) to this decline; followed by Madhya Pradesh/Chhattisgarh (14%); West Bengal (11%); Maharashtra (9%); etc. By comparing state's percent share in total net-decline in IMR of India with state's percent share in live births – one can estimate whether a particular state has contributed *'favourably to net-decline'* (state's percent share in net-decline > state's percent share in live births) or *'unfavourably to net-decline'* (state's percent share in net-decline ≤ state's percent share in

live births) in IMR of India during a particular period *(4th to 8th column Vs 9th column, of Table-1)*. During 1990-2010, Madhya Pradesh/Chhattisgarh contributed most favourably to the net-decline *(with its share of 10% to live births it has contributed 14.4% to total net-decline in IMR of India)*. Orissa, West Bengal, Tamil Nadu, Maharashtra, Karnataka and Andhra Pradesh were the other states, which contributed favourably to net-decline. In contrast, Bihar/Jharkhand contributed most unfavourably to net-decline. However, during 2006-10, Bihar/Jharkhand, Madhya Pradesh/Chhattisgarh, Rajasthan and Uttar Pradesh/Uttarakhand transitioned from unfavourable to favourable states; contributing 57% to net-decline in IMR of India when their share to live births was 52% (Table 1).

If the declining trend in IMR observed during 1990-2010 continues linearly, India's IMR would be 42 per 1000 live births (95% CI: 38-45) by 2015 and MDG-4 target level of '28' would be achieved in 2023-24. If the decline follows an exponential trend, India's IMR would be 45 per 1000 live births (95% CI: 41-49) by 2015, and MDG-4 target would be achieved in 2033-34. Unless special efforts are made to reduce IMR in Assam, Bihar/Jharkhand, Haryana, Rajasthan and Uttar Pradesh/Uttarakhand - it may take at least up to 2023-24 for India to reach the MDG-4 target, and much longer for the aforementioned states.

Measles immunization rates: India is doing well on the other MDG-4 indicator, as the percentage of 12-23-month-old children immunized against measles improved from 42% in 1991-92[8] to 74% by 2009[17].

Goodness of fit of linear and exponential regression-curves on IMRs for India during 1990-2010 were appropriate, with respective chi-square values of 0.79 ($p < 1.000$) and 1.36 ($p < 1.00$).

Changes in MDG-5: Figure 2 depicts changes in MMRs of India and of 15 populous states, during 1997-2009. During this period, there was a precipitous decline in MMR of India from 398 to 212 per 100 000 live births, even though variations in the base (1997-98) MMR levels of states were mainly responsible for recent (2007-09) variations.

Table 2 provides changes in MMR, percent net-contribution of 15 populous states and periods to overall decline in MMR of India, and predicted levels of MMR. During 1997-2009, MMR of India declined by 47%, with an annual absolute decline of 15.5 points. Maternal deaths decreased from around 100 000 to 60 000, assuming MMRs provided by SRS are correct. If total decline in MMR of India during different periods of 1997-2009 is considered as 100%, the maximum decline occurred between 2004-06 and 2007-09 (32%), followed by 2001-03 and 2004-06 (27%). Uttar Pradesh/Uttarakhand contributed most favourably to net-decline in MMR of India (with its share of 18% to the live births, contributed 33% to MMR decline). Bihar/Jharkhand, Madhya Pradesh/Chhattisgarh, Rajasthan and Assam also contributed favourably to net-decline. It is encouraging that between 2004-06 and 2007-09, Bihar/ Jharkhand, Madhya Pradesh /Chhattisgarh, Rajasthan and Uttar Pradesh /Uttarakhand – together contributed 75% to the net-decline in India's MMR, when their collective share in live births was only 43%.

If the declining trend in MMR observed during 1997-2009 continues linearly, India will be very close to achieving the MDG-5 target level of '109' by 2016, as the MMR is predicted to

be 117 (95% CI: 109-125) in 2015. However, if the decline follows an exponential trend, India's MMR would be 159 (95% CI: 153-166) in 2015, and MDG-5 target would only be reached in 2023-24. Kerala, Tamil Nadu and Maharashtra had already reached MMR of 109 by 2009, and if the same pace of decline continues linearly or exponentially, Andhra Pradesh, Gujarat and West Bengal have a good chance of touching 109 MMR, by 2017-18. India is doing well on 'percent deliveries attended by skilled health personnel', with an improvement from 33% in 1991-92[8] to 76% by 2009[17]. Goodness-of-fit of linear regression curve on MMRs of India during 1997-2009 suggests moderate deviation from the observed values [chi-square= 0.2 ($p < 0.032$)], while the exponential fit suggests negligible deviation [chi-square=0.36 ($p < 0.055$)].

Discussion

If the pace of linear decline in MMR during 1997-2009 continues, India will be very close to attaining MDG-5 target level of '109' per 100 000 live births by 2016. However, India's IMR would be hovering around 42 in 2015 if the decline follows a linear trend, and the MDG-4 target level of '28' would only be achieved in 2033-34. If the declines in IMR/MMR follow exponential trends, reaching MDGs-4&5 targets gets further postponed by India and most states. India's MMR decline during 1997-2009 may mainly be attributed to favourable contributions from Uttar Pradesh/Uttarakhand, Bihar/Jharkhand, Madhya Pradesh/Chhattisgarh, and Rajasthan. Due to unfavourable contributions in IMR reduction efforts by Bihar/Jharkhand, Uttar Pradesh/Uttarakhand, Rajasthan and Assam, India's run for MDG-4 target is delayed.

How comparable are our IMR/MMR predictions with others? Were the state-specific changes in IMR/MMR during a particular period reflected in national-level changes in a standardized-way or not? Which one of the two regression-curves (linear/exponential) fits better to Indian IMRs/MMRs? Due to paucity of reliable MMR estimates for India/states prior to 1997[18], predictions were based on IMR. A recent Lancet series[5], projected India's IMR and MMR in 2015 as 43 and 153 respectively, while another report[19] projected India's IMR in 2015 as 46-49. These predictions matched with our IMR predictions. Our IMR extrapolations for 2015 are in synchronization with predictions of Central Statistical Organization, Government of India[14]. For the states of Assam, Orissa, and Rajasthan, there is good comparability between our MMR predictions and the Annual Health Survey (AHS, 2010-11)[20]. For MMR, our exponential regression-based predictions match closely with other findings[3, 7].

Lozano et al.[1] in their paper on tracking the progress of MDGs-4 and 5 in 163 countries predicted India's IMR and MMR in 2011 respectively as 49 (95% CI: 41-56) and 187 (95% CI: 142-238), while our linear and exponential regression-based estimates respectively were 48 (95% CI: 47-49) and 50 (95% CI: 46-54); and 178 (95% CI: 173-184) and 196 (95% CI: 195-197). As compared to referred predictions[1, 3, 4, 5, 7, , 14, 18, 19] ours are more robust due to the use of more recent IMR/MMR data, moving-average IMR estimates, and predicted IMRs/MMRs through the use of linear and exponential regression-curves.

A trend analysis of IMRs in India during 1970-2000 by Saikia et al[21] concluded that the decline was much steeper during the 1970s and 1980s, and that the IMR has stagnated during 1996-2000, 2000-04 and 2002-06. We also noticed that the decline in IMR was lowest during 1996-2001. Our decomposition of the decline in India's IMR among the states also matched with this finding[21]. Analysis of India's IMRs during 1981-1997[6] found that the decline tended to stagnate for brief periods and was often followed by a subsequent rapid decline. We are of the view that India's IMR decline still followed a similar phenomenon, as we noted a plateau during 1996-01 was followed by a rapid decline during 2001-06 (Table 1). Our findings agree with previous studies for Kerala, Tamil Nadu and West Bengal as the only states likely to achieve MDG-4 target[5, 14] due to substantial MMR declines between 2004-06 and 2007-09[1].

Contribution of state-specific changes in rate/ratio onto national-level change: If populations are similar with respect to factors associated with the event under study, there is no problem in comparing events across states. If populations are not similarly constituted, direct comparison of the overall events may be misleading[10]. In the present analysis, rather than measuring changes in IMR/MMR of India between two time points as mere percent/absolute change, we estimated it as: net-effect of state-wise distribution of live births and state-specific

mortality rates/ratios - a technique used extensively[22, 23] for understanding birth weight-specific or regional differences in mortality.

Linear versus exponential regression? While estimating the progress made by different countries including India towards MDGs-4 and 5, linear regression curves were used[1, 5]. However, for understanding the decline in IMRs of India and Nepal in the past three decades, exponential regression curves were found to be more appropriate[13.] IMR decline in 18 Western nations in the 20th century was, for the most part, neither linear nor exponential[15]. For India's IMR decline during 1990-2010, both linear and exponential regressions fitted well, while for MMR declines, the exponential regression fits better than the linear. As India's IMR/MMR decline during the past two decades is an outcome of heterogeneous progress made by different states, sometimes linear and sometimes exponential, and also taking into account high IMR/MMR levels in a majority of the states - it is difficult to conclude which of the two regression curves is more appropriate for the Indian scenario.

Strengths/limitations: Our analysis included latest IMRs/MMRs from SRS, the most reliable source for national and state specific estimates. For fitting regression-curves we used moving averages or periodic estimates, instead of point estimates. One of the limitations of this study is that our analysis/interpretation relied completely on the quality and completeness of SRS data. An evaluation of SRS data showed omission rates of 1.8% for births and 2.5% for deaths[24]. IMRs of SRS are considered to be robust[6], and they matched closely with all the three National Family Health Survey (NFHS)[25] estimates, for India. However, IMRs of SRS in 2010 were lower than AHS estimates by 1-10 absolute points, in 8 states[20]. India's MMRs of SRS deviated substantially with NFHS-2[26] and UN[18] estimates. As MMR estimates of UN

are usually indirect estimates[1, 3, 18], we are of the opinion that SRS estimates are still robust for India.

Is maximum decline in MMR between 2004-06 and 2007-09 due to NRHM or an artefact?

Periodic analysis of MMR decline in India during 1997-2009 indicated maximum drop between 2004-06 and 2007-09. Is this finding an artefact or influence of NRHM? Lim et al.[27], indicated that India's conditional cash transfer scheme *'Janani Suraksha Yojana (JSY)'* of NRHM contributed to an increase in institutional deliveries[17], and JSY was associated with reduction of about four perinatal and two neonatal deaths per 1000 live births, while JSY had no significant effect on maternal mortality[27]. As NRHM is credited for deploying more than 750 000 Accredited Social Health Activists (ASHAs), as change agents between the women and the health system, prospects for improved maternal and newborn care[5] are better since the launch of NRHM in 2005, as compared to the past.

Conclusions: Even though the pace of decline in IMR accelerated during 2001-10 after a period of stagnation (1996-2001), India is still predicted to fall short of achieving its MDG-4 target level of '28' per 1000 live births by 2015, in 11 out of the 15 most populous states, and in India as a nation. Bihar/Jharkhand, Uttar Pradesh/Uttarakhand, Rajasthan and Assam need to put special efforts for accelerating decline in IMR. Considering the pace of MMR decline during 1997-2009, six out of the 15 most populous states have a fairly good chance of attaining India's MDG-5 target level of '109', albeit two-three years behind schedule (2017-18).

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Table 1. State-wise changes in IMR, contribution of states and periods to India's IMR decline and year of achieving India's MDG-4 target

	Changes in IMR[1] between 1989-91 (1990) and 2009-10 (2010)		% Net contribution of the states to periodic decline in IMR of India between:					% state's share to total live births during 1990-2010	If IMR decline follows a linear trend	
State	% Decline	Annual absolute decline	1989-91 (1990) and 1995-97 (1996)	1995-97 (1996) and 2000-2002 (2001)	2000-02 (2001) and 2005-07 (2006)	2005-07 (2006) and 2009-10 (2010)	**1989-91 (1990) and 2009-10 (2010)**		Expected IMR in 2015 (95% CI)	Year of achieving MDG[2]-4 target IMR level of '28'
Andhra Pradesh	36.4	1.4	8.8	6.4	7.4	6.3	**7.5**	6.4	45.3 (42.6 - 48.1)	2031-32
Assam	28.1	1.2	1.3	1.0	2.1	2.6	**1.8**	2.8	56.7 (54.7 - 58.7)	2043-44
Bihar / Jharkhand	36.1	1.4	0.8	11.8	-1.2	16.5	**5.7**	13.2	47.2 (44.8 - 49.7)	2032-33
Gujarat	39.2	1.5	6.5	-0.8	3.7	4.7	**4.3**	5.0	42.7 (39.6 - 45.8)	2028-29
Haryana	32.2	1.2	0.3	1.5	2.1	2.0	**1.4**	2.2	47.3 (44.7 - 49.8)	2032-33
Karnataka	47.8	1.6	11.0	-1.0	5.4	4.7	**6.3**	4.7	32.4 (28.9 - 35.9)	2018-19
Kerala	30.6	0.3	1.0	1.1	-0.2	0.3	**0.5**	2.1	10.5 (9.0 - 12.0)	1988-89
Madhya Pradesh / Chhattisgarh	43.9	2.5	17.3	19.1	10.7	11.3	**14.4**	10.0	52.5 (51.0 - 54.1)	2025-26
Maharashtra	50.0	1.5	8.4	12.1	10.8	5.5	**8.8**	8.1	22.4 (20.8 - 23.9)	2010-11
Orissa	47.3	2.9	8.7	13.1	7.2	4.1	**7.8**	3.5	48.6 (45.5 - 51.7)	2022-23
Punjab	39.3	1.2	1.9	1.7	2.8	1.8	**2.1**	2.0	34.8 (32.3 - 37.2)	2021-22
Rajasthan	34.0	1.5	-4.3	5.0	9.2	7.4	**3.4**	6.7	54.0 (50.0 - 58.1)	2032-33
Tamil Nadu	57.6	1.8	4.5	5.6	8.2	5.1	**5.8**	4.5	21.2 (18.2 - 24.2)	2009-10
Uttar Pradesh / Uttarakhand	40.8	2.1	20.2	11.0	21.2	22.2	**19.6**	22.1	53.6 (51.1 - 56.1)	2029-30
West Bengal	54.5	1.9	13.7	12.5	10.7	5.4	**10.7**	6.7	22.1 (20.5 - 23.7)	2012-13
India	**42.1**	**1.8**	**100.0**	**100.0**	**100.0**	**100.0**	**100.0**	**100.0**	**41.5 (38.4 - 44.7)**	**2023-24**
% Net-contribution of different periods to India's IMR drop during 1990 and 2010	--	--	1202.8 (35.5%)	485.5 (14.3%)	871.8 (25.7%)	826.5 (24.4%)	**3386.6 (100.0%)**	--	--	--

1: IMR: Infant mortality rate per 1000 live births: three-year moving averages for all the years, except for 2010 which is a two-year average (2009, 2010)

2: MDG: Millennium Development Goal

Table 2. State-wise changes in MMR, contribution of states and periods to India's MMR decline and year of achieving India's MDG-5 target

	Changes in MMR[1] between 1997-2001 and 2006-09		% Net contribution of the states to periodic decline in MMR of India between:					% state's share to total live births during 1997 and 2009	If MMR decline follows a linear trend		If MMR decline follows an exponential trend	
State	% Decline	Annual absolute decline	1997-98 and 1999-01	1999-01 and 2001-03	2001-03 and 2004-06	2004-06 and 2007-09	**1997-98 and 2007-09**		Expected MMR in 2015 (95% CI)	Year of achieving MDG[2]-5 target MMR level of '109'	Expected MMR in 2015 (95% CI)	Year of achieving MDG[2]-5 target MMR level of '109'
Andhra Pradesh	32.0	5.3	-2.8	7.9	7.2	2.5	**3.4**	7.8	101 (57-144)	2014	115 (83 - 147)	2017-18
Assam	31.3	14.8	14.2	-10.1	0.8	5.6	**3.7**	2.7	365 (244-486)	2046	374 (295 - 453)	2082-83
Bihar / Jharkhand	50.8	22.5	37.9	3.4	15.0	15.2	**18.6**	11.0	119 (81-156)	2016	184 (172 - 196)	2024-25
Gujarat	29.5	5.2	0.7	5.0	1.2	1.2	**1.7**	5.1	107 (82-131)	2015	116 (106 - 126)	2017-18
Haryana	-12.5	-1.4	-2.2	0.5	-1.0	1.4	**-0.3**	2.1	158 (117-199)	2050	159 (141 - 177)	2073-74
Karnataka	27.3	5.6	-2.5	6.6	2.4	3.3	**2.2**	5.4	151 (114-188)	2022	162 (135 - 188)	2029-30
Kerala	46.0	5.8	-0.1	4.4	1.1	0.6	**1.2**	3.3	38 (15-60)	2003	58 (41 - 75)	2003-04
Madhya Pradesh / Chhattisgarh	39.0	14.3	6.7	14.0	7.8	14.2	**10.6**	8.4	199 (171-228)	2022	231 (205 - 257)	2035-36
Maharashtra	37.3	5.2	2.0	5.2	4.0	4.3	**3.8**	9.8	78 (56-100)	2009	90 (73 - 107)	2008-09
Orissa	25.4	7.3	-5.0	10.7	4.5	3.4	**2.9**	3.7	216 (119-313)	2026	234 (166 - 302)	2039-40
Punjab	38.6	9.0	6.7	0.1	0.2	0.6	**1.9**	2.5	120 (52-187)	2017	132 (89 - 174)	2021-22
Rajasthan	37.4	15.8	-0.2	12.0	9.6	9.5	**7.6**	5.8	232 (181-283)	2023	270 (228 - 312)	2038-39
Tamil Nadu	26.0	2.8	-5.2	7.4	3.5	1.3	**1.3**	6.3	77 (34-119)	2007	85 (55 - 114)	2007-08
Uttar Pradesh / Uttarakhand	40.8	20.6	31.5	26.5	34.4	36.5	**33.0**	18.0	253 (219-287)	2023	300 (268 - 333)	2040-41
West Bengal	52.1	13.2	18.2	6.5	9.2	0.3	**8.1**	8.2	35 (0-78)	2010	84 (67 - 102)	2012-13
India	**46.7**	**15.5**	**100.0**	**100.0**	**100.0**	**100.0**	**100.0**	**100.0**	**117 (109-125)**	**2016**	**159 (153-166)**	**2023-24**
% Net-contribution of different periods to India's MMR drop during 1997 and 2009	--	--	3654.0 (24.2%)	2545.7 (16.8%)	4141.9 (27.4%)	4770.8 (31.6%)	**15112.4 (100.0 %)**	--	--	--	--	--

1: MMR: Maternal mortality ratio per 100,000 live births: two/three year moving average

2: MDG: Millennium development goal

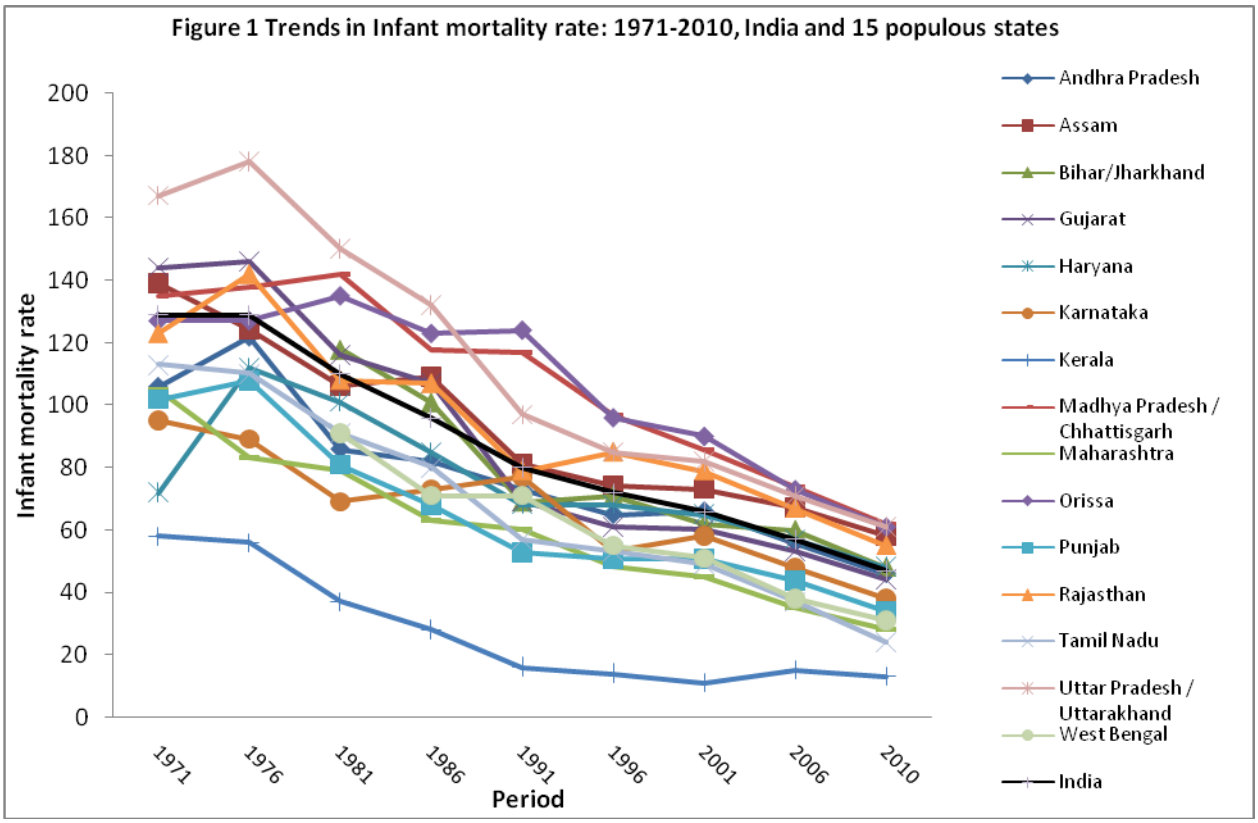
Figure 1 Trends in Infant mortality rate: 1971-2010, India and 15 populous states
Infant mortality rate
200
180
160
140
120
100
80
60
40
20
0
1971
1976
1981
1986
1991
1996
2001
2006
2010
Period
Andhra Pradesh
Assam
Bihar/Jharkhand
Gujarat
Haryana
Karnataka
Kerala
Madhya Pradesh / Chhattisgarh
Maharashtra
Orissa
Punjab
Rajasthan
Tamil Nadu
Uttar Pradesh / Uttarakhand
West Bengal
India

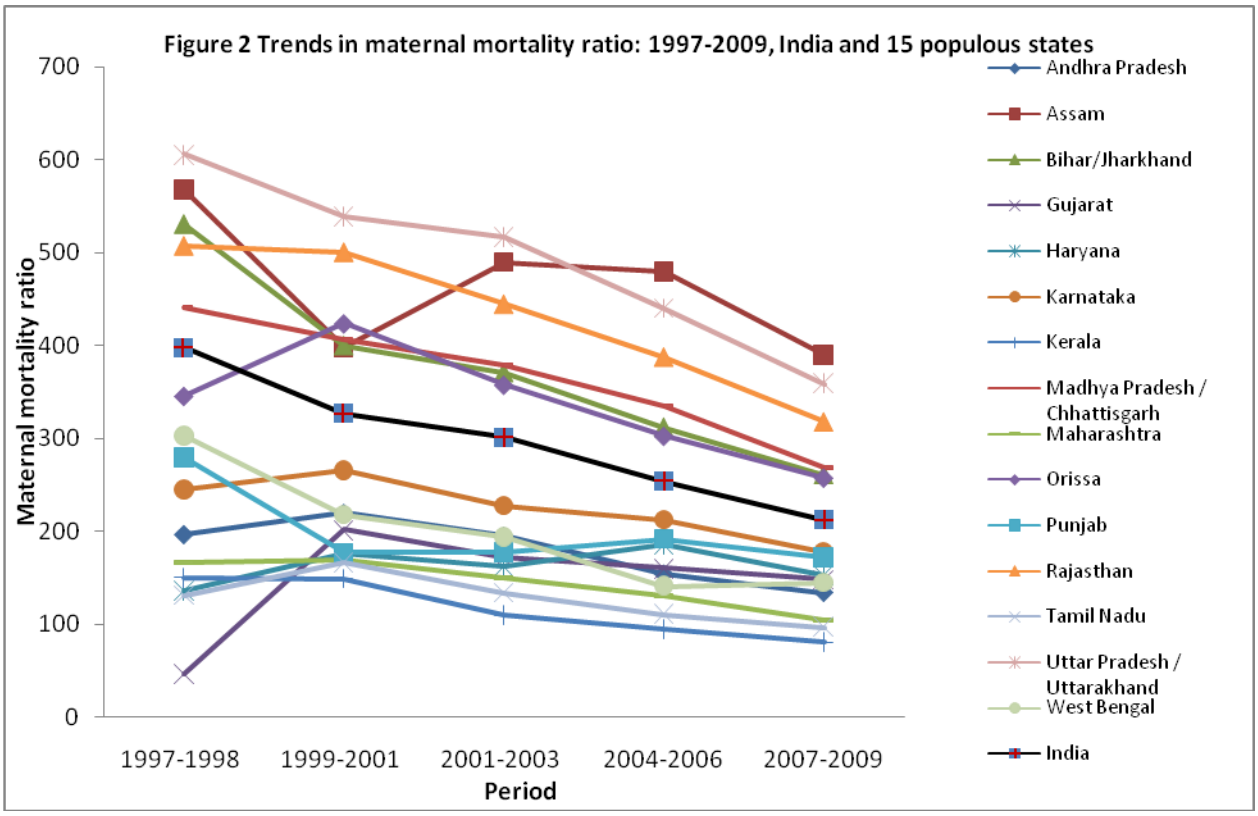
Figure 2 Trends in maternal mortality ratio: 1997-2009, India and 15 populous states
Maternal mortality ratio
700
600
500
400
300
200
100
0
1997-1998
1999-2001
2001-2003
2004-2006
2007-2009
Period
Andhra Pradesh
Assam
Bihar/Jharkhand
Gujarat
Haryana
Karnataka
Kerala
Madhya Pradesh / Chhattisgarh
Maharashtra
Orissa
Punjab
Rajasthan
Tamil Nadu
Uttar Pradesh / Uttarakhand
West Bengal
India