ORIGINAL RESEARCH ARTICLE
pISSN09763325 | eISSN22296816
Open Access Article (CC BY-SA)
www.njcmindia.com
DOI: 10.55489/njcm.130820222203

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

Fasalurahman P K Patterkadavan[1], Syed Hasan Qayed[2]

[1]Maulana Azad National Urdu University, Hyderabad, India
[2]Maulana Azad National Urdu University, Hyderabad, India

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.

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-

How to cite this article: Patterkadavan FPK, Qayed SH. Determinants of Maternal Mortality: An Empirical Study of Indian States Based on The Random Effect Model Analysis. Natl J Community Med 2022;13(8):532-541. DOI: 10.55489/njcm.130820222203

Financial Support: None declared | **Conflict of Interest:** None declared | **Date of Submission**: 27-06-2022 | **Date of Acceptance**: 24-07-2022 | **Date of Publication**: 31-08-2022

Correspondence: Fasalurahman P K Patterkadavan (Email: pknaduvil@gmail.com)

pact of JSY, the largest Conditional Cash Transfer Scheme (CCT) was impressive. It brought the marginalised rural pregnant women to public health institutions for antenatal care and delivery. Another component of NRHM, ASHA, performed the duty of IEC (Information, Education, and Communication). The result was highly impressive. Institutional delivery increased in most of the states, especially in backward states like UP, Bihar, MP, Rajasthan, Odisha, etc. and it directly worked as a catalyst for the reduction of mortality of mother and child.[4] But it was limited to a certain category population only. So, its impact was also limited, especially among urban and high-profile populations. Moreover, one of the causes of lower institutional deliveries was the large out-of-pocket expenditure in private hospitals and the lack of infrastructure and human resources in government hospitals. NRHM, to some extent, was helpful to increase infrastructure and manpower in government hospitals but did not touch on the problem of high out-of-pocket expenditure. By realising this, the government of India introduced Janani Shishu Suraksha Karyakram (JSSK) for the elimination of out-of-pocket expenditure in public health institutions after five years of NRHM. Therefore, it is important to empirically analyse the factors that influence Maternal Mortality 15 years after the introduction of NRHM.

OBJECTIVES

This research covers many goals related to the delivery of healthcare services to pregnant women. The paper simply attempted to analyse the average improvement / average reduction rate of 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:

$$Y_{it} = \beta_0 + \beta_k X_{it} + \beta_k Z_{it} + \upsilon_i + \varepsilon_{it}$$

Where i – is entity (17 states), t – is time (2007 to 2020-13 years), β_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, β_k – is the coefficient for independent and other explanatory variables, υ_i – is the individual impact of i^{th} entity (respective states here), and not measurable, and ε_{it} – is the error term, represents unobserved elements that change over time and impact Yit.

To identify whether there is a correlation between υ_i and X_{it}, ε_{it} and υ_i, 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. $$MMR_{it} = \beta_0 + \beta_1 FemLiteracy_{it} + \beta_2 l\_PNSDPatCP_{it} + \beta_3 ASHA_{it} + \beta_4 TnFRUs_{it} + \beta_5 ANC_{it} + \beta_6 OoPE_{it} + \beta_7 SNRHMExp_{it} + \beta_8 IDtoTRepDel_{it} + \beta_9 PWrfANC_{it} + \upsilon_{it} + \varepsilon_{it}$$

RESULTS

Improvements in Government health expenditure: In view of the constant growth in healthcare expendi-

tures in most industrialised countries, policymakers are interested in the relationship between healthcare expenditure and health outcomes.[5] "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".[6] 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.[7] 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 over time.

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).

Table 1: Changes in key Health Inputs

States	Per capita Government Health Expenditure		Average population covered by Sub Centres (SCs)		Average population covered by Primary Health Centres (CHCs)		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
Chhattisgarh	277	1237	4430	4105	41323.5	26977	415231	125682
Gujarat	298	1429	4029	3953	25763	24549	112889.5	100097
Haryana	255	1341	5299	6645	35103	45657	125283.5	150470
Himachal Prad.	830	2816	4894.5	3144	28431.5	11206	112976.5	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	1389	5574.5	3877	55843	17787	177356.5	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	92696
Meghalaya	738	1192	4868.5	5386	22730	21771	92223	91750
Mizoram	1646	1300	3432	1478	15521	9271	76264	60778
Nagaland	954	608	2218	2958	13897.3	18523.5	60889	61000
Odisha	262	1108	4153.5	5349	23149.8	27776	77948.5	94897
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	119288.5	144167
Uttar Pradesh	255	772	5494	8318	41453	58878	199379	254591
Uttarakhand	547	1450	6152	3986	43762	28646	182236	109881
West Bengal	250	906	5028	6070	48938.5	69231	145259.5	180638

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.[8] A study discovered a favourable link between primary health infrastructure and curative and preventative health outcomes.[9] 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.[10] According to a study improving the quality of health infrastructure facilities can help women have fewer difficulties throughout their pregnancies.[11]

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 Uttarakhand, 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, Uttarakhand, 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, Uttarakhand, Punjab, Haryana, 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, Rajasthan-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 introduction 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	2010-11	2019-20
Andhra Prad.	86.8	101.5	42.7	45.15	2322	3105	43.6	76.4	110	65
Assam	62.5	85.8	47.6	56.9	3821	5415	41.6	85.8	328	215
Bihar	49.1	68.9	71.8	69.1	1784	2848	17.9	36.8	219	149
Chhattisgarh	81.2	92.4	66.4	71.9	1480	1808	25.1	61.4	230	159
Gujarat	72.4	88	52	56.8	2136	1697	60.7	78.4	122	75
Haryana	78.4	79.6	61.6	71.7	2241	2785	38.8	60	146	91
Himachal Pra.	78.1	78.5	77.9	86.8	3329	3760	45.2	97	136	85
Jammu & Kas.	42.5	83.1	41.8	51.5	4225	5145	21.4	66.3	136	85
Jharkhand	63	79.3	61.2	64.8	1476	3150	38.6	50	219	71
Karnataka	81.3	98.7	38.3	34.1	4824	4954	59.8	88.9	144	92
Kerala	83.3	98.9	89.4	94.7	6901	6710	79.5	111.2	66	43
Madhya Prad.	78.3	79.5	48.9	55.8	1481	2529.5	39.1	11	230	173
Maharashtra	62.1	94.4	45.7	59.4	3578	2966	19.8	60.7	87	46
Manipur	45.9	55.2	39.5	49.1	10348	14518	32.8	44.7	136	85
Meghalaya	42.5	48.1	63.7	73.8	3319	3219	35.1	42.5	136	85
Mizoram	76.7	58.4	25.1	35.8	5113.5	7008	63.1	17.3	136	85
Nagaland	32.7	23.7	75.8	78.7	6393	5778	22	39.2	136	85
Odisha	85.9	81.4	81.6	72.55	4226	3932.5	66	95.1	258	150
Punjab	87.3	85.5	63.5	73.1	3639	3345.5	43.4	88.3	155	129
Rajasthan	66.5	62.7	82.7	78.6	3052	3522.5	46.5	9.2	255	164
Sikkim	80.4	65.3	66.7	48.6	3993	8334	61.8	84.8	136	85
Tamil Nadu	74.6	88.3	30.5	49.7	2609	3952.7	31.2	1.9	90	60
Tripura	53.3	69.4	44.5	44.15	5296.3	6640	49.3	65.3	136	85
Uttar Pradesh	75	74.6	43.8	50.2	5980.5	5321	36	49.7	292	197
Uttarakhand	74.5	72.1	56.6	72.4	4661.5	4002	40.7	45.7	292	99
West Bengal	71.5	84.5	52.1	-	3342.5	2683	40.7	81.2	117	98

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.[12] Institutional delivery improved because of the JSSK initiative.[13] JSSK benefited women who used public services, however, medications, consumables, and transportation added to out-of-pocket expenses.[14]

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.[15]

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 post-natal 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 Tamilnadu (-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 (66.1percent), 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), Uttar Pradesh (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.[16] 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.[17] 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

Average Increasing Rate (AIR) / Average Reduction Rate (ARR) between 2010-11 and 2019-20						
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	12.9	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	-24.8
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

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

*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

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	-.386	**
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	-.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 0.1676 units. If the total number of first referral units increases by one unit MMR will decline

by 0.1245 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:

$$\begin{aligned} &MMR_{it} \\ &= 1100.06 - 9.436\ FemLiteracy_{it} - 16.758\ PCNSDPatCP_{it} \\ &- 12.446\ TnFRUs_{it} + .699\ ANC_{it} - .387\ IDtoTRepDel_{it} \end{aligned}$$

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.[18] 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.[7] "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 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.[19] 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 Uttarakhand and UP. Institutional delivery in public health institutions has increased in all states except Goa, 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 centres, owing to greater use of expensive advanced modalities across all socioeconomic groups.[20] Evidence from rural Haryana, North India, indicated that when the JSSK plan was implemented, the number of deliveries at the primary care level increased by more than double, despite no major changes in human resources or facilities at the study institution. Since its inception in 2006, the JSY programme has helped to develop demand in the community for institutional delivery. Services were given under JSSK that contributed to a further rise in institutional de-

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 OoPE decreased. Even after the introduction 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.[21] 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.[22] 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.[23] 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.[24] 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.[25]

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.[26] Overall socio-economic development, with a focus on women's empowerment and education, can improve the usage of maternal healthcare.[27] 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.[28]

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 checkups, obstetric gynaecologists, and the ability to track high-risk pregnancies attributable to campaigns like the Pradhan Mantri Surakshit Matritva Abhiyan.[29]

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

CRM). After the program's implementation, maternal and child health indicators such as prenatal care, postnatal care, institutional delivery, vaccination, and many others have moved in the right direction.

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.

REFERENCE

1. Montgomery AL, Ram U, Kumar R, Jha P. Million Death Study Collaborators. Maternal mortality in India: causes and healthcare service use based on a nationally representative survey. PLoS One. 2014 Jan 15;9(1):e83331. doi: 10.1371/journal.pone.0083331. PMID: 24454701; PMCID: PMC3893075.
2. World Health Organization. Trends in maternal mortality: 2000 to 2017: estimates by WHO, UNICEF, UNFPA, World Bank Group and the United Nations Population Division. [Internet]. Geneva: World Health Organization.2019; available at 9789241516488-eng.pdf (8.709Mb).
3. United Nations. India and the MDGs: Towards a sustainable future for all. [Internet]. ESCAP, United Nations. 2015; available from https://www.unescap.org/resources/india-and-mdgs-towards-sustainable-future-all
4. Rai RK, Singh PK. Janani Suraksha Yojana: the conditional cash transfer scheme to reduce maternal mortality in India - a need for reassessment. WHO South-East Asia J Public Health. 2012 Oct-Dec;1(4):362-8, doi: 10.4103/2224-3151.207038. PMID: 28615601.
5. Nixon J, Ulmann P. The relationship between health care expenditure and health outcomes. The European Journal of Health Economics. 2006; 7(1): 7-18.
6. Cremieux PY, Ouellette P, Pilon C. Health care spending as determinants of health outcomes: Health Economics. 1999; 8(7): 627-39
7. Mohanty RK, Behara DK. How effective is public healthcare expenditure in improving health outcomes? An Empirical Evidence from the Indian states. Working Papers 20/300, National Institute of Public Finance and Policy, New Delhi. 2020.
8. Joumard I, Kumar A. Improving Health Outcomes and Health Care in India. OECD Economics Department Working Papers no.1184: 2015.
9. Hati KK, Majumder R. Health Infrastructure, Health Outcome and Economic Wellbeing: A District Level Study in India. 2013; IDEAS Working Paper Series from RePEc, 53363. Available from https://mpra.ub.uni-muenchen.de/53363/1/MPRA_paper_53363.pdf
10. Ghosh D, Dinda S. Health infrastructure and economic development in India. Health Economics and Healthcare Reform: Breakthroughs in Research and Practice. July 2017; 78-97.
11. Bhargava A, Chowdhury S, Singh KK. Healthcare infrastructure, contraceptive use and infant mortality in Uttar Pradesh, India. Economics and Human Biology. 2005; 3(3): 388–404.
12. Mishra S, Mohanty SK. Out-of-pocket expenditure and distress financing on institutional delivery in India. International Journal for Equity in Health.2019;18(1):99.Available from https://doi.org/10.1186/s12939-019-1001-7
13. Salve HR, Charlette L, Kankaria A, Rai SK, Krishnan A, Kant S. Improving Access to Institutional Delivery through Janani Shishu Suraksha Karyakram: Evidence from Rural Haryana, North India. Indian Journal of Community Medicine : Official Publication of Indian Association of Preventive & Social Medicine. 2017; 42(2): 73-76.
14. Tyagi U, Pattabi K, Kaur P. Utilization of Services Under Janani Shishu Suraksha Karyakram for Institutional Deliveries in the Public Sector Facilities, Sirmaur District, Himachal Pradesh, India. Indian Journal of Community Medicine : Official Publication of Indian Association of Preventive & Social Medicine, 2016; 41(1): 65-68.
15. Chandrakar A, Soni GP, Sinha AK, Jain K, Panda PS, Pradhan SK. Estimation of Out of Pocket Expenditure Under Janani Shishu Suraksha Karyakram (JSSK) in Rural Block of Chhattisgarh : A Community Based Cross-Sectional Study. National Journal of Community Medicine. 2017; 8(2): 84-89.
16. William J, Sharma S, Sharma J, Shanta YM, Mala R, Mishra US, et al. Maternal Mortality in India: A Review of Trends and Patterns. 2015; 353-6.
17. Montgomery AL, Fadel S, Kumar R, Bondy S, Moineddin R, Jha P. The effect of health-facility admission and skilled birth attendant coverage on maternal survival in India: A case-control analysis. PLoSONE. 2014; 9(6): e95696.
18. Barenberg AJ, Basu D, Soylu C. The effect of public health expenditure on infant mortality: evidence from a panel of Indian states, 1983–1984 to 2011– 2012. The Journal of Development Studies. 2017; 53(10): 1765-1784.
19. Chauhan R, Mazta SR, Dhadhwal DS, Sandhu S. Indian public health standards in primary health centres and community health centres in Shimla District of Himachal Pradesh: A descriptive evaluation. CHRISMED Journal of Health and Research. 2016; 3(1): 22-27.
20. Khyati MK, Megha SP, Snehal P, Pritesh. Effect of Janani Shishu Suraksha Karyakram: A Government Health Beneficiary Scheme - on Admission Rate and Clinical Outcome in NICU in a Tertiary Care Hospital. Natl J Community Med. 2014; 5(1): 118-121.
21. Tripathi N, Saini SK, Prinja S. Impact of Janani Shishu Suraksha Karyakram on out-of-pocket expenditure among urban slum dwellers in northern India. Indian Pediatr. 2014 Jun;51(6):475-7. doi: 10.1007/s13312-014-0430-z. PMID: 24986284.
22. Chaudhary S, Rohilla R, Kumar V, Kumar S. Evaluation of Janani Shishu Suraksha Karyakram scheme and out of pocket expenditure in a rural area of Northern India. J Family Med Prim Care. 2017 Jul-Sep;6(3):477-481. doi: 10.4103/2249-4863.222010. PMID: 29416992; PMCID: PMC5787939.
23. Sharma S, Bothra M. Maternal and Child Healthcare: An Analysis of Out-of-pocket Expenditure under the Janani Shishu Suraksha Karyakaram. 2016; IGE working paper no.366. Institute of Economic Growth.
24. Chandrakar A, Soni GP, Sinha AK, Jain K, Panda PS, Pradhan SK. Estimation of Out of Pocket Expenditure Under Janani Shishu Suraksha Karayakram (JSSK) in Rural Block of Chhattisgarh: A Community Based Cross-Sectional Study. Ntl J Community Med 2017; 8(2):84-89

25. Mitra S, Saha S, Haldar D, Sarkar AP, Biswas D, Sarkar GN. Evaluation of Janani-Sishu Suraksha Karyakram in a Community Development Block of Bankura District, West Bengal, India: A Mixed Methods Approach. Indian J Comm. Health. 2016; 28(4): 344-351.

26. Fadel SA, Ram U, Morris SK, Begum R, Shet A, Jotkar R, et al. Facility Delivery, Postnatal Care and Neonatal Deaths in India: Nationally-Representative Case-Control Studies' ONE. 2015; 10(10): e0140448. doi:10.1371/journal.pone.0140448

27. Upadhyai N, Gupta SK. Utilization of Postnatal Care Services and Factors Affecting It among Women of Urban Slums in Dehradun, Uttarakhand. Indian J Community Health [Internet]. 2019 Dec.31;31(4):470-6.

28. Das B. Study on postnatal care in a tertiary care hospital in eastern India and the reality. Int J Community Med Public Health 2020;7:3917-23.

29. Singh PK. India has achieved groundbreaking success in reducing maternal mortality. World Health Organisation, South-East Asia. 2018 June 10.