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Determinants of Immunization Coverage and Associated Factors among Children aged under Two-Year-Old in the National Immunization Program of Mewat district, Haryana (2019-2020)

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Abstract

Background: Vaccination against childhood communicable diseases through Expanded Program on Immunization is one of the most cost-effective public health interventions. Additional 1.5 million child deaths can be prevented if global vaccination coverage is improved. Mewat district has one of India's lowest immunization rates despite a long-standing Universal Immunization Program and continues to sustain a high prevalence of vaccine-preventable diseases. This study investigates determinants of immunization status among children aged 0-23 months. Methods: A community-based cross-sectional study was conducted from December 2019 to June 2020, among 800 children aged 0-23months, randomly selected in one rural and one urban ward each from all 4 blocks of Mewat. Socio-demographic conditions and vaccine-related data were collected using a semi-structured questionnaire. Immunization was assessed by vaccination card and by mother's recall where the card was unavailable. Results:Mewat has increased full immunization coverage from 13.1% in 2015-16 to 59.4%. Immunization card was available with 68.5% (292/426) beneficiaries. Dropout rates for Pentavalent1 to Pentavalent3 was 27.5% and 54% for Bacillus Calmette-Guerin to measles. After adjusting for the state of residence, religion, gender, paternal education, health professional presence during birth, place of vaccination and knowledge of mother on due dose were significantly associated with full immunization. Awareness gap and fear of side effects for vaccines were main reasons of vaccine hesitancy. Conclusion: Full immunization coverage in the district is sub optimal and behind the desired coverage goal, mainly due to vaccine hesitancy. Enhancing community knowledge about the benefits of vaccination is recommended.

Keywords: *Below two years children, immunization, reasons for partial immunization, drop out, full immunization.*

Introduction

Vaccination against childhood communicable diseases through the Expanded Programme on immunization (EPI) is one of the most cost-effective public health interventions. Vaccination contributes substantially to the achievement of Sustainable Development Goals (SDGs) by reducing mortality and morbidity among children. Globally around 29% of under-five deaths were due to vaccine-preventable diseases (VPD) in 2017 as estimated by the United Nations inter-agency group for child mortality estimation [1]. India accounted for the highest number of under-five deaths globally in 2015 [2]. Routine immunization is the nation's strategic investment and an essential strategy for saving lives and protecting health of population.

The Global Vaccine Action Plan 2011–2020 (GVAP) was unanimously endorsed in 2012 by the World Health Assembly (WHA). Globally, 19.7 million children and 70% of whom were zero-dose children still remain unvaccinated with basic childhood vaccines in 2018 [3]. GVAP had put a goal to reach immunization coverage of at least 90% children in each nation and 80% in every district by 2020. GVAP goals could potentially avert 25 million vaccine-preventable deaths by the end of the 2020 [4, 5].

India launched the Expanded Program on Immunization in 1978 and converted to the Universal Immunization Program (UIP) in 1985. It is one of the world's largest programs and currently catering to an annual cohort of 26.7 million infants and 30 million pregnant women. An estimated 38% of children still

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failed to receive all essential vaccines in their first year of life in 2016 in the country [6]. The Ministry of Health and Family Welfare Government of India launched Mission Indradhanush in December 2014 and Intensified Mission Indradhanush (IMI) in October 2017 with an aim to vaccinate all children under 2 years of age [7, 8].

Various national immunization surveys conducted from time to time had shown sub-optimal vaccination coverage in Mewat district. The coverage had always been historically low as compared to the other districts of Haryana State. District Level Household and Facility Surveys-3 (DLHS-3) conducted in 2007-08 had 11.0% full vaccination (rural 9.6%) and DLHS-4 in 2012-13 had 27.3% full vaccination (rural 20.8%) [9]. National Family Health Survey-4 (NFHS-4) in 2015-16 had shown 13.1% full vaccination in Mewat (rural 11%) [10].

Mewat district had been targeted for immunization intensification activities since December 2014 through Mission Indradhanush and Intensified Mission Indradhanush by the federal government with the goal of improving full vaccination to 90% within 5 years. To measure the impact of these immunization intensification campaigns, the Coverage Evaluation Survey (CES) was conducted by a government of India in 2018. This survey had shown that 22.5% of children did not receive any vaccine and full immunization coverage was 40.8% in Mewat [11]. Government of India had prepared a road map for achieving 90% full immunization coverage across the country in 2019 [12]. It is well recognized that national, state and district level immunization averages mask inequities in coverage, knowledge of which is essential to devise corrective strategies at the sub-districts level.

Mewat is one of the most socio-economically backward district and mainly inhabited by Meo Muslims. They constitute 79.2% of the total population as per 2011 census. A high birth rate characterizes the district; most families have more than three to four living children in the study population. The proportion of beneficiaries for vaccination services were relatively higher, with infants and children below six years constituting 22.78% of the total population [13]. The majority (89%) of the population is living in rural areas. The lack of literacy, public transport, inadequate health facilities, and a chronic shortage of potable water add immense difficulty to the masses and in particularly to the lives of ordinary women in Mewat [14]. The district had reported multiple diphtheria and measles outbreaks in 2018-19 as per the WHO-National Public Health Surveillance (NPSP) data. Mewat's large incompletely immunized susceptible cohort translates into increased risk for vaccine-preventable diseases, which partially explains the continued high burden of morbidity and mortality from such infections in children of this district. We assessed the routine immunization coverage in children below two years to determine the reasons for incomplete immunization in to identify areas for improvement.

Materials and Methods

Study Area

The study was conducted in urban and rura area of district Mewat (Haryana). Study design**:** It was community based cross-sectional study.

Study Period

Study was conducted from December 2019 to May 2020. Study population: The study included children aged between 0-23 months whose parents resided in the area for the last two years.

Inclusion criteria

1. Children aged between 0-23 completed months at time of study.
2. Children in the age group of 0-23 months whose parents were residing in the study area for a period of not less than two years.
3. Mothers/ Caregivers/Guardians who gave the consent for participation.

Exclusion criteria

1. Children in the age group of 0-23 months whose parents were residing in the study area for less than two years.
2. Parents who were not willing to participate in the study.

A community-based cross-sectional study was conducted from December 2019 to May 2020 in Mewat district. The study was conducted in all four blocks (Nuh, Ferozepur Jhirka, Punhana, and Taoru). A mixed-method design was adopted for the assessment, which was conducted in two stages. A complete list of

villages in rural areas and wards in the Mewat district's urban areas was procured from the census department. From this sampling frame, randomly one rural and one urban ward areas were selected from each block.

Sample Size Calculation for Quantitative Data Collection

The sample size was calculated based on the proportion of partial and unimmunized children in Mewat from the latest available information of Intensified Mission Indradhanush-Coverage Evaluation Survey, 2018. The sample size was calculated using the following formula [15]:

$$N = [De \times Z2 \times p (1-p)]/d2$$

Where N is the sample size, De (2) is the design effect, the ratio between the variance from the cluster design to the variance that was obtained from a simple random sampling, Z (1.96) is the certainty wanted to be expressed in the percentage point of the normal distribution corresponding to the 2-sided level of significant, P (~41%) is the immunization coverage of Mewat and d (5%) is the desired width of the confidence interval.

Therefore,

$N = [2 \times (1.96)^2 \times 0.41 \times 0.59]/ (0.05)2=742$. A non-response rate of 8% was added for a total sample size of 800.

In the second stage, households were surveyed for quantitative data collection. A simple random sampling (using the revolving pen technique) was used to select the first household for the survey in each selected village or ward. Every household with a child below two years was selected until the desired number of children were met from each selected village and urban ward. Information regarding 0-23 months children was recorded from selected households using an ODK tool, an Android-based tool. Mother/caregiver having at least one child aged 0–23 months were included, while those children whose mothers/caregivers were found to be mentally/critically ill during the data collection period were excluded from the study.

Data Processing and Analysis

For quantitative data collection, a structured questionnaire was administered to the key respondents. The questionnaire was designed on an android based ODK tool. The questionnaire mainly included immunization histories of children, mothers' socio-demographic characteristics, and knowledge of mothers on immunization. Information on vaccination coverage was collected in two ways: from the maternal and child protection (MCP) card or from the mother's/caregiver's verbal report. Data from MCP card was extracted in cases where a child immunization card was available. When there was no vaccination card for the child or if a vaccine had not been recorded on the card as being given, the mothers were asked to recall the specific vaccines given to their children. The information obtained from the child's card was taken when both conditions have been met. Before starting the actual data collection, the questionnaire was pretested on 5% of similar respondents in a similar locality of adjoining Gurugram district, which was not included in the final study. All field staff and the principal investigator have assessed the clarity and completeness, consistency, accuracy of the data. The data were cleaned and entered Epi-Info 7 for further analysis.

An excel-based and EPI -Info 7 calculations worksheet was prepared for the analysis. Bivariate and multivariate logistic regression analyses were conducted along with adjusted Odds Ratios. In the bivariable analysis, independent variables significantly associated with the dependent variable at p-value <0.20 were included in the multivariable logistic regression analysis. The variables significantly associated at p-value <0.05 were identified as predictors of immunization status. The degree of association was also assessed using crude and adjusted odds ratios.

Determinants of Immunization Status

Eight household determinants were taken into consideration, including the residence type (urban or rural), presence of a professional

attendant during childbirth (institutional delivery or home delivery), mother's

employment status, parental education, number of living children or parity status, decision-maker for immunization in the family, wealth status and household income. The residence type was categorized into rural and urban areas. The presence of a professional birth attendant during childbirth was defined as either the birth was attended by an auxiliary nurse-midwife or attended by a health professional (physician or trained nurse). Educational levels of parents were defined as no education, primary and higher than primary. Mothers' employment status was categorized as unemployed or employed. Parity status was considered low if the family had one to three children and high if the family had four or more than a four number of living children. Distance to a health facility or immunization session site was convenient if less than 30 minutes' walk to the session site.

Ethical Considerations

To maintain regular protocols of ethics, informed verbal consent was obtained from the respondents, and no attempt was made to capture the interviewees' identities.

Definitions

The immunization status of the children were categorized as follows:

Fully Immunized

Fully immunized child was defined as a child who had received one dose of Bacillus Calmette–Guerin (BCG), 3 doses of Diphtheria, Pertussis, Tetanus (DPT)/Pentavalent vaccine and 3 doses of Oral Polio Vaccine and one dose of Measles Containing Vaccine (MCV) within the age of one year as per national immunization schedule.

Partial Immunization

A child who has received at least one of the vaccines but has not completed the entire set of vaccines as per the national immunization schedule.

Not Immunized

When a child who has not received any vaccine as per the universal immunization programme schedule.

Not fully Immunized

A combination of both partially immunized and not immunized. Pentavalent vaccine: This is a combination of Diphtheria, Pertussis, Tetanus, Haemophilus Influenza type B and hepatitis B antigens.

Delayed Vaccination

Delayed vaccination for each vaccine was defined as administering the vaccine dose after 28 days of the minimum recommended age, as per India's national immunization schedule.

Distance to Health Facility (in walk time)

Distance to a health facility or immunization session site, if <30 minutes, was taken as session site convenient for vaccination.

A pre-designed survey questionnaire was used to assess the reasons for non-immunization and partial immunization of the selected child aged below 2 years.

Results

Eight hundred children aged 0-23 months were included in the study. A mean and standard deviation (±SD) of mothers' age was 24.1 (±3.3) years. The mean age of the child was 11.1 (±6.5) months, and 48.4% of them were females. Half 388 (48.5%) of the mothers were not able to read and write, while only 7.3% of them attained a secondary or higher level of education. Nearly one-half 390 (48.8%) of the father were also uneducated. About 427 (53.4%) respondents were Muslims, while 373 (46.6%) were Hindus. About two-thirds 595 (74.4%) of the total children belonged to other backward classes (OBCs) and mainly were Muslim OBCs (53.3%). About 123 (15.4%) belonged to the scheduled caste (SC), 8(1%) to the scheduled tribe (ST), and 74 (9.3%) to the non-SC/ST/OBC category.

Most children, 690 (86.3%), were born in public or private institutions, while 110 (13.8%) were home delivered. Around 203 (25.4%) of the children included in the study were of birth order four and above, reflecting a bigger family size in the sample. A few more than a quarter, 224 (28%) were of the first order. The children of second and third order were 216 (27%) and 157 (19.6%). More than one-fourth 206 (26.4%) of the households had four or more living children. About 353 (44.2%) of the households had an average monthly income below 10,000 rupees per month (Below Poverty Line limit). More than one-third (36.4%) of caregivers were agricultural laborers and

353(44.1%) were of low economic status. (Table1 and Table 2).

Figure 1 and 2 shows immunization coverage in Haryana and Mewat in various national immunization surveys. Immunization status of the total included children (N=800), 426 (53.25%) of them were fully immunized as per age, 345 (43.13%) were partially vaccinated, and the rest 29 (3.63%) had not received any antigen. Out of 426 fully vaccinated children, 292 (68.5%) had evidence of immunization supported by the card, while the vaccination status of 134 (31.5%) children was determined by mothers to recall. Similarly, 173 (50.1%) were confirmed as partially immunized by card, while 172 (49.9%) were based on mothers' recall. On the other hand, of the fully immunized children, 146 (18.25%) had received timely vaccination, while 280 (35%) received delayed vaccination. Table 3.

Turning to the individual types of immunization covered (Figure 3 and Figure 4) by the study, 769 (96.1%) of children received BCG, 706 (88.3%) of the children received both OPV1 and Pentavalent1, and 353 (44.1%) received the measles-containing vaccine. Coverage rates declined for subsequent vaccine doses as 63.5% of children received OPV3, 63.9% Pentavalent3. The proportion of children who started certain vaccines but did not complete the next intended vaccine (dropout rate) was 28.4% for OPV1 to OPV3, 27.5% was for Pentavalent1 to Pentavalent3, and 54% for BCG to Measles containing vaccine.

Table 1. Socio-demographic and Economic Characteristics of Children aged 0-23 months in Mewat, Haryana 2019

Characteristics	Urban		Rural	
	Frequency (N)	**Percentage (%)**	**Frequency (N)**	**Percentage (%)**
Religion				
Hindu	234	58.5	139	34.8
Muslim	166	41.5	261	65.3
Caste				
Scheduled Caste	92	23.0	31	7.8
Scheduled Tribe	7	1.8	1	0.3
Other Backward Caste (OBC)	269	67.3	326	81.5
General Caste	32	8.0	42	10.5
MCP card				
Yes	260	65.0	208	52.0
No	140	35.0	192	48.0
Gender				
Male	206	51.5	207	51.8
Female	194	48.5	193	48.3
Place of delivery				
Government	205	51.3	208	52.0
Private	155	38.8	122	30.5
Home	40	10.0	70	17.5
Birth Order of the child				
First	113	28.3	111	27.8
Second	120	30.0	96	24.0
Third	83	20.8	74	18.5
Four and above	84	21.0	119	29.8
Care provider				
Mother	359	89.8	364	91.0
Other Family members	41	10.3	36	9.0
Mother education				

No schooling	155	38.8	233	58.3
Primary	84	21.0	63	15.8
Middle	49	12.3	49	12.3
High/Secondary	71	17.8	38	9.5
≥ twelfth	41	10.3	17	4.3
Father education				
No schooling	185	46.3	205	51.3
Primary	33	8.3	30	7.5
Middle	36	9.0	36	9.0
High/Secondary	64	16.0	55	13.8
≥ twelfth	82	20.5	74	18.5
Employment of caregiver				
Agriculture	6	1.5	24	6.0
Government/Private job	79	19.8	99	24.8
Self-employed/Shop keeper	106	26.5	40	10.0
Daily wage laborer	150	37.5	141	35.3
Skilled labor (mechanic/tailor/driver)	59	14.8	96	24.0
Monthly income (Rupees)				
BPL (<10000)	132	33.0	221	55.3
Middle (10000-25000	243	60.8	150	37.5
High (>=25000	25	6.3	29	7.3
Number of living children (Parity)				
1	113	28.3	113	28.3
2	123	30.8	92	23.0
3	79	19.8	71	17.8
>4	85	21.3	124	31.0
Type of Dwelling				
Pucca	388	97.0	332	83.0
Semi-Pucca	12	3.0	36	9.0
Kutcha	0	0.0	32	8.0
Source of fuel for cooking				
Firewood / Dung cake	14	3.5	305	76.0
LPG	386	96.5	95	23.8
Place of vaccination				
Government Health Facilities	179	44.8	98	24.5
Private Health Facilities	8	2.0	8	2.0
Outreach AWC	213	53.3	294	73.5
Immunization site convenient				
Yes	388	97.0	391	97.8
No	12	3.0	9	2.3
ASHA visited after side effects				
Yes	142	67.3	126	56.0
No	69	32.7	99	44.0
Taken for next dose after adverse effect				
Yes	190	90.0	179	79.6
No	21	10.0	46	20.4

Received four key messages				
Which vaccines and they prevent which diseases	216	25.3	197	26.5
Side-effects of vaccines & management explained	213	25.0	162	21.8
When and where to come for the next immunization	196	23.0	150	20.2
Remember to bring a card during the next visit	106	12.4	95	12.8
Did not receive any message/no time to discuss	122	14.3	140	18.8
Heard negative stories about immunization				
Yes	45	11.3	71	17.8
No	355	88.8	329	82.3

Table 2. Distribution of Individual and Socio-Demographic Factors in Mewat, Haryana 2019-20

Variable	**Completely immunized**		**Partially / Unimmunized**		**Odds Ratio**	**Adjusted Odds Ratio**	**P-value**
	(N=426)		**(N=374**		**OR (95% CI)**	**AOR (95% CI)**	
	No.	**%**	**No.**	**%**	**value**		
Area of residence							
Urban	215	53.7	185	46.3			
Rural	211	52.7	189	47.3	0.96(0.72-1.26)	0.80 (0.58-1.1	0.19
Primary caregiver							
Mother	362	50	361	50			
Others	64	83.1	13	16.9	0.20 (0.11-0.37)		0.00
Religion							
Hindu	272	72.9	101	27.1			
Muslim	154	36	273	64	4.77 (3.52-6.45)	4.94(3.64-6.71)	0.00
Caste							
Hindu OBC and others	272	72.9	101	27.1			
Muslim backward class	154	36	273	70	4.77(3.52-6.45)		0.00
Gender							
Male	229	55.4	184	44.6			
Female	197	50.9	190	49.1	1.20(0.90-1.58)	1.40 (1.03-1.90)	0.02
Religion wise gender							
Others religion male	336	59.4	229	40.6			
Muslim Male	90	38.3	145	61.7	2.36 (1.73-3.22)		0.00
Birth Oder							
≤ 2	261	56.3	179	40.7			
>2	165	45.8	195	54.2	1.72 (1.30-2.28)		0.00
MCP card							
Available	292	62.3	176	37.7			
Not available	134	40.3	198	59.7	2.45 (1.83-3.27)		0.00
Maternal education							
Primary and above	284	68.9	128	31.1			

No education	142	36.6	246	63.4	3.84 (2.86-5.15)	2.72(1.85-3.99)	0.00
Father education							
Primary and above	275	67	135	33			
No education	151	38.7	239	61.3	3.22(2.41-4.30)	1.63 (1.08-2.49)	0.02
Employment							
Employed/Self employed	285	59.5	194	40.5			
Unemployed	141	43.9	180	56.1	1.87 (1.40-2.49)	1.16(0.81-1.66)	0.39
Monthly income (in Rupees)							
More than 5000	366	54.3	307	45.7			
Less than 5000	60	47.2	67	52.8	1.33 (0.91-1.94)	0.94(0.60-1.45)	0.78
Parity status (number of living children)							
≤ 4 Children	385	56.7	293	43.3			
> 4 Children	41	33.6	81	66.4	2.59 (1.73-3.89)	1.47 (0.94-2.28)	0.08
Place of vaccination							
Govt/Pvt	207	70.6	86	29.4			
Outreach	219	43.2	288	56.8	3.16(2.32-4.30)	2.34(1.68-3.24)	0.00
Received 4 Key messages							
Received	312	57.9	227	42.1			
Did not receive	114	43.7	147	56.3	1.77(1.31-2.38)		0.00
Distance to health facility (in walk time)							
≤ 30 minutes	418	54	356	46			
> 30 minutes	8	30.7	18	69.3	2.64 (1.13-6.14)		
Aware of next due dose of vaccine							
Aware	317	60.7	205	39.3			
Not Aware	109	39.2	169	60.8	2.39 (1.77-3.23)	1.95(1.41-2.68)	0.00
Received Anganwadi services							
Yes	215	59.3	147	40.7			
No	211	48.1	227	51.9	1.57 (1.18-2.08)		
Decision maker for immunization							
Primary care giver	205	58	148	42			
Mainly Husband	221	49.4	226	50.6	1.41(1.06-1.87)	0.0007	
Birth							
Attended by the health worker	378	54.7	312	45.3			
Not attended by health worker	48	43.6	62	56.4	1.56 (1.04-2.34)	0.97 (0.62-1.52)	0.78

Table 3. Full Immunization Status of Study Participants in Mewat (12-23 months children)

Immunization status	**Urban**	**Rural**	**Total**
Eligible for Full immunization	157	166	323
Fully immunized	92	100	192
% Fully immunized	59	60	59

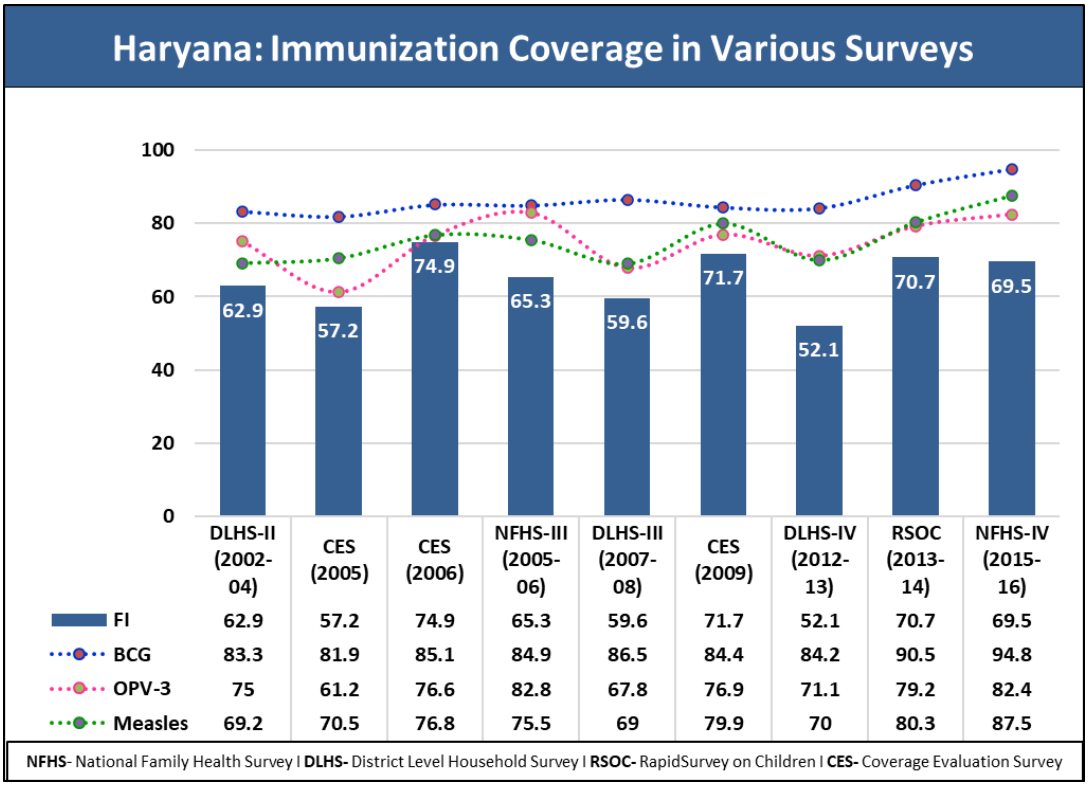

Figure 1. Haryana Full Immunization Coverage in Various Surveys 2002-2016

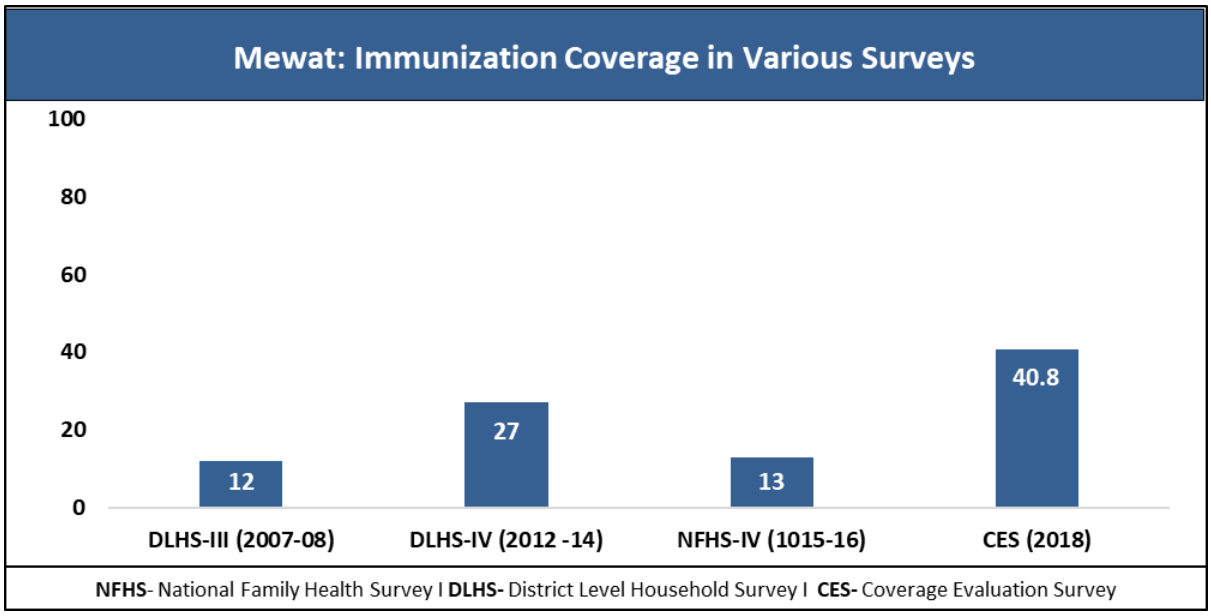

Figure 2. Mewat Full Immunization Coverage in Various Surveys

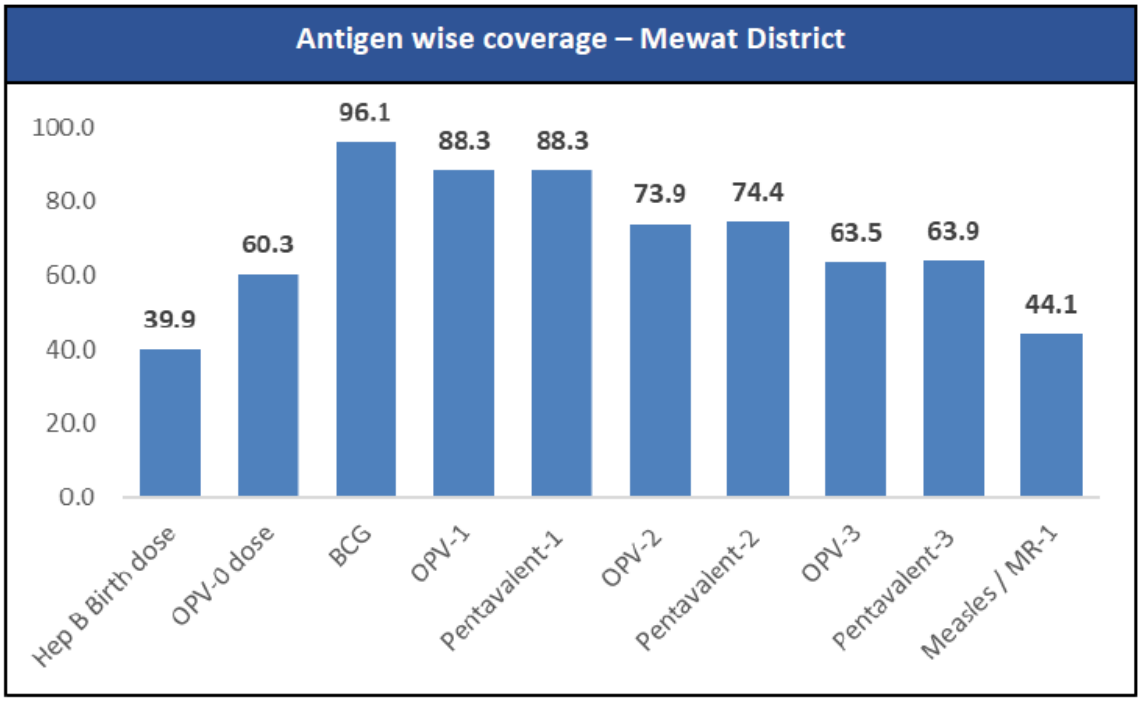

Figure 3. Antigen Wise Coverage in the Study Population -Mewat District 2019-2020

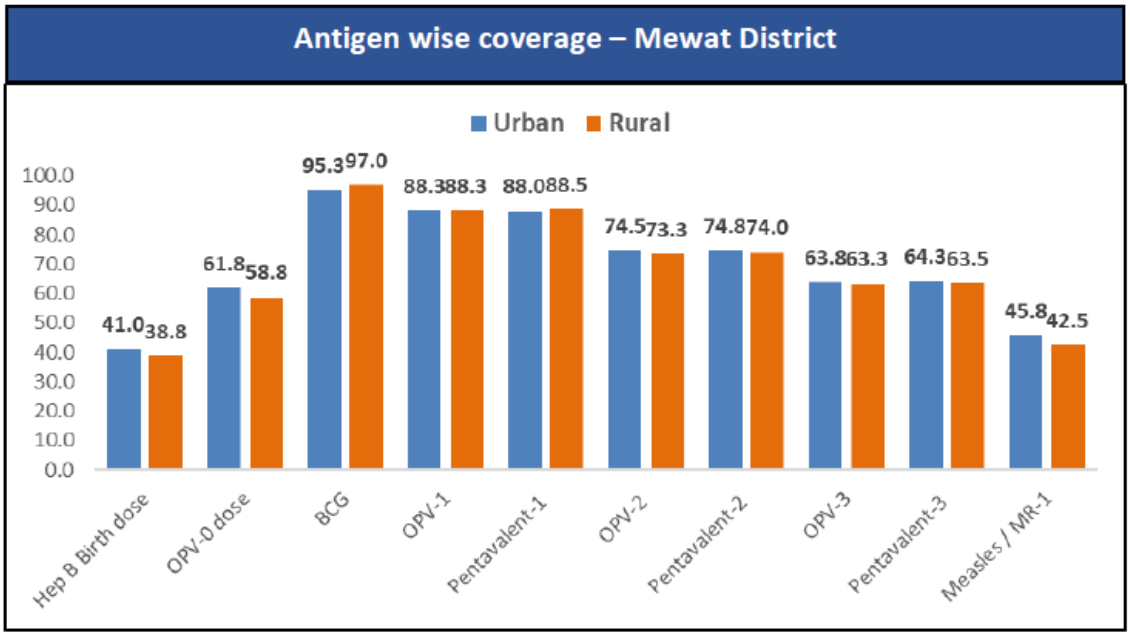

Figure 4. Urban -Rural Antigen Wise Coverage in Study Area of District Mewat 2019-20

Factors Associated with Full Immunization Status of Children

On the bi-variable analysis, birth order of the child, mothers age, parental educational status, number of living children in the family, employment, religion, caste, place of vaccination, awareness about next due dose of vaccine, the presence of a professional birth attendant in the delivery process, decision-maker for immunization in the family, distance to a health facility were found to be significantly associated with children's full immunization status. However, in the multivariate analysis, religion, gender, parental education, place of vaccination, and next due

dose of vaccine by mother were significantly associated (Table 2).

Table 2 shows that mothers who attained primary or higher education levels were 3.84 times more likely to have fully immunized children than illiterate mothers (Adjusted Odds Ratio (AOR) =2.72 95% CI=1.85-3.99). Mothers who had good knowledge and awareness about the next due dose about immunization were 1.9 times more likely to have a fully immunized child than those who had poor knowledge (AOR=1.95, 95% CI=1.41-2.68). Children of the Hindu religion were 4.9 times more likely to have fully immunized than Muslim religion (AOR=4.94,95% CI=3.64-6.71). Children born in health institutions had 2.34 times more chance of being fully vaccinated than children born at home (AOR=2.34, 95% CI=1.68-3.24). Children with male gender had 1.4 times more chance of being fully immunized than female gender (AOR=1.40,95% CI=1.03-1.90).

Younger mothers (<20 years of age) were less likely to vaccinate their children than older mothers (AOR=4.1,95% CI=1.94-8.71).

Figure 3 shows antigen wise coverage among 0-23 months children; BCG had the highest coverage (96.1%), followed by a first, second, and third dose of oral polio vaccine and Pentavalent vaccines. Overall, a decreasing trend was observed with OPV-1 (88.3%), Pentavalent-1 (88.3%) to OPV-3 (63.5%), Pentavalent-3 (63.9%) and further fall was observed for MCV-1 (44.1%). The dropout rates from BCG to MCV-1was 15.6%, while Pentavalent-1 to Pentavalent-3, it was 7.2%.

Figure 4 shows the overall vaccination coverage of each vaccine in urban and rural areas. Overall, Hep B vaccination coverage at birth was 319 (39.9%), which was the lowest compared to other antigens. It was 38.8% for rural and 41% in urban areas. Overall OPV–0 dose vaccination coverage was 60.3%, while, in urban and rural areas, it was 61.8% and 58.8%, respectively. Overall, BCG vaccination coverage was 96.1%, while, in urban and rural areas, it was 95.3% and 97%, respectively. OPV1 vaccination coverage was 88.3% and 88.3% in urban and rural areas, respectively, while overall it was 88.3%. Pentavalent1 vaccination coverage was 88% and 88.5% in urban and rural areas, respectively, while overall it was 88.3%. OPV2 vaccination coverage was 74.5% and 73.3% in urban and rural areas, respectively, while overall it was 73.9%. Pentavalent2 vaccination coverage was 74.8% and 74% in urban and rural areas, respectively, while overall it was 74.4%. OPV3 vaccination coverage was 63.8% and 63.3% in urban and rural areas, respectively, while overall it was 63.5%. Pentavalent3 vaccination coverage was 64.3% and 63.5% in urban and rural areas, respectively, while overall it was 63.9%. Overall, measles-rubella vaccination coverage was 44.1%, while, in urban and rural areas, it was 45.8% and 42.5%, respectively. Overall, DPT booster1 coverage was 15.5% and MR2 coverage was 15.6% at the district. The dropout rate for BCG to measles-rubella vaccine in the age group of (12-23 months) in urban was 12.5%, while it was 18.4% in rural, whereas the overall dropout rate was 15.6%. The dropout rate for pentavalent1 to pentavalent3 in urban was 11.3%, while it was 11.9% in rural areas, whereas the overall dropout rate was 11.7%. The dropout rate for OPV1 to OPV3 in urban areas was 12%, while it was 11.4% in rural areas; the overall dropout rate for OPV1 to OPV3 was 11.76%. The dropout rate for MR1 to MR2 in urban areas was 57.14%, while it was 52.6% in rural areas; the overall dropout rate at the district level was 54.8%.

More than half (51.6%) of the respondents chose government facilities for the delivery, one-third (34.6%) chose private health facilities for a delivery while,13.8% delivered at home. The majority (77%) of the respondents chose government health facilities for delivery in Punhana block while only one-third in Taoru block. Overall availability of immunization card in the district was 58.5%, maximum in Taoru block 75%, and minimum in Nuh block 40%. Decisions regarding vaccination of the children were dependent on either their husband or family members. The prime influence was the husband in 54.3% at the district level (62.3% in rural areas and 46.3% in the urban areas.

Overall, 426 (53.3%) children in the age group of 0-23 months were fully immunized, 345 (43.1%) were partially immunized and 29 (3.6%) completely unimmunized. Notably, 46.7% of the children did not receive age-appropriate immunization. Only 18.3% of the children were immunized on time as per age in

0-23 months. The most common reason for no immunization/partial immunization was fear of side effects of vaccines (28%), followed by the awareness gap (24%), child traveling (21%), and operational reasons (16%), as shown in Figure 5.

Among children aged 12-23 months, timely immunization was seen in 3.1% and delayed in more than half (56.3%) of the children. About 38.4% of children were partially immunized, and 2.2% did not receive any vaccines. The common reason for no or partial immunization was lack of awareness in (32%) followed by fear of side effects of the vaccine (27%) of the children, as shown in Figure 6.

Reasons for 426 fully vaccinated (age appropriate vaccination) children aged 0-23 months were analyzed. It was observed that 145 (34%) caregivers accepted immunization after counseled by the health workers regarding benefits of immunization. zing their children, 221 (51.9%) replied that vaccines prevent children from diseases.About 51(12%) trusted health system and vaccines and only 9 (2.1%) were self motivated to get their children vaccinated.

Reasons for 374 partially and unimmunized children were also analyzed in detail. The most common reason for partial or no immunization was fear of adverse events following vaccination in 119 (27%), 93 (21.5%) child away from home, 57 (13%) no one contacted the family, 67 (15.2%) immunization session not held, 24 (5.5%) family not aware of the need of immunization and 18 (4.1%) were unaware of the missed dose,12 (2.7%) child was sick and caregiver did not opt for vaccination, 12 (2.7%) family was resistant to immunization, 4 (0.9%) had concern for loss of wages, 3 (0.7%) caregiver not opted for multiple injections, 2 (0.5%) vaccine was not available at session site and 24 (5.5%) did not specify any reason for not getting immunized.

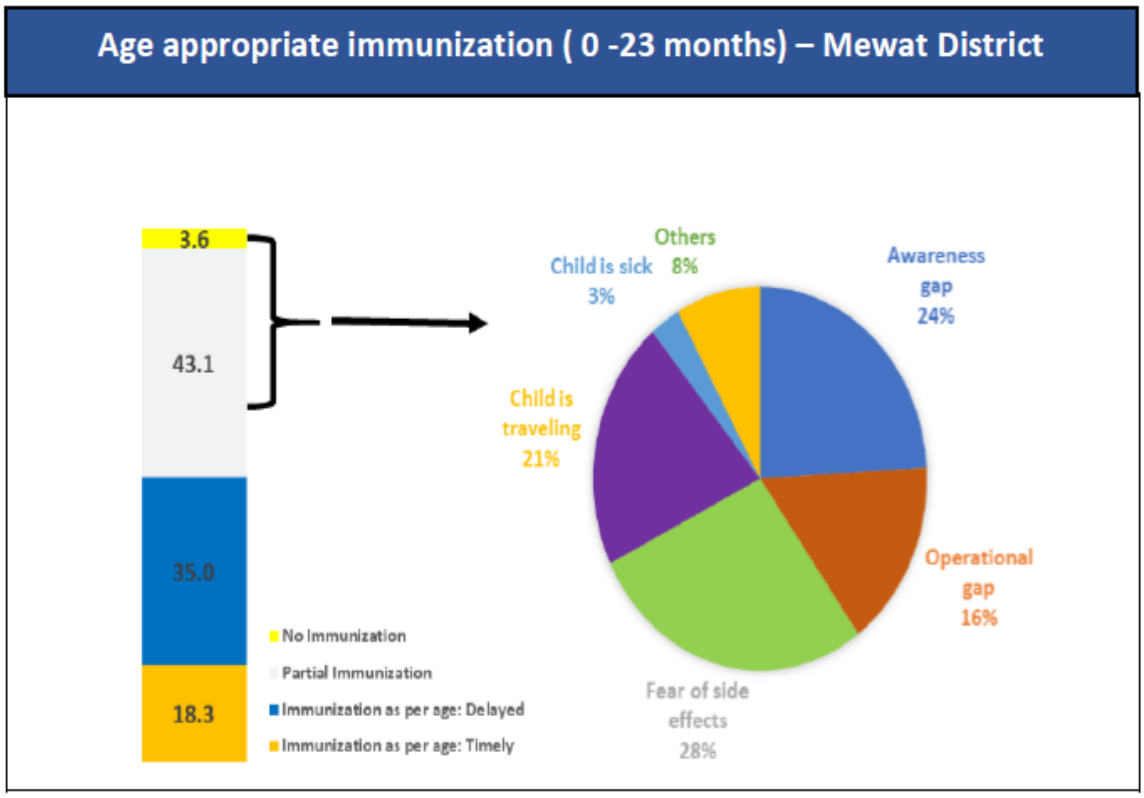

Figure 5. Age Appropriate Immunization in the Study Area in 0-23 Months Children in Mewat 2019-2020

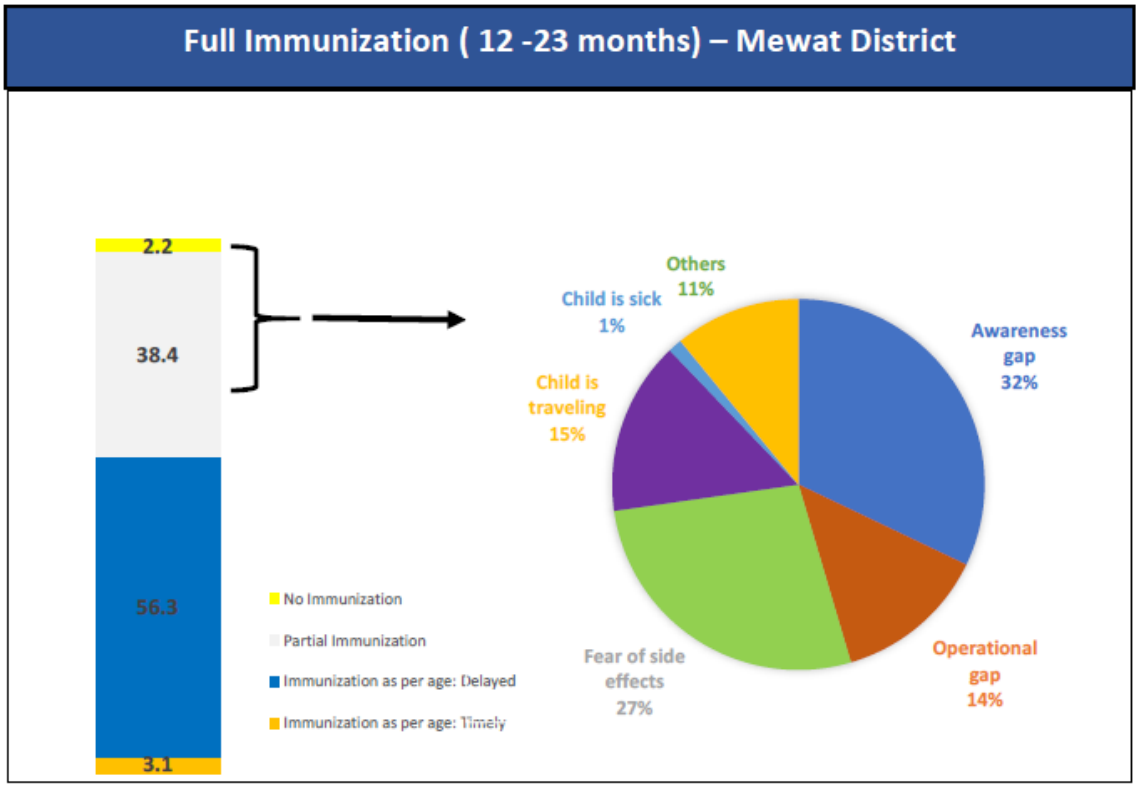

Figure 6. Full Immunization in the Study Area in 12-23 Months Children in Mewat 2019-2020

Discussion

A total of 800 children (400 from urban areas and 400 from rural areas) aged 0-23 months were residing in the rural and urban areas of district Mewat were included in the study. The coverage of fully immunized children in the study area was found to be 59% (59% in urban area and 60% in rural area) to be quite high as compared to National Family Health Survey (NFHS-4) (2015-16) district figures i.e., 13.1% (rural 11%) indicating that there has been a significant improvement in overall immunization coverage of all vaccines in recent years, as a result of continuous efforts being put in to achieve universal immunization coverage by the government. Similarly, the coverage in this study was higher when compared to the District Level Household Survey (DLHS-4) (2012-13), where the percentage of fully immunized children was only 27.3% in the district (rural 20.8%). Mewat district had the highest percentage (46%) of "partially immunized" and 16% "no immunized" children in 2018 [16]. All other Haryana districts had full immunization coverage (FIC) of more than 60%. Coverage evaluation survey (CES) in 2018 had also shown that the percentage of children aged 12-23 months who received full immunizations increased from 13.1% in 2015-16 to 40.8% in Mewat.

Our findings revealed that more than one-third (40.6%) of the children in 12–23 months age group were "partially immunized" or had "no immunization." More than one-third (37.4%) of the primary caregivers were not aware of the vaccine's next due date in the present study, which was similar to the study conducted in Bijapur, Karnataka [17]. Full immunization coverage in the district still falls short of the WHO and UNICEF's Global Immunization Vision and Strategy goal of 80% coverage [18].

Factors affecting the childhood vaccinations are more complex and multifactorial. Various factors included the locality (urban/rural/slums) of residence [19, 20] parental education [21, 22] socioeconomic status of the households [23, 24, 25] caste and religion [26, 27], parity and mother's age at birth [28, 29] and distance to health service centers [30, 31]. Gender discrimination disfavoring female child is also an essential determinant of childhood vaccination in India [28, 29]. Parental education, religion, employment, family size, and place of delivery were the main

demographical factors that affected immunization in the district. Mothers were the primary caregiver in the majority of the cases in our study. Approximately half of the primary caregivers (48.5%) in the study were not having any formal education. Overall low literacy rate of 54.08% (males 69.9%; females 36.6%) in the district probably contributed to the ignorance and blind beliefs or myths among the beneficiary's families and society. Illiterate parents were not aware of the benefits of immunization and its schedule and had shown a lack of interest in the child's vaccination. Decisions for vaccination of the children were dependent either on their husband or elderly male family members. Only 3.8% of primary caregivers independently decided to get their children vaccinated. About one-third of primary caregivers believed that immunization makes their children sterile.

The institutional births had improved from 37.6% in 2015-16 to 86.3% during the study period. We found that improvement in the institutional delivery rates and availability of the professional birth attendant during the delivery process had a positive and significant association with children's immunization status. Higher immunization coverage were seen in the studies where professional birth attendant were present during the process [32, 33]. The auxiliary nursing midwives (ANMs) provide antenatal, perinatal, nutrition & reproductive advices, and immunization services in villages. They are accepted by the local community and play important role in mobilizing them for vaccination.

During our study, it was revealed that maternal age was significantly associated with immunization coverage. There were 3.5 times more chances of children being fully vaccinated if the maternal age was more than 20 years (AOR=3.53,95% CI 1.75-7.10). Children of older mothers were more likely to be fully immunized. Our study results were similar to the study conducted by [34]. Women under 20 years of age in Mewat may be less likely to make their own decisions regarding vaccinating their children; mainly husbands and family members are the decision-makers. Older mothers are likely to have more experience raising children and more likely to be knowledgeable about children's health, which may be the possible explanation of improved coverage at this age.

In the present study, coverage for the BCG vaccine was remarkably high, indicating a certain healthcare services access by the community. BCG vaccine is provided at the time of birth in government institutions, and an increase in institutional deliveries in recent years may be a contributing factor. The gradual decrease in the vaccination coverage from the birth-administered BCG to DPT3/ Pentavalent3 given at age six months could be secondary to difficulty in accessing immunization services, lack of understanding for the need for further vaccination, loss in motivation or perceived need for child vaccination, or a combination of all these factors. Difficulty in accessing health services could be explained, at least in part, by institutional and societal discrimination directed at parents belonging to lower socioeconomic strata, castes and poorer households, and physical barriers such as unavailability of services due to long distances to health centers, and unavailability of health workers at the health centers.

Usually, children in urban areas had been reporting to have better vaccination outcomes than children residing in rural areas. The proportion of fully vaccinated children was slightly better in urban areas (53.7%) than in rural areas (52.7%); however, we did not find any significant difference in our study. An extensive network of community health workers (Anganwadi and ASHA workers) in rural areas of Mewat and their task is to mobilize children and pregnant women to receive immunization services; a comparable network may not exist in urban areas may the possible reason. This could partially account for our finding that urban children with the same level of poverty, education, religion, and caste as rural children still have lower chances of being fully vaccinated, with significant implications for targeted immunization intervention programs and related policies. The urban areas in Mewat have both middle-class neighborhoods and large concentrations of poor and uneducated families (of Muslim religion), who mostly lack of awareness about the benefits of immunization. It was found in the study that women do not get their children adequately immunized, saying that multiple injections hurt (7.8%) their children and cause

other kinds of side-effects (61.2%). They were also of the view that their children were doing well without immunization; hence there was no need to give them pain by the injections. Findings revealed that overall awareness for the next vaccination due date was among 61% of primary caregivers. In the present study, most respondents cited the main reason for low immunization was the awareness gap followed by fear of side effects. Awareness about vaccination plays a critical role in vaccine acceptance. Information regarding the immunization schedule and the next due date of vaccination allows mothers and caregivers to plan well in advance, reducing the probability of missed vaccinations. Similar results have been shown in a study conducted [35, 36]. in Lucknow district, and Nath B in urban slums of Lucknow [37] stated that low awareness was the most common reason for partial or no immunization from Kakinada, Andhra Pradesh [38] showed that the most common reasons for partial/no immunization were an ill child (27.5%), lack of knowledge about vaccination (25.12%), migration to other places with no understanding of place and time of vaccination (17.5%). A study [39] from the rural area of district Tonk, Rajasthan showed the most common reason for partial/nonimmunized was sickness 22 (36.06%) of an elder sibling because of the previous vaccination followed by 20 (32.07%) of the illness of the beneficiary at the time of vaccination. A study [40] in tertiary care hospital of North India showed that the common reasons for partial immunization and non-immunization were lack of knowledge about vaccination (30.3%), apprehension about side effects of vaccination (28.8%), and lack of knowledge about subsequent doses (22.09%). Another focal study from Surajgarha Block, [41] was 55.2%. In rural Uttar Pradesh, it was 50% as per [42]. The full immunization coverage was much lower in the studies from Bihar and Uttar Pradesh. This may be attributed to the lower awareness level and fewer health services utilization in both the territories.

In the present study, 59.4% of children were fully immunized in the age group of 12-23 months in a rural area of Tripura [43] highlighted in their research that the main reasons for low immunization are the lack of knowledge (26.7%), any illness of the child (26.7%), followed by fear of possible adverse effects (20%). The consolidated Intensified Mission Indradhanush report stated the reason for non-vaccination were awareness issues (45%), AEFI apprehension (24%), vaccine resistance 11%), child traveling (8%), and program-related gaps in 4% of the respondents. Our research found that most Mewat children who received partial immunizations missed the pentavalent vaccine (DPT, Hepatitis B and Haemophilus influenza b) and measles vaccine. The dropout rate for BCG to measles in the present study was 54% and pentavalent-1 to pentavalent-3 was 27.5%. Dropout rates were much higher in our study than the research conducted in Tamil Nadu [44], the dropout rate from BCG to measles was 15.9% and pentavalent-1 to pentavalent-3 was 4.1%. Pentavalent vaccine consists of a series of three injections, and children with partial immunizations had received the first one or two injections. During our study, we found the most common reason for partial or no immunization was fear of side effects following vaccination. Also, we found a significant drop out of 54% in BCG to measles-rubella1. The possible explanation may be that mothers forget to have their children immunized once they reach a certain age, such as nine months, the period for measles vaccination.

Commonly, DPT vaccine coverage is accepted as the standard reflecting immunization program performance. The first DPT/ Pentavalent vaccine dose is an indicator of access to health care services. The third DPT/Pentavalent dose coverage demonstrates the family's ability to access and utilize immunization services in multiple visits. The high dropout (more than 10%) of DPT/Pentavalent services in Mewat shows that information regarding the benefits of immunization and the need for multiple immunization visits have not reached all the mothers. Our study had revealed the highest coverage (97.5%) with BCG vaccine. It is administered up to first 15 days as a birth dose and up to one year of the age. The increasing number of institutional delivered babies with the help of health workers played a significant role in increasing the coverage of BCG vaccination.

In the present study, we found the availability of immunization cards with 58.5% of the beneficiaries on the survey's date. The

vaccination card availability was the highest (75%) of the children in Taoru block and the lowest in Nuh block (40%). Our study results were similar to a tribal block of Thane district [45]. In the study conducted in Surajgarha block of Bihar [41], and the availability was 65.7% and 88.4% in the study executed in urban slums of Ahmedabad city [46].

In our study 43.3% (36/83) Muslim male children were fully immunized as compared to 80.9% (68/84) Hindu male children. Similarly, 34.2% Muslim female children were fully immunized as compared to 74.4% Hindu female children. Overall, gender disparity in full immunization was highest among Muslims compared to Hindus. Girls born in India have a 40% higher risk of ill-health as compared to boys and are less likely to access healthcare services, including immunization. Girls have lower immunization coverage than boys also reinforce the findings of previous studies of gender disparities in childhood immunization. Evidence outside India indicates more significant gender-based discrimination among Muslims than non-Muslim religions [47, 48]. A recent study has documented son preference among various religious groups in India and found that women from Muslim households have a slightly higher son preference. Women from other non-Hindu, non-Muslim religions, have slightly lower preference for sons than the Hindu and Muslim women. Among Muslims, lack of education, and relatively poor socio-economic status (due to the patriarchal social setup and ideology) may produce circumstances leading to son being the most dependable socioeconomic insurance [49]. Such consideration may have resulted in gender discrimination healthcare utilization among Muslim children.

Mothers/caregivers having Muslim as their religion were less likely to be fully immunized. Most Muslims are often not formally educated and not in employment. Immunization activities are perceived to be deliberately designed by outsiders (enemies of Islam) to reduce the Muslim population through vaccines' fortification [50]. Misconceptions like this could have flown over to countries, including India. Children from Hindu religious affiliations had better vaccination coverage. The factors affecting childhood vaccination in the Indian states of Madhya Pradesh, Bihar, Uttar Pradesh, and Rajasthan [51]. It showed that children are more likely to receive immunization if their parents are a couple, with the father literate and the mother with at least a middle-school-education level who received antenatal care or delivered in an institutional environment. The importance of maternal education in children's health is universally recognized. Children of more educated mothers are more likely to be fully immunized [52, 53]. A woman with a better educational background is more likely to be aware of immunization's importance. It is also possible that better-educated mothers are more receptive to novelty and modern ideas, more confident in making decisions for their families' health, and more skilled at obtaining health information. Furthermore, preventive health services are more readily accepted by people with better educational backgrounds. Women with the most education are likely to be wealthier; they also have better access to health facilities and immunization services. Education is correlated with family welfare. Maternal education has also long been established as a significant predictor of childhood vaccination in India. Well-educated mothers have a positive relationship between immunization and maternal education [54]. Based on these findings, when there is a higher concentration of illiterate people in more deficient healthcare services settings, improving access to PHCs could help address inequities in vaccination coverage in areas characterized by lower maternal education levels. In our study, approximately half (48.5%) of mothers were illiterate.

In our study, 204 (49.3%) children born in government institutions, 174 (62.8%) born in private institutions received all age-appropriate doses of immunization. Our finding that children born in government institutions were at greater risk of non-vaccination than those born in private institutions. Government institutions need to be further strengthened to deliver immunizations or increase immunization coverage. There is a need to provide financial or policy incentives for government facilities to ensure that children are appropriately immunized.

Another finding in the study was the poor knowledge of the caregivers regarding immunization. Though a clear majority of the

respondents agreed that vaccination is essential to protect their children from deadly infectious diseases, most of them could not even name one condition that immunization protected against. This observation further cemented with the finding that the main reason for the failure of vaccination was a lack of knowledge about the universal immunization schedule. Previous studies had highlighted that India's existing health inequities are related to a lack of attention to social determinants of health, including education, employment, and the healthcare system's failure to deliver to those in need [55]. We have found significant disparities in vaccination coverage between the richest and poorest children and between the children of mothers with high education and low education, confirming findings in previous literature [56, 57, 58]. Inequities in vaccination coverage among social and religious groups in India were also clearly evident. Previous vaccination studies [59] that investigated the effects of religion on vaccination coverage dichotomized religion as Hindu and non-Hindu and found that non-Hindu religions have lower vaccination coverages. Similar findings were seen in the study [60], who concluded that though many parents were aware of the importance of vaccination in general, specific information on the importance of completing the schedule and knowledge on vaccine-preventable diseases other than poliomyelitis were limited.

The present study was conducted at the grassroots level in all the four blocks of Mewat district, which shows the factors like lack of awareness regarding benefits of immunization at the community level, fear of the side effects because of vaccines is some of the challenges which need to be addressed at primary care level to achieve full immunization coverage. Briefly, community preparedness can be assessed and compared between the blocks to identify high priority areas for different stakeholders.

Although, UIP vaccines have been offered free of cost to everyone by the government. The time and financial cost of reaching the health facilities can be an obstacle to the parents. Household income influences the likelihood that children receive full immunization. This result is like the results of many previous studies that show that children from wealthier families are more likely to be immunized than from poorer families [61, 62, 63].

Similar to previous research studies about the number of living children or parity status, our study also showed that mothers who had more than four children were less likely to immunize their children; many children in the family decreased the chance of children receiving full immunization. The mother might become busy fulfilling her children's need as the number of children in the family increase [64].

Children in rural areas had no significantly different probability of receiving full immunization than children in urban areas. The sources of information in the present study regarding immunization were mainly healthcare workers 703 (87.9%). Similar results were found in a survey [37]. They concluded that Auxiliary Nurse Midwives (ANMs), paramedical workers, were the primary source of information regarding children's immunization. Similar findings were seen in a study [65] that the most used source of vaccine information was the health care provider, i.e. (91.7%).

Decreasing in coverage rates was observed between the subsequent vaccine doses. The dropout rate observed in this study was exceeding the WHO acceptable dropout limits (>10%).

The gender gap in immunization coverage has been shown to exist in all states of India. These studies showed that female children are significantly less likely to receive full immunization than their male counterparts. Similar results were observed (AOR=1.40,95% CI 1.03-1.90)) and p-value <0.02 in the present study. The reasons for under- and non-vaccination were multifactorial and complex. Educational status of parents, place of delivery of the child, lack of awareness of next vaccine due dose, and lack of knowledge about immunization schedule, long-distance to a health facility, big family size was identified as predictors of full immunization coverage in the study.

Conclusion

As mentioned earlier, despite the program being in operation for more than three decades, the immunization program has not only failed in achieving its target but lagging far behind the

90% coverage mark in the district. An unfortunate fact is that though a clear majority of the population recognized the importance of immunization, superficial knowledge of the immunization schedule and failure in motivating the target population for completing the immunization schedule has led to a large proportion of the children being partially immunized. Fear of AEFIs has also played a critical role in preventing children from getting vaccinated without proper communication to alleviate the concern by the health system.

The government should develop a comprehensive multi-pronged strategy to address vaccine hesitancy and bring out the observed changes in society's male members' attitudes and practices. These efforts should be directed in both directions. The demand side should raise the community awareness of the importance of timely completion of vaccination. From the supply side, the government should create effective communication strategies to address the fears regarding AEFIs among the community to participate in the vaccination program effectively.

Findings of our study call for a social mobilization programme which is required to prevent dropout from immunization, particularly by families of the girl children. The government and local administration must mobilize community and religious leaders to boost immunization rates and ensure equity in demand for immunization and access by children of both the genders. As a matter of policy, gender issues must be integrated into child immunization programme of the state, particularly in Mewat.

Limitation

The immunization history by mother's recall was a limitation. This is prone to systematic error (recall bias) caused by differences in accuracy of immunization information over a period up to 2 years, and most were uneducated. Since immunization status and predicting factors were assessed simultaneously, it is impossible to establish a cause-effect relationship. Despite this limitation, the results are useful for immunization program managers, the research community, and Haryana's government.

To improve immunization coverage, the Government of India has launched several programs. One of these is the Mission Indradhanush program, which provides immunization services closer to the community. Even though immunization coverage has been improving year by year in the country, it is still below the WHO standard of 80% in Mewat. This disparity might be elucidated by either household- or district-level determinants. Low maternal education levels, high poverty levels, and poor access to professional health attendants for maternal and child health services are among the district's characteristics with low immunization coverage. Mewat is having relatively few hospitals and health centers.

Our recommendations to the government could enhance the sub-health centers in the villages and ensure community empowerment. Improving health workers' communication skills can be key in imparting information about immunization to families and decision-makers. Improving mothers' and fathers' health knowledge by merely involving the community leaders would provide an approach to informing families about immunization, especially for fathers with lower formal education levels. Increasing the number of health workers (auxiliary nursing midwives) is essential for immunization coverage. The government should provide funding to increase the number of health workers at the village level. Improvement of health workers' quality has also proven an excellent policy to improve the quality of health. Finally, reducing economic inequality among all to ensure equitable coverage.

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