

Association between missed vaccination doses and parental knowledge, attitudes, and socioeconomic factors among children aged 12–23 months: a cross-sectional study from a tertiary care centre in Haryana

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ABSTRACT

Background: Childhood immunisation remains one of the most cost-effective public health interventions globally. Despite the Universal Immunisation Programme (UIP) in India, vaccination coverage is suboptimal in several states including Haryana, with a significant proportion of children missing scheduled doses.

This study aimed to assess the prevalence of missed vaccination doses and to identify associated parental knowledge, attitudinal, and socioeconomic predictors among children aged 12–23 months attending a tertiary care centre in Haryana.

Methods: A hospital-based cross-sectional study was conducted from January 2023 to June 2023 in the Department of Pediatrics, Maharshi Markandeshwar Institute of Medical Sciences and Research (MMIMSR), Mullana, Ambala, Haryana. A total of 350 parents/caregivers of children aged 12–23 months were enrolled by systematic random sampling. Vaccination status was verified against immunisation cards and mother–child protection (MCP) cards. Parental knowledge was assessed using a validated 20-item questionnaire and attitude was measured on a 15-item Likert scale. Socioeconomic status was classified using the modified Kuppuswamy scale (2023 update). Binary logistic regression was used to identify independent predictors of missed vaccination doses.

Results: The prevalence of missed vaccination doses was 38.6% (n = 135/350). The measles-rubella (MR) vaccine (46.7%) and DPT booster (36.3%) were the most frequently missed. On multivariate analysis, poor parental knowledge (adjusted OR 4.10; 95% CI 2.34–7.19), unfavorable attitude toward vaccination (AOR 3.52; 95% CI 2.01–6.16), maternal education below secondary level (AOR 3.18; 95% CI 1.79–5.65), lower socioeconomic status (AOR 2.83; 95% CI 1.60–5.00), rural residence (AOR 2.09; 95% CI 1.19–3.67), and distance greater than 5 km from the immunisation centre (AOR 1.82; 95% CI 1.01–3.29) were independently associated with missed vaccination doses.

Conclusion: Nearly two-fifths of children in this study had missed at least one vaccination dose. Modifiable determinants such as poor parental knowledge and unfavorable attitudes, alongside structural barriers of low socioeconomic status and rural residence, were the primary drivers. Targeted health education interventions, community outreach, and strengthening of the cold chain in peripheral areas are urgently warranted.

Keywords: Vaccination; immunisation; missed doses; parental knowledge; attitudes; socioeconomic factors; Universal Immunisation Programme; India

How to cite this article: Kummari Divya, Rishika Sinha Roy, Dharani Yesaswini, Saladi Mounika. Association between missed vaccination doses and parental knowledge, attitudes, and socioeconomic factors among children aged 12–23 months: a cross-sectional study from a tertiary care centre in Haryana. *Int J Drug Deliv Technol.* 2026;16(79s):600–606. DOI: 10.25258/ijddt.16.79s.113.

Introduction

Vaccination is one of the most successful and cost-effective public health interventions ever devised, preventing an estimated 2–3 million deaths annually and averting millions more cases of disease, disability, and suffering worldwide.

Despite decades of progress, global vaccine coverage remains uneven, and an estimated 19.8 million children worldwide did not receive three doses of diphtheria–tetanus–pertussis (DTP3) vaccine in 2021, the majority residing in low- and middle-income countries.

In India, the Universal Immunisation Programme (UIP) was launched in 1985 and has been periodically expanded to include newer vaccines. The UIP currently provides free vaccines against twelve vaccine-preventable diseases including diphtheria, pertussis, tetanus, poliomyelitis, measles, rubella, hepatitis B, Haemophilus influenzae type b, rotavirus, pneumococcal disease, Japanese encephalitis (in endemic districts), and typhoid (in urban areas).

According to the National Family Health Survey-5 (NFHS-5, 2019–21), the full immunisation coverage among children aged 12–23 months in India was

76.4%, representing a substantial improvement over the previous decade. However, this still implies that approximately one in four Indian children remains incompletely vaccinated, leaving them vulnerable to preventable diseases. Haryana reported full vaccination coverage of 74.0% in NFHS-5, with considerable intra-state heterogeneity between districts.

The determinants of incomplete vaccination are multifaceted and include individual, household, community, and health-system factors. Parental knowledge about the purpose, schedule, and benefits of vaccines has consistently been identified as a powerful enabler of vaccination uptake. Conversely, vaccine hesitancy—driven by negative attitudes, concerns about safety, and misinformation—is increasingly recognised as a threat to immunisation programmes globally.

Socioeconomic factors including maternal education, household income, socioeconomic class, family structure, and geographic access to immunisation centres further mediate vaccination behaviour.

Studies from northern India have reported missed vaccination rates ranging from 30% to 45%, with marked variation by district, residence, and facility type. Most existing evidence is derived from community-based studies or household surveys, with relatively fewer hospital-based assessments that capture the population attending tertiary paediatric services—a group that may differ from the general population in health-seeking behaviour.

The Ambala district of Haryana, where MMIMSR is located, is semi-urban with a largely agrarian hinterland and serves a substantial rural catchment. An understanding of missed vaccination in this context has direct implications for targeted outreach by the hospital and district immunisation programme.

This study was therefore undertaken to (i) determine the prevalence of missed vaccination doses among children aged 12–23 months attending the paediatric outpatient department of MMIMSR, Mullana, and (ii) identify the association between missed doses and parental knowledge, attitudes, and socioeconomic factors, so as to inform evidence-based interventions.

Materials and methods

Study design and setting

A hospital-based cross-sectional analytical study was conducted from January 2023 to June 2023 in the Paediatric Outpatient Department (OPD) and immunisation clinic of the Department of Pediatrics, Maharshi Markandeshwar Institute of Medical Sciences and Research (MMIMSR), Mullana, Ambala, Haryana, India. MMIMSR is a 750-bed tertiary care teaching hospital catering to urban and peri-urban populations in Ambala district as well as rural villages from the adjoining districts of Ambala, Kurukshetra, and Yamuna Nagar.

Eligibility criteria

Parents or primary caregivers of children aged 12–23 months who attended the OPD or immunisation clinic during the study period were eligible for inclusion. Children whose immunisation cards or MCP cards were unavailable and those whose parents were unable or unwilling to provide informed consent were excluded.

Sample size

Using the prevalence of incomplete immunisation of 38% from a comparable tertiary care study in Haryana, with 95% confidence level, absolute precision of 5%, and an anticipated non-response rate of 10%, the minimum required sample size was calculated to be 375; a final sample of 350 participants was achieved after accounting for exclusions ($n = 12$) and refusals ($n = 13$).

Sampling technique

Systematic random sampling was used. Eligible families attending the OPD on study days were listed; every alternate eligible family was approached and recruited until the daily quota was met.

Data collection instruments

A pre-tested, structured, interviewer-administered questionnaire in Hindi was used. The instrument comprised: (a) a socio-demographic section; (b) a 20-item parental knowledge scale (maximum score 20) validated against a standard immunisation knowledge tool with a Cronbach's alpha of 0.81; (c) a 15-item attitude scale using a 4-point Likert format (maximum score 60), validated with Cronbach's alpha of 0.79; and (d) assessment of vaccination status. Knowledge was classified as good (score ≥ 15), average (10–14), or poor (< 10). Attitude was classified as favorable (score ≥ 40) or unfavorable (< 40).

Socioeconomic status was assessed using the Modified Kuppuswamy Scale updated for 2023 income strata, classifying families into upper (Class I–II), middle (Class III), and lower (Class IV–V) categories.

Outcome variable

The primary outcome was missed vaccination dose, defined as failure to receive one or more doses of any vaccine recommended under the UIP for the child's age, as verified against the immunisation/MCP card or, where cards were unavailable, maternal recall corroborated by hospital immunisation records.

Statistical analysis

Data were entered in Microsoft Excel and analysed using IBM SPSS version 25.0 (IBM Corp., Armonk, NY). Categorical variables are presented as frequencies and percentages. The association between independent variables and missed vaccination was assessed using the chi-squared test. Variables with $p < 0.20$ in bivariate analysis were entered into a binary logistic regression model using the enter method. Adjusted odds ratios (AOR) with 95% confidence intervals (CI) are reported. A two-tailed $p < 0.05$ was considered statistically significant.

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Ethical considerations

The study was approved by the Institutional Ethics Committee of MMIMSR, Mullana (Reference: IEC/MMIMSR/2022/145). Written informed consent was obtained from all participants prior to enrolment. Confidentiality of data was maintained throughout.

Results

Socio-demographic characteristics

A total of 350 parents/caregivers were enrolled. The majority of participants were from rural areas (57.7%) and belonged to the Hindu religion (80.0%). The mean maternal age was 26.4 ± 4.2 years. A large proportion of mothers had educational attainment below the secondary level (36.0%). The most common paternal occupation was farming or agricultural labour (30.0%). Nearly half the families belonged to the lower socioeconomic class (Class IV–V, 44.0%) as per the Kuppuswamy scale. Nuclear families constituted 56.0% of the sample and 48.0% resided more than 5 km from the nearest immunisation centre.

Table 1. Socio-demographic profile of study participants (n = 350)

Characteristic	Frequency (n = 350)	Percentage (%)
Place of residence: Urban	148	42.3
Place of residence: Rural	202	57.7
Mean maternal age (years $\pm$ SD)	26.4 ± 4.2	-
Religion: Hindu	280	80.0
Religion: Muslim	53	15.1
Religion: Others	17	4.9
Maternal education: Illiterate / Primary	56	16.0

Maternal education: Middle school	70	20.0
Maternal education: Secondary	105	30.0
Maternal education: Higher secondary	70	20.0
Maternal education: Graduate and above	49	14.0
Paternal occupation: Farming / agricultural labour	105	30.0
Paternal occupation: Unskilled / semi-skilled labour	91	26.0
Paternal occupation: Skilled worker / service	87	24.9
Paternal occupation: Business / professional	67	19.1

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Socioeconomic status: Upper (Class I–II)	70	20.0
Socioeconomic status: Middle (Class III)	126	36.0
Socioeconomic status: Lower (Class IV–V)	154	44.0
Family type: Nuclear	196	56.0
Family type: Joint / extended	154	44.0
Distance from nearest immunisation centre: < 5 km	182	52.0
Distance from nearest immunisation centre: 5–10 km	112	32.0
Distance from nearest immunisation centre: > 10 km	56	16.0

Vaccination status and missed vaccines

Of the 350 children, 215 (61.4%) had received all age-appropriate UIP vaccines and were considered fully vaccinated, while 135 (38.6%) had missed at least one dose. Among those with missed doses, the majority had missed one dose (51.9%), followed by two doses (31.1%) and three or more doses (17.0%). The MR vaccine was the most commonly missed vaccine (46.7%), followed by the DPT booster (36.3%), OPV booster (28.1%), and the third dose of Pentavalent vaccine (16.3%). The mean parental knowledge score was 12.4 ± 3.8 out of a maximum of 20; 28.0% demonstrated good knowledge, 43.4% average

knowledge, and 28.6% poor knowledge. Unfavorable attitudes toward vaccination were recorded in 48.0% of respondents.

The leading reasons for missing vaccination doses included forgetting the vaccination date or ignorance about the schedule (36.3%), child illness on the scheduled day (28.1%), caregiver unavailability (20.7%), fear of adverse effects (15.6%), vaccine unavailability at the centre (10.4%), and religious or cultural reasons (5.9%).

Table 2. Vaccination status, knowledge scores, and attitudinal profile (n = 350)

Parameter	n	%
Fully vaccinated (all UIP doses complete)	215	61.4
Missed at least one dose	135	38.6
1 missed dose (among n = 135)	70	51.9
2 missed doses (among n = 135)	42	31.1
≥ 3 missed doses (among n = 135)	23	17.0
Measles-Rubella (MR) vaccine missed	63	46.7
DPT booster missed	49	36.3
OPV booster missed	38	28.1
Pentavalent 3rd dose missed	22	16.3

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Good knowledge (score ≥ 15)	98	28.0
Average knowledge (score 10–14)	152	43.4
Poor knowledge (score < 10)	100	28.6
Favorable attitude (score $\geq 40/60$)	182	52.0
Unfavorable attitude (score < 40)	168	48.0

Bivariate analysis

Bivariate analysis revealed statistically significant associations between missed vaccination and rural residence ($p < 0.001$), maternal education below secondary level ($p < 0.001$), lower socioeconomic status ($p < 0.001$), joint family structure ($p = 0.006$), poor parental knowledge ($p < 0.001$), unfavorable attitude ($p < 0.001$), and distance greater than 5 km from the health centre ($p = 0.009$).

Table 3. Bivariate analysis of factors associated with missed vaccination doses (n = 350)

Variable	Missed doses n (%)	Complete vaccination n (%)	OR (95% CI)	p-value
Rural residence	93 (68.9)	109 (50.7)	2.14 (1.33–3.44)	< 0.001
Maternal education < secondary	84 (62.2)	42 (19.5)	6.73 (4.14–10.94)	< 0.001
Lower SES (Class IV–V)	82 (60.7)	72 (33.5)	3.07 (1.95–4.84)	< 0.001

Joint extended family	72 (53.3)	82 (38.1)	1.85 (1.19–2.87)	0.006
Poor knowledge (score < 10)	75 (55.6)	25 (11.6)	9.15 (5.25–15.94)	< 0.001
Unfavorable attitude	88 (65.2)	80 (37.2)	3.12 (1.97–4.93)	< 0.001
Distance > 5 km from health centre	77 (57.0)	91 (42.3)	1.80 (1.14–2.84)	0.009

Multivariate logistic regression

All variables significant at $p < 0.20$ in bivariate analysis were entered into the logistic regression model. On multivariate analysis, poor parental knowledge remained the strongest independent predictor of missed vaccination (AOR 4.10; 95% CI 2.34–7.19; $p < 0.001$), followed by unfavorable attitude (AOR 3.52; 95% CI 2.01–6.16; $p < 0.001$), maternal education below secondary (AOR 3.18; 95% CI 1.79–5.65; $p < 0.001$), lower socioeconomic status (AOR 2.83; 95% CI 1.60–5.00; $p < 0.001$), rural residence (AOR 2.09; 95% CI 1.19–3.67; $p = 0.009$), and distance greater than 5 km from the immunisation centre (AOR 1.82; 95% CI 1.01–3.29; $p = 0.048$). Joint family type was not independently associated with missed doses (AOR 1.38; 95% CI 0.79–2.41; $p = 0.240$).

Table 4. Multivariate logistic regression – independent predictors of missed vaccination doses

Predictor variable	Adjusted OR	95% Confidence interval	p-value
Poor parental knowledge (score < 10)	4.10	2.34–7.19	< 0.001
Unfavorable parental attitude	3.52	2.01–6.16	< 0.001

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Maternal education < secondary	3.18	1.79–5.65	< 0.001
Lower socioeconomic status (Class IV–V)	2.83	1.60–5.00	< 0.001
Rural residence	2.09	1.19–3.67	0.009
Distance > 5 km from health centre	1.82	1.01–3.29	0.048
Joint / extended family type	1.38	0.79–2.41	0.240

Discussion

This hospital-based cross-sectional study found that 38.6% of children aged 12–23 months attending a tertiary care paediatric facility in Ambala district, Haryana, had missed at least one UIP-recommended vaccination dose. Poor parental knowledge, unfavorable attitudes, low maternal education, lower socioeconomic status, rural residence, and distance from the immunisation centre were independently associated with missed vaccination.

The prevalence of incomplete vaccination observed in this study (38.6%) is consistent with the NFHS-5 estimate for Haryana (74.0% full coverage, implying 26.0% incompleteness at the state level), and with hospital-based studies by Kumar et al. from Delhi (37.0%) and Singla et al. from Ludhiana (33.6%). The higher prevalence compared to population-based surveys is likely attributable to the preponderance of rural and lower-SES families in the hospital catchment, who are inherently at higher risk of default.

Poor knowledge emerged as the single strongest predictor of missed doses (AOR 4.10), consistent with evidence from multiple Indian studies demonstrating that parental ignorance of the vaccination schedule, benefits, and consequences of non-vaccination is a major proximate cause of default. The mean knowledge score in this cohort (12.4/20) suggests considerable scope for improvement. The fact that 36.3% of parents cited forgetting the date or ignorance about the schedule as reasons for missing a dose underscores the

opportunity for targeted pre-vaccination counselling and recall reminders.

Unfavorable parental attitudes were independently associated with almost 3.5-fold increased odds of missed vaccination (AOR 3.52). This finding mirrors global patterns of vaccine hesitancy, which the WHO Strategic Advisory Group of Experts (SAGE) has identified as one of the ten greatest threats to global health. Concerns about adverse effects, cited by 15.6% of parents with missed doses in this study, are modifiable through evidence-based communication strategies that address perceived risks in a culturally sensitive manner.

Maternal education below secondary level conferred more than three times the odds of missed vaccination (AOR 3.18), consistent with a large body of literature linking higher maternal education with better health-seeking behaviour, including vaccination uptake. In the Indian context, female education is strongly correlated with household decision-making autonomy; uneducated mothers may lack both the knowledge and the agency to ensure their children receive all vaccines. Lower socioeconomic status (Kuppuswamy Class IV–V) was associated with nearly a three-fold increase in the odds of missed vaccination (AOR 2.83). Although UIP vaccines are provided free of charge, indirect costs including transport, opportunity cost of lost wages, and out-of-pocket expenditure during hospital visits remain significant barriers for families in lower economic strata. Rural residence and distance from the immunisation centre were also independently significant, consistent with data from prior literature that found geographic barriers among the most commonly reported reasons for non-vaccination across multiple low- and middle-income countries.

The MR vaccine and DPT booster were the most frequently missed vaccines, a pattern seen in national surveys and other northern Indian studies. Both are second-year doses requiring additional visits after the primary series is complete, and caregiver motivation often wanes after the infant's perceived vulnerability period. Innovative strategies such as scheduled reminder calls, mobile-based tracking, and outreach immunisation camps targeting 12–18-month age groups could specifically address this gap.

Strengths of this study include verification of vaccination status against immunisation cards rather than relying solely on maternal recall, use of validated knowledge and attitude scales, and systematic random sampling. Limitations include the hospital-based sampling frame, which may not represent the full district population, and the cross-sectional design, which precludes causal inference. Social desirability bias in self-reported knowledge and attitudes cannot be excluded, although interviewer-administered questionnaires in a non-judgmental setting were used to minimise this.

Conclusion

Approximately two-fifths of children aged 12–23 months attending this tertiary paediatric centre had missed at least one UIP-recommended vaccination dose. Poor parental knowledge and unfavorable attitudes—both modifiable determinants—were the strongest independent predictors, followed by structural barriers of low maternal education, low socioeconomic status, rural residence, and geographic inaccessibility.

Integrated interventions combining parental health education at the point of care, community-level outreach immunisation camps, mobile reminder systems, and engagement of frontline health workers (ASHAs and ANMs) are essential to close the immunisation gap in this population.

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