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RESEARCH ARTICLE

Understanding inequalities in child immunization in India: a decomposition approach

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Abstract

The importance of childhood immunization for healthy child growth and development is well recognized and is considered to be the best and most cost-effective lifesaver. Low socioeconomic status has been shown to be associated with low child immunization and health care utilization, but the inequalities in immunization coverage due to social and economic factors are poorly understood. This study aimed to explore the association between child immunization coverage and various socioeconomic factors and to quantify their contributions to generating inequalities in immunization coverage in India. The study data are from the National Family Health Survey-4 conducted in 2015–16. The association between socioeconomic determinants and child full immunization coverage was estimated using the χ^2 test and binary logistic regression. Concentration indices were estimated to measure the magnitude of inequality, and these were further decomposed to explain the contribution of different socioeconomic factors to the total disparity in full immunization coverage. The results showed that the uptake of immunization in 2015–16 was highly associated with mother's educational status and household wealth. The concentration index decomposition revealed that inequality (immunization disadvantage) was highest among poorer economic groups and among children whose mothers were illiterate. The overall concentration index value indicates that the weaker socioeconomic groups in India are more disadvantaged in terms of immunization interventions. The results offer insight into the dynamics of the variation in immunization coverage in India and help identify vulnerable populations that should be targeted to decrease socioeconomic inequalities in the country.

Keywords: Immunization; Inequality; India

Introduction

At the end of the Millennium Development Goal (MDG) era, the international community agreed on a new framework of Sustainable Development Goals (SDGs) aimed at ending preventable deaths of newborns and children under five years of age by 2030 (Bora & Saikia, 2018; UN-DESA, 2019). The importance of immunization for healthy child growth and development is well recognized globally. The global under-five mortality rate declined from 93 deaths per 1000 live births in 1990 to 39 deaths per 1000 live births in 2018 (WHO, 2019c). An accelerated reduction has been witnessed over the past two decades compared with the 1990s (UN-IGME, 2019). Despite this progress, child survival remains an urgent concern. Although knowledge and technologies for life-saving interventions are available, around 15,000 children die globally every day, mostly from treatable diseases and preventable causes (WHO, 2017). Globally, immunization prevents around 2–3 million deaths every year from diseases like influenza, diphtheria, measles, tetanus and pertussis and is considered to be the best and most cost-effective lifesaver (WHO, 2019b).

The World Health Organization defines immunization as the process whereby a person is made immune or resistant to an infectious disease, typically by the administration of a vaccine (WHO, 2019a). Vaccines are available for most of the deadly childhood diseases, such as polio, diphtheria, measles, pertussis and tetanus, pneumonia due to *Haemophilus influenza* type b (Hib) and *Streptococcus pneumoniae* and diarrhoea due to rotavirus. As per WHO guidelines (WHO, 2012), children aged 12–23 months who have received one dose of BCG vaccine, three doses of DPT vaccine, three doses of the polio vaccine and one dose of measles vaccine are considered to be fully immunized.

In 1985 the Government of India launched the Universal Immunization Program (UIP) in line with the WHO's Expanded Programme on Immunization (EIP) to ensure universal and equitable access for children and mothers to vaccines (Singh, 2013; Lahariya, 2015). Today, India's immunization programme covers around 26.7 million infants and 30 million pregnant women annually (MoFHW, 2016). In terms of numbers, it seems as though most children in India are immunized, but this generalization might not show the real picture. Although steady progress has been made in the past decade, routine childhood vaccination coverage has been slow to increase (Gurnani *et al.*, 2018). India's commitment to attaining full immunization with all available vaccines for children up to 2 years of age is still doubtful, and the country still has a significant proportion of children who are not fully immunized – 38% (IIPS & ICF, 2017).

India's immunization division of the Ministry of Health and Family Welfare (MoFHW) is responsible for providing technical assistance, the review of programme implementation plans, vaccine and cold chain logistics, activities related to routine immunization, monitoring Adverse Events Following Immunization (AEFI) and strategic communication and immunization programme training. It facilitates the National Technical Advisory Group on Immunization (NTAGI) by reviewing and making recommendations on various technical and programmatic immunization issues (MoFHW, 2013). A large share of vaccination in India is provided by the public sector (through outreach sessions held at Anganwadi centres, sub-centre etc.). Accredited Social Health Activists (ASHAs) and Anganwadi Workers (AWWs) support Auxiliary Nurse Midwives (ANMs) by mobilizing eligible children to the session site and ensuring that no child is missed. A network of more than 27,000 cold chain points has been set up across the country where vaccines are stored at recommended temperatures to ensure potent and safe vaccines are delivered to children. Special immunization drives like Mission Indradhanush and Intensified Mission Indradhanush have been launched in the country aimed at increasing awareness about vaccination and decreasing the fear of side-effects. These missions focus on high-risk settlements identified as pockets with low coverage due to geographic, demographic, ethnic and other operational challenges (MoFHW, 2018).

However, there is a need to examine these efforts in terms of their outcomes to ensure greater focus on the child through improvements in existing schemes and suggest new holistic interventions. India also lacks a powerful mechanism to track vaccine-preventable diseases. There is significant concern about the burden of socioeconomic inequalities borne by the poor and other vulnerable groups in the country. Even though efforts to reduce disparities are in place, achievements are disproportionately low (Mohanty & Pathak, 2009).

Differentials in immunization coverage are complex and multidimensional and diverge significantly across regions, countries, age and income groups, families and communities. In the Indian context, many studies have tried to identify the factors that might be acting as barriers to more comprehensive vaccination of children. A study on the Intensified Mission Indradhanush strategy showed that cross-sectoral participation, sustained high-level political support, advocacy, supervision across sectors and better communication could increase vaccination rates in children at high risk (Gurnani *et al.*, 2018). Lahariya (2015) argued that it is possible to increase coverage with available vaccines and overall programme performance by strengthening health systems. Ganguly *et al.* (2018) identified that poor follow-up and communication was the prime reason for high partial/non-immunization and dropouts in rural districts. They showed that a

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computerized immunization due-list could be used to achieve more than 85% full immunization coverage within 2 years in Indian villages. A cross-sectional survey among urban poor in Delhi showed that the socioeconomic status of the household, health awareness, female illiteracy and gender inequality were essential determinants of coverage (Devasenapathy *et al.*, 2016). Another community-based cross-sectional study conducted in the slum areas of Mumbai suggested that effective communication, active involvement of communities in immunization activities and constructive feedback were vital for strengthening the immunization programme (Singh *et al.*, 2019b).

It has been shown that low socioeconomic status is significantly associated with low child immunization and other indicators of health care utilization, but the inequalities caused by social and economic factors have been poorly quantified. Some existing studies have examined the effects of socioeconomic status on child health, immunization and mortality using cross-sectional data. However, only a few have extended their findings to characterize levels of inequality, using either rate ratios or, especially, more advanced measures of inequality. To the best of the author's knowledge, no previous study has looked into the quantification of determinants of immunization coverage using the latest round of the National Family Health Survey conducted in 2015–2016 (NFHS-4). Measuring and explaining socioeconomic inequalities in health and health care are critical for planning and implementation of health intervention strategies and achieving equity in health care. In this context, this paper offers several insights to explain the dynamics behind existing inequalities in child vaccination coverage across various socioeconomic groups using a decomposition method. This study aimed to explore the association between child full immunization coverage and various socioeconomic factors, and to estimate the magnitude of persisting inequalities and explain the contribution of different socioeconomic predictors to the total disparity in vaccination coverage in India.

Methods

Data

Data were taken from the NFHS-4 conducted in 2015–2016. The NFHS is a large-scale, multi-round survey conducted on a representative sample of households throughout India and provides information on population, health and nutrition for all of India and for each state and union territory (IIPS & ICF, 2017). A sample of 47,839 children aged 12–23 months was selected for the study.

Dependent variable

In the NFHS-4, information on vaccination coverage was collected from the child's health card and direct reporting by the mother. A binary outcome variable was calculated based on whether the child had received all the basic vaccinations by the age of 12–23 months (i.e. one dose of BCG vaccine, which protects against tuberculosis, three doses of DPT vaccine, which protects against diphtheria, pertussis and tetanus, three doses of the polio vaccine and one dose of measles vaccine), with '0' representing children who had not received all the basic vaccinations at the time of the survey, and '1' representing those who had.

Independent variables

Previous studies examining the determinants of child immunization coverage in the Indian context suggest that paternal education (Ghosh, 1991; Rammohan *et al.*, 2012), social status and religion (Shrivastwa *et al.*, 2015), birth order of the child (Patra, 2006), place of residence (Padhi, 2001; Pebley *et al.*, 1996) and economic status (Arokiasamy & Pradhan, 2011; Mathew, 2012) are important factors influencing immunization coverage. Singh *et al.* (2014) noted that existing health inequities in India are related to a lack of attention to the social determinants of health, including education and employment, and the failure of the health care system to deliver to those most in need. This study included the following demographic and socioeconomic characteristics as independent explanatory variables: sex of the child, birth order (first, second, third, four or more), place of residence (rural and urban), mother's education level (no education, primary, secondary and higher – ten more years), religion (Hindu, Muslim, Christian and 'other'), social group (Scheduled Caste [SC], Scheduled Tribe [ST], Other Backward Class [OBC] and 'other'), sex of household head, region (North, Central, East, North-east, West and South) and wealth index (poorest, poorer, middle income, richer and richest).

Statistical analysis

In the first stage of the statistical analyses, the socioeconomic determinants of vaccination coverage were assessed using basic descriptive statistics. In the second stage, the association of socioeconomic determinants with immunization coverage was estimated using the χ^2 test and binary logistic regression. In the third stage, the concentration indices were estimated to measure the magnitude of inequality between groups. And finally, the concentration indices were decomposed to explain the contribution of different socioeconomic predictors to the total disparity in vaccination coverage.

Logistic regression is widely used in cross-sectional studies to estimate associations between variables as it is easy to interpret and communicate, especially to the layman (Barros & Hirakata, 2003). In a logistic regression model, the function is written as:

$$\mathrm{Log}\left(\frac{p}{1-p}\right) = \mathrm{Log}\left(\frac{a}{b}\right) = \beta_0 + \beta_1 x_1 \cdots\cdots\cdots\cdots\cdots\cdots\cdots + \beta_k x_k$$

where p is the probability of the outcome of interest, x is the explanatory variable, a/b is the odds of success and the estimated odds ratio (OR) of a given covariate X_i is $e^{\beta i}$.

All statistical analyses were performed using Stata 15 (StataCorp, 2017). The All India States Shapefile used in the study was downloaded from the DHS programme spatial data repository (ICF, 2020). The boundaries of the Jammu & Kashmir region in the shapefile were modified according to the official boundaries recognized by the Government of India. The final feature class had 642 polygons representing each survey district in NFHS-4. All the spatial analyses were conducted in ArcGIS 10.5 (ESRI, 2017).

Concentration Index

Generally, concentration curves are used to identify socioeconomic inequality in health sector variables. However, a concentration curve does not give a measure of the magnitude of inequalities that can be used for comparison across different time periods, socioeconomic groups, countries and regions. The concentration index (Kakwani, 1977, 1986) measures the degree of socioeconomic-related inequality in a health variable (Wagstaff *et al.*, 1991). It has been used to measure and to compare the degree of socioeconomic-related inequality in child mortality (Wagstaff, 2000), child immunization (Gwatkin *et al.*, 2007; Lauridsen & Pradhan, 2011; Doherty *et al.*, 2014; Singh, 2019a), health subsidies (O'Donnell, 2008), child malnutrition (Wagstaff & Watanabe, 2003), utilization of full antenatal care (Gupta *et al.*, 2017) and health care utilization (van Doorslaer *et al.*, 2006). In this study, the concentration index has been used to measure the degree of socioeconomic inequality in vaccination coverage among the children aged 12–23 months in India.

The concentration index is defined as twice the area between the line of equality and the concentration curve. So, when there is no socioeconomic-related inequality, the concentration index is zero. The convention is that the index is negative when the curve lies above the line of equality,

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indicating the disproportionate concentration of vaccination coverage among the poor, and is positive when it lies below the line of equality. A negative value of the concentration index means low coverage among the poor. The concentration index can be obtained using the following formula:

$$C = \frac{2}{N\mu} \sum\nolimits_{i=1}^{n} h_i \, r_i - 1 - \frac{1}{N} \tag{1}$$

where h_i denotes the health sector variable, μ is its mean and $r_i = 1/N$ is the fractional rank of an individual in economic status, with $i=1$ for the poorest and $i=N$ for the richest. For convenience, in computation the concentration index can be defined in terms of covariance between the health variable and the fractional rank in the economic status (Wagstaff & Watanabe, 2003):

$$C = \frac{2}{\mu} \operatorname{cov}_w(h_i, r_i) \tag{2}$$

where h_i and r_i are respectively the health status of the i^{th} individual and the fractional rank of the i^{th} individual regarding the index of economic status; μ is the mean of the health variable in the sample and cov_w denotes the covariance.

Decomposition of the concentration index

The concentration index gives the measure of socioeconomic-related inequality in health or health care. It can be further decomposed to estimate how determinants proportionally contribute to inequality in a health variable. The method proposed by Wagstaff *et al.* (2003) was used in this study to decompose the socioeconomic inequality in vaccination coverage among children aged 12–23 in India. A decomposition method is usually preferred over regression models to study socioeconomic-related inequality, as it gives estimates on the relative contribution of factors to inequality in a health variable. For any linear additive regression model, the vaccination uptake variable Y_i can be presented as:

$$Y_i = \alpha + \sum\nolimits_k \beta_k X_{ki} + \varepsilon_i \tag{3}$$

where β_k values are coefficients and ε_i is the error term. It is assumed that everyone in the selected sample or subsample, irrespective of their income, faces the same coefficient vector β_k. Interpersonal variations in Y_i are thus assumed to derive from systematic variations across income groups in the determinants of y, i.e. X_{ki}. The equation of concentration index for Y_i, C, can be written as:

$$C = \sum\nolimits_k \left(\frac{\beta_k \overline{X}_k}{\mu} \right) C_k + \frac{GC_\varepsilon}{\mu} \tag{4}$$

where μ is the mean of Y_i, $\overline{X}_k$ is the mean of X_k and C_k is the concentration index for X_k. In the last term $\frac{GC_\varepsilon}{\mu}$ (residual), GC_ε is the generalized concentration index for ε_i. Equation (4) has two components. The first is the deterministic or 'explained' component. This is equal to a weighted sum of the concentration indices of the regressors where the weights are the elasticities. Elasticity is defined as a unit-free measure of partial association, i.e. the percentage change in the health variable associated with a percentage change in the explanatory variable $\frac{\beta_k \overline{X}_k}{\mu}$ of Y_i with respect to each X_k. The second is a residual, or 'unexplained', component. This reflects the inequality in health that cannot be explained by systematic variations in the X_k across different socioeconomic groups. This is the unexplained component reflecting the inequality in vaccination coverage across socioeconomic groups that cannot be explained by the selected predictors.

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Results

The percentage distribution of the sample children aged 12–23 months who had received all necessary vaccinations by the time of the survey by background characteristics is given in Table 1. Of the total 47,839 children, 13,602 came from urban areas and 34,237 from rural areas.

There was an almost equal distribution of male and female children in the sample. Immunization coverage was slightly lower among female than male children, and urban areas had higher coverage than rural areas. The chance of children receiving all necessary vaccinations was negatively related to birth order, being highest (67.23%) among children of birth order one and lowest (49.35%) among children of birth order four or higher. The uptake of immunization increased with an increase in mother's education. The children whose mothers had a higher level of education had the highest rate (70.50%) and those whose mothers had never attended school had the lowest rate (51.50%). Immunization coverage was higher among the children from female-headed households compared with those of male-headed households.

As for social groups, uptake was highest among children belonging to the 'other' social group category, and lowest among children belonging to Scheduled Tribes. The children of 'other' religions (Sikhs, Buddhist, and Jains) had the highest level of immunization coverage (74.73%) and Muslim children had the lowest rate (55.36%). In terms of household wealth, immunization coverage was lowest (52.81%) among the children of the most impoverished families, and the percentage coverage rose with an increase in family income, i.e. 64.20% coverage among the children of middle-income families and 69.95% among the children of the most affluent families, clearly showing that household wealth is a vital determinant the immunization coverage in India. When different geographical regions were taken into consideration, the East and South states had a greater proportion of fully immunized children than the North-east and Central states.

The geographical distribution of the percentage of children fully immunized showed that there are a large number of districts in the northern and eastern parts of the country with similar geographies that have a low percentage of fully immunized children (Figure 1). Of the 640 districts covered, only 111 had more than 80% of children fully immunized, while seven districts had less than 20% and 47 districts had 20–39% of children fully immunized. The majority of districts (216 and 254) had 40–59% and 60–79% of children fully immunized, respectively. The data for sex areas were either unavailable or had a low sample size.

The results of the χ^2 test and logistic regression showed that uptake of full immunization was highly associated with mothers educational status, birth order and household wealth. The odds of receiving full vaccination among the richest were twice more than among their poorest counterparts. The odds were respectively 1.47 times, 1.46 times and 1.33 times higher among children whose mothers have attained higher education (OR=1.47, CI: 1.286, 1.673), secondary education (OR=1.46, CI: 1.352, 1.580) and primary education (OR=1.33, CI: 1.221, 1.448) compared with the children of mothers without any education. Furthermore, Muslim children were 25% less likely to be fully immunized than Hindu children. In addition, Scheduled Tribe children were 8% and OBC children 6% less likely to be fully immunized compared with children belonging to Scheduled Castes. The probability of children receiving full immunization was negatively related to birth order, i.e. the odds were 30% less for children of birth order 4 and higher, 22% less for children of birth order 3, and 11% less for children of birth order 2, compared with children of birth order 1. Children belonging to the richest and middle wealth index families were respectively 2.12 times (OR=2.12, CI: 1.838, 2.456) and 1.61 times (OR=1.61, CI: 1.470, 1.761) more likely to be fully immunized compared with the children of the most deprived (poorest) families. The χ^2 value was significant for all background characteristics except for the sex of the child.

The results of the decomposition analysis of the concentration index for immunization among children aged 12–23 months by background characteristics are shown in Table 2. The table shows the coefficients of the regressors, concentration indices and the total contribution, as well as the percentage contributions, of explanatory variables. The concentration index shows that the

Table 1. Percentage of children aged 12–23 months with full immunization, adjusted odds ratios (AORs) and χ^2 values by background characteristics, India, 2015–16, N=47,839

Background characteristics	Full immunization (%)	AOR	95% CI	χ^2	n
Sex					
Male (Ref.)	62.05	1.00		0.016	24,750
Female	61.93	1.00	[0.949, 1.056]		23,089
Place of residence					
Urban (Ref.)	63.85	1.00		88.8639	13,602
Rural	61.25	1.14**	[1.047, 1.242]		34,237
Birth order					
1 (Ref.)	67.23	1.00		707.9715	18,177
2	63.47	0.89**	[0.837, 0.956]		15,900
3	56.89	0.78***	[0.721, 0.849]		7320
4 or more	49.35	0.70***	[0.646, 0.766]		6442
Mother's education					
No education (Ref.)	51.50	1.00		1179.588	13,165
Primary	60.36	1.33***	[1.221, 1.448]		6649
Secondary	66.52	1.46***	[1.352, 1.580]		22,468
Higher	70.50	1.47***	[1.286, 1.673]		5557
Religion					
Hindu (Ref.)	63.00	1.00		452.2034	37,474
Muslim	55.36	0.75***	[0.690, 0.821]		8088
Christian	61.70	0.92	[0.732, 1.154]		1000
Other	74.73	1.61***	[1.294, 2.002]		1277
Caste/Tribe					
SC (Ref.)	63.18	1.00		327.176	10,207
ST	55.81	0.92	[0.828, 1.013]		4956
OBC	61.87	0.94	[0.870, 1.014]		21,104
Other	63.81	0.99	[0.901, 1.097]		11,571
Sex of household head					
Male (Ref.)	61.88	1.00		10.889	41,865
Female	62.79	1.01	[0.932, 1.099]		5974
Wealth index					
Poorest (Ref.)	52.81	1.00		1195.057	11,742
Poorer	60.60	1.39***	[1.286, 1.493]		10,308
Middle	64.20	1.61***	[1.470, 1.761]		9683
Richer	66.87	1.83***	[1.634, 2.051]		8939
Richest	69.95	2.12***	[1.838, 2.456]		7167

(*Continued*)

Table 1. (*Continued*)

Background characteristics	Full immunization (%)	AOR	95% CI	χ^2	*n*
Region					
North (Ref.)	63.93	1.00		1019.45	6291
Central	53.81	0.84***	[0.772, 0.924]		12,447
East	70.08	1.89***	[1.706, 2.101]		12,495
North-east	49.61	0.68***	[0.599, 0.778]		1691
West	54.53	0.65***	[0.569, 0.740]		6010
South	68.09	1.12	[0.994, 1.261]		8904
All India	61.99				47,839

Ref.: reference category; CI: confidence interval.
***$p<0.001$, **$p<0.005$, *$p<0.010$.

estimated value of the relative contribution was negative for factors such as weak economic status (concentration index: –0.539), the mother being illiterate (concentration index: –0.161) and a birth order of 4 or more (concentration index: –0.057). Therefore, weaker socioeconomic groups are more disadvantaged in terms of immunization interventions. The concentration index decomposition reveals that inequality was highest among the weak economic group (43.90%) and among children whose mothers were illiterate (32.78%). The overall concentration index value was –0.093, indicating that the weaker socioeconomic groups in India are more disadvantaged in terms of immunization interventions. The residual value (–0.637%) represents the portion of inequality in vaccination coverage that is not determined by the systematic variations among the chosen explanatory variables. Hence the analysis results suggest that disparity in immunization coverage is more concentrated among the more vulnerable sections of society.

Discussion

Despite significant progress being achieved in reducing child mortality through vaccination in India, the country's commitment to the attainment of child immunization, with all available vaccines for children up to 2 years of age and pregnant women, is still in doubt. There are also concerns about persistent socioeconomic inequalities in India, with the most vulnerable sections of society bearing the greatest burden. The Rapid Survey on Children 2013–2014 conducted by UNICEF and the Ministry of Health and Family Welfare revealed the deprived status of children in India (MWCD, 2017), clearly showing that low socioeconomic status is significantly associated with child immunization and health care utilization. However, inequalities caused by social and economic factors have been poorly quantified. This study aimed to identify the socioeconomic factors affecting child immunization and to quantify their contribution to inequalities in immunization coverage in India.

The study results suggest that household wealth is a significant factor in the persistence of inequalities in child full immunization coverage in India, with low economic status, low illiteracy of mothers and high birth order families being most deprived. Weaker socioeconomic groups are more disadvantaged in terms of immunization interventions. Lauridsen and Pradhan (2011), using NFHS-3 data, found that low household economic status (38%), mother's illiteracy (34%), level of illiteracy (10%) and state domestic product (14%) all contributed to socioeconomic inequalities in immunization coverage in India. Over the past decade, the disparity in immunization due to household economic status increased by 6 percentage points from 38% to 44%, while the contribution of mother's illiteracy declined slightly by 2 percentage points – from 34% to 32%.

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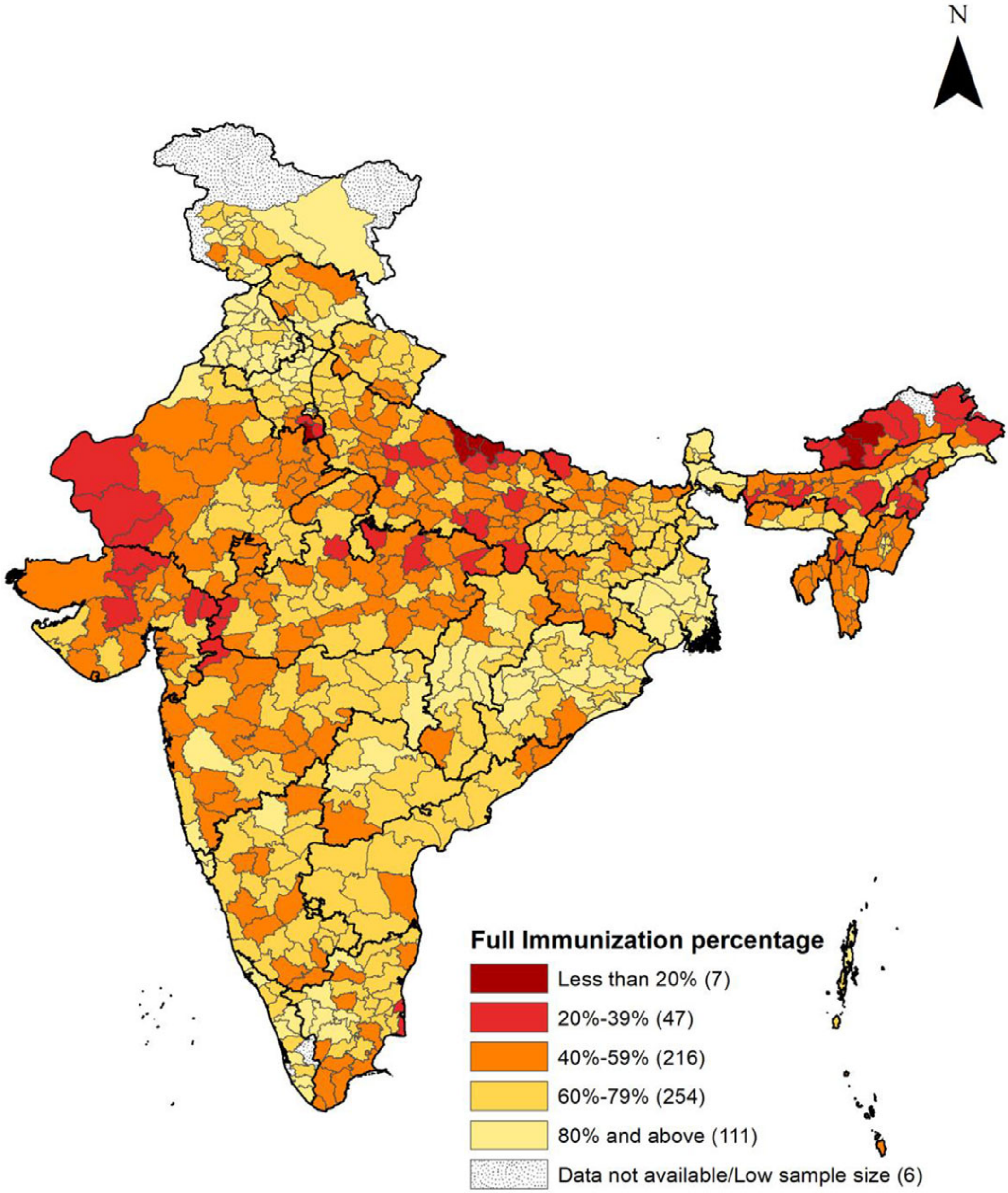

Figure 1. Indian districts by percentage of children fully immunized, NFHS 2015–16.

These findings are consistent with other contemporary studies of the socioeconomic and regional factors affecting childhood immunization (Gwatkin *et al.*, 2007; Doherty *et al.*, 2014; Debnath & Bhattacharjee, 2018).

Since immunization is given to children free of charge through several interventions, underlying factors such as accessibility, vaccine hesitancy and awareness through education play vital roles in accessing vaccination among the weaker economic sections of society. The proportion of people sceptical about getting vaccinated has increasing tremendously in India in recent years (Krishnamoorthy *et al.*, 2019; Priya *et al.*, 2020). Safety concerns, perceived disease susceptibility,

Table 2. Decomposition analysis of concentration index for full immunization among children aged 12–23 months by background characteristics, India, 2015–16

Background characteristics	Mean of full immunization	Elasticity	Concentration index	Contribution to concentration index	Percentage contribution
Male child	0.483	−0.002	0.002	0.000	−0.020
Rural residence	0.716	−0.054	0.180	0.010	−10.47
Birth order 4 or more	0.135	−0.199	−0.057	−0.011	12.24
Mother illiterate	0.275	−0.190	−0.161	−0.031	32.78
Belong to SC/ST	0.104	−0.088	0.043	−0.004	4.030
Household head a woman	0.125	0.043	0.013	0.001	−0.61
Poor economic status	0.461	0.076	−0.539	−0.041	43.90
Residual	0.059				
Percentage contribution of residual	−0.637				
Concentration index	−0.093				
Percentage contribution of fixed effects	0.818				

doubts about the need for vaccines against uncommon diseases, religious beliefs, ineffective interpersonal communication, suspicions about new vaccines and anti-vaccine groups gaining traction in the political sphere are some of the reasons for vaccine hesitancy in the country (Kashyap *et al.*, 2019; Agrawal *et al.*, 2020; Sharma *et al.*, 2020). As a result, confidence in vaccines is declining, particularly in the weaker economic sections of the society.

Socioeconomic inequalities result from the dispossession of some segments of the population historically, politically, economically and socially. The tragic effect of these inequalities is to deny specific sub-groups their right to be healthy. Efforts to support immunization must focus on those not currently being reached, such as stigmatized, marginalized and geographically isolated children. This may require the strengthening of health personnel and increase in the provision of health facilities, medicines, equipment and vaccines. It will also require removing barriers to accessing services, both cultural and economic. In certain circumstances, it might be necessary to address the societal barriers to immunization, which may require action beyond government remit. Poor households need to be uplifted through income-generating programmes and policies. Knowledge and awareness about the importance of immunization need to be disseminated among vulnerable groups, and more work needs to be done to generate their interest in government health programmes. The health sector can play a crucial role in increasing awareness and catalysing policies and programmes to reduce barriers and improve access to services. A more resilient health system needs the backing of local and global 'alert and response' mechanisms to mitigate the impact of child deaths due to preventable causes and treatable diseases.

Public policies in India should target deprived communities where the uneducated and poor are concentrated, and also areas with clearly demonstrated low vaccination coverage. Such targeting would not only reduce inequalities, but also help the country to achieve education and economic development goals. Therefore, programmes and policymakers should shift their concern from achieving 'average' lower vaccination coverage to the 'distribution' of schemes among the neediest groups.

As this study was based on secondary data, many crucial factors such as *per capita* expenditures on immunization, health system performance, supervision, follow-up, household health awareness, effective communication, community participation and other supply-side factors remain unaddressed. An in-depth analysis looking at the effectiveness of the resources deployed to immunize children across India might give a better understanding of the inequalities from the supply side. Future studies should use decomposition analysis in the health sector so that policies and programmes target the root causes of inequality.

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Conflicts of Interest. The author has no conflicts of interest to declare.

Ethical Approval. This research used a publicly available secondary data source (NFHS), without any identifiers, available in the public domain on the following website: https://dhsprogram.com/data/available-datasets.cfm. All procedures contributing to this work comply with the ethical standards of the relevant national and institutional committees on human experimentation and with the Helsinki Declaration of 1975, as revised in 2008.

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