



RESEARCH PAPER



Influence of socio-demographic factors on coverage of full vaccination among children aged 12–23 months: a study in Indian context (2015–2016)

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ABSTRACT

Background: Vaccine-preventable diseases (VPDs) are one of the key public health concerns in low and middle-income countries due to incomplete vaccination coverage. Nearly three million children up to 5 years of age die due to VPDs each year. Vaccination plays a significant role in reducing child mortality and morbidity from VPDs. Globally, full vaccination coverage efficiently saves two to three million children's lives from life-threatening VPDs.

Objective: This study intends to inspect the influence of socio-demographic factors on full vaccination coverage of children aged 12–23 months in India.

Methods: A cross-sectional observational study was carried out using the NFHS-4, 2015–2016 data of India. A total of 44,771 children aged 12–23 months born to the mothers aged 15–49 years in the last 5 years preceding the survey were used for this study. For the analyses of the data, Bivariate and Multivariate analyses were performed.

Results: The prevalence of full vaccination coverage of children aged 12–23 months in India was 62%. The result of the study indicated that maternal educational attainment, household wealth status, child size at birth, and maternal health-care services are the main significant predictors of full vaccination coverage. Other socio-demographic factors include maternal age, sex of the household head, exposure to mass media, child birth order, social category, religion, place of residence and region also play significant role in the coverage of full vaccination.

Conclusion: The study found that socio-demographic factors play a significant role in full vaccination coverage children in India. Therefore, policymaker and administrators should accentuate the inventive approach for the development of women education, improvement of family income, and easy accessibility of maternal and child healthcare services to surmount the impediment of children full vaccination coverage, which eventually reduce the risk of child morbidity and mortality.

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Introduction

Vaccination is an important life-saver aspect of a child at the early age and a cost-effective tool against vaccine-preventable diseases (VPDs).^{1–3} It plays a significant role in reducing child mortality and morbidity from VPDs.^{1–3} During 2011–2020, vaccination coverage helps to reduce under-five mortality by about 24%.^{4,5} Globally, full vaccination coverage efficiently saves nearly two to three million children's lives annually from 20 life-threatening VPDs; such as diphtheria, influenza, measles, tetanus and pertussis.⁶ As per Immunization Agenda (IA), 2030, vaccination will avert about 24 million people from falling into poverty.⁷

As lifesaving significance, the World Health Organization (WHO) has started Expanded Programme on Immunization (EPI) in 1974 to wipe out under-five mortality from VPDs. After the initiation of EPI, vaccination coverage was significantly increased over the decades.⁸ To ensure impartial access of present vaccines to the children despite their living places, all the members of the World Health Assembly (WHA) have approved Global Vaccine Action Plan (GVAP) in 2012.⁸ Globally, 116 million (85%) infants received three doses of DTP (diphtheria-tetanus-pertussis-containing vaccines) and

125 (64%) countries reached 90% or more DTP3 coverage rate in 2019.⁹ In 2011, globally, full vaccination coverage of 12–23 months children was increased to 83%.¹⁰

In spite of these, VPDs are one of the key community health concerns due to deficient full vaccination coverage.¹¹ Each year, globally about three million children die due to VPDs¹² and which is 20% of total under five child deaths.¹³ Nevertheless, in 2019, globally 20 million children were unable to access lifesaving vaccines like measles, tetanus, and diphtheria within 12 months of their life.¹²

The full vaccination coverage is the percentage of children who have received all compulsory doses of particular vaccines within 12 months of their age. It is the principal indicators of utilization of vaccination by a population, and higher rate of routine vaccination coverage is very effective to eradicate VPDs from the populations.^{14,15} As per WHO, children covered with full vaccination if they received single dose of BCG and measles, all three doses of DPT and polio vaccines within first year of their life.¹⁶

In 1978, after the implementation of EPI globally, India did not delay to take immediate actions in this regard.¹⁷ As in 1984, UNICEF identified six VPDs; meanwhile the Indian

government had launched the Universal Immunization Programme (UIP) to attain the 85% vaccination of all children by 1990. And due course of time subsequent population and health policies like Child Survival and Safe Motherhood Programme (1992), Reproductive and Child Health (RCH) Program (1997), National Population Policy (2000), and National Rural Health Mission (2005–2017) had been launched.^{18–20} Despite having such an effort, child vaccination coverage rate increased gradually and after the three decades India failed to achieved the target. Though, full vaccination coverage (the children aged 12–23 months old received all dose of particular vaccine) was increased from 44% in 2005–06 to 62% in 2015–16.²¹ However, still 38% of total children aged 12–23 months in India were left behind full vaccination, either who have misses any of the doses of particular vaccine or never received any of the doses of particular vaccines.²¹

Many studies reported that socio-economic, cultural and institutional factors were the main determinants for lower coverage of full vaccination of children.^{11,15,22–33} Other study reported that the lack of parental awareness about vaccination, lower educational attainment of parents, caste difference, gender disparity and poverty were the causes of lower coverage of full vaccination of children.³⁴ Similarly, lack of proper knowledge, maternal education, mother's autonomy and social prejudice have an immense impact on the fact of full vaccination coverage of children.³⁵ Many studies were carried out at local and district level in India documented that various socio-economic and demographic factors have a significant association with full vaccination coverage.^{36–38}

The religious belief and sex of the household head is the significant determining factors of children full vaccination coverage, which are not documented by other previous studies.^{11,24,31,38} This study also addresses child size at birth that is a significant determinant of full vaccination coverage. Therefore, this study tries to fill those gaps and present current evidences on the factors associated with full vaccination coverage.

The main objective of this study is to identify the factors that influence on the coverage of full vaccination of children aged 12–23 months in India. Therefore, it can be applied to make policies and programmes by the administrators and policy makers to improve the full vaccination coverage of children among the groups who are in disadvantage position in terms of socio-economic condition and healthcare services accessibility.

Methods

Study design

For the analysis, we used the National Family Health Survey (NFHS-4) cross-sectional data of India conducted in 2015–2016 under the stewardship of Ministry of Health & Family Welfare (MoHFW). The nodal agency for the NFHS-4 was International Institute of Population Sciences (IIPS), Mumbai, designated by the MoHFW.

The NFHS was a nationwide representative sample survey of India to provide the latest vital information about women, family planning and child health. In the NFHS-4, a total of 699,686 sample women aged 15–49 years and 112,122 sample

men aged 15–54 years were surveyed from 601,509 households. The women and men response rates were 97% and 92%, respectively. The sample was selected through a two-stage stratified sampling techniques consisting of 28,586 clusters (20,059 in rural, 8397 in urban, and 130 from slum) as per the list provided by municipal corporation offices. At first, clusters were chosen by probability proportional method to the cluster sizes. Secondly, 22 households from each cluster were chosen with an equivalent chance systematic selection from the family listing. Finally, from the each household 15–49-years-old women were surveyed, and women were asked to give complete information about their children born in the last 5 years. The details about the sampling techniques were provided in the NFHS-4 report of India.²¹

In this study, the permission from the Government of India was not required to re-analyze the NFHS-4 data because these data are available in public domain (<http://www.measuredhs.com/>) and conducted under the scientific and administrative supervision of the International Institute for Population Sciences (IIPS), Mumbai, India under the stewardship of the Ministry of Health and Family Welfare (MoHFW), Government of India. However, many earlier studies evident that there was no requirement of separate permission from the Government of India.^{39–44} The IIPS performed an independent ethics review of the 2015–16 NFHS protocol. The data collection procedures were also monitored and approved by ICF Macro, Calverton, Maryland, USA. All individuals selected in the NFHS were provided with informed voluntary as well as written consent. Each individual's approval was sought, and only then was the interview conducted.

Study participants

A total number of 259,627 children aged below 5 years born in the last 5 years to the mothers aged 15–49 years ($n = 259,627$ children born to $n = 259,627$ mothers). Out of these, 12–23 months-old children were 49,922. Among them, 641 children were died and some of children were missing. However, we used a subsample of 44,771 mothers and living children (aged 12–23 months) pairs. The sample children of 12–23 months age group were extracted from the children current age group variable.

Outcome variables

To assess the socio-economic and demographic factors, the outcome variables of the study were full vaccination coverage of all basic vaccination of children aged 12–23 months. The full vaccination coverage of all basic vaccinations consists of one dose of BCG (Bacillus, Calmette-Guerin) three doses of DPT (Diphtheria Pertussis Tetanus), three doses of polio, and one dose of measles vaccine any time before the survey.²¹ The information on particular vaccination coverage was collected based on vaccination cards or the verbal report by the mothers. If the children received or not received the particular vaccine, the response was recorded as Yes or No, otherwise recoded as don't know. These were coded as 0, 1, and 8 if the responses were No, Yes, and don't know, respectively. For the analysis purpose, only the women who responded definitely ("Yes" and

“No”) are included in the present study. Further, those children were received one dose of BCG, three doses of DPT, three doses of polio, and one dose of measles anytime before the survey were coded as 1 (covered with full vaccination) and otherwise 0 if either who have misses any of the doses of BCG, DPT, polio or measles vaccine or never received any dose of that vaccines (not covered with full vaccination).

Explanatory variables

The selected predictor variables integrated in the analysis are: sex of the child (male and female), place of residence (urban and rural), social category (Scheduled Caste [SC], Scheduled Tribe [ST], Other Backward Classes [OBC] and Others), religious belief (Hinduism, Islam and Others), maternal aged (15–24, 25–34 and 35+), maternal education (no education, primary, secondary and higher), currently married (yes and no [never married, widow, divorced, separated and deserted]), exposure to mass media (no, partial and full exposure), sex of the household head (male and female), wealth quintile (poorest, poorer, middle, richer and richest), place of delivery (home and health facility), birth order (1st, 2–3rd and 4+), Four or more antenatal care (ANC) visit (yes and no), post-natal care (PNC) visit (yes and no), child size at birth (large, average and small) and region ([North: Jammu & Kashmir, Punjab, Himachal Pradesh, Uttarakhand, Haryana, Chandigarh, Rajasthan and Delhi], [Central: Uttar Pradesh, Madhya Pradesh and Chhattisgarh], [East: Bihar, Jharkhand, Odisha and West Bengal], [Northeast: Sikkim, Assam, Manipur, Arunachal Pradesh, Mizoram, Tripura, Meghalaya and Nagaland], [West: Gujrat, Goa, Maharashtra, Dadra & Nagar Haveli and Daman & Diu] and [South: Andaman & Nicobar Island, Andhra Pradesh, Karnataka, Kerala, Telangana, Tamil Nadu, Lakshadweep and Puducherry]).

However, the Government of India has analyzed the vaccination coverage of children with specific variables such as; sex of the child, birth order, place of residence, mothers' schooling, religion, caste or tribe, wealth index and region of residence.²¹ In this study, vaccination coverage of children aged 12–23 months was analyzed comprehensively, including other socio-economic and health-related factors such as: child size at birth, maternal age, current marital status of mother, exposure to mass media, ANC & PNC visits, place of delivery and sex of the household head. Also, this study not only shows the vaccination coverage by socio-demographic factors but also tried to analyze the impact of socio-demographic factors on vaccination coverage. Hence, the comprehensive analyses have differentiated our study from the analysis of the Government of India. Therefore, this study also does not raise any proprietary rights issues, ethical concerns or conflict of interest.

Explanation of explanatory variables

Mass media exposure

Mass media exposure of women was measured based on the frequency of reading newspaper and magazine, watching television and listening radio per week. Based on these three media, women were classified into three groups, such as no exposure (accesses none of those media at least once a week),

partial exposure (accesses any two of those media at least once a week), and full exposure (accesses all those media at least once a week).

Household economic status

Wealth quintile is the substitute referential of household economic status. Household wealth quintile is measured by principal component analysis based on the score given to each individual on the basis of number and type of consumer goods and housing characteristics that are possessed by the household and classified into five quintile groups.²¹ The each quintile corresponds to 20% of respondents, ranges from 1 (poorest) to 5 (richest).

Child size at birth

Mothers have estimated the size of living children at the time of birth as small, normal, and large.

Statistical analysis

To identify the association between full vaccination coverage and socioeconomic factors, Bivariate and multivariate analysis were used. Descriptive statistics also used for the analysis of the data. In this study firstly, proportion of full, partial and no vaccination coverage was calculated. Secondly, percentage distribution was calculated to show the socioeconomic and demographic variation of variables of the sample. The distribution of Bivariate percentage is also calculated to observe the variation in socioeconomic & demographic characteristics and full vaccination coverage. Further, the Pearson's chi-square test of significance was carried out to measure the significance level of these variations. The association between full vaccination coverage and socioeconomic and demographic factors were estimated by adjusted and crude odds ratio (ORs) with the confidence intervals (CIs) of 95% using the binary logistic regression models. The adjusted odds ratio were controlled for sex of the child, place of residence, social category, religion, maternal age, maternal education, currently married, sex of the household head, wealth quintile, place of delivery, birth order, antenatal visit, post natal visit, and child size at birth and region. The analyses were performed in STATA 12.1 version (StataCorp LP, Lakeway Drive, College Station, Texas, USA).

Results

The study shows the single dose of BCG, first, second, and the third dose DPT, first, second and third dose of polio and single dose Measles vaccination coverage of children aged 12–23 months was 92, 90, 86, 78, 91, 86, 73 and 81 per cent respectively. The study also shows that the full and partial vaccination coverages were 62 and 32 per cent whereas 6 per cent children were not covered by any of the above specific vaccines.

Table 1 illustrates the socio-economic and demographic characteristics of children aged 12–23 months and their mother. Over, two-third of children's size at birth was average and most of the children's birth order was second to third. Most of the women's age was 15–34 years. More than one-fourth of women had no educational attainment. Over, 99 per

Table 1. Socio-economic and demographic characteristics of women with children aged 12–23 months in India, NFHS 2015–16.

Variables	n	Weight %
Child characteristics		
Sex of the child		
Male	23,501	52.35
Female	21,270	47.65
Child size at birth		
Large	7,870	19.91
Average	31,442	68.00
Small	5,459	12.10
Birth order		
1	16,148	37.04
2–3	21,756	49.47
4+	6,867	13.49
Maternal characteristics		
Maternal age		
15–24	17,978	42.71
25–34	23,513	51.21
35+	3,280	6.08
Maternal education		
No education	12,580	27.17
Primary	6,287	13.83
Secondary	21,093	47.19
Higher	4,811	11.81
Currently married		
No	585	0.95
Yes	44,186	99.05
Exposure to mass media		
No	12,012	25.68
Partial	29,445	67.21
Full	3,314	7.11
Healthcare characteristics		
Four or more ANC visit		
No	23,480	48.56
Yes	21,291	51.44
Place of delivery		
Home	9,012	17.15
Health facility	35,759	82.85
PNC visit		
No	28,684	62.38
Yes	16,087	37.62
Family characteristics		
Sex of the household head		
Male	39,319	87.66
Female	5,452	12.34
Wealth index		
Poorest	11,288	24.30
Poorer	10,198	21.30
Middle	9,121	20.30
Richer	7,718	18.83
Richest	6,446	15.27
Social characteristics		
Religion		
Hinduism	32,369	78.46
Islam	7,123	16.76
Others	5,279	4.78
Social category		
SC	8,434	21.35
ST	8,720	10.19
OBC	17,748	44.30
Other	9,869	24.16
Spatial characteristics		
Place of residence		
Urban	10,864	28.68
Rural	33,907	71.32
Region		
North	8,480	13.10
Central	12,563	25.75
East	9,702	26.31
Northeast	6,285	3.39
West	3,158	12.81
South	4,583	18.63

cent women were currently married and only about 7% women fully exposure to mass media. More than 80 per cent of women had ANC visits and delivered their children at the health facility. One of three women had no PNC visit. The majority of the household head was male and a majority of children' belong to the poorest and poorer wealth index. The majority of children belong to Hindu, OBC, residing in rural areas and from central and east region of India.

Table 2 presents full vaccination coverage by socio-economic and demographic characteristics. Overall vaccination coverage of children was 62 per cent. Moreover, there were significant differences in full vaccination coverage by socio-economic and demographic characteristics.

Table 3 shows the association between full vaccination coverage of children aged 12–23 months and socio-economic and demographic factors in India. The odds of full vaccination coverage likely to be less among the children whose size at birth was large (AOR: 0.891 and 95% CI: 0.844–0.940) and small (AOR: 0.886 and 95% CI: 0.833–0.943) than those size at birth was normal and lower among the children whose order of birth was 2nd to 3rd (AOR: 0.868 and 95% CI: 0.827–0.911) and fourth or more (AOR: 0.745 and 95% CI: 0.691–0.803) than those order of birth was first. The children whose mother aged was 15–24 years, the coverage of full vaccination were likely to be less (AOR: 0.799 and 95% CI: 0.729–0.875) than those children whose mother age was 35 years or more. The full vaccination coverage was likely to be more among the children whose mother had primary (AOR: 1.232 and 95% CI: 1.153–1.316), secondary (AOR: 1.297 and 95% CI: 1.224–1.373) and higher education (AOR: 1.282 and 95% CI: 1.170–1.405) than those children mother had no formal educational, among the children whose mothers' had partial (AOR: 1.162 and 95% CI: 1.100–1.228) and full (AOR: 1.229 and 95% CI: 1.117–1.352) mass media exposure than those mother had no exposure to mass media, whose mother had four or more ANC visit (AOR: 1.665 and 95% CI: 1.591–1.742) than those mother had no antenatal visit, whose mother had delivered at health facilities (AOR: 1.544 and 95% CI: 1.464–1.628) than those mother had delivered at home, whose mother had PNC visit (AOR: 1.501 and 95% CI: 1.437–1.567) than those mothers had no post natal visit, whose household head was female (AOR: 1.070 and 95% CI: 1.006–1.138) than those household head was the male. Similarly, full vaccination coverage was likely to be more among the children belong to poorer (AOR: 1.211 and 95% CI: 1.138–1.288), middle (AOR: 1.372 and 95% CI: 1.278–1.477), richer (AOR: 1.453 and 95% CI: 1.340–1.576) and richest (AOR: 1.567 and 95% CI: 1.423–1.725) wealth quintiles than those belonged to poorest wealth quintile. Children belong to Islam religious belief, the full vaccination coverage was likely to be less (AOR: 0.771 and 95% CI: 0.727–0.818) and more among the children belong to other religious belief (AOR: 1.196 and 95% CI: 1.099–1.301) than those belonging to Hindu religion. The full vaccination coverage was likely to be less among the children who belong to ST (AOR: 0.855 and 95% CI: 0.795–0.921) than those children belong to other social categories. The children who reside in rural areas, full vaccination coverage was likely to be more (AOR: 1.135 and 95%

Table 2. Full vaccination coverage by socio-economic and demographic characteristics of women with children aged 12–23 months in India, NFHS-2015–16.

Variables	Full immunization coverage (weighted %)		p-Value
	No (n = 17,238)	Yes (n = 27,533)	
Children characteristics			
Sex of the child			
Male	37.44	62.56	0.7779
Female	37.04	62.96	
Child size at birth			
Large	37.31	62.69	<0.0001
Average	36.66	63.34	
Small	40.45	59.55	
Birth order			
1	32.13	67.87	<0.0001
2–3	37.63	62.37	
4+	49.90	50.10	
Maternal characteristics			
Maternal age			
15–24	36.08	63.92	<0.0001
25–34	37.50	62.50	
35+	43.32	56.68	
Maternal education			
No education	47.88	52.12	<0.0001
Primary	38.63	61.37	
Secondary	32.87	67.13	
Higher	28.67	71.33	
Currently married			
No	40.22	59.78	0.0286
Yes	37.22	62.78	
Exposure to mass media			
No	47.02	52.98	<0.0001
Partial	34.06	65.94	
Full	32.11	67.89	
Healthcare characteristics			
Four or more ANC visit			
No	59.42	40.58	<0.0001
Yes	42.12	57.88	
Place of delivery			
Home	51.35	48.65	<0.0001
Health facility	34.33	65.67	
Postnatal visit			
No	42.18	57.82	<0.0001
Yes	29.07	70.93	
Family characteristics			
Sex of the household head			
Male	37.36	62.64	0.0013
Female	36.44	63.56	
Wealth index			
Poorest	46.29	53.71	<0.0001
Poorer	38.58	61.42	
Middle	35.14	64.86	
Richer	32.6	67.4	
Richest	29.52	70.48	
Social characteristics			
Religion			
Hinduism	36.29	63.71	<0.0001
Islam	43.92	56.08	
Others	29.51	70.49	
Social category			
SC	35.96	64.04	<0.0001
ST	42.78	57.22	
OBC	37.51	62.49	
Other	35.58	64.42	
Spatial characteristics			
Place of residence			
Urban	35.48	64.52	<0.0001
Rural	37.96	62.04	
Region			
North	35.09	64.91	<0.0001
Central	46.00	54.00	
East	29.22	70.78	
Northeast	48.45	51.55	
West	44.68	55.32	
South	30.86	69.14	

CI: 1.075–1.198) than those children who reside in urban areas. Finally, the full vaccination coverage was likely to be more in the north (AOR: 1.207 and 95% CI: 0.110–1.312) and east region (AOR: 2.049 and 95% CI: 1.181–2.231) and likely to be less in northeast (AOR: 0.747 and 95% CI: 0.678–0.823) and west region (AOR: 0.713 and 95% CI: 0.646–0.787) than south region.

Discussion

In spite of several global and nationwide efforts to improve the full vaccination coverage, a substantial section of children was unable to access all the basic vaccination in India. However, a remarkable improvement has been observed in the full vaccination coverage from the last decade. Though, the full vaccination coverage in India was relatively lower (62%) compared to its neighbor countries, such as; Bangladesh (86%),⁴⁵ Nepal (78%),⁴⁶ and Pakistan (66%).⁴⁷ As the full vaccination coverage is directly associated with child health and child mortality, India needs to improve the proportion of all the basic vaccination coverage.

The present study has identified several socio-economic and demographic determinants for the full vaccination coverage of children aged 12 to 23 months. The full vaccination coverage was significantly associated with child size at birth, birth order of child, maternal age, maternal education, exposure to mass media, ANC, PNC, Place of delivery, sex of the household head, household wealth index, religion, social category, place of residence and region.

The result of Multivariate analysis of the study has found that the sex of the children has no significant association with full vaccination coverage. The study conducted in Senegal has reported the same result.²⁹ The children with small and large size at birth were likely to lower full vaccination coverage compared to those children whose size at birth was normal. Although, the study on Papua New Guinea showed an insignificant association between child size at birth and full vaccination coverage.¹¹ The children with two or more orders of birth were less likely to receive full vaccination coverage compared to children with first birth order. The various studies shows there was no significant association between birth order of children and full vaccination coverage^{11,25,27,31,48} while other studies revealed that the probability of full vaccination coverage was higher among lower birth order children.^{27,33} It can be said that the child care attention of parents toward the first child is very impressive as well as try to vaccinate completely for their healthy life.

The full vaccination coverage was likely to be less among children with the mother of aged 15–24 years compared to the children with the mother of aged 35 years or more. Other earlier studies show there was no significant association between maternal age and full vaccination coverage,^{11,25–27,31,49} while the result is consistent with other studies conducted in Zimbabwe.³² Lack of experience of the younger mothers may be the probable cause of lower vaccination coverage among the children. Also, more empowerment were given to older women by the families to visit health facilities alone; newlyweds and younger are generally not encouraged to go out of the house alone.

Table 3. Bivariate and Multivariate logistic regressions for socio-economic and demographic factors associated with full vaccination coverage in India, NFHS 2015–16.

Variables	Crude OR (95% CI)	Adjusted OR (95% CI)
Children characteristics		
Sex of the child		
Male [®]	1	1
Female	1.006 (0.968–1.045)	1.016 (0.976–1.058)
Child size at birth		
Large [®]	0.947** (0.900–0.996)	0.891*** (0.844–0.940)
Average	1	1
Small	0.823*** (0.777–0.873)	0.886*** (0.833–0.943)
Birth order		
1 [®]	1	1
2–3	0.790*** (0.757–0.824)	0.868*** (0.827–0.911)
4+	0.496*** (0.469–0.526)	0.745*** (0.691–0.803)
Maternal characteristics		
Maternal age		
15–24	1.274*** (1.182–1.373)	0.799*** (0.729–0.875)
25–34	1.318*** (1.224–1.419)	0.947 (0.872–1.028)
35+ [®]	1	1
Maternal education		
No education [®]	1	1
Primary	1.389*** (1.306–1.476)	1.232*** (1.153–1.316)
Secondary	1.886*** (1.803–1.973)	1.297*** (1.224–1.373)
Higher	2.550*** (2.372–2.741)	1.282*** (1.170–1.405)
Currently married		
No [®]	1	1
Yes	1.203** (1.020–1.419)	1.156 (0.971–1.376)
Exposure to mass media		
No [®]	1	1
Partial	1.798*** (1.723–1.878)	1.162*** (1.100–1.228)
Full	2.195*** (2.022–2.383)	1.229*** (1.117–1.352)
Healthcare characteristics		
Four or more ANC visit		
No [®]	1	1
Yes	2.139*** (2.678–2.963)	1.665*** (1.591–1.742)
Place of delivery		
Home [®]	1	1
Health facility	2.324*** (2.217–2.435)	1.544*** (1.464–1.628)
PNC visit		
No [®]	1	1
Yes	1.763*** (1.692–1.837)	1.501*** (1.437–1.567)
Family characteristics		
Sex of the household head		
Male [®]	1	1
Female	1.101*** (1.038–1.168)	1.070** (1.006–1.138)
Wealth index		
Poorest [®]	1	1
Poorer	1.346*** (1.276–1.421)	1.211*** (1.138–1.288)
Middle	1.755*** (1.658–1.857)	1.372*** (1.278–1.473)
Richer	2.015*** (1.897–2.141)	1.453*** (1.340–1.576)
Richest	2.514*** (2.354–2.686)	1.567*** (1.423–1.725)
Social characteristics		
Religion		
Hindu [®]	1	1
Islam	0.716*** (0.680–0.754)	0.771*** (0.727–0.818)
Other	0.847*** (0.798–0.898)	1.196*** (1.099–1.301)
Social category		
SC	0.964 (0.907–1.024)	1.017 (0.949–1.090)
ST	0.654*** (0.616–0.693)	0.855*** (0.795–0.921)
OBC	0.934*** (0.888–0.984)	0.991 (0.936–1.049)
Other [®]	1	1
Spatial characteristics		
Place of residence		
Urban [®]	1	1
Rural	0.826*** (0.790–0.864)	1.135*** (1.075–1.198)
Region		
North	0.885*** (0.819–0.956)	1.207*** (0.110–1.312)
Central	0.541*** (0.504–0.582)	0.994 (0.919–1.076)
East	0.979 (0.907–1.057)	2.049*** (1.181–2.231)
Northeast	0.487*** (0.450–0.528)	0.747*** (0.678–0.823)
West	0.599*** (0.545–0.658)	0.713*** (0.646–0.787)
South [®]	1	1
Constant		
Observation		0.396*** (0.313–0.501)
		44,771

OR = Odds ratio, CI = Confidence interval, ANC = antenatal care, PNC = post-natal care, SC = Scheduled Caste, ST = Scheduled Tribe, OBC = Other Backward Classes, 95% Confidence interval in parentheses; *** $p < .01$, ** $p < .05$, * $p < .1$, [®] = Reference category.

The study depicts that maternal education is an important significant determining factor of full vaccination coverage. The full vaccination coverage was increased with increasing level of maternal education. The studies carried out in Ethiopia, Papua New Guinea, Zimbabwe, Afghanistan, Kenya, Bangladesh, and Senegal are corroborated the present study.^{11,25,28–30,32,49} The health awareness among the educated mothers was more than the less educated mother. The study also found that full vaccination coverage was higher among those children whose mothers were fully exposed to mass media. This might be due to maternal and child healthcare related information especially child vaccination was provided by the government through mass media, subsequently mothers acquired that information from those media. The study conducted in Ethiopia found that there was no significant association between exposure to mass media and full vaccination coverage.²⁷

The full vaccination coverage was higher among the children whose mother had four or more ANC visit, delivered at the health facility and PNC visit than those who had no ANC visit, and delivered at home and no PNC visit. The findings of the present study were consistent with other studies conducted in Afghanistan, Zimbabwe, Ethiopia, Senegal, Indonesia for ANC visit,^{25–27,29,30,32} Zimbabwe, Ethiopia, Senegal, Indonesia for the place of delivery^{25–27,29,32} and Ethiopia, Papua New Guinea for PNC visit.^{11,31} This may be due to easy accessibility of ANC and subsequently increase maternal and child health care, and prior knowledge about vaccination which further transfer toward their child health care,^{25–27,29,30,32} babies delivered at health facility provided an instant initial dose of vaccination and prescribed instruction for vaccination by health professional increase vaccination coverage,^{26,32} and PNC checkup may aware the mother about the vaccination of children.

The full vaccination coverage was higher among the children whose family led by females than those families led the males. The study conducted in Ethiopia reported that full vaccination coverage was lower among the children whose family led by females.²⁵ This might be due to family's responsibility and work pressure may divert woman attention from vaccination schedule.²⁵ Also, poor economic status of women-headed families were the reason of lower coverage of child vaccination.^{50,51} The study on Papua New Guinea reported that there was no significant variation of full vaccination coverage of children by sex of the household head.¹¹

The study found that full vaccination coverage of children was increased with increasing families' wealth status. This is generally happening because of variation in educational attainment and child care practice followed by health care awareness and accesses. The studies conducted in Indonesia, Ethiopia, Nigeria, Zimbabwe, Bangladesh, Southwestern Ethiopia, and Papua New Guinea are corroborated the finding of the study.^{11,25,26,31,32,52–55} The study found that full vaccination coverage was significantly varied among the religions. Full vaccination coverage was higher and lower among the children belong to other religions and Islam religion respectively than those belong to Hindu religion. While prior studies in Zimbabwe, Papua New Guinea, and Tamil

Nadu ascertain that religions have no significant influence on children's full vaccination coverage.^{11,32,38} Among the Muslims, due to lack of awareness and belief on immunization, the full vaccination coverage was lower among the children. The study also found that, children belong to ST; full vaccination coverage was significantly lower than others. The result is similar to the other study conducted in rural Vellore of Tamil Nadu, India.³⁷ This might be due to lack of educational and health care awareness and lack of belief in vaccination because most of the Tribes are yet to be untouchable. In the other study, the result was not significant in Tamil Nadu, India.³⁸ However, there is no significant variation in vaccination coverage between SC, OBC with others. In the study, place of residence was strongly associated with full vaccination coverage. The full vaccination coverage was higher among rural children than urban children. This might be due to the development of health infrastructure and implementation of health care programme in rural areas and immunization awareness among rural communities. The result was consistent with other previous studies conducted in Afghanistan, Burkina Faso, and India^{30,56–58} while other studies in Senegal, Papua New Guinea, and Zimbabwe demonstrated no association with full vaccination coverage.^{11,29,32} In other studies, full vaccination coverage was significantly higher in urban areas of Ethiopia.²⁵

There is a significant difference in full vaccination coverage among the regions in India. This might be due to variation in a health care facility, health-seeking behavior, wealth status, educational attainment, and women empowerment. The studies conducted in Zimbabwe, Senegal, and Ethiopia corroborate the present study^{29,31,32} while a study in Papua New Guinea, there was no significant difference in vaccination coverage among the regions.¹¹

Strengths and limitations of the study

Nationally, representative data and multi-stage sampling method used for respondents' selection make this study strength. This, to a larger extent, augments the generalizability of the findings to all children aged 12–23 months in India. The mothers were gave verbal responses about child vaccination and which may be prone to recall bias. The casual relationship between predictor variable and explanatory variables was unable to determine because nature of the data was cross-sectional. Another serious limitation of this study is recalling the size of the child at birth by the mother was subjective and done after long gap. It would be very difficult for any mother to be able to recall size of the baby at birth after a year or beyond. Other limitation of this study is that we have determined full vaccination coverage based on children aged 12–23 months received all basic vaccines anytime before the survey instead of first year of their life.

Conclusion

The study has inspected socioeconomic and demographic factors full vaccination coverage of children aged 12–23 months in India. The full vaccination coverage of children aged 12–23 months India was 62%. It is found that full vaccination

coverage is not satisfactory across the socio-economic and demographic group because a larger portion of children are still beyond full vaccination coverage.

The findings of the study show the importance of education, household economic improvement, and maternal and child healthcare services. The government should give more attention to enhance girls' educational opportunities, improvement of household economic condition, maternal and child healthcare services related infrastructure and accessibility and accessibility of information regarding vaccination for the improvement of full vaccination coverage.

Disclosure of potential conflicts of interest

No potential conflict of interest was reported by the author(s).

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