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Inter-state disparities in Maternal Mortality Ratio in India – Two decade Analysis

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Abstract

Maternal mortality rates in India are high, especially in states that belong to the empowered action group (EAG). The study focuses on identifying inter- and intra-state differences while discussing trends and patterns in maternal mortality reduction in India. Our research reveals that the developments in the maternal mortality ratio (MMR) over the past 20 years—particularly the rate of decline—have not been consistent with the apparent advancements in the nation's socioeconomic indices. Massive MMR disparities between and within states are a significant policy concern. The MMR reported for the EAG/Assam group, for example, was 438 in 2001–03 and 148 in 2017–19, over five times greater than Kerala's (MMR 30), the state with the lowest MMR of all. High maternal mortality in India, especially in states with an empowered action group (EAG), is a serious policy problem. This study explores the patterns and trends in the decline of maternal mortality in India and emphasizes the differences between the states. It has been discovered that the developments in the maternal mortality ratio (MMR) over the previous two decades, notably the pace of fall, do not correspond well with the apparent advancements in the nation's socioeconomic metrics. A significant policy problem is the enormous in the inter - state disparities in the Maternal mortality ratio reduction.

Keywords: MMR, Maternal Mortality, maternal health, NRHM (National Rural Health Mission), disparity, India

Introduction

According to the UN inter agency, from 2000 to 2017 the global figure of maternal mortality ratio (MMR) has been reduced from 342 to 211 per 100,000 live births, which is 38% reduction.(1) This indicates that the average yearly reduction is 2.9 percent. But this is less than the half of the 6.4 percent yearly rate which is required to achieve Millennium Development Goal which is 70 maternal deaths per 100,000 live births(WHO *et al.* 2019)(2). According to the regional level analysis of trends in maternal mortality, different countries have substantial decline but still far away from the MDG goal. (1) In 2017-19, Maternal Mortality Ratio was reported to be 103 maternal deaths per 100,000 live births.(3) According to the WHO, regional and country level estimates for the year 2017, the estimates of maternal mortality for the countries India and Nigeria altogether accounted for around one –third (35%) of the total global maternal deaths burden.(2) The cost of human life and social welfare is enormous when maternal mortality rates are thus high. Thus, it is of utmost importance to the nation and the world to reduce MMR more quickly.(4)(2) Furthermore, there are serious equity issues because studies have shown that there are substantial intra- and interstate inequities and that marginalized communities and indigenous populations bear a disproportionately high burden of maternal mortality.(5)(4) By scaling up effective clinical interventions and enhancing access to primary and referral care, the level of MMR could be decreased in a relatively short period of time.(6) Under the Reproductive and Child Health (RCH) programme and National Rural Health Mission, a number of significant initiatives have been launched in India (NRHM). Despite this exceptional focus, the MMR decline has recently slowed down; however the majority of maternal deaths in India continue to be linked to social marginalization, poor nutrition, and poverty—factors on which policies have no effect.(7) The problem of high MMR in India must also be understood and addressed, which requires dedicated effort. This is the primarily factor behind this study's by which investigation of patterns and trends in maternal mortality in India will be studied.

Literature review - National and state level trends and Pattern of Maternal Mortality Ratio (MMR)

From 1997 Sample Registration System (SRS) is providing direct estimates of MMR for national and state level. SRS is the continuous ongoing event of demographic survey which conducted

and organized by Office of Registrar General, India. SRS provides consistent and stable estimates of MMR by adopting methodology that pooled the three years data (RGI 2018)(8). In 1940, Bhore committee estimated 2000 maternal deaths in India per 100,000 live births.(9) Later in 1950s Mudaliar committee concluded estimated 2000 maternal deaths in India per 100,000 live births.(10) The estimates of MMR were 800 in 1970, 500 in 1980 and 400 in 1990.(11)(12)(13) Some of these estimates were less reliable in differences and trend pattern of maternal mortality while some estimates were statistical invalid.(1)Due to these issues, direct estimates of MMR have been acquired through the sample registration system (SRS) at the national and state levels since 1997. Direct estimates of MMR seem more preferable, easy and convenient to calculate as they were taken from real cohort of births.(14)

The MMR has significantly decreased, going from 400 per 100,000 live births in the early 1990s to 301 in 2001 and 103 in 2017, according to estimates from India's Sample Registration System (SRS). (3)(15) The latest estimates of SRS have shown a continuous drop in the MMR from 113 to 103 per 100,000 live births With the highest prevalence in the state of Assam (205 per 100,000 live births) and the lowest in the state of Kerala (30 per 100,000 live births. (8) (3) The results of earlier studies show that, despite of India's total MMR having dramatically decreased, the pace of drop in MMR varies between the states. (3) (16) (5) (17) (18) (19) (20). Approximately 70% of the estimated total maternal deaths in India were reported by Empowered Action Group (EAG) states, including Bihar, Madhya Pradesh, Rajasthan, Uttar Pradesh, Assam and Odisha, West Bengal states. (3) (18)(21) Assam alone accounted for around 12% while Madhya Pradesh and Uttar Pradesh contributes 10% - 10% of the maternal deaths. (3)(18)(21) Maternal mortality ratios in EAG states are significantly higher than the national average(21)

Method

The data has been extracted from periodic release of MMR bulletin SRS, Office of the Registrar General of India. In time series data, study variable has been extracted at nine points of time (2001-03, 2004-06, 2007-09, 2010-12, 2011-13, 2014-16, 2015-17, 2016-18, 2017-19). However, cross-sectional data sample size for 2017-19 is extracted from eighteen major states of India. Since 1969–1970, the SRS has been a key source for fertility and mortality data, and it is the largest demographic survey in India. It is intended to give accurate estimates of fertility and mortality statistics for rural and urban areas, independently, at the state and national levels. Every ten years, the SRS sampling frame is revised based on the findings of the most recent census. The sample size and design for each year are chosen to ensure that the results based on SRS data are comparable throughout time (for further information on sampling, see RGI, 2001 - 03 to 2017-19).

Variable

The outcome variable is Maternal Mortality Ratio and its difference that has been calculated at different point of time. The variables involved in the study are of two types – (1) Time series data on the study variable has been taken at various time intervals at national level; (2) Cross-sectional data (2016-18) of study variable has been taken from the 18 states of India.

Statistical Analysis

In this chapter time series and cross sectional analyses have been used to find out inter - state disparities in achieving MMR target. For this, Maternal Mortality Ratio in India & major states 2001-03, 2004-06, 2007-09, 2010-12, 2011-13, 2014-16, 2015-17, 2016-18, 2017-19 have been compiled from periodic bulletin of Sample Registration System (SRS). The analysis has been carried in four stages. Firstly, time series data of MMR has been compiled from period 2001 to 2019 where progress in MMR reduction has been analyzed by observing increase or decrease in 95% confidence interval width of MMR in different states. In second stage, progress towards Sustainable Development Goal (SDG)-3 and National Health Policy (NHP) 2017 targets as per MMR 2016-18 Report has been check. In third stage, the test of equality of proportion using large sample statistics has been applied to examine the hypothesis that there is no significant state level decline MMR over the years. In the last fourth stage, the magnitude of inter - state

disparities have been examined through different inequality markers like range difference, range ratio, standard deviation and coefficient of variation.

Results

On compilation of estimates of Maternal Mortality Ratio (MMR) and the analysis of 95% confidence interval in India & major states of periods 2001-03, 2004-06, 2007-09, 2010-12, 2011-13, 2014-16, 2015-17, 2016-18, 2017-19 as shown in table 1, it has been observed that Confidence Intervals have been steadily rising across the some of the states over time. These intervals are significantly broader for a number of states, including Aasam, Odisha and Punjab despite the fact that the width of the CI is narrower for India as a whole (or for a group of states such as EAG, South subtotal and others states). However, MMR estimates of these states in year 2017-19: 205(Aasam); 136(Odisha) and 114(Punjab). It is interesting to note that the estimate's upper confidence limit exceeds 100 in these three states. Also it is exceeding in Bihar, Gujarat, Haryana, Karnataka, Madhya Pradesh, Rajasthan, Uttar Pradesh, West Bengal and India as a whole but these states have narrower width of CI as compared to the Assam, Odisha and Punjab. Hence, based on these inferences it is statistically established to consider these issues while framing decision on state-level MMR reduction.

Table 1 Maternal Mortality Ratio (MMR) in India & major states 2001-03, 2004-06, 2007-09, 2010-12, 2011-13, 2014-16, 2015-17, 2016-18, 2017-19

S.No.	India & Major states	2001-03	2004-06	2007-09	2010-12	2011-13	2014-16	2015-17	2016-18	2017-19
	India	301	254	212	178	167	130	122	113	103
	95% CI	[285, 317]	[289, 270]	[198, 226]	[166, 191]	[155, 179]	[119, 141]	[112, 133]	[103, 123]	[94, 113]
1	Andhra Pradesh	195	154	134	110	92	74	74	65	58 [21, 95]
		[136, 266]	[108, 215]	[87, 182]	[72, 165]	[52, 131]	[32, 116]	[32, 116]	[26, 104]	
2	Assam	490	480	390	328	300	237	229	215	205
		[397, 537]	[363, 623]	[280, 500]	[236, 443]	[205, 394]	[151, 323]	[144, 313]	[133, 297]	[125, 285]
3	Bihar	371	312	261	219	208	165	165	149	130
		[315, 443]	[258, 374]	[210, 313]	[174, 270]	[163, 253]*	[124, 206]	[118, 212]	[104, 194]	[88, 171]

4	Gujarat	172 [123, 240]	160 [114, 217]	148 [100,1 96]	122 [82, 177]	112 [69, 155]	91 [54, 129]	87 [51, 123]	75 [41, 109]	70 [38, 103]
5	Haryana	162 [109,2 37]	186 [123,2 71]	153 [90, 217]	146 [91, 225]	127 [68, 185]	101 [50, 152]	98 [48, 148]	91 [43, 139]	96 [47, 144]
6	Karnata ka	228 [174,2 97]	213 [159, 280]	178 [124, 233]	144 [100, 206]	133 [84, 181]	108 [66, 150]	97 [57, 136]	92 [53, 131]	83 [45, 120]
7	Kerala	110 [65,17 3]	95 [52,16 0]	81 [35, 127]	66 [31, 120]	61 [22, 101]	46 [12, 79]	42 [9, 75]	43 [10, 77]	30 [2, 58]
8	Madhya Pradesh	379 [308, 457]	335 [276, 403]	269 [213, 325]	230 [181, 289]	221** [170, 272]	173 [131, 215]	188 [139, 238]	173 [126, 221]	163 [117, 209]
9	Maharas htra	149 [100, 210]	130 [87, 186]	104 [61, 146]	87 [52, 138]	68 [32, 103]	61 [29, 93]	55 [26, 85]	46 [19, 73]	38 [14, 63]
10	Odisha	358 [282, 449]	303 [233, 387]	258 [189, 327]	235 [173, 313]	222 [156, 287]]	180 [121, 240]	168 [110, 225]	150 [96, 205]	136 [85, 188]
11	Punjab	178 [110, 278]	192 [125, 284]	172 [100, 244]	155 [95, 247]	141 [73, 209]	122 [50, 194]	122 [51,19 4]	98 [56,20 2]	114 [46, 182]
12	Rajastha n	445 [367, 526]	388 [317, 469]	318 [251, 384]	255 [198, 323]	244 [185, 303]	199 [141, 256]	186 [131, 242]	164 [112, 215]	141 [94, 189]
13	Tamilna du	134 [86, 193]	111 [72, 164]	97 [56,, 138]	90 [54, 137]	79 [43, 116]	66 [32, 99]	63 [31, 96]	60 [29, 92]	58 [27, 89]
14	Uttar Pradesh	517 [462, 576]	440 [386, 499]	359 [308, 409]	292 [249, 343]	285** * [240, 330]	201 [163, 239]	82 [170,2 63]	197 [152, 241]	167 [126, 208]
15	West Bengal	194 [147, 250]	141 [102, 189]	145 [102, 188]	117 [82, 164]	113 [75, 151]	101 [61, 141]	94 [55, 132]	98 [59, 137]	109 [68, 151]
16	Other	235 [202, 272]	206 [172, 245]	160 [130, 191]	136 [109, 168]	126 [99, 132]	97 [72, 122]	96 [71, 121]	85 [62, 108]	77 [55,99]

The trend analysis shown here is largely based on the SRS estimates provided in nine subsequent MMR advisories for the periods 2001–2003, 2004–2006, 2007–2009, and 2010–2012, 2011-13, 2014-16, 2015-17, 2016-18 and 2017-19. Figure 1 makes it clear that the MMR in India is still alarmingly high (103 maternal deaths per 100,000 live births), and that the rate of MMR decline has recently slowed.

The MMR across high focus states (EAG states and, in particular, Assam) is expected to be 257 deaths per 100,000 live births by the end of Phase 1 of the NRHM (2005–12). Maternal mortality thus remains a major concern in these states. Furthermore, it is uncertain whether the national and international targets for a significantly faster MMR reduction can be fulfilled. Although, the MMR was a major focus in the first and second phases of the RCH (1997-2005 and 2005 onwards), the period from 2001 to 2006 can be regarded as the pre-NRHM period. The MMR decreased during this time (from 301 in 2001-03 to 254 in 2004-06), dropping roughly 50 points. The NRHM, which was introduced in 2005, committed a lot more time and money to enhancing the health system than earlier programmes. In order to undertake the essential structural reforms in the public health care and delivery system in India, the Government of India created the National Health Mission (NHM) in 2015, combining the former National Rural Health Mission (NRHM) and National Urban Health Mission (NUHM). The **Reproductive-Maternal-Neonatal-Child and Adolescent Health (RMNCH+A)** services offered by the NHM design boost the healthcare system and help to achieve significant demographic and health goals. Programs like the Janani Suraksha Yojana (JSY) under NRHM have dramatically boosted the number of institutional deliveries and prenatal care visits, by lowering MMR (22)(23)(24)(25).

MMR would have to be reduced than 70 per 100,000 live births by 2030 in accordance with Sustainable Development Goal (SDG)-3. Also, in accordance with NHP (National Health Policy) 2017, the MMR target for 2020 is 100 per 100,000 live births.

Table 2 Progress towards Sustainable Development Goal (SDG)-3 and National Health Policy (NHP) 2017 targets as per MMR 2016-18 Reports

	Sustainable Development Goal (SDG)-3	NHP (National Health Policy) 2017
Goal	MMR - 70 per 100,000 live births by 2030	MMR - 100 per 100,000 live births by 2017
Achieved	5 states- Andhra Pradesh (65); Telangana(63); Tamilnadu(60); Maharashtra(46) and Kerala(43)	11 States – Uttarakhand (99); West Bengal (98); Karnataka (92); Haryana (91); Gujrat(75); Jharkhand(71); Andhra Pradesh (65); Telangana(63); Tamilnadu(60); Maharashtra(46) and Kerala(43)

However, seven of the eight EAG states—including Bihar, Madhya Pradesh, Chhattisgarh, Odisha, Rajasthan, Uttar Pradesh, and Uttarakhand—remain far from meeting the SDG-3 objective.(3)

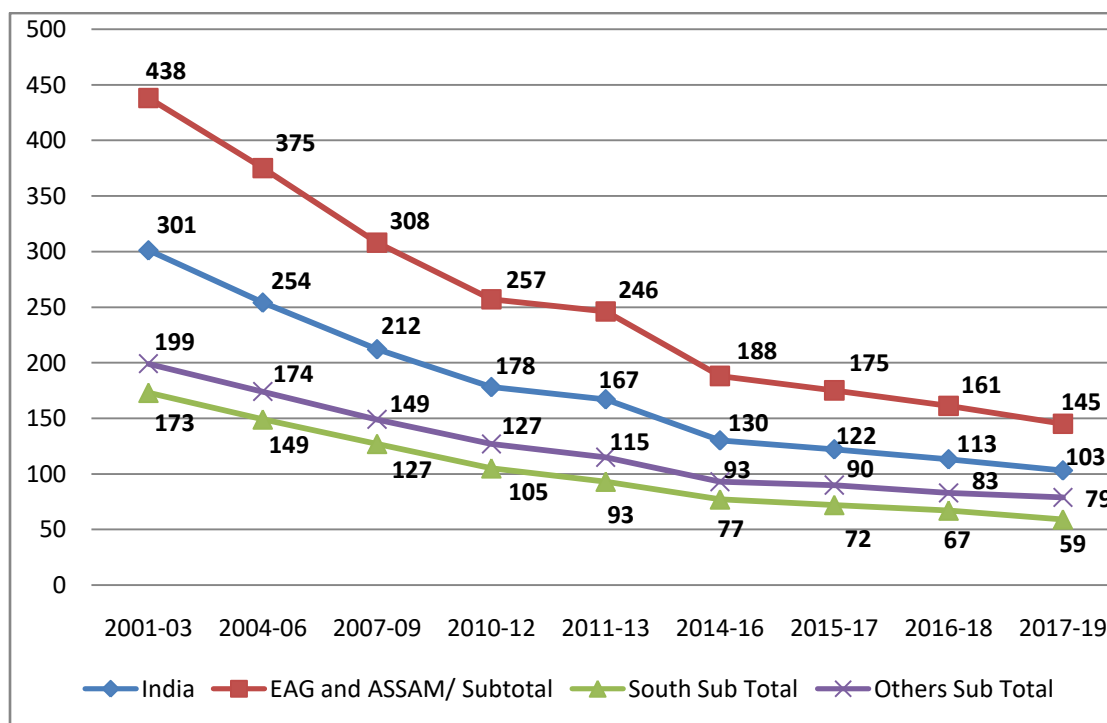


Figure -1 Maternal mortality Ratio Region wise (SRS 2001-2019)

Table 3 From 2001 to 2017* Statistical Significance in MMR decline

India & Major states	2001/03-2004/06	2004/06 - 2007/09	2007/09 – 2010/12	2010/12 – 2011/13	2011/13 – 2014/16	2014/16 – 2015/17
India	0.00001	0.00001	0.00001	0.21	0.00001	0.46
Assam	0.056	0.258	0.24	0.68	0.40	0.0005
Bihar	0.056	0.07	0.05	0.71	0.07	0.0001
Madhya Pradesh	0.07	0.03	0.09	0.78	0.13	0.52
Odisha	0.31	0.18	0.33	0.75	0.36	0.71
Rajasthan	0.07	0.056	0.02	0.74	0.17	0.65
Uttar Pradesh	0.001	0.0010	0.002	0.70	0.00014	0.25
EAG and Aassam	0.00001	0.00001	0.00001	0.41	0.00001	0.25
Andhra Pradesh	0.10027	0.47	0.322	0.58	0.18	0.96
Karnataka	0.11	0.22	0.267	0.76	0.71	0.68
Kerala	0.423	0.66	0.57	0.87	0.49	0.75
Tamilnadu	0.31	0.61	0.62	0.78	0.63	0.75
South Subtotal	0.01	0.118	0.09	0.00001	0.00001	0.60
Gujarat	0.58	0.52	0.25	0.00001	0.00001	0.64
Haryana	0.96	0.35	0.68	0.00001	0.00001	0.00001
Maharashtra	0.37	0.33	0.33	0.00001	0.00001	0.00001
Punjab	0.94	0.61	0.50	0.00001	0.00001	0.00001
West Bengal	0.04	0.72	0.14	0.00001	0.00001	0.00001
Other	0.03	0.038	0.05	0.58	0.03	0.02
Others Subtotal	0.11	0.01	0.003	0.32	0.00001	0.7

*Sample female population (15-49 years) data is available only up to MMR; Result is significant for (P <0.05);

In table 3, there is a statistical reduction in MMR have been seen only at India level, Uttar Pradesh/Uttarakhand, EAG and Aassam at 5% level of significance. However, in comparison of period 2010-12 and 2014-16, the difference are significant for south subtotal, Gujarat, Haryana, Maharashtra, Punjab and West Bengal. The difference was significant may be due to NHM and RMNCH +A maternal health care programmes.

Absolute and Relative reduction – State-wise Analysis

The review and analysis of policy usually includes a progress assessment. Here, we use both the absolute (A) and relative (R) approaches to measure progress. These indicators are calculated using any two periods, t_1 and t_2 , as follows:

$$\text{Absolute Progress in MMR (MMR}_A\text{)} = \text{MMR}_{t_1} - \text{MMR}_{t_2}$$

$$\text{Relative Progress in MMR (MMR}_R\text{)} = 1 - (\text{MMR}_{t_2} / \text{MMR}_{t_1})$$

India & major states	NRHM Period (2007-2012)			NHM(2013-2018)		
Andhra Pradesh	42	6	31.0%	34	10	31.3%
Assam	90	1	23.0%	95	3	23.1%
Bihar	53	3	20.0%	78	5	20.3%
Gujarat	36	7	24.0%	42	9	24.3%
Haryana	26	11	17.0%	31	11	17.0%
Karnataka	45	5	25.0%	50	7	25.3%
Kerala	20	12	25.0%	31	11	24.7%
Madhya Pradesh	48	4	18.0%	58	6	17.8%
Maharashtra	36	7	35.0%	30	12	34.6%
Odisha	36	7	14.0%	86	4	14.0%
Punjab	31	10	18.0%	27	13	18.0%
Rajasthan	74	2	23.0%	103	2	23.3%
Tamilnadu	18	13	19.0%	21	14	18.6%
Uttar Pradesh	74	2	21.0%	118	1	20.6%
West Bengal	32	9	22.0%	4	15	22.1%
Other	34	8	21.0%	49	8	21.3%
India	45		21.0%	64		21.2%

Here progress of MMR have been specifically examined and calculated over two periods i.e. NRHM period (2007-2012) and NHM period (2013-2018). It has been assumed that the pace of reduction in MMR has been reduced in NHM period (2013-2018) as compared to the NRHM

period (2007-2012). But it is interesting to note that MMR reduction at national level for NHM period (2013-2018) is 45 and NRHM period (2007-2012) is 64.

Inter-state Disparities in MMR reduction

Given such large deviation in MMR, it is important to examine inter-state dimensions to understand whether the MMR difference is reducing. Following inequality markers- range, ratio of highest and lowest MMR, standard deviation and coefficient of variation have been calculated and analyzed. The difference between the greatest and lowest MMR in each state, used to calculate the MMR range, which has decreased over time. For instance, from 2001 and 2003, the states with the greatest MMRs (Uttar Pradesh/Uttarakhand) and lowest MMRs (Kerala) differed by 407 points.

Table 4; Magnitude of inter-state disparities in MMR, India 2001-03 to 2017-19

Inequality Marker	2001-03	2004-06	2007-09	2010-12	2011-13	2014-16	2015-17	2016-18	2017-19
Range difference (Highest Lowest MMR)	407	385	309	262	239	191	187	172	175
Range ratio: Highest/ Lowest MMR	4.70	5.05	4.81	4.97	4.92	5.15	5.45	5.00	6.83
Standard deviation	134.84	120.60	95.31	78.63	77.20	58.03	54.97	54.42	49.86
Coefficient of variation	0.500	0.502	0.473	0.460	0.488	0.459	0.476	0.483	0.476

In 2017-19, the difference between the highest (Assam) and lowest (Kerala) MMR states was 175 points. The range ratio, which is calculated as the ratio of the highest MMR state to the lowest MMR state, has not seen any significant reduction even while the gaps between the extremes are decreasing. In fact, the MMR of the state with the lowest performance is over six times that of the state with the best performance. The standard deviation shows that the variation in MMR between states is also getting decreasing.

Discussion

The study attempted to understand the variation in MMR in different states of India. By 2030, all nations should have MMRs below 70 per 100,000 live births and none should have MMRs above 140 per 100,000 live births, according to the global SDG targets.(26) According to the SRS 2016-18, seven of the eight EAG states—including Bihar, Madhya Pradesh, Chhattisgarh, Odisha, Rajasthan, Uttar Pradesh, and Uttarakhand—remain far from meeting the SDG-3 objective.(3) In our study, in the analysis of 95% confidence interval of India and its major states, it is significantly broader for a number of states, including Aasam, Odisha and Punjab. Also, in all these states upper confidence limit and MMR both are exceeding 100 in year 2017-19, despite the fact that the width of the CI is narrower for India as a whole (or for a group of states such as EAG, South subtotal and others states) in the year 2017-19. In year 2010-12, confidence interval was broader for the states Kerala, Maharashtra and Tamilnadu while MMR less than 100.(7) Thus, our findings from mapping highlight the presence of heterogeneity in MMR among EAG and Aasam/ subtotal, south subtotal and others subtotal across the included states in the country. In our study, for only India, Uttar Pradesh/Uttarakhand, EAG, and Aasam have statistically lower MMR rates been seen at the 5% level of significance. The change is notable for the South Subtotal, Gujarat, Haryana, Maharashtra, Punjab, and West Bengal when comparing the years 2010–12 and 2014–16. The NHM and RMNCH +A may be to account for the considerable variance. The predicted fall in MMR is relatively weak given the scope and expectations of the NRHM, while it may be argued that it would be challenging to achieve faster reductions at lower levels of the phenomena.(27)

Conclusion

The analysis shows that a major policy concern is India's high rate of maternal mortality, especially in the EAG states and Assam. However, the rate of decline over the past two decades, in particular, has not decreased at a proportionate pace. Also, significant inter-state differences in MMR continue to be a key concern, where seven of the eight EAG states—including Bihar, Madhya Pradesh, Chhattisgarh, Odisha, Rajasthan, Uttar Pradesh, and Uttarakhand—remain far from meeting the SDG-3 objective.(3) So, it is important to understand in order to reach faster MMR reductions that economic performance alone would not be adequate but also improvements in socio-economic indicators are also required. Geographically, states with high MMR tend to be unfavorable, thus economic progress would be mostly restricted to favoured places, while the most remote and tribal

areas would continue to be neglected and have high MMR. (28) Economic growth might spur MMR improvements, but in order to reduce MMR more quickly, investments must also be managed to make in the health system, women's empowerment and education, provision of qualified human resources in the fields of medicine, good governance, and transportation infrastructure. In order to help with policymaking and improve the efficacy of various interventions, it is also crucial to improve the recording and sharing of crucial health (and health-related) information. India's development path needs to show a stronger sociopolitical commitment to the health, in order to set it leading ahead from other nations.

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Certificate of Original contribution

This is to certify that the submitted manuscript titled Inter-state disparities in Maternal Mortality Ratio in India – Two decade Analysis by Divya Sharma¹, Dr. Ajit Singh Solanki², Dr Pooja Soni³, Dr. Utkarsh Khare³ (¹ PhD Scholar, Department of Statistics, Bhupal Nobles' University Udaipur, Rajasthan, India, ² Assistant Professor, Department of Statistics, Bhupal Nobles' University Udaipur, Rajasthan, India, ³ Assistant Professor, Ananta Institute of Medical Science and Research Centre, Rajsamand, Rajasthan, India Correspondence to : Dr. Utkarsh Khare, Email: utkarshkhare153@gmail.com) is original contribution. The paper has not been submitted or accepted for publication anywhere else.