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# Temporal Trend and Inequality in Immunization Coverage in India

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## Abstract

Since 1978, India through its various health policies target to achieve the universal immunization, but profound progress is yet to be seen. This paper examine the trend in immunization coverage and differential access among the population subgroups. Data for the analysis was extracted from the two recent rounds of the National Family Health Survey (NFHS) conducted in 2005–2006 and 2015–2016. Descriptive statistics were used to understand the level of coverage, whereas the ratio method and concentration index was used to understand the inequality. The study identified immunization coverage had improved from 44 percent in 2005–2006 to 62 percent in 2015–2016. However, considerable variation was observed among the regions and various wealth quintiles. In the Southern region, 63 percent of children from the poorest wealth quintile were fully immunized compared to 36 percent in North Eastern region. The coverage of full immunization among richest children was found to be 1.5 times higher than that of the poorest. The concentration index remains positive showing the pro-rich inequality. A positive result was found in the Northern and Northeastern region, where the poorest were showing an impeccable improvement over the period. Moreover, the study found the gap by place of residence and gender was close to convergence. The study suggests that the immunization programs have to be inclusive, with widespread reach, leaving no stones unturned. These steps can be beneficial in diminishing inequalities, acting as an essential ingredient in achieving the sustainable development goals.

**Keywords:** inequality, immunization, India, NFHS, temporal

## 1. Introduction

Socioeconomic inequalities in a child health is a major policy concern to achieve the Sustainable Development Goals (SDGs) framed by the United Nations in 2015 [1]. However, progress toward reducing these inequalities in child health indicators is not noteworthy among and between the countries [2]. Irrespective of the continued global effort to reduce the infant and child mortality rates, the targets of Millennium Development Goals (MDG) remained unattainable in many developing countries [3]. Nearly, 5.6 million of under-five death occurs worldwide [4], out of which quarter of death are due to vaccine-preventable diseases. Moreover, an estimated 19.9 million infants worldwide stay absent for routine immunization services. Around 60 percent of these children live in 10 countries, mainly from Africa and South Asia including India [5]. Though the Global Vaccine Action Plan (GVAP) has been endorsed by 194 countries in 2012, to ensure the equitable access to immunization by the year 2020, profound progress is yet to be seen [6].

Immunization coverage is given high priority globally and nationally especially for developing countries like India. The Indian immunization program started in 1978 after the Alma-Ata declaration aimed at immunizing all children [7]. To accelerate this, appropriate policy measures were put in place during those times, but the task of attaining these were quite arduous. The Government of India recently launched the *Mission Indradhanush* (UIP) in 2014 with the target of achieving universal immunization coverage [https://www.nhp.gov.in/mission-indradhanush1\\_pg](https://www.nhp.gov.in/mission-indradhanush1_pg). Irrespective of these attempts, nearly one-third of the children remain to be far away from vaccinations in India [8–12].

India, known for its multifaceted society and social hierarchy, dealt with higher social, economic, and regional inequality. A growing number of studies in India examined inequalities in child health status including full immunization coverage [9, 13, 14]. The studies found significant gap in wealth-related, rural–urban, and gender-related inequality in immunization coverage [15–18]. Some studies also observed large differentials among the economic groups, caste, and religion of the household [11, 19, 20]. Among the other factors, maternal education, proximity to a health facility, place of delivery, and pre- and postnatal checkup of mothers are among the leading factors affecting immunization coverage in India [21–24]. Apart from that, appropriateness of the timing of the vaccination is lagging in India and many states [25]. In order to reduce the disparity in immunization coverage, countries must adopt proequity programs aimed at reducing the gap in immunization coverage.

The present study is conceptualized under the following rationale. Firstly, in terms of immunization, India is one of the major contributor of unimmunized children in the world [5]. So, it is essential to understand the pattern of full immunization coverage in general and specific vaccinations in particular among various geographies of India. Secondly, many literatures suggest the pervasiveness of economic inequality among children in various health indicators. Therefore, it becomes imperative to study the pattern of inequality among the better off and worse off population subgroups. Thirdly, the WHO Commission on social determinants of health positioned strategically to reduce health inequalities and considers gender as one of the main determinants. It is widely established that pronounced gender bias still exists in India, favoring males over females. In this concern, understanding gender segregation in immunization practices is critical for policy formulation. In the same line, this study is a revisit to understand the temporal variation and inequality in immunization coverage among the regions of India. The present study will deliver the dynamic pattern of inequality in regions of India and provide guidance to frame policy as per the present challenges at hand.

The main objective of this paper was to document pattern and inequalities in immunization coverage in India over two periods of time (2005–2006 and 2015–2016). Further, this paper was an attempt to understand inequality patterns in immunization coverage by the wealth quintile at the regional level. We have investigated inequalities in full immunization coverage using various inequality indexes that are related to three characteristics, namely economic status, place of residence, and sex of the child.

## **2. Data and methods**

### **2.1 Data**

In an attempt to understand the variation in immunization among children, data from the third and fourth rounds of National Family Health Surveys (NFHSs) were

used. These surveys were conducted in 2005–2006 and 2015–2016 by International Institute for Population Sciences (IIPS) under the stewardship of the Ministry of Health and Family Welfare (MoHFW), Government of India, with technical support from ICF International. The survey is designed in line with Demographic and Health Surveys (DHS) conducted worldwide. Both the surveys were large-scale surveys that provide state- and national-level estimates on fertility, infant mortality and child mortality, and other family welfare and health indicators. The survey uses a multi-stage stratified random sampling to select the households. Using the appropriate sampling weight, the survey provides estimates for various geographical regions. More about the survey design, sampling procedure, and questionnaire are provided in the national report [8].

The unit of our analysis is the regions of India. The two rounds of National Family Health Survey have followed a uniform pattern in segregating the states qualifying them for a particular region. In our study, the composition of regions based on the state is guided by the NFHS report. As uniformity is maintained in framing the geographical region, it is comparable over time.

### 3. Methods

Full immunization among children aged 12–23 months is the primary outcome variable in this study. Children are considered as fully immunized only when they receive vaccination against tuberculosis (BCG), three doses of diphtheria, pertussis (whooping cough), and tetanus (DPT) vaccine; three doses of poliomyelitis (Polio) vaccine; and one dose of the measles vaccine by the age of 12 months. In India, BCG should be given at birth or first clinical contact; DPT and polio require three vaccinations at approximately 4, 8, and 12 weeks of age; and the measles vaccine should be given at age 12 months or sooner after reaching 9 months of age. Information on vaccination coverage was collected from the child's health card and direct reporting from the mother. We have used the kid's file for analysis; the survey has selected only those households that had childbirths in the last 5 years prior to the survey. The sample size of the children is 49,284 in 2015–2016 and 9559 in 2005–2006.

#### 3.1 Measuring inequality in immunization coverage

This study used two summary indexes to measure inequality in immunization coverage. The first measure is a simple ratio of the threshold of the population characteristics. The ratio measure is considered as a crude measure as it does not consider the estimates except the threshold. Despite its limitation, the measure is considered as a crucial relative measure of inequality and provides a clear idea of discrepancy in health indicators among the population subgroup. Wealth inequality ratio (WIR), rural–urban inequality ratio (RUIR), and gender-related inequality ratio (GIR) were calculated to quantify the inequality based on these attributes. The formula for these measures as guided by the other studies [26, 27] are as follows:

Rich – Poor Inequality Ratio

$$= \left( \frac{\% \text{of fully immunized children in the richest wealth class}}{\% \text{of fully immunized children in the poorest wealth class}} \right) * 100$$

$$\text{Urban – Rural Inequality Ratio} = \left( \frac{\% \text{of fully immunized urban children}}{\% \text{of fully immunized rural children}} \right) * 100$$

$$\text{Gender Inequality Ratio} = \left( \frac{\% \text{ of fully immunized boys}}{\% \text{ of fully immunized girls}} \right) * 100$$

The second summary measure used here was the concentration index, which is one of the widely used inequality measures in public health research. This is a wealth-based inequality measure that provides the concentration of health indicators at a different economic level in the various subgroups of the population. The concentration index is defined as twice the area between the concentration curve and the line of equality (the 45-degree line). So, in some cases, when there is no socioeconomic-related inequality, the concentration index is found to be zero. The thumb rule is that the index takes a negative value when the curve lies above the line of equality, indicating unbalanced concentration of the health variable (in this case immunization coverage) among the poor, and a positive value when it lies below the line of equality indicating disproportionate concentration of the health variable (in this case immunization coverage) among the poor. The formula for finding the concentration index is as follows:

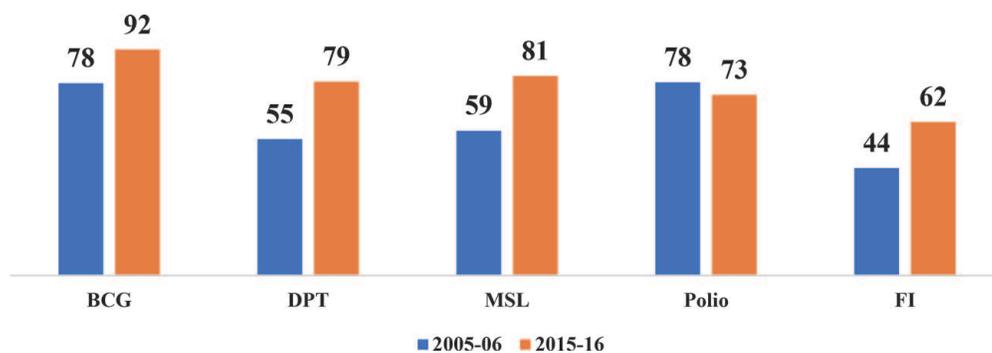
$$\text{Concentration Index : } C = \frac{2}{\mu} \sum_{i=1}^n covw(y_i, R_i)$$

where  $y_i$  is the full immunization coverage of the  $i^{\text{th}}$  child;  $R_i$  is the fractional rank of the  $i^{\text{th}}$  child (for weighted data) in terms of the index of household economic status;  $\mu$  is the (weighted) unconditional mean of the full immunization coverage of the sample; and  $cov_w$  denotes the weighted covariance. All the analyses are performed in Stata 14.

#### 4. Results

**Figure 1** presents the pattern and trend in immunization coverage in India and the regions for 2005–2006 and 2015–2016. The full immunization coverage in India had gone up by 18 percent from 44 percent in 2005–2006 to 62 percent in 2015–2016. Several vaccinations such as DPT, BCG, and measles and full immunization had shown a significant improvement in the same period except for the polio vaccination.

**Table 1** shows full immunization coverage across different wealth classes at two time periods (2005–2006 and 2015–2016). It is clearly evident that the coverage of all vaccines was higher among wealthier classes of the society. The full immunization coverage across the different wealth quintile had grown over the years, and



**Figure 1.** Coverage of various components of immunization in India in NFHS-3 (2005–2006) and NFHS-4 (2015–2016).

Vaccination component	NFHS-3 (2005–2006)				NFHS-4 (2015–2016)			
	Poorest	Richest	Ratio	CI*	Poorest	Richest	Ratio	CI*
BCG	64.00	95.60	1.49	0.08	86.99	95.42	1.10	0.02
DPT	33.90	81.90	2.42	0.17	70.40	85.66	1.22	0.04
POLIO	40.00	85.20	2.13	0.04	66.74	78.35	1.17	0.03
MSL	69.90	87.37	1.25	0.16	73.18	88.79	1.21	0.04
FI	24.45	71.02	2.90	0.21	53.42	70.25	1.32	0.06

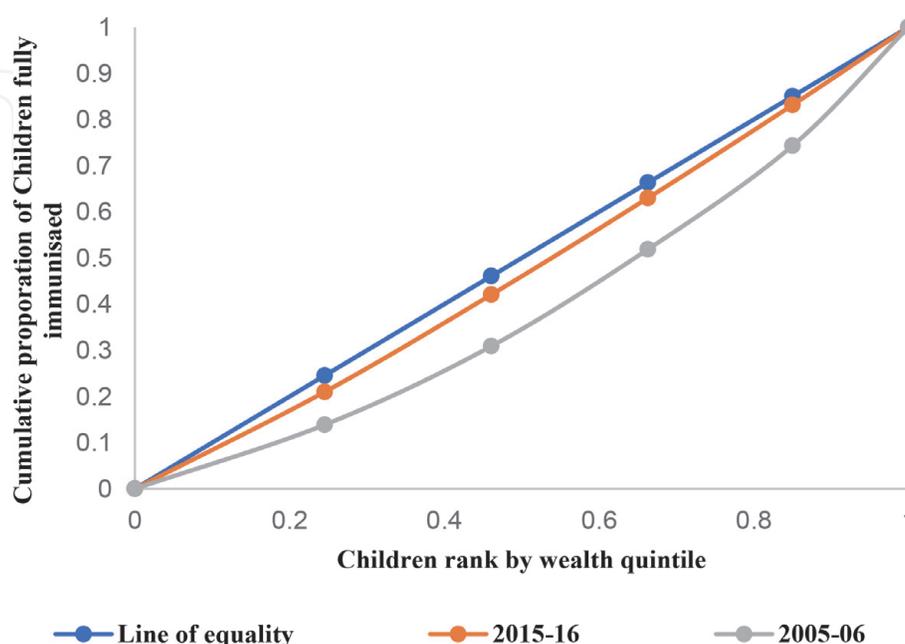
\*CI stands for concentration index.

**Table 1.**  
 Level of various vaccinations and full immunization coverage and inequality measures among the wealth quintile in India in 2005–2006 and 2015–2016.

ratio among the richest and poorest has narrowed much. For instance, wealth inequality ratio (WIR) was found to be 2.42 in 2005–2006, which reduced to almost half (1.22) in 2015–2016.

The concentration index for all the vaccinations was found to be positive, which signifies the prorich inequality. The concentration curve for full immunization coverage (**Figure 2**) for both the periods lies below the line of equality indicating higher level of coverage among the higher wealth quintile. The curve for 2015–2016 is closer to the line of equality than that of 2005–2006 representing the decreasing wealth-based inequality over time.

**Table 2** exhibits region-wise differential in immunization coverage among the poorest and richest wealth quintile across regions of India. Immunization coverage remained higher in the Southern region, both for the poorest and richest during both the periods. The immunization coverage for the Northeastern region was found to be 11.4 percent, lowest among the poorest wealth quintile in 2005–2006, while the Western region accounted for the lowest with 40.23 percent in 2015–2016. The ratio for both the periods was highest in the Northeastern region with 5.47 in 2005–2006 and 1.85 in 2015–2016. On the contrary, the ratio for the Southern region occupied the bottom position. An interesting pattern was observed with a



**Figure 2.**  
 Concentration curve of full immunization coverage by wealth quintal in 2005–2006 and 2015–2016.

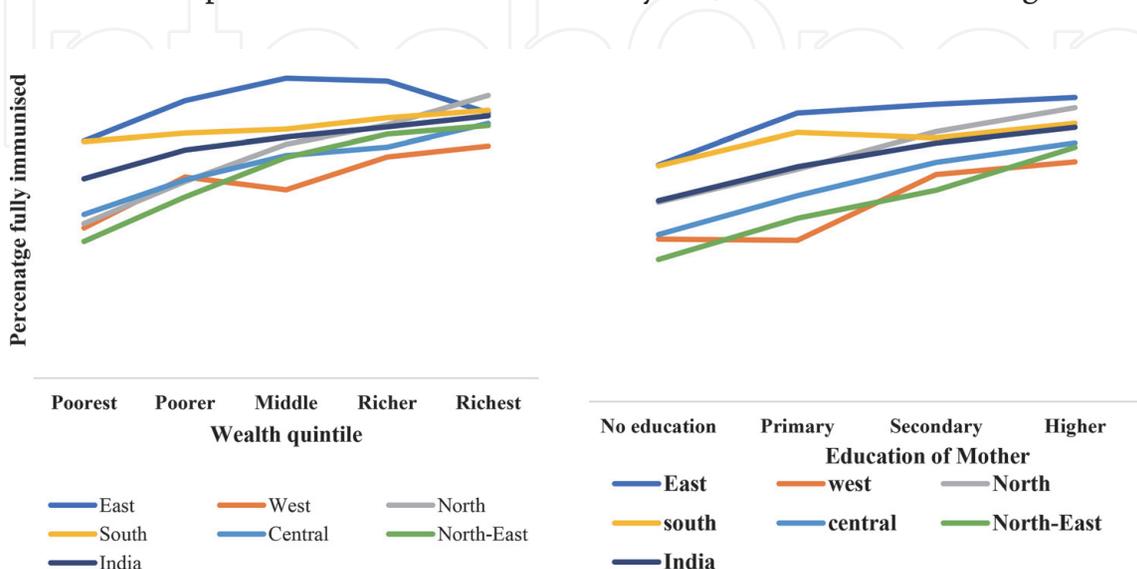
Region	NFHS-3 (2005–2006)				NFHS-4 (2015–2016)			
	Poorest	Richest	Ratio	CI*	Poorest	Richest	Ratio	CI*
East	30.31	76.30	2.51	0.18	63.51	71.04	1.12	0.06
West	29.94	69.86	2.33	0.16	40.23	62.20	1.55	0.07
North	13.63	72.13	5.29	0.26	41.41	75.71	1.83	0.10
South	40.42	78.95	1.95	0.11	63.35	71.73	1.13	0.02
Central	18.40	60.34	3.27	0.23	43.85	68.20	1.56	0.10
North East	11.40	62.43	5.47	0.25	36.60	67.66	1.85	0.12

\*CI stands for concentration Index.

**Table 2.** Level of full immunization coverage and inequality measure among the wealth quintile in India in 2005–2006 and 2015–2016.

drastic decline in the WIR from 5.29 to 1.83 in the Northern region and 5.47 to 1.85 in the Northeastern region. This is accompanied by an increase in immunization coverage among the poorest wealth quintile from 13.63 and 11.40 percent in 2005–2006 to 41.41 and 36.60 percent in 2015–2016 in the North and Northeastern region, respectively. Splitting the full immunization rates according to the mother’s education and wealth group, we found a gap among the two thresholds favoring the richest and highly educated (Figure 3). The same inspected across regions manifested a significant role of education in enhancing immunization coverage.

Table 3 explains the urban–rural differentials in immunization coverage and describes the urban–rural gap in immunization coverage across the regions of India. It was clear from the table that the coverage in full immunization at the national level for both rural and urban has improved. However, rural areas had fared well in comparison to the urban areas, shrinking the gap between them, as indicated in the latest round. However, the Southern region had excelled in immunization coverage leaving behind other regions and India as well. Another very striking finding can be seen from the Northeastern region, where the figures had shown improvements in a decade, with the urban coverage increasing from 40 to 67.09 percent in 2015–2016. Moreover, the rural areas of the Central region have shown an upward trend from 24.68 to 52.97 percent in 2015–2016. Over the years, immunization coverage had



**Figure 3.** Percentage of children fully immunized by household wealth and education status of mothers in India, 2015–2016.

increased significantly in both urban as well as rural areas and interestingly the increase was more profound in rural areas.

**Table 4** presents results of gender differentials in full immunization across the various regions of India. It can be noted that in almost all the regions of the country, the percentage of children receiving full immunization had improved over time both for male and female. There were no differentials in immunization among the male and female found in 2015–2016 depicting the gender inequality ratio closer to one. This reflects an improvement in immunization practices and reduction of the gap between males and females.

To make the result more tangible over time, we have calculated the predicted probability of full immunization coverage using the binary logistics regression and presented in **Table 5**. The predicated probability was 69 percent among the richest compared to 54 percent among the poorest. Wealth-related inequality ratio is 1.27 in 2015–2016, which declined from 1.77 in 2005–2006. Among all the regions, we found a significant gap among these two optimum groups. The highest adjusted wealth-related inequality ratio was observed in Northeastern and Northern region. Considering all other variable constants, the predicted probability for full immuni-

Region	NFHS-3 (2005–2006)			NFHS-4 (2015–2016)		
	Urban	Rural	URIR*	Urban	Rural	URIR*
East	56.36	42.52	1.33	71.92	70.47	1.02
West	64.66	46.23	1.40	54.71	54.94	1.00
North	60.12	40.77	1.47	67.59	62.36	1.08
South	64.63	57.19	1.13	68.35	68.37	1.00
Central	44.68	24.68	1.81	59.11	52.97	1.12
North East	39.39	33.56	1.17	67.09	47.86	1.40
India	57.69	38.72	1.49	64.24	61.72	1.04

\*URIR stands for urban–rural inequality ratio.

**Table 3.**  
 Level of full immunization coverage by place of residence and urban–rural inequality ratio among the regions of India in 2005–2006 and 2015–2016.

Region	NFHS-3 (2005–2006)			NFHS-4 (2015–2016)		
	Male	Female	GIR*	Male	Female	GIR*
East	45.85	43.50	1.05	71.32	70.08	0.98
West	57.37	50.69	1.13	53.39	56.39	1.06
North	47.48	44.36	1.07	61.97	66.60	1.07
South	62.77	56.92	1.10	68.35	68.38	1.00
Central	30.53	26.81	1.14	55.99	52.56	0.94
North East	33.96	34.99	0.97	51.33	50.04	0.97
India	45.48	41.62	1.09	62.30	62.50	1.00

\*GIR stands for gender inequality ratio.

**Table 4.**  
 Level of full immunization coverage among male and female and gender inequality ratio by regions of India in 2005–2006 and 2015–2016.

zation as nearly equivalent in case of rural and urban as well as for male and female. Considering education-related inequality, we found that the predicative probability of full immunization among the mothers belonging to higher education group is 67

NFHS-3 (2005–2006)	India	East	West	North	South	Central	North-East
<b>Wealth status of household</b>							
Poorest	0.35	0.38	0.39	0.29	0.56	0.27	0.15
Poorer	0.39	0.48	0.45	0.45	0.56	0.29	0.25
Middle	0.49	0.50	0.55	0.57	0.67	0.33	0.41
Richer	0.53	0.59	0.64	0.62	0.64	0.35	0.41
Richest	0.61	0.57	0.72	0.66	0.71	0.43	0.61
<b>Education of mothers</b>							
No education	0.37	0.38	0.51	0.44	0.49	0.24	0.27
Primary	0.47	0.49	0.59	0.50	0.67	0.37	0.32
Secondary	0.57	0.60	0.64	0.68	0.66	0.46	0.43
Higher	0.65	0.69	0.71	0.74	0.82	0.55	0.45
<b>Place of residence</b>							
Urban	0.46	0.41	0.62	0.52	0.64	0.37	0.33
Rural	0.49	0.51	0.61	0.59	0.66	0.30	0.38
<b>Sex of the child</b>							
Male	0.49	0.47	0.63	0.57	0.67	0.33	0.37
Female	0.48	0.48	0.60	0.57	0.63	0.31	0.35
<b>NFHS-4 (2015–2016)</b>							
<b>Wealth status of household</b>							
Poorest	0.54	0.66	0.42	0.54	0.71	0.48	0.40
Poorer	0.61	0.73	0.55	0.62	0.66	0.55	0.52
Middle	0.65	0.76	0.55	0.69	0.68	0.59	0.58
Richer	0.67	0.74	0.63	0.68	0.71	0.61	0.58
Richest	0.69	0.71	0.66	0.73	0.73	0.64	0.57
<b>Education of mothers</b>							
No education	0.56	0.65	0.48	0.62	0.66	0.49	0.41
Primary	0.62	0.74	0.52	0.65	0.73	0.57	0.53
Secondary	0.65	0.73	0.61	0.69	0.70	0.60	0.56
Higher	0.67	0.72	0.58	0.72	0.71	0.62	0.60
<b>Place of residence</b>							
Urban	0.61	0.64	0.54	0.65	0.70	0.55	0.52
Rural	0.63	0.71	0.60	0.68	0.70	0.56	0.53
<b>Sex of the child</b>							
Male	0.62	0.70	0.57	0.65	0.69	0.57	0.52
Female	0.63	0.70	0.59	0.69	0.71	0.54	0.54

**Table 5.** Predicated probabilities of full immunization coverage by wealth status, education of mother, place of residence, and sex of the child in India and its region in 2005–2006 and 2015–2016.

percent compared to 56 percent among uneducated mothers in India. Like other two characteristics, education of mother also exhibits significant disparity among these two threshold levels. Almost all of the regions show the pattern of declining trend of education-related disparity, but there continues to be a gap that cannot be ignored.

## 5. Discussion

The present study has made an effort to revisit the temporal change and differential access in immunization coverage in regions of India. In the line of previous literature, the present study using the last two rounds of NFHS studied the rich-poor inequality, rural-urban inequality, and gender-related inequality to understand the equity gap in immunization among regions of India. The latest round of NFHS found that there was a substantial increase of 18 percent in coverage of full immunization as compared to earlier rounds. Except the polio vaccine, all other vaccines had improved over time. The full immunization coverage, as well as DPT and measles vaccines, had improved for more than 40 percent in the period 2005–2016. The improvement in the immunization program can be attributable to the national immunization policies in India.

In India, immunizations are provided free of cost in public health facilities. Irrespective of this, 91% of children were vaccinated against BCG, while DPT and measles are lower compared to it. By convention, a newborn is immediately vaccinated by a dose of BCG, after his entry into this world, whereas, at a later point in time, it becomes little difficult for some parents to let their child receive the doses further signifying the importance of getting immunized at birth. A study found that 40 percent of children in India are left out before completing the series of DPT [17]. The burden of work on mothers, commuting to the public health facility, can be attributed for witnessing an increase in dropouts in further doses of vaccinations. However, a very astonishing picture gets reflected from the observed decline in polio vaccination. Though it is cost-free and has widespread coverage, the figures fell a little from 78 to 73 percent in a decade. The reasons may be ascertained that the present population does not consider polio as a severe and threatening disease [28].

The findings show that inequality in specific vaccination coverage as well as in full immunization coverage had shown substantial proric inequality. The inequality in full immunization coverage was found to be higher among the richer classes also followed to be in the regions. The result was consistent with other studies in India and abroad [18, 26]. But the temporal variation in each vaccination witnessed a significant decline in the gap among the poorest and richest wealth quintile. The ratio in full immunization coverage almost halved over the intersurvey period. This can be thought of as an improvement in the coverage of vaccination among children from the poorest wealth quintile. DPT coverage among children from the poorest wealth quintile doubled, while measles improved 1.5 times over the period, which is instrumental in doubling the full immunization coverage. A positive pattern can be witnessed in the Northern and Northeastern region, where the poorest are showing an impeccable improvement over the period. This can be accredited to advancement in the coverage of immunization, dedicated, well-trained, and sensitive ASHA workers, or community health workers.

Children from urban areas were reported to be better immunized as compared to their rural counterparts. These findings were in tune with studies done in the regional context. In 2015–2016, we found a very marginal rural-urban gap among the regions except for the Northeastern region. The reasons can be due to low

urbanization and inadequate or unfit health facilities. The previous literature has highlighted the male advantages in obtaining the vaccination [13, 27]. This study found that the gap in immunization was close to convergence. These achievements can be attributed to an increase in female education, effective gender sensitization programs, and improved communication between health workers and the community.

This study is an attempt in understanding the changes in coverage and inequality among the regions of India dealt with some limitation. The sample size of the children in the NFHS-3 was very less, so it is misleading to find the estimates by different wealth quintiles among the smaller states. Estimates of vaccination coverage in India are based on the vaccination card or the parental recall, but the accuracy and validity of the response are critical. In India, vaccination card is not universal, and the use of parental recall against the absence of vaccination card can sometimes be incomplete or inaccurate.

## **6. Conclusion and policy implications**

Our analysis shows that a significant variation can be observed in the region-wise distribution of a child's immunization. With an aim to increase the immunization coverage among children, the government has initiated several programs, targeted at achieving universal immunization. Though the initiation of new programs gets underway, the achievement of desired targets to be met is often confronted with the lack of community health workers, inadequate infrastructure and human resource, and majorly political will. The study suggests that the immunization programs have to be inclusive, with widespread reach, leaving no stones unturned. These steps can be beneficial in diminishing inequalities, acting as an important ingredient in achieving the Sustainable Development Goals.

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## **Competing interests**

The author declared that he does not have any competing interest.

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## **Ethics approval and consent to participate**

As the study is based on the secondary data and available in public domain, it needs no prior approval.

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