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Original Research Article

Determinants of Full Immunization Coverage among Children Under Five Years in a Rural Community

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Conflict of interest: Nil

Abstract

Background: Complete childhood immunization is essential for preventing vaccine-preventable morbidity and mortality. Despite improvements in vaccination services, incomplete immunization persists in rural communities. This study assessed full immunization coverage and its determinants among children under five years in rural Agra, Uttar Pradesh.

Material and Methods: A community-based cross-sectional study was conducted during 2022–2023 among 300 children aged 12–59 months. Immunization status was determined using immunization cards and caregiver information. Sociodemographic, maternal, child-related, and health-service factors were assessed. Chi-square tests and multivariable logistic regression were used to identify determinants of full immunization.

Results: Of 300 children, 218 (72.7%) were fully immunized, 68 (22.7%) were partially immunized, and 14 (4.7%) were unimmunized. Full immunization was significantly associated with maternal education, lower birth order, socioeconomic status, antenatal care, immunization-card availability, maternal knowledge, and regular ASHA/ANM contact. Adequate maternal knowledge was the strongest independent predictor (AOR 3.42; 95% CI: 1.79–6.54), followed by immunization-card availability (AOR 2.68; 95% CI: 1.35–5.32) and regular ASHA/ANM contact (AOR 2.57; 95% CI: 1.33–4.96). Lack of awareness regarding subsequent doses was the most common reason for incomplete immunization.

Conclusion: Approximately three-fourths of children were fully immunized. Maternal awareness, education, antenatal care, maintenance of immunization records, and regular contact with frontline health workers were important determinants of full immunization.

Keywords: Immunization Coverage; Children Under Five; Vaccination; Rural Community; Maternal Knowledge; ASHA; Uttar Pradesh.

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Introduction

Immunization is one of the most effective public health interventions for reducing childhood morbidity and mortality from vaccine-preventable diseases. Despite the availability of vaccines through India's Universal Immunization Programme, incomplete or delayed immunization continues to occur, particularly among socioeconomically disadvantaged and rural populations. Immunization coverage is influenced by a complex interaction of parental, household, community, and health-service-related factors. [1]

Maternal education has consistently emerged as an important determinant of childhood vaccination. Educated mothers are more likely to have greater awareness of vaccination schedules, recognize the benefits of immunization, and utilize preventive healthcare services. [2] In addition, gender-related differences in healthcare utilization and vaccination have been reported in different regions of India, reflecting persistent social and household-level inequalities. [3] Studies from different parts of India have identified parental education, socioeconomic status, birth order, place of delivery, availability of an immunization card, accessibility of vaccination services, and parental knowledge as important predictors of complete immunization. [4,5] Health-system barriers, including inconvenient vaccination sessions, distance from health facilities, missed opportunities, and inadequate communication with healthcare workers, may further contribute to incomplete immunization. [6]

To improve vaccination coverage among children who are partially immunized or unimmunized, the

Government of India introduced intensified strategies such as Mission Indradhanush, with particular emphasis on underserved and hard-to-reach populations. [7] However, local assessment of immunization coverage and its determinants remains essential for identifying vulnerable groups and planning targeted interventions.

Therefore, the present study was undertaken to assess full immunization coverage and determine the sociodemographic, maternal, child-related, and health-service factors associated with full immunization among children under five years of age in a rural community of Agra, Uttar Pradesh.

Materials and Methods

Study Design and Setting: A community-based cross-sectional study was conducted in a rural community of Agra district, Uttar Pradesh, during 2022–2023. The study assessed immunization coverage among children under five years of age and identified factors associated with full immunization.

Study Population and Sample Size: The study included 300 children aged 12–59 months residing in the selected rural community. The mother or primary caregiver of each eligible child was interviewed to obtain information regarding immunization status and potential determinants of vaccination.

A sample size of 300 was considered adequate to estimate immunization coverage and evaluate important factors associated with full immunization in the study population.

Inclusion Criteria: Children aged 12–59 months who had been residing in the selected rural area for at least six months and whose mother or primary caregiver was available to provide immunization-related information were included.

Exclusion Criteria: Children whose immunization status could not be assessed either through an immunization card or reliable caregiver history, children temporarily visiting the study area, and caregivers unwilling or unable to provide the required information were excluded.

Sampling Technique: A multistage sampling technique was used. Rural areas/villages were selected from the study region, followed by systematic household sampling within the selected areas. Households were visited sequentially until the required number of eligible children was obtained. When more than one eligible child was present in a household, one child was selected using a simple random method to avoid household-level clustering.

Data Collection: Data were collected using a pre-designed, structured questionnaire administered to the mother or primary caregiver through face-to-face interviews.

Information was collected regarding:

- Age and sex of the child
- Birth order
- Maternal and paternal education
- Parental occupation
- Socioeconomic status
- Family type and family size
- Place of delivery
- Antenatal care utilization
- Institutional delivery
- Immunization card availability
- Maternal knowledge regarding vaccination
- Distance from the nearest vaccination facility
- Contact with ASHA/ANM workers
- Availability and accessibility of vaccination services
- Reasons for missed or delayed vaccination

Assessment of Immunization Status: Immunization status was assessed primarily from the Mother and Child Protection (MCP) card/immunization card. When the card was unavailable, vaccination history reported by the mother or primary caregiver was recorded according to the study protocol.

Children were categorized as fully immunized, partially immunized, or unimmunized based on receipt of age-appropriate vaccines recommended under India's Universal Immunization Programme applicable during the study period.

For determinant analysis, the primary outcome was dichotomized as fully immunized versus not fully immunized.

Assessment of Maternal Knowledge: Maternal knowledge regarding childhood immunization was assessed using questions related to vaccine-preventable diseases, vaccination schedules, importance of completing the schedule, timing of vaccination, and management of minor adverse events following immunization. Correct responses were assigned a predetermined score, and mothers were subsequently categorized as having adequate or inadequate knowledge according to the study scoring criteria.

Socioeconomic Assessment: Socioeconomic status was assessed using an appropriate socioeconomic classification applicable to the rural Indian population during the study period. Households were grouped into socioeconomic categories for analysis of the association between economic status and complete immunization.

Outcome Variables: The primary outcome was the proportion of children who were fully immunized.

Potential determinants included maternal education, paternal education, socioeconomic status, birth order, sex of the child, institutional delivery, antenatal care, availability of an immunization card, maternal knowledge, accessibility of vaccination services, and contact with community health workers.

Statistical Analysis: Data were entered and analyzed using SPSS version 25.0. Categorical variables were expressed as frequencies and percentages, while continuous variables were summarized using mean ± standard deviation. Full immunization coverage was calculated as a percentage with an appropriate 95% confidence interval. Associations between immunization status and categorical determinants were assessed using the Chi-square test or Fisher's exact test, as appropriate.

Variables showing significant or clinically relevant associations on univariate analysis were entered into a multivariable binary logistic regression model to identify independent determinants of full immunization. Adjusted odds ratios (AORs) with 95% confidence intervals (CIs) were calculated. A p-value <0.05 was considered statistically significant.

Results

A total of 300 children aged 12–59 months from the selected rural community of Agra, Uttar Pradesh, were included in the study. Of these, 218 (72.7%) were fully immunized, 68 (22.7%) were partially immunized, and 14 (4.7%) were unimmunized. Full immunization coverage was significantly associated with maternal education, socioeconomic status, birth order, institutional delivery, immunization card availability, maternal knowledge, accessibility of vaccination services, and contact with community health workers.

Table 1: Sociodemographic Characteristics and Immunization Status of Study Participants

Variable	Total n (%)	Fully Immunized n (%)	Not Fully Immunized n (%)	p-value
Age (months)				
12–23	78 (26.0)	55 (70.5)	23 (29.5)	0.711
24–35	75 (25.0)	56 (74.7)	19 (25.3)	
36–47	76 (25.3)	54 (71.1)	22 (28.9)	
48–59	71 (23.7)	53 (74.6)	18 (25.4)	
Sex				
Male	159 (53.0)	119 (74.8)	40 (25.2)	0.357
Female	141 (47.0)	99 (70.2)	42 (29.8)	
Birth order				
1–2	207 (69.0)	164 (79.2)	43 (20.8)	<0.001*
≥3	93 (31.0)	54 (58.1)	39 (41.9)	
Maternal education				
No formal/primary	92 (30.7)	52 (56.5)	40 (43.5)	<0.001*
Secondary	136 (45.3)	106 (77.9)	30 (22.1)	
Higher secondary/above	72 (24.0)	60 (83.3)	12 (16.7)	
Socioeconomic status				
Lower	104 (34.7)	62 (59.6)	42 (40.4)	<0.001*
Middle	146 (48.7)	113 (77.4)	33 (22.6)	
Upper	50 (16.7)	43 (86.0)	7 (14.0)	

***Statistically significant.**

Children of birth order 1–2 had significantly higher full immunization coverage than children of birth order ≥3 (79.2% vs 58.1%; p<0.001). Coverage also increased progressively with maternal educational and socioeconomic status. No significant association was observed between immunization status and the child's age or sex.

Table 2: Maternal and Healthcare-Related Factors Associated with Full Immunization

Determinant	Fully Immunized n/N (%)	Not Fully Immunized n/N (%)	p-value
≥4 antenatal visits			
Yes (n=210)	171 (81.4)	39 (18.6)	<0.001*
No (n=90)	47 (52.2)	43 (47.8)	
Place of delivery			
Institutional (n=248)	192 (77.4)	56 (22.6)	<0.001*
Home (n=52)	26 (50.0)	26 (50.0)	
Immunization card available			
Yes (n=236)	190 (80.5)	46 (19.5)	<0.001*
No (n=64)	28 (43.8)	36 (56.2)	
Adequate maternal knowledge			
Yes (n=205)	174 (84.9)	31 (15.1)	<0.001*
No (n=95)	44 (46.3)	51 (53.7)	
Regular contact with ASHA/ANM			
Yes (n=226)	182 (80.5)	44 (19.5)	<0.001*
No (n=74)	36 (48.6)	38 (51.4)	
Vaccination facility within 5 km			
Yes (n=247)	191 (77.3)	56 (22.7)	<0.001*
No (n=53)	27 (50.9)	26 (49.1)	

***Statistically significant.**

Full immunization was significantly more frequent among children whose mothers had received at least four antenatal visits, delivered in a health institution, possessed an immunization card, had adequate knowledge regarding vaccination, maintained regular contact with ASHA/ANM workers, and lived within 5 km of a vaccination facility (p<0.001).

Table 3: Reasons for Partial or Non-Immunization among Not Fully Immunized Children (n=82)

Reason*	Number	Percentage (%)
Lack of awareness regarding subsequent doses	28	34.1
Fear of adverse effects	21	25.6
Child ill at scheduled vaccination	18	22.0
Caregiver busy/unavailable	17	20.7
Vaccination session inconvenient/missed	14	17.1
Distance/transport difficulty	12	14.6
Vaccine unavailable at scheduled visit	8	9.8
Family opposition	7	8.5
Migration/travel	6	7.3

***Multiple responses were permitted; therefore, percentages do not total 100%.**

The most frequently reported reason for incomplete immunization was lack of awareness regarding subsequent vaccine doses (34.1%), followed by fear of adverse effects (25.6%) and illness of the child at the scheduled vaccination visit (22.0%). Caregiver-related constraints, missed vaccination sessions, and accessibility problems were also important reasons.

Table 4: Multivariable Logistic Regression of Determinants of Full Immunization

Determinant	Adjusted Odds Ratio (AOR)	95% CI	p-value
Maternal secondary/higher education	2.31	1.25–4.27	0.008*
Birth order 1–2	1.92	1.06–3.48	0.032*
Middle/upper socioeconomic status	1.84	1.02–3.32	0.043*
≥4 antenatal visits	2.14	1.14–4.01	0.018*
Institutional delivery	1.76	0.91–3.41	0.093
Immunization card available	2.68	1.35–5.32	0.005*
Adequate maternal knowledge	3.42	1.79–6.54	<0.001*
Regular ASHA/ANM contact	2.57	1.33–4.96	0.005*
Vaccination facility within 5 km	1.89	0.96–3.72	0.066

***Statistically significant.**

After adjustment for potential confounding factors, adequate maternal knowledge was the strongest independent determinant of full immunization (AOR 3.42; 95% CI: 1.79–6.54; p<0.001).

Availability of an immunization card (AOR 2.68), regular contact with ASHA/ANM workers (AOR 2.57), maternal education (AOR 2.31), and adequate antenatal care (AOR 2.14) also remained significant independent predictors.

Discussion

The present community-based study assessed immunization coverage and its determinants among 300 children aged 12–59 months in rural Agra, Uttar Pradesh. Overall, 72.7% of children were fully immunized, while 22.7% were partially immunized and 4.7% were unimmunized. These findings indicate that although the majority of children had completed age-appropriate vaccination, a considerable proportion remained incompletely protected.

Delayed or incomplete vaccination is influenced by several interacting demographic, socioeconomic, and health-service factors. Choudhary et al. [8] reported that delayed vaccination among Indian children was associated with socioeconomic disadvantage and maternal and healthcare-related characteristics. Similarly, predictors of childhood vaccination identified in national-level analyses include parental education, household wealth, birth order, and utilization of maternal healthcare services. [9]

In the present study, maternal education was significantly associated with full immunization. Children whose mothers had secondary or higher education had greater odds of being fully immunized (AOR 2.31).

Socioeconomic inequalities in utilization of maternal and child healthcare services have been documented in India, with economically disadvantaged households experiencing greater barriers to accessing preventive services. [10] Srivastava et al. [11] also demonstrated persistent socioeconomic inequalities in childhood immunization coverage, supporting the importance of social and economic determinants observed in the present study.

Birth order was another significant determinant, with children of birth order 1–2 having higher immunization coverage than those of birth order ≥3. Larger families may experience competing demands for parental time and household resources, which can reduce utilization of preventive healthcare. Maternal healthcare utilization may also provide opportunities for counselling regarding subsequent childhood preventive services. [12]

No significant difference in full immunization was observed according to the sex of the child. This is encouraging in view of previously reported geographical, rural–urban, and gender differentials in childhood vaccination across India. [13] Nevertheless, continued efforts are required to ensure equitable vaccination coverage across all socioeconomic groups and geographical areas.

Health-service contact emerged as an important determinant. Children whose mothers had at least four antenatal visits were more likely to be fully immunized, while regular contact with ASHA/ANM workers independently increased the likelihood of complete vaccination. State-specific differences in rural vaccination coverage have been linked to variation in healthcare accessibility, socioeconomic characteristics, and utilization of immunization services. [14] Strengthening community-level follow-up may therefore help identify children who miss scheduled doses.

Adequate maternal knowledge was the strongest independent determinant of full immunization in the present study (AOR 3.42). Lack of awareness regarding subsequent doses was also the most frequently reported reason for incomplete immunization, followed by fear of adverse effects. Intensification initiatives such as Mission Indradhanush have attempted to address these barriers through targeted vaccination sessions and mobilization of children who are partially immunized or unimmunized. Summan et al. [15] demonstrated that periodic intensification of routine immunization can improve vaccination coverage and timeliness.

The observed coverage should also be considered within the broader improvement in childhood vaccination achieved in India over recent years. Nayar et al. [16] demonstrated substantial temporal improvement in routine childhood vaccination, although geographical variation continues to persist. The present findings indicate that further improvement in rural areas may be achieved by strengthening maternal education and counselling, maintaining immunization records, improving antenatal care utilization, and ensuring regular contact between families and frontline health workers.

Conclusion

Full immunization coverage among children under five years in the rural community of Agra was 72.7%. Maternal education, lower birth order, better socioeconomic status, adequate antenatal care, possession of an immunization card, maternal knowledge, and regular contact with ASHA/ANM workers were important determinants of complete immunization. Lack of awareness and fear of adverse effects were major reasons for incomplete vaccination. Strengthening community-based counselling, tracking of missed doses, immunization-card retention, and active involvement of frontline health workers may

further improve vaccination coverage in rural populations.

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