Determinants of Maternal Mortality: An Empirical Study of Indian States Based on the Random Effect Model Analysis

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ABSTRACT

Background: Healthcare for mothers and children is a significant indicator of a country's well-being. India is one of the nations that were experiencing a rather slow improvement in maternal and child health. During the early 21st century, the country was victim to high rates of maternal deaths, around 254 per hundred thousand live births (SRS-2004-06), larger than the world average.1 In 2017, there were almost 810 preventable deaths of women every day connected to pregnancy and delivery.2 Millennium Development Goal number five intended to lower the MMR by three-quarters from 1990 to 2015. India has made great progress toward the Millennium Development Goals, with several targets being met ahead of the 2015 deadline, but development has been uneven.3 To achieve these objectives, the government set up National Rural Health Mission (NRHM) in 2005, with the goal of providing good healthcare in the rural area and promoting high-quality infrastructure, particularly in backward areas, with a focus on improving infants, children, and maternal health.

Aims: The objective of this study is to analyse the changes in health infrastructure, government health expenditure, antenatal care, postnatal care, institutional delivery, Maternal Mortality Ratio (MMR) and the determinants of MMR in India.

Methodology: The study is based on secondary data. It employs an Average Increasing Rate (AIR) and Average Reduction Rate (ARR), as well as a panel data random effect model.

Results: Empirical results say MMR has a statistically significant inverse relationship with female literacy, Per capita Net State Domestic Product (PNSDP), and institutional delivery. The study concludes that after the introduction of NRHM and its constituent elements like JSY and JSSK, government expenditure on health, health infrastructure, the percentage of antenatal care, post-natal care, and institutional delivery increased in most of the Indian states, thus helping to increase the pace of the reduction of MMR. However, state performance varies greatly.

Conclusions: Policy alone will not provide the desired results; it is also critical to focus on education, particularly female literacy, and economic empowerment.

Keywords: Maternal Mortality Ratio, Per capita Government Health Expenditure, Antenatal Care, Out-of-Pocket Expenditure, Institutional delivery, Postnatal Care

INTRODUCTION

Mother and child healthcare is an important indication of a country's well-being. India is one of the countries that has seen a modest improvement in maternal and child health. During the early 21st century, the country was victim to high rates of maternal deaths, around 254 per hundred thousand live births (SRS-2004-06), larger than the world average.1 In 2017, there were almost 810 preventable deaths of women every day connected to pregnancy and delivery.2 Millennium Development Goal number five intended to lower the MMR by three-quarters from 1990 to 2015. India has made great progress toward the Millennium Development Goals, with several targets being met ahead of the 2015 deadline, but development has been uneven.3 To achieve these objectives, the government set up National Rural Health Mission (NRHM) in 2005, with the goal of providing good healthcare in the rural area and promoting high-quality infrastructure, particularly in backward areas, with a focus on improving infants, children, and maternal health.

One of NRHM’s flagship programmes, Janani Suraksha Yojana (JSY) has introduced in 2005. The im-
improvement in government health expenditure: Average Increasing Rate (AIR) or Average Reduction Rate (ARR) is calculated for all the health inputs like Per capita Government Health Expenditure, Average Population Covered by SCs, PHCs, and CHCs, health outcomes like Antenatal Care, Institutional Delivery in Government Hospitals, Out of Pocket Expenses during Delivery in Government Facilities, Post-Natal Care and health impacts like MMR between 2010-11 and 2019-20. This study also aimed to explain the determinants of maternal mortality in India after the implementation of NRHM.

**METHODOLOGY**

This study is based on secondary data. For comparison, mostly 2010-11 and 2019-20 data are used. The data was collected from government sources like Sample Registration System, Health Management Information System (HMIS), National Family Health Survey (NFHS-4 and NFHS-5), Rural Health Statistics (RHS), and Annual Health Survey (AHS). This study has the following methodological divisions:

First, an Average Increasing Rate (AIR) or Average Reduction Rate (ARR) is calculated for all the health indicators mentioned above, except for the average population covered by SCs, PHCs, and CHCs. In that indicator case, a government public health standard norm is used for the analysis of the improvement.

\[
\text{AIR/ARR} = \frac{\text{Final Value} - \text{Initial Value}}{\text{Initial Value}} \times 100
\]

Second, previous studies on the impact of JSSK on mother and child healthcare were analysed and interpreted.

Third, to empirically analyse, the factors determining the reduction of MMR, the random effect model is used. The data for Indian states from 2007-08 to 2019-20 (13 years) were used for empirical analysis. The states in which the number of pregnant women registered in a year is two lakh or more were included in the data set. MMR data for Jammu and Kashmir is not available so it is excluded from the data set. There are therefore 17 states.

The model is:

\[
Y_{it} = \beta_0 + \beta_k X_{it} + \beta_k Z_{it} + \upsilon_i + \epsilon_{it}
\]

Where \( i \) is entity (17 states), \( t \) is time (2007 to 2020-13 years), \( \beta_0 \) is the intercept, \( Y_{it} \) is the dependent variable (MMR here), \( X_{it} \) are the independent variables or the variable of interests, \( Z_{it} \) are other explanatory variables like Percentage of Female literacy and per capita net state domestic product, \( \beta_k \) is the coefficient for independent and other explanatory variables, \( \upsilon_i \) is the individual impact of \( i \)th entity (respective states here), and not measurable, and \( \epsilon_{it} \) is the error term, represents unobserved elements that change over time and impact \( Y_{it} \).

To identify whether there is a correlation between \( \upsilon_i \) and \( X_{it} \), Hausman test is applied, which accepted the null hypothesis. The Breusch and Pagan Lagrangian multiplier test confirms the random effect and evidence of significant differences across states. The model is a linear-log model in which some of the explanatory variables are in log form.

Here in the model, we used ASHA Workers in position (ASHA), the total number of First Referral Units (TnFRUs), the percentage of antenatal care (ANC), Out-of-Pocket Expenditure in a public facility (OoPE), State NRHM Expenditure (SNRHMExp), Institutional Delivery to total reported delivery (IDtoTRepDel), and pregnant women registered for ANC (PWrfANC) as explanatory variables against the Regressand MMR. Variables like female literacy rate (FemLiteracy), Per capita State Domestic Product at Constant Price (L_PNSDPatCP), are used to identify the effect of other explanatory variables and for avoiding omitted variable bias. The following is the estimated panel random effect regression equation for these variables:

1. \( \text{MMR}_{it} = \beta_0 + \beta_{\text{FemLiteracy}} X_{it} + \beta_{\text{TnFRUs}} + \beta_{\text{ANC}} + \beta_{OoPE} + \beta_{\text{SNRHMExp}} + \beta_{\text{IDtoTRepDel}} + \beta_{\text{PWrfANC}} + \upsilon_i + \epsilon_{it} \)

**RESULTS**

Improvements in Government health expenditure: In view of the constant growth in healthcare expenditure,
Cultures in most industrialised countries, policymakers are interested in the relationship between healthcare expenditure and health outcomes. In an attempt to address data heterogeneity difficulties, Cremieux et al looked at the relation between spending and health outcomes in ten Canadian provinces from 1978 to 1992. Lower healthcare spending was connected with a significant rise in new-born mortality and a reduction in life expectancy. Across Indian states, per capita government health care expenditure has inversely related on infant and child mortality, malaria cases, and a positive impact on life expectancy and immunisation coverage, whereas this impact is rather small in the High-Focus States. In response to the achievement of the Millennium Development Goals, the government implemented the NRHM and other programmes, which resulted in an increase in public health expenditure across states overtime.

Over the study period, all states' per capita government health spending increased (Table 1). In Himachal Pradesh, Kerala, and Uttarakhand, the difference is greater, whereas, in Bihar, Jharkhand, UP MP, and Assam, it is smaller. Haryana, Kerala, and Gujarat have higher average improvement rates, while Uttarakhand, Assam, and J&K have lower average improvement rates (Table 3).

| States             | Per capita Government Health Expenditure | Average population covered by Sub Centres (SCs) | Average population covered by Primary Health Centres (PHCs) | Average population covered by Community Health Centres (CHCs) |
|--------------------|------------------------------------------|-----------------------------------------------|-----------------------------------------------------------|-----------------------------------------------------------|
|                    | 2010-11 2019-20                          | 2010-11 2019-20                                | 2010-11 2019-20                                            | 2010-11 2019-20                                           |
| Andhra Pradesh     | 364 1125                                  | 4105 4623                                     | 26977 30026                                                | 125682 245571                                           |
| Assam              | 465 998                                   | 4864 6291                                     | 111408 30875                                               | 126456 165017                                           |
| Bihar              | 186 504                                   | 24589 10626                                   | 158275 55670                                               | 253523 704780                                           |
| Ghuttisgarh        | 277 1237                                  | 4430 4105                                     | 413325 26977                                               | 415231 25682                                            |
| Gujarat            | 298 1429                                  | 4029 3953                                     | 25763 24549                                                | 112889 100097                                           |
| Haryaena           | 255 1341                                  | 5299 6645                                     | 35103 45657                                                | 125283 150470                                           |
| Himachal Prad.     | 830 2816                                  | 4894.5 3144                                   | 28431.5 11206                                               | 112976 75483                                            |
| Jammu & Kash.      | 789 1535                                  | 3147 3150                                     | 13264 15322                                               | 94467.5 113452                                           |
| Jharkhand          | 219 717                                   | 5211 7272                                     | 54610.5 93899                                               | 138544.5 163637                                          |
| Karnataka          | 359 1309                                  | 5574.5 3877                                   | 55843 17787                                                | 173356.5 191076                                          |
| Kerala             | 441 2149                                  | 3008.5 2140                                   | 15680.5 13574                                               | 120892.5 50709                                           |
| Madhya Pradesh     | 281 811                                   | 3954.5 5769                                   | 31389 49204                                                | 120815.5 190922                                          |
| Maharashtra        | 306 1216                                  | 5898 6027                                     | 42187.5 35171                                               | 183775.5 176629                                          |
| Manipur            | 881 809.5                                 | 5189 4351                                     | 29430 23689                                                | 134662.5 92969                                           |
| Meghalaya          | 738 1192                                  | 4868.5 5386                                   | 22730 21777                                                | 92223 91750                                              |
| Mizoram            | 1646 1300                                 | 3432 1478                                     | 15521 9271                                                 | 76264 60778                                              |
| Nagaland           | 954 608                                   | 2218 2958                                     | 138973.3 18523.5                                           | 60889 61000                                              |
| Odisha             | 262 1108                                  | 4153.5 5349                                   | 23149.8 27776                                               | 77948.5 94987                                             |
| Punjab             | 304 1108                                  | 5694 6039                                     | 35299 42822                                                | 147527 200157                                           |
| Rajasthan          | 321 1126                                  | 5142 4245                                     | 35184.5 27547                                               | 150300 100443                                           |
| Sikkim             | 1476 903.5                                | 3227.5 2210                                   | 20480.5 13414                                               | 147471.5 194500                                           |
| Tamil Nadu         | 331 1293                                  | 3191 4172                                     | 19487.5 25561                                               | 144455 94410                                              |
| Tripura            | 670 462.5                                 | 3421 2670                                     | 24794.5 24028                                               | 119208.5 144167                                          |
| Uttarakhand        | 255 772                                   | 5494 8318                                     | 41453 58078                                                | 13979 254592                                              |
| West Bengal        | 250 906                                   | 6028 6070                                     | 48938.5 69231                                               | 145259.5 108638                                           |

Source: Rural Health Statistics and Annual Health Survey for 2010-11 and 2019-20, Ministry of Health and Family Welfare, GoI

Health infrastructure and health outcomes: Many national and international research has shown that there is a substantial link between health infrastructure and health outcomes. Improved access to health services, trained health workers, better drug usage, and increased funding for health in India can all help to improve health outcomes. A study discovered a favourable link between primary health infrastructure and curative and preventative health outcomes. The availability of hospitals, staff in health centres, and the number of hospital beds might all contribute to a lower IMR and longer life expectancy. According to a study improving the quality of health infrastructure facilities can help women have fewer difficulties throughout their pregnancies. The healthcare infrastructure in rural areas has been made as a three-level system based on demographic norms. SCs can serve a maximum of five thousand people in plain areas and three thousand in hilly areas, whereas PHCs can serve a maximum of thirty thousand people in plain areas and twenty thousand in mountainous areas, and CHCs can serve a maximum of 1,20,000 people in plain areas and 80,000 in hilly areas. In this study, we’re looking at the average population served by SCs, PHCs, and CHCs as a health infrastructure variable to determine if there’s a link between health outcomes and infrastructure. As of March 31, 2020, there were 1,55,404 SCs, 24,918 PHCs, and 5183 CHCs in rural areas of the country (Rural Health Statistics-2019-20).
Average Population covered by Sub Centres (SCs): SCs are the most remote and initial point of interaction between the primary health care system and the general public. 2010-11 data shows (Table 1) that only five states had an SCs for less than five thousand population in the plain area, Rajasthan, Karnataka, Chhattisgarh, Assam, and Uttarakhnad, where Bihar (24,589), Maharashtra (20,182) and Andhra Pradesh (10,702) were highly overpopulated. In 2019-20 all-state reduced their burden on the population in SCs.

Chhattisgarh, Haryana, Kerala, Odisha, and West Bengal improved their health accessibility by reducing the average population covered by SCs, PHCs and CHCs. Most of the states are now coming under the population norm of five thousand which we can say that it is a positive effect of NRHM and its constituent elements. According to RHS-2019-20, the states of Rajasthan (2968), Gujarat (1888), Chhattisgarh (1387), Madhya Pradesh (1352), and Karnataka (1045) have had a considerable growth of SCs since 2005.

Average Population covered by PHCs: The PHCs were created to provide rural residents with comprehensive curative and preventative health care, with an emphasis on health promotion and prevention. Only a few states, like Kerala, Karnataka, Chhattisgarh, Punjab, Uttarakhnad, and Rajasthan, had population densities below 30,000 in 2010-11, whereas Assam, Bihar, and Jharkhand were highly overpopulated (Table 1). Except for a few states including West Bengal, MP, Uttarakhnad, Punjab, Har- yana, Meghalaya, and Arunachal Pradesh all states decreased the surplus population load on PHCs in 2019-20. As of March 31, 2020, there were 24,918 PHCs operating in rural locations around the country. PHCs have increased in the states of Jammu & Kashmir-589, Karnataka-495, Gujarat-407, Raja- shan-381 and Chhattisgarh-275 since 2005 (RHS-2019-20).

Average Population Covered by Community Health Centres (CHCs): CHCs act as a referral centre for four PHCs, as well as providing obstetric care and expert consultations. As per 2010-11 data (Table 1) Bihar, UP, MP, Haryana, and West Bengal are overpopulated. Present data shows there is not much improvement in the case of CHCs across the states in the study period. Except for Kerala, West Bengal, Odisha, and Haryana in all other states, the population burden on CHCs increased. Community Health Centres have not increased in India even after the intro- duction of NRHM. It increased nominally less than 2000 in numbers from 2005 (3346) to 2020 (5183). That means there is no increase in CHCs in proportion to the increase in population.

Antenatal Care and Health Outcomes: Antenatal care is regarded as a critical component of the healthcare system.

Table 2: Changes in key Health outcomes

| States         | % of Antenatal Care | % of Institutional delivery in public facility | OoPE during delivery in public facility | % Of Postnatal Care | MMR |
|----------------|---------------------|-----------------------------------------------|----------------------------------------|---------------------|-----|
|                | 2010-11 2019-20     | 2010-11 2019-20                               | 2010-11 2019-20                        | 2010-11 2019-20     |     |
| Andhra Prad.   | 86.8 101.5          | 42.7 45.15                                    | 2322 3105                              | 43.6 76.4           | 110 |
| Assam          | 62.5 85.8           | 47.6 56.9                                    | 3681 5415                              | 41.6 85.8           | 328 |
| Bihar          | 49.1 68.9           | 71.8 69.1                                    | 1784 2848                              | 17.9 36.8           | 219 |
| Chhattisgarh   | 81.2 92.4           | 66.4 71.9                                    | 1480 1808                              | 25.1 61.4           | 230 |
| Gujarat        | 72.4 88             | 52 56.8                                      | 2136 1697                              | 60.7 78.4           | 122 |
| Haryana        | 78.4 79.6           | 61.6 71.7                                    | 2241 2785                              | 38.8 60             | 146 |
| Himachal Pra.  | 78.1 78.5           | 77.9 86.8                                    | 3329 3760                              | 45.2 97             | 136 |
| Jammu & Kas.   | 42.5 83.1           | 41.8 51.5                                    | 4225 5145                              | 21.4 66.3           | 136 |
| Jharkhand      | 63 79.3             | 61.2 64.8                                    | 1476 3150                              | 38.6 50             | 219 |
| Karnataka      | 81.3 98.7           | 38.3 34.1                                    | 4824 4954                              | 59.8 88.9           | 144 |
| Kerala         | 83.2 98.9           | 89.4 94.7                                    | 6901 6710                              | 79.5 111.2          | 66  |
| Madhya Prad.   | 78.3 79.5           | 48.9 55.8                                    | 1481 2529.5                            | 39.1 11             | 230 |
| Maharashtra    | 62.1 94.4           | 45.7 59.4                                    | 3578 2966                              | 19.8 60.7           | 87  |
| Manipur        | 45.9 55.2           | 39.5 49.1                                    | 10348 14518                            | 32.8 44.7           | 136 |
| Meghalaya      | 42.5 48.1           | 63.7 73.8                                    | 3319 3219                              | 35.1 42.5           | 136 |
| Mizoram        | 76.7 58.4           | 25.1 35.8                                    | 5113.5 7008                            | 63.1 17.3           | 136 |
| Nagaland       | 32.7 23.7           | 75.8 78.7                                    | 6393 5778                              | 22 39.2             | 136 |
| Odisha         | 85.9 81.4           | 81.6 72.55                                   | 4226 3932.5                            | 66 95.1             | 258 |
| Punjab         | 87.3 85.5           | 63.5 73.1                                    | 3639 3345.5                            | 43.4 88.3           | 155 |
| Rajasthan      | 66.5 62.7           | 82.7 78.6                                    | 3052 3522.5                            | 46.5 9.2            | 255 |
| Sikkim         | 80.4 65.3           | 66.7 48.6                                    | 3993 8334                              | 61.8 84.8           | 136 |
| Tamil Nadu     | 74.6 88.3           | 30.5 49.7                                    | 2609 3952.7                            | 31.2 1.9            | 90  |
| Tripura        | 53.3 69.4           | 44.5 44.15                                   | 5296.3 6640                            | 49.3 65.3           | 136 |
| Uttar Pradesh  | 75 74.6             | 43.8 50.2                                    | 5980.5 5321                            | 36 49.7             | 292 |
| Uttarakhand    | 74.5 72.1           | 56.6 72.4                                    | 4661.5 4002                            | 40.7 45.7           | 292 |
| West Bengal    | 71.5 84.5           | 52.1 52.1                                    | 3342.5 2683                            | 40.7 81.2           | 117 |

OoPE = Out of Pocket Expenditure

source: Rural Health Statistics, Annual Health Survey, HMIS and SRS data for 2010-11 and 2019-20
It encourages institutional births, lower maternal mortality, and a higher likelihood of infant survival. Based on the efficacy of the healthcare system, the World Health Organization advises at least four prenatal care visits. In India, the percentage of Antenatal check-ups (three or more) has risen from 70.9 per cent to 79.5 per cent (Table 2). The highest positive change is marked by J&K, Madhya Pradesh, and Bihar whereas the lowest is marked by UP, Uttarakhand, Punjab, and Rajasthan with negative changes.

**Institutional Birth in Public Facility:** Skilled delivery attendance is a key metric for tracking progress toward Millennium Development Goal 5. NRHM and its components, especially Janani Suraksha Yojana (JSY) and Janani Shishu Suraksha Yoajana (JSSK) encourage institutional delivery to reduce maternal and infant deaths. JSSK was established in India in 2011 to provide free institutional delivery to pregnant women. Due to the implementation of these programmes, institutional delivery in India has increased many folds. Institutional delivery improved because of the JSSK initiative. JSSK benefited women who used public services, however, medications, consumables, and transportation added to out-of-pocket expenses.

Institutional delivery has grown in almost all states throughout this time span. Karnataka has the most unfavourable change (-10 percent). Kerala and Himachal Pradesh have the highest levels of institutional delivery in absolute terms (Table 2 & 3). ID at a public facility is lower in high-profile states.

**Out-of-pocket expenditure in public facilities:** Out-of-Pocket Expenses (OoPE), which accounts for more than 60 per cent of overall health spending in India, is the primary source of funding (Indian Institute of Public Health). Many services are focused on maternal health since they are the most vulnerable and majority group (2/3rd) of the population, and most diseases and deaths among them are avoidable.

To eliminate OoPE in mother and child healthcare, the government launched JSSK in 2011. The scheme is open to all. According to NFHS-5 data (Table 2), OoPE in government health facilities has grown in most states. Manipur (14518) and other North-Eastern states, Kerala (6710), and J&K (5145) have the highest levels. Gujarat (1697), West Bengal (2683), and Bihar (2848) have far lower rates. West Bengal (44.7 per cent), Goa (24.1 per cent), and Gujarat (20.6 per cent) have greater average reduction rates (Table 3).

**Postnatal Care:** Promoting prenatal care and competent birth attendance is obviously insufficient to enhance the health of mothers and children. “According to the WHO’s postnatal care recommendations, all mothers and their new-borns should get the essential routine postpartum care, with special focus given to low birth weight and early diagnosis, referral, or management of emergency conditions. Postnatal visits between 6 and 12 hours after birth, as well as follow-up visits between 3 and 6 days, 6 weeks, and 6 months, are all recommended.”

Attention throughout antenatal and postnatal care is required in India, where both mothers and children are vulnerable to a variety of health risks because of malnutrition and poverty. Several policy changes have been undertaken by the Indian government to boost postnatal coverage. Most Indian states boosted postnatal care between 2010 and 2019, ranging from 12 per cent in Uttarakhand to 210 per cent in J&K and Andhra Pradesh (2022 per cent). But major states like Tamil Nadu (-94 per cent), Rajasthan (-80 per cent), and MP (-72 per cent) saw negative developments across these time periods (Table 2 & 3).

**Maternal Mortality Ratio (MMR) in India:** The Maternal Mortality Ratio (MMR) is defined as the number of maternal fatalities caused by pregnancy and childbirth problems per 100,000 live births within a certain period. Maternal mortality, which reflects women's social and economic disadvantages, has been designated as a key concern in India’s health strategy. The National Health Mission has made significant and planned investments to promote maternal health. In India, the MMR has dropped by 68.7 per cent, from 556 in 1990 to 174 in 2015, an average yearly reduction of 4.6 per cent. The target for MMR was 109 per 1,000 live births by 2015.

The SRS data clearly shows that all Indian states improved their MMR situation by significantly lowering maternal fatalities. From 2010 to 2017, the average decrease rate was 36.5 per cent. Jharkhand (67.6 per cent) and Uttarakhand (66.1 per cent), on the other hand, have the highest ARR, while West Bengal (16.2 per cent) and Punjab have the lowest (16.8 per cent). Kerala (43), Maharashtra (46), and Tamil Nadu (60) have the lowest maternal mortality ratio, whereas Assam (215), Uttarakhand (197), MP (173), and Rajasthan have the highest maternal mortality ratio (164). Most states, except for Punjab, Bihar, Odisha, Chhattisgarh, Rajasthan, Madhya Pradesh, Uttar Pradesh, and Assam, met the MDG-5 objective of reducing MMR to 109 by 2015 (Table 2 & 3).

We can detect large disparities in performance among Indian states. This observation are important because the safe motherhood programmes was introduced a long way back. In India, most maternal mortality is still linked to variables including nutrition, poverty, and social marginalisation, on which interventions have had little or no influence. According to their findings, economic growth alone can cause changes in MMR in India. They observed that MMR and PNSDP, TFR, and SC/ST populations had a strong relationship. Another study re-examines the causes of maternal mortality in India, using data from the SRS 2001–03, and concludes that direct obstetric factors account for over 80 per cent of maternal fatalities in India. As a result, policymakers may employ these regions to achieve the MMR objective more effectively.
Table 3*: AIR/ ARR between 2010-11 and 2019-20 of key health indicators

| States                  | PGHE  | ANC  | IDinPF | OoPE  | PNC  | MMR  |
|-------------------------|-------|------|--------|-------|------|------|
| Andhra Pradesh          | 209.1 | 16.9 | 5.7    | 33.7  | 75.2 | -40.9|
| Assam                   | 114.6 | 37.3 | 19.5   | 41.7  | 106.3| -34.5|
| Bihar                   | 171.0 | 40.3 | -3.8   | 59.6  | 105.6| -32.0|
| Chhattisgarh            | 346.6 | 13.8 | 8.3    | 22.2  | 144.6| -30.9|
| Gujarat                 | 379.5 | 21.5 | 9.2    | -20.6 | 29.2 | -38.5|
| Haryana                 | 425.9 | 1.5  | 16.4   | 24.3  | 54.6 | -37.7|
| Himachal Pradesh        | 239.3 | 0.5  | 11.4   | 129.4 | 114.6| -37.5|
| Jammu & Kashmir         | 94.6  | 95.5 | 23.2   | 21.8  | 209.8| -37.5|
| Jharkhand               | 227.4 | 25.9 | 5.9    | 113.4 | 29.5 | -67.6|
| Karnataka               | 286.9 | 21.4 | -11.0  | 2.7   | 48.7 | -36.1|
| Kerala                  | 387.3 | 18.7 | 5.9    | -2.8  | 39.9 | -34.8|
| Madhya Pradesh          | 188.6 | 1.5  | 14.1   | 70.8  | -71.9| -2.48|
| Maharashtra             | 297.4 | 52.0 | 30.0   | -17.1 | 206.6| -47.1|
| Manipur                 | -8.1  | 20.3 | 24.3   | 40.3  | 36.3 | -37.5|
| Meghalaya               | 61.5  | 13.2 | 15.9   | -3.0  | 21.1 | -37.5|
| Mizoram                 | -21.0 | -23.9| 42.6   | 37.0  | -72.6| -37.5|
| Nagaland                | -36.3 | -27.5| 3.8    | -9.6  | 78.2 | -37.5|
| Odisha                  | 322.9 | -5.2 | -11.1  | -6.9  | 44.1 | -41.9|
| Punjab                  | 264.5 | -2.1 | 15.1   | -8.1  | 103.5| -16.8|
| Rajasthan               | 250.8 | -5.7 | -5.0   | 15.4  | -80.2| -35.7|
| Sikkim                  | -38.8 | -18.8| -27.1  | 108.7 | 37.2 | -37.5|
| Tamil Nadu              | 290.6 | 18.4 | 63.0   | 51.5  | -93.9| -33.3|
| Tripura                 | -31.0 | 30.2 | -0.8   | 25.4  | 32.5 | -37.5|
| Uttar Pradesh           | 202.7 | -0.5 | 14.6   | -11.0 | 38.1 | -32.5|
| Uttarakhand             | 165.1 | -3.2 | 27.9   | -14.1 | 12.3 | -66.1|
| West Bengal             | 262.4 | 18.2 | -19.7  | 99.5  | -16.2| -37.5|

*PCGHE-Per capita government health expenditure; ANC- Antenatal Care; IDinPF- Institutional Delivery in Public Facility; OoPE- Out of Pocket Expenditure (OoPE) during delivery in a public institution; PNC- Postnatal Care; MMR- Maternal Mortality Ratio

Source: Authors calculation based on the data from RHS, AHS, HMIS, and SRS data

Table 4: Result of Random Effect Model

| MMR           | Coef.  | St.Err. | t-value | p-value | [95% Conf Interval] | Sig  |
|---------------|--------|---------|---------|---------|---------------------|------|
| FemLiteracy   | -9.436 | 1.088   | -8.67   | 0.000   | -11.569 -7.303      | ***  |
| l_PNSDPatCP   | -16.758| 8.353   | -2.01   | 0.045   | -33.131 -38.6       | **   |
| ASHA          | -1.011 | 5.732   | -0.18   | 0.860   | -12.246 10.223      | *    |
| TnFRUs        | -12.446| 5.677   | -2.19   | 0.028   | -23.572 -1.32       | **   |
| ANC           | .699   | .196    | 3.56    | 0.000   | .314 1.084          | ***  |
| OoPE          | 3.878  | 2.057   | 1.89    | 0.059   | -.153 7.909         | *    |
| SNRHMExp      | -11.963| 7.248   | -1.65   | 0.099   | -26.169 2.243       | *    |
| IDtoTRepDel   | -.387  | .187    | -2.07   | 0.039   | -.754 -0.02         | **   |
| PWrfANC       | .224   | .126    | 1.77    | 0.076   | -.023 .472          | *    |
| Constant      | 1100.06| 65.795  | 16.72   | 0.000   | 971.104 1229.016    | ***  |

Mean dependent var 203.452, SD dependent var 90.963, Overall r-squared 0.577, Number of obs 208, Chi-square 508.382, Prob > chi2 0.000, R-squared within 0.734, R-squared between 0.420

*** p<0.01, ** p<0.05, * p<0.1
Source: Authors own calculation

**Empirical Analysis:** For finding out the association between health inputs on specific health outcomes, say, MMR, the random effect model is used. Here in the model, we used ASHA Workers in position (ASHA), the total number of First Referral Units (TnFRUs), the percentage of antenatal care (ANC), Out-of-Pocket Expenditure in a public facility (OoPE), State NRHM Expenditure (SNRHMExp), Institutional Delivery to total reported delivery (IDtoTRepDel), and pregnant women registered for ANC (PWrfANC). Variables like female literacy rate (FemLiteracy), Per capita State Domestic Product at Constant Price (l_PNSDPatCP), are also used to identify the effect of other explanatory variables and for avoiding omitted variable bias.

The random effect model's findings (Table 4) indicate that majority of the variables we considered have a negative and significant association with MMR. Female literacy (p<.01), PNSDPatCP (p<.01), TnFRUs (p<.05) and IDtoTRepDel (p<.05) all are negatively associated with MMR, this means if female literacy increases by one unit MMR will decrease by 9.44 units. Similarly, if per capita state domestic product increase by one unit the MMR will come down by 0.44 units. If the total number of first referrals increases by one unit MMR will decline.
For the sake of facilities concerned, the number of SCs rose by 6 per cent, the number of PHCs increased by 9 per cent, and the number of CHCs expanded by 55 per cent between 2005 and 2016. The issue with this expansion is that the number of SCs, which serve as patients' initial point of contact, has not expanded in proportion to the population, which has increased by 15.7 per cent during this time. As a result, the strain on the PHC and the CHC has increased. With a shortage of approximately 81 per cent of experts, CHCs are already in a dire situation.

“Since 2005, the government has succeeded in providing buildings for SCs, PHCs, and CHCs, which have risen to 65 per cent, 45 per cent, and 91 per cent, respectively, under the name of infrastructure. However, these buildings lack basic facilities and resources for delivering healthcare. According to the Rural Health Statistics 2016, 71 per cent of PHCs have labour rooms, although the study does not specify the equipment or functional status of these labour rooms in accordance with Indian Public Health Standard criteria. There is an 83 per cent shortage of surgeons and 76 per cent shortage of obstetricians and gynaecologists in CHCs nationwide. India’s healthcare spending remains the lowest among BRICS countries. Such statistics mean that specialised healthcare treatment in rural India is difficult, which has driven rising numbers of people to costlier private healthcare. In rural India, 58 per cent of hospitalised treatment was carried out in private hospitals, while in urban India the figure was 68 per cent, according to the Key Indicators of Social Consumption on Health 2014 survey carried out by National Sample Survey Office. This is the reason why in our study empirical analysis shows a positive and significant relationship (p<.1) between Out-of-Pocket expenditure and IMR in which most facilities are still not available in public health facilities so pregnant women have to depend on private facilities to safeguard their pregnancy and childbirth.

The percentage of Antenatal Care increased in most of the states except Goa, Mizoram, Nagaland, Odisha, Punjab, Rajasthan, Sikkim Uttarakhad and UP. Institutional delivery in public health institutions has increased in all states except Goa, Mizoram, and Karnataka, and Rajasthan. The twin components of NRHM, JSY and JSSK have a proven track record of boosting institutional births and obstetric patient bookings (thereby improving antenatal care). They have also raised the number of NICU admissions at level III government hospitals, while in urban India the figure was 68 per cent, according to the Key Indicators of Social Consumption on Health 2014 survey carried out by National Sample Survey Office. This is the reason why in our study empirical analysis shows a positive and significant relationship (p<.1) between Out-of-Pocket expenditure and IMR in which most facilities are still not available in public health facilities so pregnant women have to depend on private facilities to safeguard their pregnancy and childbirth.

DISCUSSION

The study found an increasing trend in the case of Per capita Government Health Expenditure in all states from 2010-11 to 2019-20. India has one of the lowest public healthcare budgets in the world, with the public healthcare system receiving only 1.26 per cent of the country’s total GDP. Barenberg et al. (2015) examined the influence of government health expenditure on new-born mortality rates using unbalanced panel data of Indian States and Union Territories from 1983-84 to 2011-12. Using a simultaneous equation model, they observed that government health expenditure helps to minimise IMR among Indian states. Farahani et al. (2010) examined the relationship between state-level public health spending in India and individual mortality across all age groups using household-level data from the National Family Health Survey II (NFHS-II) conducted from 1998-1999. A 10 per cent increase in public health spending decreases mortality by around 2 per cent, according to the results of the probit regression model.

Using panel Fixed Effects models, R K Mohanty, and D K Behera (2020) of the National Institute of Public Finance and Policy in New Delhi investigated the effects of public health spending on selected health outcomes such as life expectancy, infant and child mortality rates, malaria, and immunisation across 28 Indian states from 2005 to 2016. “The empirical findings reveal that per capita health-care spending has a positive and statistically significant influence on life expectancy and immunisation, but a negative impact on new-born mortality, child mortality, and malaria cases. Per capita income, like public health investment, has a negative influence on new-born and child mortality and malaria, while having a positive impact on boosting life expectancy across States.” Our study also reiterates that a unit increase in state NRHM expenditure leads to a decrease in the IMR by 0.1196 units (p<.1).

As far as the average population covered by health facilities are concerned, the number of SCs rose by 6 units. If institutional delivery increases by one unit MMR will decline by 0.387 units. One of the flagship programmes ASHA Workers has no significant impact on reducing MMR according to this empirical result. Similarly, the result says if antenatal care increases MMR also will increase (highly significant). It is quite contrary to what has been seen and recommended which is a serious issue to be further studied whether it is because of the lack of quality of antenatal care provided to pregnant women, especially in rural areas or because of any other reason.

Based on this result, we can write the regression equation as:

$$\text{MMR}_t = 1100.06 - 9.436 \text{FemLiteracy}_t - 16.758 \text{PCNSDPatCP}_t - 12.446 \text{TnFRUs}_t + .699 \text{ANC}_t - .387 \text{IDtoTRepDel}_t$$

\[\text{DISCUSSION}\]

The study found an increasing trend in the case of Per capita Government Health Expenditure in all states from 2010-11 to 2019-20. India has one of the lowest public healthcare budgets in the world, with the public healthcare system receiving only 1.26 per cent of the country's total GDP. Barenberg et al. (2015) examined the influence of government health expenditure on new-born mortality rates using unbalanced panel data of Indian States and Union Territories from 1983-84 to 2011-12. Using a simultaneous equation model, they observed that government health expenditure helps to minimise IMR among Indian states. Farahani et al. (2010) examined the relationship between state-level public health spending in India and individual mortality across all age groups using household-level data from the National Family Health Survey II (NFHS-II) conducted from 1998-1999. A 10 per cent increase in public health spending decreases mortality by around 2 per cent, according to the results of the probit regression model.

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livery in the study area's population that had previously been primed by the JSY programme.

Out of Pocket Expenditure still exists in public health institutions during delivery. In Kerala, Goa, Gujarat, Maharashtra, Meghalaya, Nagaland, Telangana, and West Bengal Out-of-Pocket Expenditure decreased. Even after the introduction of JSSK in most of the states, there is no sign of elimination of OoPE rather it is increased while comparing with the previous NFHS-4 data. Although OoPE decreased slightly after the implementation of JSSK, there was no discernible difference in catastrophic health expenses between the pre-JSSK (21.2 per cent) and post-JSSK (15.6 per cent) periods. According to another research, 83.5 per cent of the sample group who received JSSK benefits had OoPE. The computed average expenditure was INR 4289. The median OoPE was INR 1100. Beneficiaries were still facing substantial health expenditures, according to a survey done in regions of Delhi. Diagnostics accounted for the largest percentage of spending, which may be ascribed to infrastructure bottlenecks; pharmaceuticals accounted for the second-largest share of spending, which can be linked to a lack of availability of drugs. The JSSK initiative in Chhattisgarh has not been able to achieve its goal of decreasing the expenditure on pregnant women in public health facilities. Medicine, food, and transportation accounted for many of the costs. Due to a lack of human resources, poor health facility infrastructure, and irregular and insufficient pharmaceutical supplies, recipients are forced to pay exorbitant fees during institutional delivery. This demonstrates that government spending on the plan is insufficient, which should be addressed by wise resource allocation to increase JSSK efficacy. More than 70 per cent of pregnant women in West Bengal's Bankura area are aware of the programme, yet only 20 per cent of them use it. Medicine, transportation, and diagnostics are the areas of expense. According to this study, JSSK failed to meet its intended purpose of providing cost-free services to pregnant women and unwell babies due to shortcomings in its implementation, mostly at facility levels.

Post-Partum check-ups (48 hours to 14 days) have been increased in all states except Madhya Pradesh, Rajasthan, Tamilnadu and Mizoram. Maternal Mortality decreased in all states between 2010-11 and 2019-20. In India, the combined effect of facility births and postnatal examinations is connected to a much lower risk of new-born death than merely delivering the baby in a facility. If these associations are causal, facility delivery combined with postnatal examinations in India might prevent roughly a third of all new-born deaths. Overall socio-economic development, with a focus on women's empowerment and education, can improve the usage of maternal healthcare. According to research done in eastern India, despite several government programmes, excellent socioeconomic level, the mother's education, and the existence of health-related disorders in the mother or the infant, post-natal care remains unacceptably low, owing to a lack of effective postnatal care counselling. Staff sensitization, standard policy, and mother-centred counselling are still needed to improve postnatal care services.

States not achieved MMR target in compliance with MDG-5 (109 or less by 2015) are Bihar, Madhya Pradesh, Odisha, Rajasthan, Uttar Pradesh, Assam, Chhattisgarh, Jharkhand, and Uttarakhand. There exist interstate variations in the performance of maternal healthcare mainly because of demographic, educational, social, cultural, geographical, and economic factors. Even though India fell short of the MDG target, the country has made significant progress. This is due to four significant variables. First, with the implementation of the NRHM, India has made a deliberate effort to enhance access to high-quality maternal health services. Since then, institutional delivery has grown from 38 per cent to 79 per cent. Second, state-subsidised demand-side financing programmes like the Janani Shishu Suraksha Karyakram – which provides free transportation and no-cost delivery, including C-section, to all pregnant women giving birth in public health institutions – have largely eliminated the traditional urban-rural divide in institutional births. In all, 75 per cent of rural births are currently based on skilled attendance, compared to 89 per cent of metropolitan births. Third, India has placed a high priority on addressing the socioeconomic determinants of maternal health. India's women are more literate than ever before, with 68 per cent able to read and write. They are also marrying later age, with only 27 per cent of them marrying before the age of 18. Finally, the government has made significant efforts to promote beneficial collaboration between public and private healthcare providers. Women now have access to prenatal check-ups, obstetric gynaecologists, and the ability to track high-risk pregnancies attributable to campaigns like the Pradhan Mantri Surakshit Matritva Abhiyan.

LIMITATIONS

There is a dearth of long-term, continuous, and comprehensive data linked to several significant variables of interest in this study, which makes it difficult to use dynamic models like the ARDL-ECM. This could affect how accurate the outcomes are. The more observations in the data set, the more accurate will be the study.

CONCLUSION

To conclude we can say that NRHM and its constituent elements like JSY and JSSK policy articulations and information distribution are present in all states, resulting in an increased understanding of pregnant women's and ill new born's entitlements. For JSY/JSSK registered pregnant women, almost all entitlements are being received, although out-of-pocket expenses for medicines, diagnostics, and referral transportation for pick-up and drop-off remain (13th
Even though, ASHA workers, who are one of the most important components of the National Health Mission, excel in all states when it comes to improving access to maternity, neonatal, and child healthcare but not been able to bring down MMR in the country according to the empirical analysis of this study. This is because of their limitation in rural areas because of high population pressure. However, the goal of eliminating out-of-pocket expenditure remains unachieved. Providing continuous access to essential medicines and diagnostic services continues to be a difficulty, and it is an area where states should focus if the aim of Universal Health Coverage is to be met. Human resources are an essential component of every healthcare system. In most states, sanctioned postings do not meet IPHS standards, resulting in severe shortages or unreasonable deployment. Deficiencies in service delivery reflect the effects of shortages.

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