A Critical Review of India's RMNCH+A Strategy (2014) to achieve UN SDG 2030 goal for Neonatal Mortality Rate

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Abstract

This paper examines the effectiveness of the Reproductive, Maternal, Newborn, Child Health + Adolescent Health (RMNCH+A) strategy, 2014, specifically two components (1) additional investment to high-priority districts (HPDs), and (2) engaging various development organizations, on increasing the intervention coverage in the high-priority geographies, to achieve United Nations Sustainable Development Goals (UN SDG) of 12 NMR by 2030 and India Newborn Action Plan (INAP, 2014) goals of single digit neonatal mortality rates across states and districts. The publicly available data from various sources such as the National Family Health Survey (NFHS), the India Disease Burden Study (IDBS), and data from publications triangulated, to explore the trajectory of NMR across states and districts. The study also examines the effect of strategic focus on program efficiency, with a special focus on high-priority districts, which have received an additional 30% funding, and technical support from development organizations. It is found that there has been no change in the trajectory of NMR decline in the last 40 years across states, the north-south gap remains consistent, except in Jammu and Kashmir and Himachal Pradesh. There is no substantial difference in program efficiency, measured using composite intervention coverage indicators, between the high-priority districts and non-high-priority districts after the implementation of the RMNCH+A strategy. The improvement in program efficiency is low in districts where NMR was high. The role of the development partners is not impactful in achieving the results, and there are noticeable variations in their performance. The development partners that support the biggest state, Uttar Pradesh, have increased their program efficiency between 2015-16 and 2019-21. However, its program's efficiency is lower than other development partners, who are working in other states. It is evident that if the current trend continues bigger north India states, Uttar Pradesh, Madhya Pradesh, Odisha, and Chhattisgarh are unlikely to achieve UN SDG or INAP goals by 2030. We found that the prioritization strategies did not work as envisaged. Such an effect can be attributable to a lack of trained human resources, poor quality of care, and other health system gaps. There is a need for further investigation to evaluate the effect of such strategies in improving the program impact and document what worked and what did not so that evidence-based policy planning of the country can be strengthened.

Introduction

As per the UN IGME estimates (2021), India recorded about 489,655 (425,197 – 558,051) neonatal deaths in 2020, which accounts for 21% of the global burden of neonatal deaths, and almost 10% of under-five deaths (UNICEF,2021). Nationally, neonatal deaths account for 71% of infant deaths and 62.5% of under-five deaths, as per the Sample Registration Survey report published in September 2022 (SRS,2020).

India has been at the forefront of national policies and programs to improve child survival. Newborn survival has captured the attention of implementors and policymakers, as it accounts for 70-80% of the total under-five child mortality. The major milestone in this direction started with the launch of the Child Survival and Safe Motherhood Programme (CSSM) in 1992, the Reproductive and Child Health Programme Phase I (RCH I) in 1997, and RCH II in 2005; the National Rural Health Mission (NRHM),

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2005. Later in 2013, the NRHM scope widened with increased focus on urban areas, and the entity was renamed as National Health Mission (NHM). The NHM implemented important schemes such as Janani Suraksha Yojana (JSY), one of the important programs to increase institutional delivery (Paul & Chellan, 2013), and Janani Shishu Suraksha Karyakram (JSSK) to improve access to care in terms of transportation, food, and drugs (Chaudhary et al., 2017). These programs have increased maternal health and child survival outcomes to a very high level.

One of the major programs to improve maternal and child health outcomes was the RMNCH+A program. The key feature of the RMNCH+A program strategy (MOHFW,2013; Taneja et al.,2018)] was to focus on 184 high-priority districts of India, that were lagging by (a) providing 30% additional resource allocation, (b) adopting a life-cycle approach called RMNCH+A strategy, and (c) engaging with development agencies to obtain an independent perspective through monitoring and supportive supervision. A National RMNCH+A Unit (NRU) was constituted at the national level to monitor the progress of the RMNCH+A program across all states of India. The development agencies and the National Health Mission at the state level played the role of State RMNCH+A Units (SRUs) and implemented the program following the guidance from NRU.

There are implementation guidelines released by the NRUs (Ministry of Health and Family Welfare & Government of India, 2013) to improve the coverage and quality of the maternal and child health program, and focus was given to achieving Millennium Development Goal (MDG) 4 & 5 which are related to improvement in maternal and child health survival. Of late, with the introduction of the United Nations Sustainable Development Goals (UN SDG) in 2015, the country's MDG goals were aligned with the 2015 UN SDG goals, specifically goal number 3.2 which deals with reducing neonatal mortality (NMR) to at least 12 deaths per 1,000 live births and under-5 mortality (U5MR) to at least as low as 25 deaths per 1,000 live births (Food and Agriculture Organization of the United Nation, 2015; United Nations, 2023). Around the same time, in 2014, to complement the RMNCH+A strategy, another policy initiative from the government of India was taken, at the time when 500 days were left to achieve the MDG timeline, was the India Newborn Action Plan (INAP), which aims at single-digit NMR by 2030 (Ministry of Health and Family Welfare & Government of India, 2014). In addition to setting a goal of single digit of NMR 2030 the INAP also focused on preventing stillbirths. The INAP is the Indian chapter of a global initiative led by UNICEF and WHO and provides a road map of strategic actions for ending preventable newborn deaths and stillbirths (World Health Organization., 2014).

In this paper, an attempt has been made to understand, if there is any effect of these initiatives, in reducing the NMR across states and districts, and the effect of the RMNCH+A program in the high-priority districts. More specifically, the paper aims to understand.

I. If there is any change in the trajectory of decline in the NMR across major Indian states after major policy impetus in 2013-14, and the level of progress made towards achieving UN SDG and INAP -goals by 2030 using the indicator Annual Average Rate of

Reduction (AARR) of NMR before and after the policy change in 2013-14.

II. The effect of National RMNCH+A Unit (NRU) interventions on improving the coverage across high-priority districts (HPDs), and after 2013-14.

Materials and Method

Data

The neonatal mortality indicator used in this paper, at the national and state level, are compiled from the last two rounds of Sample Registration System (SRS) reports(SRS,2019; SRS, 2020) In 2020, SRS was conducted on 8,841 sampling units covering 8.3 million sample population, which included 4,958 rural and 3,883 urban sampling units.

The district-level NMR for 2017 is adopted from indirect estimations such as the India Disease Burden Study (IDBS) (Dandona et al., 2020), which used data from the National Family Health Survey (NFHS-4, 2015-16) and SRS to provide district-level estimates, indirectly. The NMR estimates in this report captured the neonatal mortality situations prevailing during 2013-14 when the RMNCH+A program was launched, as both NFHS and SRS estimates are based on the retrospective experience of events that happened for 5 years and 1 year before the survey, respectively.

The coverage indicators used in this paper are from NFHS-4(2015-16) and NFHS-5(2019-21). The NFHS-4 captured the coverage of maternal and child health indicators prevailing before the launch of the RMNCH+A program in 2013-14, while NFHS-5 captured the coverage of the same indicators after 2013-14. These two rounds of data are well-positioned to compare pre-post coverage of RMNCH+A interventions.

The NFHS is a national and sub-national representative survey for India. In the fifth and last round of NFHS 2019-21, a total of 636,699 households, which included 724,115 women, and 101,839 men were sampled. We have extracted the required coverage data from the fact sheet published in the NFHS portal for reporting state and district-level indicators.

Method

This section describes the method used for state-level analysis and district-level analysis.

State level analysis

The state-level analysis is conducted in response to the first objective, where we have described the trajectory of NMR change from 2013-14 to 2020 using the Annual Average Rate of Reduction (AARR).

To estimate the AARR, we have used the log-linear regression approach (UNICEF,2007)]. The AARR is the average relative percent decrease per year in prevalence or rate. A positive sign indicates a reduction or a declining trend in NMR and a negative sign indicates an increase or an upward trend.
If the prevalence in a baseline year t_0 is Y_0

$$Y_{ti} = Y_0*(1-b\%)\ (t_i - t_0), \text{ so that}$$
$$\ln (Y_{ti}) = \ln(Y_0) + (t_i - t_0) *\ln(1-b\%)$$
$$= \ln(Y_0) + t_i*\ln(1-b\%) - t_0*\ln(1-b\%)$$
$$= \beta*t_i + C_0$$

Where $\beta = \ln(1-b\%)$ and $C_0 = \ln(Y_0) - t_0*\ln(1+b\%)$, a constant

β, the coefficient of *it*, in a simple linear regression of ln (Y*i*) against it can then be translated into *b%*, the AARR, by the following formula: *AARR = 1 - exp*(β).

The standard error (SE) is calculated using the delta method proposed by WHO(WHO-UNICEF Technical Expert Advisory Group on Nutrition Monitoring (TEAM), 2017), which is *SE(AARR) = exp*(β) *SE* (β).

The estimated AARR is done for two consecutive periods, 2010-15, and 2016-20 separately for each state. The starting year of the second period is selected as 2016 as most of the interventions were started in 2013-14 and we assumed one year time for rolling out the interventions, and it divides the 10 years into equal two five-year windows, an assumption of the model used here.

The projection of state-level NMR in 2025 and 2030 is done assuming a constant AARR of the 2016-20 level.

Finally, the change in the AARR between the period of 2010-15 and 2016-20 is computed as Absolute change = AARR (2016-20) – AARR (2010-15), which means a negative sign indicates a decline in the rate between the two periods. On the other hand, the relative change is computed as relative change=AARR (2016-20) / AARR (2010-15), which means a value <1 indicates a decline in the rate between two periods.

The crude projected (observed) newborn mortality is computed by applying the estimated AARR of 2016-20 in the project state-level population (TAG, 2011-2036) for each year from 2020 to 2030 (not shown).

District level analysis

Outcome indicator

To assess the effectiveness of the program's strategies adopted during 2013-14, we assessed whether the composite coverage of recommended interventions has been improved in 2019-21 in those districts that had a high level of neonatal mortality rate before 2017. The NMR for the districts is adopted from the India State-Level Disease Burden Initiatives (ISDB), known as the GBD study, (Dandona et al.,2020),.

Composite coverage indicators (program effectiveness)

The composite coverage indicator for 2019-21 is computed from the NFHS-5 fact sheet by taking the simple arithmetic mean of three recommended coverage indicators of INAP, the higher composite coverage indicates greater effectiveness of the program strategies.

1. *Mothers who made at least 4 or more antenatal care visits (%)*: The antenatal check-up is one of the crucial interventions in countries where emergency obstructive care for pregnant women is limited to prevent NMR (Doku & Neupane, 2017). The antenatal check-up provides an easy option for pregnant women to be screened for potential risks during pregnancy or delivery for the mother and child. WHO's recommendations on ANC for positive pregnancy experience focus on eight ANC visits, with first contact scheduled during the first trimester(WHO, 2016).
2. *Institutional births (%)*: An increase in institutional delivery translating into a reduction in NMR was significant in many LMIC settings, but not all(Goudar et al., 2020). In India, an increase in institutional delivery is proven to be an effective strategy for reduction in NMR if backed by improved quality of care at the health facility (Shajarizadeh & Grepin, 2022). Since the inception of NHM, the increase in institutional delivery has been one of the important strategies of the government of India and the states. The JSY scheme launched in 2005 is one of the important contributors to the increase in institutional delivery (Paul & Chellan, 2013), through incentivizing families and ASHAs to access services at facilities, it also reduced out-of-pocket expenditure for childbirth (Chaudhary et al., 2017).
3. *Mothers who received postnatal care from a doctor/nurse/LHV/ANM/midwife/other*

health personnel within 2 days of delivery (%): Postnatal care, particularly on the first day, is paramount for a reduction in the NMR(Dol et al., 2023). It is found that in developing countries, where home delivery is high, postnatal care within the first two days of birth by healthcare providers can significantly reduce neonatal mortality (Baqui et al., 2009). In India, it is found that post-natal care by a skilled provider within a day decreases the chances of neonatal mortality by 26%.

In the district-level analysis, we have used the following two methods.

First, we conducted bi-variate cross-tabulation in the district-level maps of India to assess whether the composite coverage (program effectiveness) in 2019-21 was high in those districts where NMR was high before the introduction of the RMNCH+A program. We also saw a change in the composite coverage between 2015-16 and 2019-21. The NMR was adopted from 2017 GBD estimates, which captured NMR before 2015 for both high-priority and non-high-priority districts.

Secondly, a multivariate linear regression analysis is conducted to identify the effect of district-level NMR before 2013-14, on the level and change of program effectiveness, measured in terms of composite coverage, after 2013-14, adjusting for two programs (treatment) variables, (i) the category of districts as high-priority and non-high priority districts, and (ii) the development partners providing support in implementing the RMNCH+A strategy. In addition, important socioeconomic variables included in the models are the sex ratio at birth, the proportion of households with access to electricity, and the proportion of women with 10+ years of education.

The result of the interaction effects is presented using the marginal effect of the RMNCH+A program on program effectiveness, after adjusting for confounders.

Result

The trend of U5MR, IMR, NMR, ratio NMR/IMR, and ratio NMR/U5MR in India from 2011 to 2020 are summarized in Figure 1. A remarkable reduction in U5MR was observed: 55 in 2011 to 32 in the year 2020. A similar pattern is also observed in IMR and NMR.

There are substantial state-level variations in the NMR, although the pattern of decline is similar. The NMR for Kerala continues to decline from 7 to 4 per 1000 live births, between 2010-2020. Tamil Nadu achieved a single-digit rate of 9 in 2020. Maharashtra reached 11 in 2011 Delhi achieved its SDG goal in 2016, with a single-digit NMR in 2019. The Punjab and Jammu & Kashmir achieved SDG goals in the year 2019 and 2020, respectively. Himachal Pradesh in 2020 was 13, very close to the SDG goal. None of the East Indian states have achieved the SDG goals, but they continue to follow a similar rate of decline as other North Indian states (Figure 2).

The Annual Average Rate of Reduction of NMR for India and major states is shown in Table 1. Overall, India has experienced a decline in AARR between 2010-15 and 2016-20, a relative change of 0.75, CI: 0.50 – 0.98. In south India, 5 of the 6 states have experienced a positive absolute increase and relative changes of > 1, indicating an increase in the AARR between the two periods, and a faster decline in NMR. Tamil Nadu has the highest increase in relative change AARR between the last two study periods at 3.25 (CI:6.86-2.41), followed by Andhra Pradesh at 2.38 (CI: 3.73 – 2.02), and Kerala at 1.73 (CI: 2.19 – 1.64).

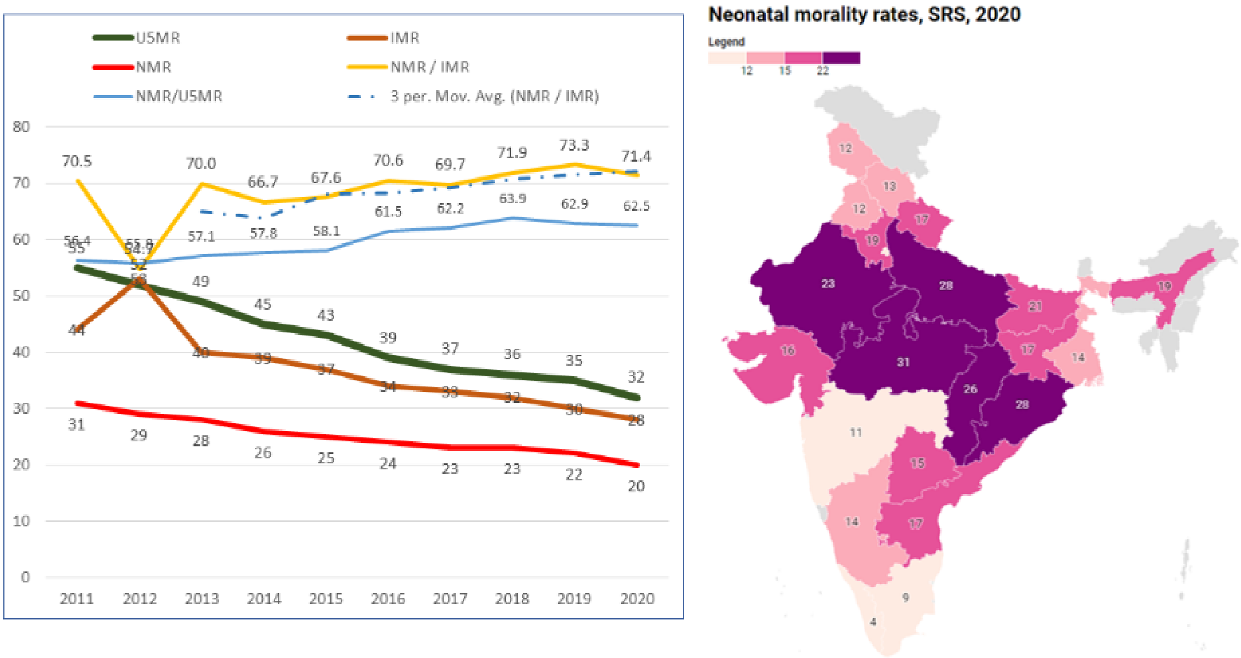


Figure 1 NMR, IMR, U5MR, and the ratio of NMR to IMR (2011-2020), Sample Registration System

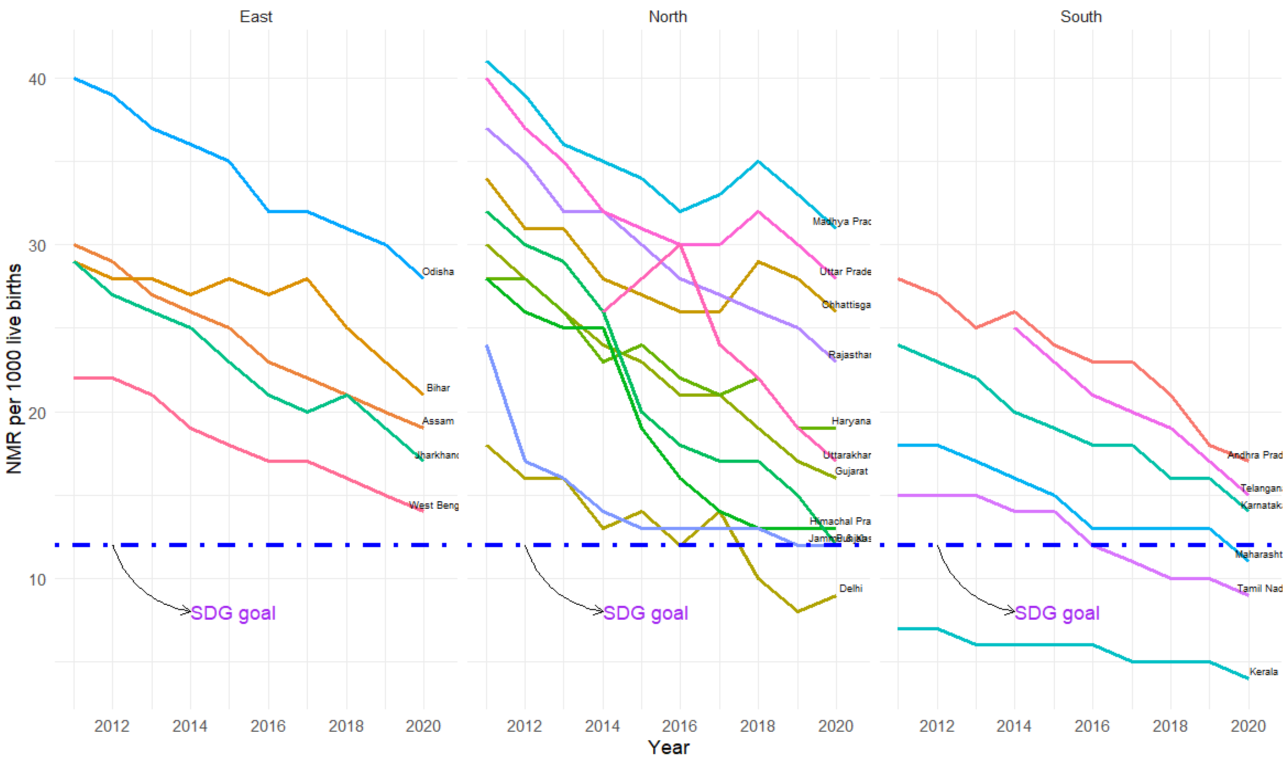


Figure 2 Neonatal mortality rates for major states of India (2011-2020), Sample Registration System

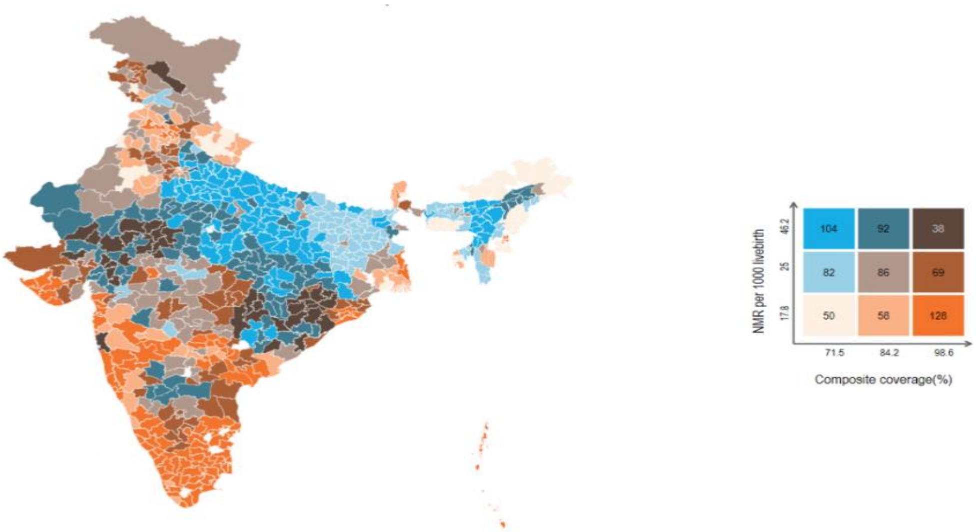
Table 1 Annual Average Rate of Reduction (AARR) and NMR for India and major states, 2011-2020

Region	States	2011-15				2016-20				Absolute change			Relative change			NNMR		
		AARR	SE	LB	UB	AARR	SE	LB	UB	AARR	LB	UB	AARR	LB	UB	2020	2025	2030
India	*India*	5.3	0.3	4.6	5.9	4	0.9	2.3	5.8	-1.3	-2.3	-0.1	0.75	0.50	0.98	20	16.0	12.0
South	Kerala	4.5	1.5	1.6	7.4	7.8	2.2	3.5	12.1	3.3	1.9	4.7	1.73	2.19	1.64	4	2.4	0.9
South	Telangana	8	0	8	8	8	1	6.1	9.9	0	-1.9	1.9	1.00	0.76	1.24	15	9.0	3.0
South	Andhra Pradesh	3.4	0.9	1.5	5.3	8.1	1.3	5.6	10.7	4.7	4.1	5.4	2.38	3.73	2.02	17	10.1	3.2
South	Tamil Nadu	2	0.7	0.7	3.4	6.5	0.9	4.8	8.2	4.5	4.1	4.8	3.25	6.86	2.41	9	6.1	3.2
South	Karnataka	5.9	0.5	4.9	6.9	6	1.2	3.6	8.4	0.1	-1.3	1.5	1.02	0.73	1.22	14	9.8	5.6
South	Maharashtra	4.7	0.7	3.4	6.1	3.3	1.9	-0.4	6.9	-1.4	-3.8	0.8	0.70	-0.12	1.13	11	9.2	7.4
North	Gujarat	6.6	0.3	6	7.3	7.3	1	5.3	9.2	0.7	-0.7	1.9	1.11	0.88	1.26	16	10.2	4.3
North	Jammu & Kashmir	10.3	2.3	5.8	14.7	8.9	2.2	4.6	13.3	-1.4	-1.2	-1.4	0.86	0.79	0.90	12	6.7	1.3
North	Uttarakhand	-7.7	0	-7.7	-7.7	12.8	1	10.8	14.8	20.5	18.5	22.5	-1.66	-1.40	-1.92	17	6.1	-4.8*
North	Madhya Pradesh	4.7	0.5	3.6	5.8	0.6	1.6	-2.5	3.7	-4.1	-6.1	-2.1	0.13	-0.69	0.64	31	30.1	29.1
North	Himachal Pradesh	7.8	2.4	3.1	12.5	4.8	1.6	1.6	8	-3	-1.5	-4.5	0.62	0.52	0.64	13	9.9	6.8
North	Delhi	6.9	2	2.9	10.9	10.7	4.4	2.2	19.3	3.8	-0.7	8.4	1.55	0.76	1.77	9	4.2	-0.6*
North	Haryana	4.9	1.4	2.2	7.6	3.9	1.4	1.1	6.7	-1	-1.1	-0.9	0.80	0.50	0.88	19	15.3	11.6
North	Rajasthan	5	0.7	3.6	6.3	4.6	0.5	3.6	5.6	-0.4	0	-0.7	0.92	1.00	0.89	23	17.7	12.4
North	Uttar Pradesh	6.3	0.4	5.5	7.2	1.4	1.5	-1.6	4.3	-4.9	-7.1	-2.9	0.22	-0.29	0.60	28	26.0	24.1
North	Punjab	13.2	2.5	8.4	18.1	2.4	0.8	0.8	3.9	-10.8	-7.6	-14.2	0.18	0.10	0.22	12	10.6	9.1
East	Odisha	3.4	0.2	2.9	3.9	3.3	0.7	1.9	4.6	-0.1	-1	0.7	0.97	0.66	1.18	28	23.4	18.8
East	West Bengal	5.3	0.9	3.5	7.2	5	0.7	3.6	6.4	-0.3	0.1	-0.8	0.94	1.03	0.89	14	10.5	7.0
East	Chhattisgarh	5.5	0.8	4	7	-0.7	1.9	-4.4	2.9	-6.2	-8.4	-4.1	-0.13	-1.10	0.41	26	26.9	27.8
East	Assam	4.6	0.3	4	5.2	4.7	0.1	4.5	4.8	0.1	0.5	-0.4	1.02	1.13	0.92	19	14.5	10.1
East	Bihar	1.1	0.7	-0.3	2.4	6.8	1.4	4.1	9.4	5.7	4.4	7	6.18	-13.67	3.92	21	13.9	6.7
East	Jharkhand	5.3	0.4	4.4	6.1	4.6	1.6	1.5	7.8	-0.7	-2.9	1.7	0.87	0.34	1.28	17	13.1	9.2

Note: Some of the states have negative NMR in 2030 because we have used linear projection (*)

Madhya Pradesh has the lowest relative change in AARR at 0.13 (CI: -0.69 – 0.64), followed by Punjab at 0.18 (CI: 0.10 – 0.22), and Uttar Pradesh at 0.22 (CI: -0.29 – 0.60). Uttarakhand shows a very large absolute increase of 20.5 (CI: 18.5 – 22.5) and a negative relative change in AARR between the last two periods, -1.66 (CI: -1.40 - 1.92). Most of the east Indian states have a similar change in AARR as north Indian states, except Bihar. Bihar has experienced the highest absolute and relative increase in the AARR between the last two study periods which was 5.7 (CI: 4.4 - 7) and 6.18 (CI: -13.7 – 3.92), respectively[i].

The Bi-variate map (Figure 3) presents that among the (234, 33%) districts belonging to the highest tertial of NMR of 2017 in the country. Of these (90, 39%) districts are HPDs and (144, 61%) districts are non-HPDs. There are (104, 44%) districts, in this highest NMR tertial category, where the composite coverage in 2019-21 was in the lowest tertial, and (44, 48%) of those are HPDs. These 104 districts account for 15% of the total districts in the country and are concentrated in Uttar Pradesh (55, 52.9%), Assam (14, 13.5%) Chhattisgarh (8, 7.7%), and Bihar (6, 5.8%).

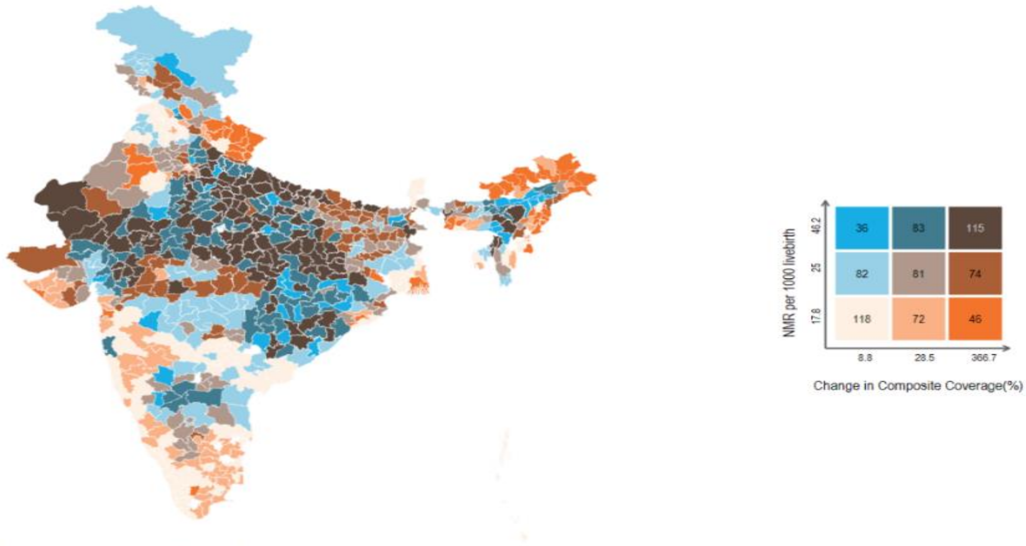


Source: GBD 2017 & NFHS-5 2019-21

Figure 3 Bivariate map of composite coverage (2019-21) and NMR (2017) for the districts of India

Figure 4, presents the percentage change in the composite coverage between 2015-16 and 2019-21, categorized according to the tertial of NMR, (as per GBD 2017). Among the districts with the highest tertile of NMR, almost half of the districts (115, 49%) show a high level of change in composite coverage. The major proportion of the districts with high NMR and high change in composite coverage between 2015-16 and 2019-21 is concentrated in Uttar Pradesh (39, 34%), Madhya Pradesh (26, 23%), and Rajasthan (12, 10%). Among the high-priority 90 districts, which belong to the highest tertile of NMR, a high level of change in composite coverage is observed in 66% of the districts.

Table 2a, summarizes the comparatives of three types of districts, the districts with a very high level of NMR and low (104 districts), medium (92 districts), and high (104 districts) levels of composite coverage. Among the 104 low-coverage and high NMR districts, 42% are high-priority districts and 59% are supported by BMGF. There is no substantial difference in socio-economic variables in these three types of districts.



Source: GBD 2017, NFHS-4(2015-16) & NFHS-5(2019-21)

Figure 4 Bivariate map of the **c**hange in composite coverage between 2015-16 & and 2019-21 vis-a-vis NMR 2017 for the districts of India

Table 2a Comparison of selected RMNCH+A and program indicators in districts with high NMR and different levels of composite coverage (CC) in 2019-21

Variables	Composite coverage (CC) category in high NMR districts					
	Low CC		Moderate CC		High CC	
	Number	%	Number	%	Number	%
Composite coverage (%)	104	62.6	92	77.9	38	87.9
Four + ANC (%)	104	40.6	92	60.2	38	78.2
Institutional delivery (%)	104	79.6	92	90.4	38	94.9
Mother received PNC care (%)	104	67.7	92	83.0	38	90.5
Children received PNC care (%)	104	67.5	92	82.7	38	90.4
received ANC in 1st trimester (%)	104	61.0	92	73.0	38	79.9
C-section rate (%)	104	11.3	92	14.3	38	16.1
New-born immediately breastfeed (%)	104	31.6	92	42.7	38	52.6
Sex ratio at birth	104	950	92	945.8	38	947.6
women with 10+years education (%)	104	31.5	92	32.3	38	32.4
The household has electricity (%)	104	91.3	92	97.3	38	97.8
High priority district						
No	60	57.7	57	62.0	27	71.1
Yes	44	42.3	35	38.0	11	28.9
Aspirational district						
No	74	71.2	72	78.3	27	71.1
Yes	30	28.8	20	21.7	11	28.9
State lead Partner, NRU						
BMGF	61	58.7	12	13.0	0	0.0
DFID	8	7.7	22	23.9	2	5.3
NIPI	0	0.0	0	0.0	1	2.6
UNFPA	2	1.9	12	13.0	10	26.3
UNICEF	25	24.0	44	47.8	24	63.2
USAID	8	7.7	2	2.2	1	2.6

Table 2b, summarizes the comparisons of the three types of districts with high NMR in 2017, and the level of change, between 2015-16 and 2019-21, in composite coverage categorized as low (36), medium (83), and high (115). It is found that the change in 4+ANC coverage follows a different pattern than the other two indicators, it is lower in those districts that have higher NMR and high level of change in the composite

coverage (115, 47.2%) than in low (36, 69.7%), and moderate change districts (83, 63.7%).
Table 3 highlights, the comparisons of four models of multiple linear regression on program effectiveness, measured in terms of composite coverage in 2019-21 by select independent variables such as the level of NMR (as per GBD, 2017) according to their tertial, district type: HPD or non-HPD, type of development partner supporting the state in implementing the RMNCH+A program and selected control variables on social determinants such as sex ratio at birth, availability of electricity, and level of female education (10+ years). On average, the program effectiveness is -13.97% (CI: -16.51% - -11.42%) lower if the state lead partner is BMGF. The district that has not been supported by any state-led partners (SLPs) is more likely to have better program effectiveness than others. The HPD districts are less likely to have a higher coverage or program effectiveness.

The marginal effects (Figure 5) derived from the interaction of the state and HPD suggest that the program efficiency increases monotonically as the level of NMR increases. However, the difference between HPD and non-HPD is not significant. The disaggregated analysis by states suggests that these differences are not significant in the four states that contribute to the larger burden of neonatal mortality.

Table 2b Comparisons of selected RMNCH+A and program indicators in three types of districts that had high NMR in 2017 and experienced low, medium, and high levels of changes in composite coverage (CC) between 2015-16 & 2019-21

Variables	Low change in CC		Moderate change in CC		High change in CC	
	Number	%	Number	%	Number	%
Composite coverage, NFHS-4 (%)	36	69.7	83	63.7	115	47.2
Change in 4+ANC coverage between NFHS-4 & 5	36	-2.8	83	27.1	115	133.6
Change in institutional delivery between NFHS-4 & 5	36	4.7	83	13.6	115	31.0
Change in PNC mother's coverage between NFHS-4 & 5	36	1.1	83	27.0	115	74.2
Change in PNC child coverage between NFHS-4 & 5	36	153.9	78	269.7	97	550.0
Change in first trimester ANC coverage between NFHS-4 & 5	36	-1.0	83	18.8	115	86.3
Change in C-section rates between NFHS-4 & 5	36	51.9	83	45.9	115	60.8
Change in immediate breastfeeding coverage between NFHS-4 & 5	36	-9.3	83	5.1	115	5.5
Change in sex ratio between NFHS-4 & 5	36	2.4	83	4.6	115	1.6
Change in level of women's education between NFHS-4 & 5	36	15.7	83	24.3	115	36.9
Change in the availability of electricity between NFHS-4 & 5	36	11.6	83	14.7	115	32.3
High priority district						
Non-HPD	25	69.4	63	75.9	56	48.7
HPD	11	30.6	20	24.1	59	51.3
Aspirational district						
No	30	83.3	63	75.9	80	69.6
yes	6	16.7	20	24.1	35	30.4
State lead Partner, NRU						
BMGF	7	19.4	24	28.9	42	36.5
DFID	0	0	6	7.2	26	22.6
NIPI	1	2.8	0	0	0	0
UNFPA	1	2.8	11	13.3	12	10.4
UNICEF	26	72.2	41	49.4	26	22.6
USAID	1	2.8	1	1.2	9	7.8

Table 3 Comparisons of models of multiple linear regression on program effectiveness, measured in terms of composite coverage in 2019-21, by the selected program indicators

Variables	Model 1			Model 2			Model 3			Model 4		
	Odd Ratio	95 CI		Odd Ratio	95 CI		Odd Ratio	95 CI		Odd Ratio	95 CI	
		Lower	Upper		Lower	Upper		Lower	Upper		Lower	Upper
NMR (Tertile)												
low	**			**			**			**		
moderate	-5.42*	-7.83	-3.02	-3.42*	-5.81	-1.03	-2.87*	-5.19	-0.55	2.64	0.42	4.85
high	-6.47*	-8.93	-4.01	-3.23*	-5.82	-0.64	-1.29	-3.86	1.27	6.81*	4.31	9.31
HPD												
Non-HPD	**						**			**		
HPD	-6.59*	-8.87	-4.31				-7.45*	-9.53	-5.38	-3.51*	-5.41	-1.62
Partners												
UNICEF				**			**			**		
BMGF				-14.91*	-17.76	-12.06	-15.63*	-18.39	-12.86	-13.97*	-16.51	-11.42
DFID				0.18	-3.62	3.98	0.07	-3.60	3.75	1.23	-2.07	4.53
NIPI				7.32*	1.83	12.80	7.60*	2.30	12.91	2.12	-2.60	6.85
NONE				11.17*	3.64	18.70	10.61*	3.33	17.89	7.06	0.67	13.45
UNFPA				1.68	-2.88	6.25	1.27	-3.15	5.68	1.17	-2.75	5.10
USAID				-2.25	-4.98	0.47	-1.69	-4.33	0.95	-6.08	-8.49	-3.68
Sex Ratio										**		
Electricity										0.66*	0.44	0.88
Female Education										0.42*	0.35	0.50
_cons	81.73	79.99	83.47	80.49	78.77	82.21	81.67	79.97	83.36	1.74	-20.72	24.20

** P<.05, ** Reference category*

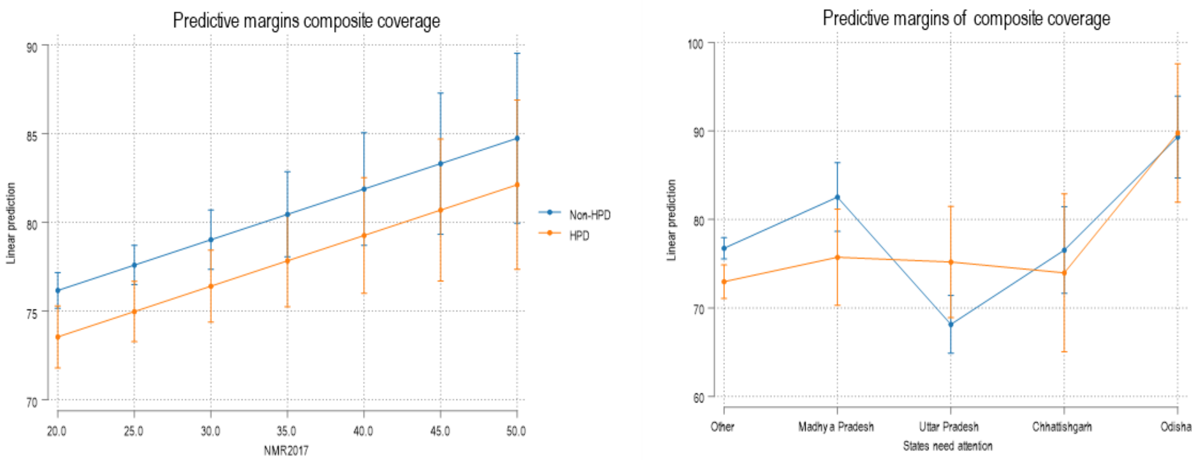


Figure 5 Marginal effect of NMR 2017 and selected states on composite coverage (CC)

Table 4 highlights, the comparisons of four models of multiple linear regression on program effectiveness, measured in terms of change in the composite coverage in successive two rounds of NFHS in 2014-15 and 2019-21. The independent variables are the level of NMR (as per GBD 2017) according to their tertial, district type: HPD or non-HPD, type of development partner supporting the state in implementing the RMNCH+A program, selected control variables of social determinants such as sex ratio at birth, availability of electricity, and level of female education (10+ years). The model performance is highest in the complete model (M4). The direction of the relationship changes from M1 to M4. In M1 there is an improvement in the program effectiveness, measured in terms of change in the composite coverage, in districts that are in the highest tertial of NMR and among high-priority districts. However, in the final model, the change in the program effectiveness is found to be lower for districts with high NMR, a de-prioritization. In the full model M4, it has been found that the districts where the state lead development partners are DFID have the highest change in performance effectiveness 21.8% (CI: 12.1% - 31.4) followed by the second effective BMGF 12.6% (CI: 5.1% - 20.0%), and this observation is consistent across all models. The marginal effects (Figure 6) of change in the composite coverage derived from the interaction of state and HPD suggest that the change in program efficiency decreases monotonically as the level of NMR increases. The difference in change in program efficiency between HPD and non-HPD is not significant across all four poor-performing states.

Table 4 Comparison of models of multiple linear regression on program effectiveness, measured in terms of change in the composite coverage in successive rounds of NFHS in 2014-15 and 2019-21, by the selected program indicators

Variables	Model 1			Model 2			Model 3			Model 4		
	Odd Ratio	95 CI Lower	95 CI Upper	Odd Ratio	95 CI Lower	95 CI Upper	Odd Ratio	95 CI Lower	95 CI Upper	Odd Ratio	95 CI Lower	95 CI Upper
NMR (Tertile)												
Low	**			**			**			**		
Moderate	-0.25	-6.14	5.64	-3.25	-9.53	3.03	-4.48	-10.62	1.67	-12.81*	-19.27	-6.35
High	11.12*	5.11	17.14	7.05*	0.23	13.87	2.73	-4.08	9.54	-9.74*	-17.03	-2.46
HPD												
Non-HPD	**						**			**		
HPD	15.93*	10.34	21.52				16.62*	11.11	22.12	10.42*	4.90	15.94
Partners												
UNICEF				**			**			**		
BMGF				14.30*	6.80	21.79	15.89*	8.55	23.23	12.59*	5.17	20.00
DFID				22.75*	12.77	32.73	22.99*	13.24	32.74	21.76*	12.14	31.38
NIPI				-6.74	-21.15	7.66	-7.38	-21.45	6.68	1.45	-12.33	15.23
NONE				-9.17	-28.95	10.61	-7.94	-27.26	11.38	-2.57	-21.21	16.06
UNFPA				7.17	-4.83	19.17	8.10	-3.62	19.82	8.06	-3.38	19.50
USAID				6.77	-0.38	13.93	5.52	-1.48	12.52	11.82*	4.80	18.83
Sex ratio										**		
Electricity										-1.17*	-1.82	-0.53
Female lit										-0.62*	-0.84	-0.41
_Cons	17.31	13.04	21.58	18.92	14.40	23.44	16.28	11.78	20.78	161.28	95.77	226.78

* P<.05, ** Reference category

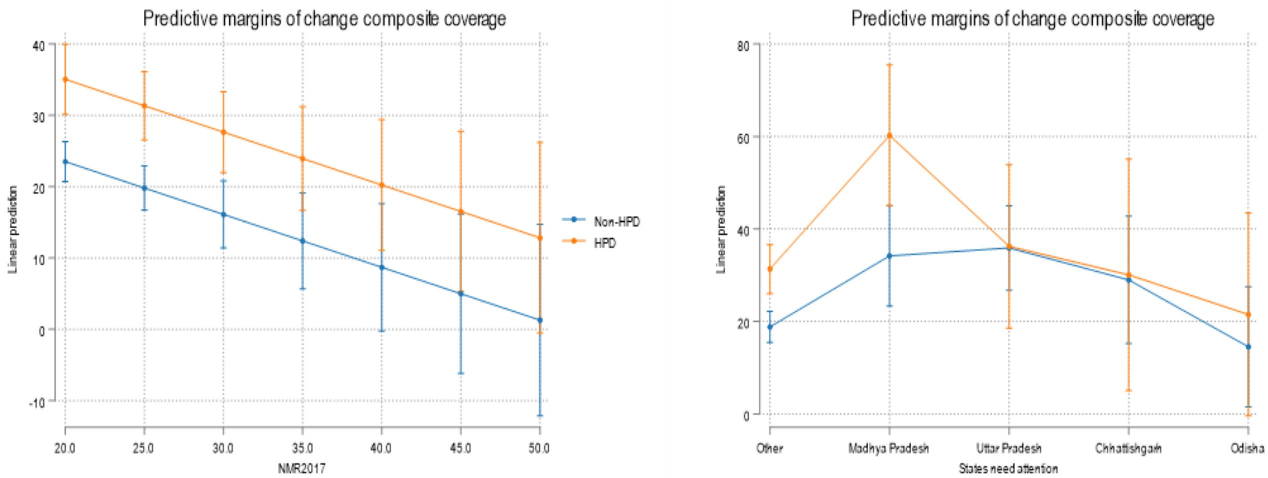


Figure 6 Marginal effect of NMR 2017 and selected states on change in composite coverage (CC)

Discussion

There is no dearth of evidence that India made substantial progress in improving maternal and child health outcomes in the last two decades, attributable to several programs, and a collaboration of government and other stakeholders.

We found that the pattern of NMR north-south contrast of Indian states highlighted almost 40 years back by Dyson and More, remains unchanged (Dyson and Moore 1983). The south Indian states have continued to experience a historically low level of NMR. The states that continue to experience a very high burden of NMR are primarily Madhya Pradesh, Uttar Pradesh, Rajasthan, Chhattisgarh, and Odisha. These are also States that are likely to miss the UN SDG target of 12 NMR by 2030 if the current trend continues. Bihar is demonstrating a faster decline in NMR and will reach below the single digit of NMR by 2030 plausibly with a success story for other north Indian states to follow.

The analysis revealed that the RMNCH+A strategies of district prioritization and engagement of development partners did not provide the desired outcome. Since the implementation of the program, in 2013-14, the change in program efficiency was low in the geographies where NMR was high. Although the states with support from development organizations have shown an increase in coverage of essential interventions, the high-priority districts continue to lag in improving program efficiency (composite coverage). The program efficiency was monotonically high in the districts where NMR was high, but a special focus on high-priority districts did not result in any additional advantage. Hence, it is difficult to conclude whether support from development organizations has made any real improvement.

Some of the major learnings that we can accumulate from this synthesis are as follows.

The first and far most important concern is the lack of available data to monitor NMR, SBR, and other child health impact or outcome level indicators. There are no district-level estimates available for important indicators such as NMR and SBR. The state-level estimates published by SRS do not provide uncertainty intervals, a major limitation for effective policy formulation. The other major source of NMR estimates is the state-level generated using the National Family Health Survey (NFHS) but it is often not accepted in the policy documents as it usually provides a higher rate of NMR. The methodological difference makes it difficult for policymakers to choose between the two, and the convention is to quote SRS in all planning and budgeting. The other source of data is IHME, which revises its estimates based on the newly published data (Dandona et al., 2020), which is irregular. There has been a lot of impetus to improve public health informatics such as HMIS since 2008, which captures the outcome of the facility births, but no substantial progress has been made in those directions (Tiwari et al., 2016; Bodavala, 2016; Saikia et al., 2021; Geol et al., 2016). There is an urgent need to produce sub-national rates for NMR and other related indicators for India, for improving planning and mobilizing appropriate resources. Even there is evidence in the existing literature that a major source of variation of important maternal & and child health indicators is below the district level (Lee et al., 2022).

Secondly, it is also observed that a lack of good quality sub-national estimates leads to the misclassification of districts, as observed during the RMNCH+A programming (2014) in identifying high-priority districts. There are districts with a high level of NMR but not classified as high-priority districts. We have found that a higher proportion of these non-HPD districts that had high NMR, continue to have a low level of program coverage. Inspired by such flawed logic of classifying, such prioritization continued, for example, aspirational district programs. It has been found that there is an absence of any variations in the MNCH indicators between aspirational and non-aspirational districts, as per the NFHS-5 (Lee et al.,2022).

Thirdly, we found seeking support from development partners, specifically, philanthrocapitalist organizations by the health department is not effective, as the progress in the bigger states is not showing substantial gains in the reduction of NMR, the bigger states like Uttar Pradesh and Madhya Pradesh. There is a need for further analysis of the nature of support provided by the development partners, and their accountability in these states, to improve the program's efficiency.

Fourthly, one of the major bottlenecks in these larger states with poor coverage is the lack of trained health personnel, which has been a neglected issue for several decades. There is a high level of deficit in the number of doctors, nurses & and midwives in these states. In India, there are only 11 states that qualified for the WHO norms of 44.5 per 10,000 population(CHBI,2021). In Uttar Pradesh, this ratio is 11.8, in Bihar 5.6, in Madhya Pradesh 23.7, and Chhattisgarh 17.4. The NRU program did not focus on filling these gaps.

Finally, the quality of care remains a major challenge, although there is a sharp rise in the ANC coverage and Institutional delivery rates across the states. The philanthrocapitalist support could focus more on improving the quality of health care. Evidence suggests that high institutional delivery in India does not protect against neonatal deaths without the desired quality of care (Lee et al.,2022). Quality childbirth is often characterized by compromised patient safety and privacy, inadequate clinical care, and incidences of abuse and informal payments[Saxena et al.,2018)]. There is also a need to improve the quality of ANC in these states (Upadhyay et al., 2020).

Conclusion

The study suggests that the current rate of decline of NMR is not sufficient for the bigger north Indian states such as Uttar Pradesh, and Madhya Pradesh to achieve the UN SDG goal by 2030. There is no clear evidence that the prioritization of districts and engagement of development partners has a substantial effect on improving the coverage of essential program interventions, in areas where more focus intervention is needed. Hence, there is a need for revisiting the strategy, with a scientific evaluation framework, to understand what worked and what did not work across different states and among different development partners. At the same time, there is also a need to fill the data gaps, so that timely analysis and feedback can be given, and program prioritization can be done based on high-quality evidence. There is a need for improvement overall health system, human resource capacity, and quality of care.

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Author contributions

The authors confirm their contribution to the paper as follows: study conception and design: Arup Kumar Das; data compilation: Akhilesh Yadav: analysis and interpretation of results: Arup Das. Draft manuscript preparation: Arup Das, Critical Review of Manuscript: Arup Das, Akhilesh Yadav. All authors reviewed the results and approved the final version of the manuscript.

Conflict of interest and funding

The author would like to declare no competing interests whatsoever regarding this study.

Ethics and consent

The secondary data used for the study does not contain any identifiable information on the study subjects. Thus, no ethical approval was required. The dataset analyzed during the current study is available in the data repository on the Demographic Health Survey website, and Census website and can be obtained by furnishing a data request form. To obtain the data, the following link can be used.

https://dhsprogram.com/data/availabledatasets.cfm., *https://censusindia.gov.in/census.website/data/SRSSTAT*

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