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Regional Disparities in Childhood Immunization: BCG and DPT Coverage among Children aged 12–23 Months in Poor Performance States, India (NFHS-5)

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ABSTRACT

Prevalence of Vaccine Preventable Diseases exists despite development of vaccines. Zero dose DPT and vaccination gap for BCG has resulted inconsistent immunization coverage of aged 12-23 months in India. There is persistent lower immunization coverage in northern, central and north-eastern regions. The NFHS-5 data was used to understand the variation between the poor performance regions in order to accelerate immunization based on needs and priority. Data observed lower immunization coverage compared to BCG and DPT coverage alone. Arunachal Pradesh and Meghalaya had the highest dropout requiring immediate attention by the health care system. Muslims in main stream and Schedule Tribe in northeast need to be prioritized for vaccine awareness. A pattern of increasing immunization coverage with increasing birth order observed in Arunachal Pradesh while main stream states had decreasing immunization with increasing birth order. Future studies can be done to get more evidence-based research in relation with birth order and immunization.

Keywords: DPT, BCG, Immunization, Coverage, Vaccine

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Introduction

Vaccine Preventable Diseases (VPD) are crucial for prevention from infectious diseases in children.[1] Developing vaccines for childhood diseases like Tuberculosis, Poliomyelitis, Rotavirus infection, Measles, Mumps, Rubella, Varicella, Diphtheria, Pertussis and Tetanus has significantly reduced the incidence of infection.[1,2] Despite the vaccine development, approximately 20 million children still have incomplete course of vaccination causing vulnerability to Vaccine Preventable Diseases (VPD).[2] Outbreak of Diphtheria, whooping cough and measles persists in the current time.[3]

Immunization averts child morbidity and mortality, and is central to India's Universal Immunization Programme.[4] However, coverage remains uneven across regions and population groups.[4] Data showed considerable increase in full vaccination coverage since 1992.[5] However, there has been variability in vaccination coverage and gaps in vaccine dosages.[6] Previous studies showed prevalence of zero dose DPT consistent in Indian states from 1993 to 2021.[7] Moreover, decline rate observed in BCG, OPV and measles vaccination since 2015-16 with disparity across states. [3]States like Uttar Pradesh, Bihar, Jharkhand and North-Eastern regions have higher vaccination gap for BCG than the national average of 9.7.[6] The geography can play an important factor with the variation in the performance of overall health of the child.[8,9] The Southern coastal states like Tamil Nadu and Kerela were performing better in child health compared to central low-lying plain states like Uttar Pradesh and Madhya Pradesh and North-Eastern hilly terrain like Assam and Meghalaya.[8] Consequently, these lower performance states also have poor performance in full immunization coverage.[5] Studies also highlighted disparity across the districts.[5, 8] Most of the districts of Kerela and Tamil Nadu were considered high performance for child health. On the other hand, Punjab have one high performing district while rest are poor performing districts.[8] Further, previous studies showed cultural and religious disparity along with

geographical variation for Multidimensional Child Deprivation Index (MCDI) in states like Nagaland, Meghalaya, Jharkhand and Bihar. [10]

In India with variation and disparity in development across the states, Aspirational District Program (ADP) and Aspirational Block program (ABP) were introduced.[8] The programs are to accelerate overall development of the poor performing districts and blocks with health and nutrition as one of the core areas.[8] Government have also introduced programs to navigate the performance of immunization coverage by introducing Mission Indradhanush in 2015 for improving the poor performing districts.[2] Later Intensified Indradhanush was established in 2017 in the selected poor performing districts and urban areas.[2] Despite progress of these programs, the existence of vaccine hesitancy, logistical barriers and disparity still exits.[1] Further, there is target set by SDG 30 for U5MR and NMR.[8] Few states like Tamil Nadu, Maharashtra, Karnataka and Kerela achieved the target for maximum of their districts, but most states with poor performance like Uttar Pradesh, Jharkhand and Bihar still require attention and improvement to achieve the target. [8]

The North-East faces geographic barriers and service access challenges, while large northern states experience scale and systems constraints.[11]According to NFHS- 1 to NFHS-5 data the Central, Eastern and North-Eastern regions has poor performance in vaccine coverage for children.[3,12] Though all three regions are having poor performance in immunization coverage, they are distinct and varying in geographies. [12]There is limited understanding if altitudes can be a factor in overall health ofchild.[8] Past study suggested on periodic evaluation for understanding between and within group differences beyond average improvement of child Immunization in India.[12] The improvement in poor performing regions need attention for Universal Immunization Coverage attaining equity.[5] With consistent prevalence of zero dose DPT and highest dosage gap for BCG as per NHFS-5 data in India, it's crucial to understand the variation between poor performance states to strategize planning and interventions according to needs and priority. Therefore, this study compares the immunization coverage of DPT and BCG among children aged 12-23 in poor performance regions including Rajasthan, Uttar Pradesh, Madhya Pradesh, Arunachal Pradesh and Meghalaya using data from NFHS-5

Objective: To understand the variation in BCG and DPT immunization with background characteristics in poor performance states

Methods

The study utilizes data from the National Family Health Survey (NFHS-5, 2019–21), a nationally representative cross-sectional household survey that employs a stratified two-stage sampling design covering both urban and rural areas across all states in India. For this analysis, data were extracted for five poor-performing states in terms of immunization coverage—Uttar Pradesh (UP), Madhya Pradesh (MP), Rajasthan (RJ), Arunachal Pradesh (AP), and Meghalaya (MG). The analysis focused on children aged 12–23 months, as this age group is expected, according to WHO and the Indian immunization schedule, to have completed the primary vaccination series including BCG and DPT by the end of the first year of life. The outcome variables examined were receipt of BCG, receipt of DPT-1, dropout after DPT-1 (received DPT-1 but not fully immunized), full immunization, and zero-dose status (no vaccines received). Key explanatory variables included the child's sex and birth order, mother's education, household wealth index, religion, caste/tribe, and place of residence (urban/rural). Coverage rates for BCG, DPT-1, dropout, and full immunization were calculated by these background characteristics, and comparative analyses were conducted between the five states and across subgroups. The findings, including patterns, disparities, and dropout trends, are summarized in tables and figures for clarity.

Result

The NFHS-5 (2019-21) summary Table-1 on child immunization for children aged 12-23 months across six Indian states—Uttar Pradesh (UP), Madhya Pradesh (MP), Rajasthan (RJ), Arunachal Pradesh (AP), and Meghalaya (MG) —reveals several important trends. Across most states, a high proportion of children have received BCG vaccine and the first dose of DPT, with coverage above 90% in UP, MP, and RJ, and between 82%-89% in AP and MG. However, the percentage of children who

complete all basic vaccinations is notably lower: Rajasthan leads with 80.4% fully vaccinated, followed by MP, UP, AP, and MG. Dropout rates—children who received DPT-1 but were not fully immunized— in AP (13.4%) and MG (17.8%), indicating gaps between initial vaccine uptake and completion. Additionally, the proportion of children who received no immunization at all remains highest in AP (9.2%) and MG (8.8%).

Table- 1: Child immunization coverage for children aged 12-23 months across six Indian states

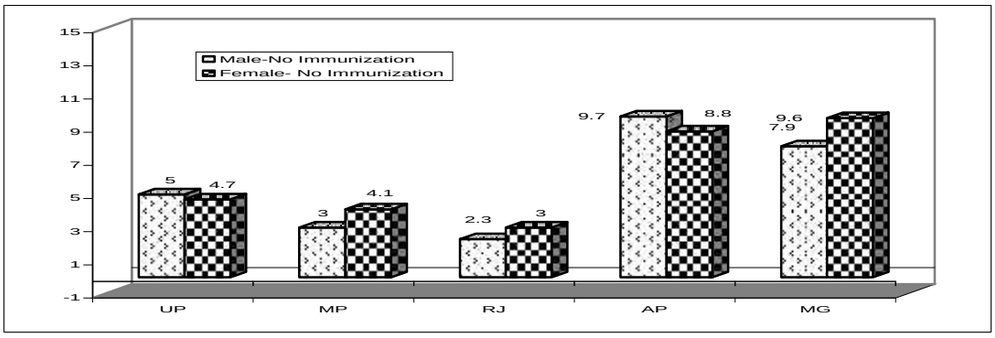
Based on all Children							
State	**Received BCG**	**Received DPT-1**			**Received DPT-1 but not fully immunized**	**No immunization at all**	**Fully vaccinated (all basic vaccinations)**
		Yes		**No**			
UP	93.2	90.9	9.1	21.2	4.9	69.6	6412
MP	95.4	94.0	6.0	16.9	3.5	77.1	3053
Raj	95.6	94.6	5.4	14.2	2.6	80.4	2520
AP	87.9	86.6	13.4	21.7	9.2	64.9	1008
MG	89.3	82.2	17.8	18.4	8.8	63.8	1076

Gender: Gender differences are marginal but present in Uttar Pradesh, with girls ahead (70.6% fully vaccinated vs. 68.7% boys). In Madhya Pradesh, boys have marginal higher coverage (BCG 95.7%, DPT-1 94.3%) compared to girls (BCG 95.1%, DPT-1 93.7%). In Rajasthan, girls are better (81.2% fully immunized) compared with boys (79.7%). Further, in Meghalaya the boys are marginally better protected (65.0%) compared to girls (62.7%). Vaccination coverage varies in Arunachal Pradesh, with females showing slightly higher completion rates (66.6% fully immunized) (Table 2).

Table -2: Gender Difference in Vaccination uptake of BCG, DPT-1 and Full vaccination

Vaccine Coverage	**Uttar Pradesh**		**Madhya Pradesh**		**Rajasthan**		**Meghalaya**		**Andhra Pradesh**	
	Male	**Female**	**Male**	**Female**	**Male**	**Female**	**Male**	**Female**	**Male**	**Female**
BCG	92.9	93.7 ↑	95.7 ↑	95.1	95.8 ↑	95.2	90.0↑	88.5	87.7	88.1 ↑
DPT-1	90.6	91.9 ↑	94.3 ↑	93.7	94.5	94.7 ↑	82.1	82.3 ↑	86.8 ↑	86.4
Full Vaccination	68.7	70.6 ↑	78.3 ↑	75.9	79.7	81.2 ↑	65.0 ↑	62.7	63.1	66.6 ↑

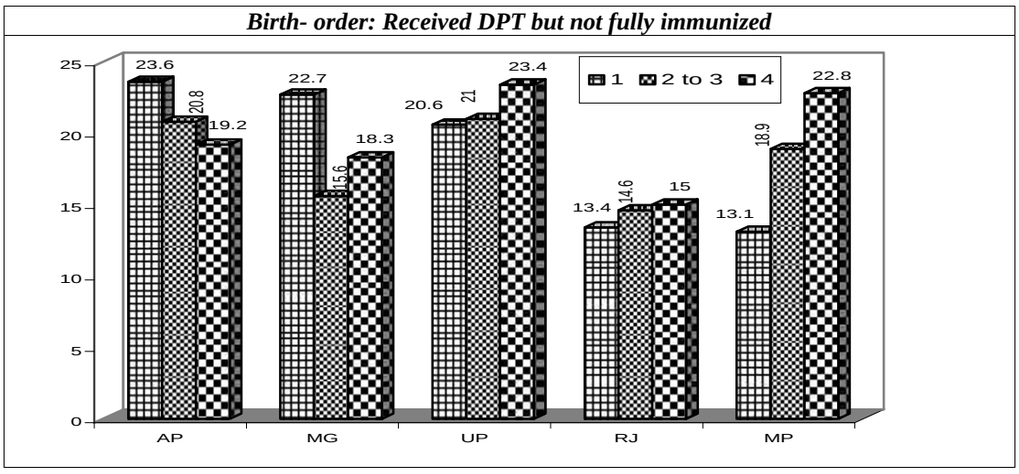
Figure-1: Gender wise no immunization status aged 12-23 months in poor performance states



Zero dose immunization for female is higher for Madhya Pradesh, Rajasthan and Meghalaya and lower for Uttar Pradesh and Arunachal Pradesh as depicted in Figure-1. Among males, Arunachal Pradesh has highest zero dose with 9.7% whereas among females, Meghalaya has highest with 9.6%. With higher immunization coverage in either sex, there is lower zero dose immunization of the same sex in all regions except Rajasthan. Despite higher full immunization coverage among female with 81.2%, there is higher zero dose among female in Rajasthan with 3%.

Birth order: All the regions have higher BCG and DPT-1 coverage for the 1st born and lower for the last born. (Table -3). Except Madhya Pradesh which have shown higher DPT-1 coverage for the birth order of 2-3 with 95%, followed by 1st born (94.5%) and 4+ (88.1%). There is variability in the DPT received with not fully immunized as shown in figure 2. While UP, RJ and MP have a trend of higher drop outs for DPT with increase in number of birth order, AP have lower dropouts with increase in birth order. Further, Meghalaya observed pattern with lower dropouts in birth order for 2-3 (15.6 %) followed by 4+ (18.3%) and 1 (22.7%). Furthermore, MP have shown greater disparity between the birth orders on dropouts.

Figure- 2: Birth order: Incomplete vaccination of DPT across five states



In Uttar Pradesh, birth order plays a significant role: first-borns show the highest coverage (71.7%) fully immunized; 4.2% unimmunized), but protection declines with subsequent births—among children of fourth order or higher, only 65.2% are fully immunized, and 7.1% receive no vaccines.

In Madhya Pradesh, first-born children have the highest levels of full immunization (81.5%). Immunization rates drop considerably for fourth or higher birth order (65.3%), alongside a higher percent not fully immunized (11.9%) and not immunized at all (6.2%). This highlights greater vulnerability to incomplete vaccination among later-born children.

In Rajasthan, birth order has a clear influence. First-born children have the highest protection (81.4% fully immunized; 2.4% unimmunized), while coverage declines with increasing birth order. Among fourth-order or later births, only 78.3% are fully immunized, with 3.2% receiving no vaccines.

In Meghalaya, birth order shows a clear gradient. First-borns achieve the highest coverage (64.7% fully immunized, 5.2% none), while children of fourth or higher order face significant disadvantages (61.0% fully immunized, 11.5% none).

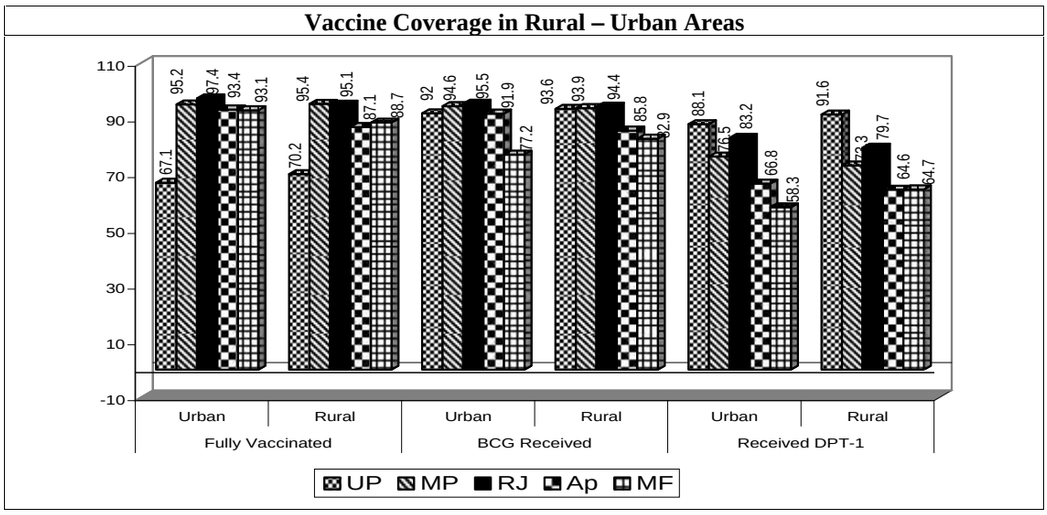
In Arunachal Pradesh, birth order impacts vaccination outcomes-first-born children have a 63.6% full immunization rate, with 8.7% not immunized at all, while children of birth order four or more have a similar full immunization rate (63.8%) but a slightly higher no-immunization rate (11.2%).

Table-3: Vaccine coverage of BCG and DPT-1 in respect to background characteristics

Vaccine Coverage		UP		MP		RJ		MG		AP	
		BCG	**DPT-1**	**BCG**	**DPT-1**	**BCG**	**DPT-1**	**BCG**	**DPT-1**	**BCG**	**DPT-1**
Birth Order	1	94.2	92.3	96.0	94.5	96.2	94.8	92.6	87.3	89.1	87.1
	2-3	93.6	90.7	95.5	95.0	95.7	94.8	89.7	81.5	88.0	87.0
	4+	90.1	88.5	93.1	88.1	92.6	93.2	86.5	79.4	83.9	83.1
Religion	Hindu	93.9	91.8	95.3	93.9	95.7	94.9	**98.5**	**94.2**	91.4	88.9
	Muslim	90.3	86.2	96.4	95.9	93.7	90.8	*	*	*	*
	Others	*	*	**100.0**	**98.0**	**100.0**	**100.0**	88.8	81.5	86.9	85.8
Caste	SC	92.7	91.1	96.0	94.6	95.9	95.1	*	*	82.2	82.9
	ST	92.8	84.3	95.4	91.8	95.9	94.1	89.0	82.0	86.8	85.8
	OBC	93.1	90.9	95.3	94.9	95.5	94.5	*	*	96.0	92.3
	Other	94.3	91.2	95.1	94.4	95.2	95.2	**89.6**	**83.6**	91.7	88.5
Wealth	Poorest	89.8	87.7	93.7	91.5	94.3	92.4	86.6	78.8	79.0	77.1
	Poorer	93.5	91.1	95.8	93.3	93.6	92.1	88.4	83.9	89.3	88.3
	Middle	95.2	92.8	96.2	96.5	94.9	94.8	95.5	85.4	90.2	88.6
	Richer	94.8	92.4	97.6	97.4	97.1	95.5	96.8	88.7	96.1	95.1
	Richest	94.7	91.8	95.6	95.2	97.6	97.8	*	*	**94.8**	**94.8**

Residence: The BCG coverage is comparatively better than DPT-1 in both urban and rural areas. (Figure-3). UP have received higher vaccine coverage for BCG and DPT-1 with more than 88% but have lower than 70% full immunization in both urban and rural areas as depicted in the graph. Meghalaya have shown higher vaccination received for BCG of 82.9% and DPT of 64.7% in rural areas, but have shown higher full immunization of 93.1% in urban areas. While, Madhya Pradesh has similar immunization coverage in urban-rural areas, Rajasthan and Arunachal Pradesh have better immunization coverage in urban areas compared to rural areas (Figure 3).

Figure -3: Vaccination coverage in urban-rural areas of poor performance states



Education: Maternal education emerges as a critical determinant in Uttar Pradesh. Children of uneducated mothers are less likely to be fully immunized (64.2%) and more often unimmunized (7.7%), compared with those whose mothers completed 12+ years of schooling (72.8% and 3.7%, respectively). In Madhya Pradesh, Maternal education is positively associated with immunization: children whose mothers have 12 or more years of education show the highest full immunization (81.4%) and lowest non-immunization (2.4%), compared to those with no education (fully immunized: 71.1%; no immunization: 5.0%). Further in Rajasthan, children of mothers with secondary or higher schooling (10+ years) achieve the highest coverage (84.9%–81.3% fully immunized; ≤2.3% unimmunized), while children of mothers with no education are significantly disadvantaged (76.0% fully immunized; 4.2% unimmunized). Maternal education is a decisive factor in Meghalaya. Children of uneducated mothers are least protected (47.1% fully immunized, 14.1% unimmunized), while coverage improves steadily with higher schooling. However, some fluctuations appear among intermediate education categories, likely due to small sample sizes. In Arunachal Pradesh, mother's education is strongly linked to immunization coverage. Children of mothers with no education have low full immunization rates (60.2%) and very high rates of no immunization (15.2%). Children of mothers with 12 or more years of education have better outcomes (72.8%) fully immunized, 2.7% no immunization).

Religion, Caste and Wealth: In Uttar Pradesh, Hindu children show higher coverage (70.9%) fully vaccinated; 4.0% unimmunized) compared to Muslims (63.4% and 8.7%). Dropout is notably higher among Muslim children—13.8% receive DPT-1 but fail to complete the schedule. Caste and wealth further underline inequities. Scheduled Tribes exhibit the lowest coverage (53.1%) and the highest non-immunization (31.1%). Children from the poorest households also lag behind (63.6% fully immunized; 7.0% unimmunized), while the richest are better protected (71.6% and 3.9%, respectively).

Religious background in Madhya Pradesh shows that Hindu children have immunization rates close to the state average (fully immunized: 77.7%, none: 3.6%), while Muslim children have lower rates of full immunization (67.7%) and a much higher percentage not immunized (3.6%), with a notably high dropout among those receiving DPT-1 but not fully immunized (28.2%). Caste categories point to disparities: scheduled caste (SC) and wealthier children have higher full immunization rates (SC: 81.0%; richest: 82.0%) compared to scheduled tribes (ST: 76.4%) and other backward classes (OBC: 78.3%). Full immunization is highest among the wealthiest (82.0%) and drops among the poorest (74.3%), with non-immunization lowest for the richest (2.4%).

In Rajasthan, religious differences are also evident. Hindu children are better covered (80.7% fully immunized; 2.5% none) than Muslim children (75.6% fully immunized; 4.6% none), with Muslim children showing a higher dropout after DPT-1 (9.2%). Caste and wealth stratification highlight persistent inequities. Scheduled Castes perform best (82.9% fully immunized; 1.5% unimmunized), while Scheduled Tribes and OBCs hover close to the state average. Wealth shows the sharpest divide: in the richest households, 83.9% are fully immunized and only 0.5% receive no vaccines, compared to 75.3% and 3.4% among the poorest.

Religion and caste reveal marked inequities in Meghalaya. Hindu children report stronger coverage (76.8% fully immunized), while other groups lag behind. Among Scheduled Tribes, who make up the majority in Meghalaya, only 64.1% are fully immunized, and almost 9% remain unimmunized—indicating persistent vulnerability in this community. Wealth disparities are also evident. Children from the poorest households have lower coverage (62.7% fully immunized; 11.4% none), while those from middle and richer households fare somewhat better, though gaps remain across all strata.

Religious and caste data show variability in Arunachal Pradesh: Hindu children have a relatively higher full immunization level (~69.5%) and lower no-immunization rate (~5%), while Scheduled Castes and Scheduled Tribes have lower full immunization and higher no immunization rates. Wealth disparities exist as well, with poorest households showing a full immunization rate of 54.8% and a high no immunization rate of 17.5%, while richer households have improved coverage but still face dropout challenges.

Discussion

Vaccine Preventable Diseases are important for prevention from communicable diseases in children. [1]With time there is increase in vaccination coverage reducing the morbidity and mortality among children in India.[4] However, the coverage remains uneven across regions and an outbreak persists in the current time.[3] Zero dose prevalence of DPT is consistent[7] and highest dosage gaps for BCG observed.[6] A periodic evaluation within and between the regions needs attention for improvement in immunization.[12] Therefore, to build equity and attain universal immunization coverage, this study focused on the poor performance regions in understanding the trends in variation in BCG and DPT coverage aged 12-23 months children with background characteristics of NHFS-5.

The study focused on the poor performing regions with diverse geography: the mountainous terrains of Arunachal Pradesh, Meghalaya with its hills and deep valleys, the deserted Rajasthan, low lying plains and plateaus of Madhya Pradesh and Uttar Pradesh diversified with foothills, plains and plateaus. Previous studies focused on overall performance of health[8], multidimensional child deprivation index[10], overall immunization coverage across all states using NFHS data.[1,5,6,9,12,13]Our study focused solely on the poor performance regions using NFHS-5data specific to DPT and BCG giving core understanding in variation and disparity in order to attain improvement in immunization.

There are similarities and variabilities observed within and between regions. Overall, among geographies, North-Eastern states including MG and AP have higher dropout rates for DPT and zero dose immunization compared to rest of the states. This suggests increasing awareness, literacy and understanding health seeking behaviour of the particular region. The vaccine coverage for BCG and DPT-1 is overall higher in all regions compared to full vaccination. Past studies with NFHS-4 data showed national average of 91.9% and 78.4% coverage for BCG and DPT where as 62% for full immunization.[14] Comparatively in our study, individual BCG and DPT coverage for the poor performance states better performed in NFHS-5 than national average of NFHS-4, except Arunachal Pradesh and Meghalaya. Overall performance increased while equitable immunization coverage needs attention in the north-eastern region for improvement beyond average.

There is variability observed with background characteristics between the states. Previous study with NFHS 1 to 3 data noted male with better immunization coverage than females in India.[15] While in our study variation in immunization coverage in both gender is observed. Gender differences are marginal within the states while variable between the states. A continued assurance of gender equity in vaccination is suggested in all the regions with boys in UP, RJ, AP and for girls in MG and MP.

With increase in birth order, there are higher dropouts for DPT in all states except in Arunachal Pradesh. Previous cross-sectional study with 85 countries revealed higher zero dose prevalence is associated with increased number of siblings showing a similar trend as in our study.[16] However, in Arunachal Pradesh, there is decrease in dropouts with increase in birth order indicating improvement in awareness among mothers with increase in no. of child births. It's recommended that the vaccine coverage for BCG and DPT for 2 to 4+ born needs to be targeted for lowering dropouts in all states, while for Arunachal Pradesh, 1st born should be targeted. A proper follow up to the designated birth order need to be prioritized for complete immunization.

The uptake of DPT-1 is comparatively lowered than BCG across urban-rural of all regions. UP have greater disparity in full vaccination when compared to vaccine coverage for BCG and DPT-1. Meghalaya have shown higher vaccination coverage for BCG and DPT in rural areas, but have shown better full immunization in urban areas. Rajasthan and Arunachal Pradesh have better immunization coverage in urban areas compared to rural areas. Past studies observed overall improvement in the rural areas compared to urban in India,[6] whereas our study showed variability with regions. Another previous study showed sharp regional disparity of different vaccination doses including cold spots like north east and central India while hot spots like southern regions. [14]With consistency with this previous data, it is suggested the vaccines needs to be prioritized and given specific to the underserved pockets to attain equity among the poor performance regions.

Muslims have notably lower immunization coverage in main stream. While in states like Meghalaya and Arunachal Pradesh, where majority resides are other religion, Hindu have better immunization coverage. Previous studies depicted lower immunization among Muslims.[5] Comparatively, our study detected both Muslims and other religions need in immunization coverage. It's suggested to be given region wise attention in context to religion. As the beliefs and customs differ in different religion, the approach in taking public health measures would differ in reducing vaccine hesitancy among them.

Among caste, scheduled tribe and OBC have lower immunization coverage in Rajasthan, UP and MP. While in AP, SC has lowest coverage followed by ST. Previous study highlighted ST to have lowest immunization coverage in India.[5] While in our study, the variations observed between the states with ST to be less immunized in mainstream and SC to be less immunized in north-east. Lower literacy and socioeconomic status showed lower vaccine coverage with higher zero dose in all the poor performance states**.** Our study is consistent with the previous studies on education and wealth.

Our study highlighted the variation in the background characteristics of poor performance region in vaccine coverage. There was variation observed between the poor performing regions for religion, caste, birth order and residence while similarity observed for wealth, education and gender. The study has given region specific trends and pattern where it needs to be prioritized. While our is secondary study, it's suggested for future research to understand the variables through in-dept primary studies.

Conclusion

With NFHS-5 data, similarity and variability observed within and between poor performance states. All states had lower immunization coverage compared to BCG and DPT-1 alone. Socioeconomic status and maternal literacy need improvement for lowering dropouts in all regions. North eastern states had highest drop outs and need immediate attention. Muslims, ST and OBC should be given emphasis in MP, RJ and UP, while other religions, SC and ST should be given importance in AP and MG in vaccine awareness. Higher Birth order in UP, MP, RJ and, 1st born in AP should be followed up in vaccine uptake.

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