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Original Research Article

Vaccination Profile of 1- to 5-Year-Old Children and Factors affecting Childhood Immunization Defaulters: A Hospital Based Study

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Abstract

Background: Childhood immunization is a proven, cost-effective intervention, yet persistent socioeconomic and access-related disparities in India contribute to missed and delayed doses.

Objectives: To determine the vaccination status of children 1 to 5 years of age; and the factors associated with childhood immunization defaulters.

Methods: This was a single-centre, hospital-based analytical cross-sectional study conducted in the Department of Paediatrics, Melmaruvathur Adhiparasakthi Institute of Medical Sciences & Research, Tamil Nadu, India, from January–December 2023; systematic random sampling of every 5th eligible child targeted a sample of 850.

Results: Among 850 children (54.1% male; 60.0% urban), age was evenly distributed across one-year bands (12–23 mo 24.7%, 24–35 mo 24.1%, 36–47 mo 25.3%, 48–59 mo 25.9%). Most families were Hindu (80.0%); lower-middle (37.6%) and upper-lower (30.6%) SES predominated. Mothers commonly had secondary education (35.3%) and were homemakers (63.5%); 72.9% had ≥4 ANC visits. Institutional delivery was high (public 50.6%, private 43.5%). Cards were available for 72.9% and BCG scars in 89.4%. Overall, 72.0% were fully immunized; defaulters constituted 28.0%. Compared with non-defaulters (n=612), defaulters (n=238) were younger (12–23 mo 30.3% vs 22.5%; p=0.025), more rural (60.1% vs 32.2%; p<0.001), from lower SES (upper-lower 39.9% vs 27.0%; p<0.001), with lower maternal education (no schooling 21.0% vs 11.4%; p<0.001), higher birth order (≥3: 28.2% vs 16.8%; p<0.001), and fewer ANC visits (<4: 43.3% vs 20.8%; p<0.001). Defaulting correlated with no card (56.3% vs 15.7%) or absent BCG scar (28.6% vs 3.6%) and greater distance (>5 km 39.5% vs 23.9%; all p<0.001).

Conclusion: Targeted strengthening of reminder–recall, card retention, reliable session calendars, and rural outreach—prioritizing low-SES, high-parity families—can meaningfully reduce defaulting and improve equitable completion of age-appropriate vaccination among 1–5-year-olds.

Keywords: Immunization Coverage, Vaccination, Child, Preschool, Health Services Accessibility, Maternal Education, India.

Introduction

India's Universal Immunization Programme (UIP) is among the largest public-health initiatives globally, targeting 26 million newborns and 34 million pregnant women each year through more than 13 million immunization sessions.[1, 2] Despite this massive scale, national surveys continue to show room for improvement in routine coverage, with NFHS-5 (2019–21) reporting that roughly three-quarters of children aged 12–23 months are fully immunized and that most vaccinations are delivered through public facilities.[3] Over the past decade, India has implemented focused catch-up drives—including Mission Indradhanush (MI) and Intensified Mission

Indradhanush (IMI)—to accelerate coverage among underserved populations and reduce 'zero-dose' and under-immunized pockets.[4] Persistent inequities reflect a mix of demand- and supply-side determinants that shape completion of the primary series and timely boosters.[5] Maternal education, household wealth, and place of residence consistently predict full immunization, with lower schooling, lower socioeconomic status, and rural residence associated with missed or delayed doses.[5, 6] Parity and birth order also matter: children of higher birth order are less likely to complete schedules, a pattern attributed to time constraints, competing caregiving demands, and opportunity costs.[6] Health-system touchpoints across the continuum of care—especially antenatal care (ANC) and facility-based delivery—facilitate counselling, birth-dose administration, and early linkage to the routine schedule, reinforcing the importance of perinatal service coverage for downstream immunization outcomes.[7, 8] Physical access remains salient: longer distances and transport barriers are linked to defaulting, underscoring the complementary roles of fixed sites and outreach in sustaining series completion.[4]

Two pragmatic markers are often used when auditing uptake and continuity of care. First, possession of a child's immunization card is not only a record but also a behavioural prompt; districts with higher card availability tend to have better completion after accounting for socioeconomic confounders, reflecting improved caregiver recall and provider tracking.[9] Second, the presence of a BCG scar—although not universal—correlates well with tuberculin conversion, and scar absence after several months may indicate failed 'take' or missed birth-dose opportunities, meriting careful interpretation in coverage assessments.[10, 11]

Within this national context, characterizing the burden of defaulting and its correlates at the facility catchment level is essential for tailoring micro-plans—linking caregiver-focused strategies (counselling, reminder–recall, card retention) with system fixes (reliable session calendars, defaulter tracking, and last-mile delivery).[4] Evidence from MI/IMI underscores that while special drives can narrow gaps rapidly, sustained gains depend on routine services that are accessible, predictable, and integrated with maternal-child health platforms.

Against this background, the objectives of the present study were to determine the vaccination status of children 1 to 5 years of age; and the factors associated with childhood immunization defaulters.

Materials and Methods

This was a single centre, hospital-based, analytical cross-sectional study conducted in the Department of Paediatrics, Melmaruvathur Adhiparasakthi Institute of Medical Sciences and Research, Tamil Nadu, India over a period of 12 months between January 2023 and December 2023. The study was approved by the Institutional Human Ethics Committee (IHEC) with reference number MAPIMS/IEC/52/2023 (Project No. 280(1)2023) dated 30/01/2023. The parents were given the Participant Information Sheet (PIS) in their native language, and its contents were verbally explained to ensure their understanding and satisfaction. Enrolment of children into the study proceeded upon receipt of informed written consent/assent. Children 1 to 5 years of age, of both gender attending the paediatric outpatient department and/or admitted in the inpatient wards were enrolled. However, children with progressive neurological disease, immunocompromised children, lack of reliable immunization history and readmission of a previously enrolled child were excluded.

Based on hospital statistics from 2022, approximately 4,000–4,500 children aged 1–5 years attend the paediatric OPD/wards annually; therefore, we anticipated a sampling frame of N=4,250 eligible children during the 12-month study period. We adopted systematic random sampling with interval k=N/n. Selecting every 5th eligible child (k=5) yielded a sample size of 850 participants. Data were collected from the primary caregiver and from available medical records using a predesigned, pretested questionnaire. Each child (1–5 years) was inspected for the presence of a BCG scar, and the immunization card—when available—was verified to ascertain immunization dates and doses. Reasons for missed or delayed vaccinations were recorded in the study proforma and subsequently analyzed. In the absence of an immunization card, caregivers provided a structured recall of the vaccines received, including the approximate timing and injection site, to aid classification. Immunization status was then categorized as follows: fully immunized—receipt of BCG, Hepatitis B, four doses of OPV, two IPV doses, Pentavalent, and MR appropriate to age; unimmunized—receipt of none of the above vaccines; partially immunized—receipt of some but not all age-appropriate primary series and/or booster doses; and defaulter—children who had missed at least one scheduled dose for any reason, including service-related issues such as cancelled sessions or vaccine stock-outs, as per age and the national immunization schedule.

Statistical Analysis: Statistical analyses were performed using SPSS (Version 27, IBM Corp., Armonk, NY). Categorical variables were

summarized as counts and column percentages within defaulter and non-defaulter groups. Between-group comparisons were conducted using Pearson's chi-square test; when expected cell counts were <5, Fisher's exact test was applied. Continuous variables, where applicable, were summarized as mean ± SD or median (IQR) based on distribution (assessed with the Shapiro–Wilk test) and compared using the independent-samples t-test or Mann–Whitney U test, respectively. Two-tailed p-values <0.05 were considered statistically significant.

Results

Among 850 children, the age distribution was even across one-year bands (12–23 months 24.7%, 24–35 months 24.1%, 36–47 months 25.3%, 48–59 months 25.9%); 54.1% were male and 60.0% resided in urban areas. Most families identified as Hindu (80.0%). Socioeconomically, lower-middle (37.6%) and upper-lower (30.6%) strata predominated.

Mothers most often had secondary education (35.3%) and were homemakers (63.5%); fathers most often had secondary (34.1%) or higher-secondary (23.5%) education. Nearly three-quarters of mothers had ≥4 ANC visits (72.9%). Institutional delivery was common (public 50.6%, private 43.5%; home 5.9%) and 30.6% were born by caesarean section. In this cohort (N=850), immunization cards were available for 72.9% of children and a BCG scar was seen in 89.4%. Overall, 72.0% were fully immunized for age, 24.0% were partially immunized, and 4.0% were unimmunized, yielding a defaulter prevalence of 28.0%. Compared with non-defaulters (n=612), defaulters (n=238) were younger (e.g., 12–23 months: 30.3% vs 22.5%; p=0.025) and far more likely to be rural (60.1% vs 32.2%; p<0.001), from lower socioeconomic strata (e.g., upper-lower 39.9% vs 27.0%; p<0.001), and to have mothers with lower educational attainment (no schooling 21.0% vs 11.4%; p<0.001). Higher birth order was associated with defaulting (birth order ≥3: 28.2% vs 16.8%; p<0.001), as was inadequate ANC utilization (<4 visits: 43.3% vs 20.8%; p<0.001). Home delivery was more frequent among defaulters (10.5% vs 4.1%), contributing to a significant overall difference across delivery place categories (p=0.001). Sex and mode of delivery did not differ significantly (p=0.382 and p=0.226, respectively).

Defaulters were markedly less likely to have an immunization card (43.7% vs 84.3% among non-defaulters) and more likely to lack one (56.3% vs 15.7%; p<0.001), and they more often lacked a BCG scar (28.6% vs 3.6%; p<0.001). Greater travel distance was associated with defaulting: >5 km (39.5% of defaulters' vs 23.9% of non-defaulters; p<0.001), whereas <3 km was less common among defaulters (26.5% vs 42.0%). Most vaccinations were obtained at fixed facilities (58.8% overall), yet defaulters more frequently reported routine outreach sessions (44.1% vs 33.5%) and less often private providers (2.9% vs 5.4%; p=0.009).

Table 1: Sociodemographic characteristics of the study participants

		Frequency (N = 850) (n)	Percentage (%)
Age	12–23 months	210	24.7
	24–35 months	205	24.1
	36–47 months	215	25.3
	48–59 months	220	25.9
Gender	Male	460	54.1
	Female	390	45.9
Residence	Urban	510	60.0
	Rural	340	40.0
Religion	Hindu	680	80.0
	Muslim	120	14.1
	Christian	40	4.7
	Other	10	1.2
Socioeconomic status	Upper	60	7.1
	Upper middle	160	18.8
	Lower middle	320	37.6
	Upper lower	260	30.6
	Lower	50	5.9
Mothers' education	No formal schooling	120	14.1
	Primary (1–5)	180	21.2
	Secondary (6–10)	300	35.3
	Higher secondary (11–12)	170	20.0
	Graduate and above	80	9.4

Fathers' education	No formal schooling	80	9.4
	Primary (1–5)	160	18.8
	Secondary (6–10)	290	34.1
	Higher secondary (11–12)	200	23.5
	Graduate and above	120	14.1
Mothers' occupation	Homemaker	540	63.5
	Unskilled/Informal	170	20.0
	Skilled	90	10.6
	Professional/Clerical	50	5.9
Birth order	1	370	43.5
	2	310	36.5
	3+	170	20.0
Antenatal care visits (Mother)	<4 ANC visits (mother)	230	27.1
	≥4 ANC visits (mother)	620	72.9
Place of delivery	Institutional (public)	430	50.6
	Institutional (private)	370	43.5
	Home	50	5.9
Mode of delivery	Vaginal	590	69.4
	Caesarean	260	30.6

Table 2: Immunization characteristics of the study participants

		Frequency (N = 850) (n)	**Percentage (%)**
Immunization card availability	Available	620	72.9
	Not available	230	27.1
BCG scar	Present	760	89.4
	Absent	90	10.6
Immunization status (age appropriate)	Fully immunized (age-appropriate)	612	72.0
	Partially immunized	204	24.0
	Unimmunized	34	4.0
Defaulter status	Non-defaulter	612	72.0
	Defaulter	238	28.0
Reasons for defaulting	Lack of awareness/forgot schedule	58	24.4
	Child illness at due date	36	15.1
	Fear of AEFI	21	8.8
	Family opposition/cultural reasons	17	7.1
	Migration/temporary relocation	28	11.8
	Distance/transport constraints	29	12.2
	Parent working/time constraints	23	9.7
	Health facility issues (stock-out/cancelled session)	26	10.9
Distance to usual vaccination point	<3 km	320	37.6
	3–5 km	290	34.1
	>5 km	240	28.2
Type of usual vaccination session/provider	Routine outreach clinic	310	36.5
	Fixed facility clinic	500	58.8
	Private pediatrician	40	4.7

Table 3: Sociodemographic factors associated with childhood immunization defaulters

		Defaulter N = 238		Non-defaulter N = 612		P value
		n	%	n	%	
Age	12–23 months	72	30.3	138	22.5	0.025*
	24–35 months	63	26.5	142	23.2	
	36–47 months	54	22.7	161	26.3	
	48–59 months	49	20.6	171	27.9	
Gender	Male	135	56.7	325	53.1	0.382
	Female	103	43.3	287	46.9	
Residence	Urban	95	39.9	415	67.8	<0.001*
	Rural	143	60.1	197	32.2	
Religion	Hindu	190	79.8	490	80.1	0.090
	Muslim	40	16.8	80	13.1	
	Christian	5	2.1	35	5.7	
	Other	3	1.3	7	1.1	
Socioeconomic status	Upper	1	0.4	59	9.6	<0.001*
	Upper middle	23	9.7	137	22.4	
	Lower middle	99	41.6	221	36.1	
	Upper lower	95	39.9	165	27.0	
	Lower	20	8.4	30	4.9	
Mothers' education	No formal schooling	50	21.0	70	11.4	<0.001*
	Primary (1–5)	66	27.7	114	18.6	
	Secondary (6–10)	84	35.3	216	35.3	
	Higher secondary (11–12)	37	15.5	133	21.7	
	Graduate and above	1	0.4	79	12.9	
Fathers' education	No formal schooling	29	12.2	51	8.3	0.040*
	Primary (1–5)	54	22.7	106	17.3	
	Secondary (6–10)	81	34.0	209	34.2	
	Higher secondary (11–12)	50	21.0	150	24.5	
	Graduate and above	24	10.1	96	15.7	
Mothers' occupation	Homemaker	151	63.4	389	63.6	0.052
	Unskilled/Informal	57	23.9	113	18.5	
	Skilled	23	9.7	67	10.9	
	Professional/Clerical	7	2.9	43	7.0	
Birth order	1	76	31.9	294	48.0	<0.001*
	2	95	39.9	215	35.1	
	3+	67	28.2	103	16.8	
Antenatal care visits (Mother)	<4 ANC visits (mother)	103	43.3	127	20.8	<0.001*
	≥4 ANC visits (mother)	135	56.7	485	79.2	
Place of delivery	Institutional (public)	120	50.4	310	50.7	0.001*
	Institutional (private)	93	39.1	277	45.3	
	Home	25	10.5	25	4.1	
Mode of delivery	Vaginal	173	72.7	417	68.1	0.226
	Caesarean	65	27.3	195	31.9	
*Statistically significant at p<0.05						

Table 4: Immunization factors associated with childhood immunization defaulters

		Defaulter N = 238		Non-defaulter N = 612		P value
		n	%	n	%	
Immunization card availability	Available	104	43.7	516	84.3	<0.001*
	Not available	134	56.3	96	15.7	
BCG scar	Present	170	71.4	590	96.4	<0.001*
	Absent	68	28.6	22	3.6	
Distance to usual vaccination point	<3 km	63	26.5	257	42.0	<0.001*
	3–5 km	81	34.0	209	34.2	
	>5 km	94	39.5	146	23.9	
Type of usual vaccination session/provider	Routine outreach clinic	105	44.1	205	33.5	0.009*
	Fixed facility clinic	126	52.9	374	61.1	
	Private paediatrician	7	2.9	33	5.4	
*Statistically significant at p<0.05						

Discussion

Our findings align with national patterns on coverage and inequalities in India, where NFHS-5 reported that 76% of children aged 12–23 months were fully immunized and BCG coverage exceeded 94%, supporting the high card possession and BCG-scar prevalence observed in our cohort.[5] The near-universal reliance on institutional delivery in our sample also mirrors NFHS-5 gains in facility births and offers an enabling platform for timely birth-dose vaccination and early linkage to routine immunization.[3, 12] The overall full-immunization level of 72% in our study is consistent with Summan et al. (2022) showing national improvements between 2015–2016 and 2019–2020, yet underscores residual gaps that persist despite programmatic acceleration.[13] The higher likelihood of defaulting among younger children (12–23 months) is plausible because many have not yet completed age-appropriate schedules and are still navigating multiple contact points and boosters; district-level analyses from India by Panda et al (2020) and Saikia et al. (2023) have similarly highlighted timing and schedule completion as critical bottlenecks in the second year of life.[14, 15] The pronounced rural disadvantage in our cohort (defaulters 60.1% rural vs 32.2% among non-defaulters) is in keeping with national survey gradients and geospatial work documenting lower full-immunization probabilities in rural and underserved pockets.[15] Programmatic evaluations of Intensified Mission Indradhanush (IMI) attribute coverage gains in such hard-to-reach areas to micro-planning, intersectoral coordination, and targeted session hold-ups, but also recognize the difficulty of sustaining those gains without strengthening routine delivery.[4, 16]

Socioeconomic patterning was evident. Defaulters clustered in lower strata (upper-lower and lower classes), echoing multi-state analyses in which household wealth and education covary with vaccine completion.[17-19] maternal education emerged as a powerful correlate. No formal schooling and only primary education were over-represented among defaulters in our study, consistent with evidence that maternal schooling improves knowledge of schedules, perceived benefits, and care-seeking for missed doses.[20] Logistic models from Indian datasets repeatedly identify maternal education as an independent predictor of complete immunization, even after adjustment for socioeconomic status and place of residence.[14]

Higher birth order (≥3) was associated with defaulting, a pattern widely reported in India and other LMIC settings, likely reflecting time and resource constraints, competing child-care demands, and normalization of minor illness as a contraindication.[20] District-level studies further note that parity interacts with other disadvantages—such as lower maternal schooling and rural residence—to widen the completion gap.[15] Antenatal care (ANC) offered a protective signal. Mothers with ≥4 ANC visits were less likely to have defaulter children, aligning with NFHS-based analyses in which adequate ANC improves exposure to counselling, scheduling, and postnatal linkages to immunization services.[14, 21-23] Likewise, the greater frequency of home births among defaulters reinforces the well-documented benefits of facility delivery for on-time birth doses, early registration, and reinforced caregiver counselling at discharge.[6] Two service-readiness markers—immunization card possession and BCG scar—showed strong negative associations with defaulting in our data. Card possession is consistently associated with higher full-immunization odds in NFHS analyses and independent studies, functioning both as a record and a tangible reminder that catalyses return visits.[6, 24] At scale, districts with high card possession display narrower full-immunization gaps after adjustment for wealth, residence, and mother's education, underscoring the card's

behavioural and systems value.[25] The BCG scar, while not a perfect proxy for receipt, is widely used as an objective marker of prior vaccination and has been associated with better survival and immunological priming in several cohorts; its absence in a sizable fraction of defaulters in our study is therefore clinically and programmatically meaningful.[26, 27] Importantly, classic Indian program guidance recognizes that some vaccinated children may not develop a visible scar, and revaccination has been considered when scar is absent beyond three months—a nuance relevant when interpreting scar-based audits.[28]

Geographic access and service modality also mattered. Greater distance to the usual vaccination point (>5 km) was linked with defaulting, consistent with studies from Assam and other Indian settings where shorter distances (<2–3 km) increased completion, likely via reduced travel costs, time, and opportunity loss.[29] Contemporary reviews echo distance and transport as persistent supply-side barriers, particularly where session frequency is low and last-mile connectivity is constrained.[30] The higher use of routine outreach among defaulters in our data may reflect selection. Outreach preferentially targets remote or migrant communities with baseline disadvantages (e.g., informal work schedules, temporary relocation), improving reach but not always ensuring series completion without follow-up and robust defaulter tracking.[4] Evidence from IMI highlights that while door-to-door line-listing and special campaigns can accelerate first-dose uptake in 'zero-dose' children, consolidation to a completed schedule requires continuity with fixed-site services and reliable session calendars.[16]

Several caregiver-reported reasons for defaulting in our cohort—lack of awareness/forgotten schedule, child illness on due date, fear of adverse events following immunization (AEFI), parental time constraints, and service issues (stock-outs/cancelled sessions)—mirror Indian hospital- and community-based studies.[31] These themes are consonant with NFHS-driven program briefs that emphasize strengthening defaulter tracking, counselling to counter AEFI fears, and session reliability to minimize missed opportunities.[14] Nationally, the immunization landscape has benefited from newer strategies (e.g., Mission Indradhanush and its intensified phases), which combine micro-planning, risk mapping, and interdepartmental coordination to reduce both demand- and supply-side gaps.[4] While such initiatives have improved coverage, district heterogeneity persists, making the case for locally tailored solutions that leverage card audits, community health workers, and reminder-recall tools to prevent slippage between doses.

This study has several limitations. First, the design precludes causal inference between exposures (e.g., maternal education, distance, ANC utilization) and defaulting; associations should be interpreted as correlational rather than causal. Second, selection bias is possible because participants were recruited from OPD/IPD settings, which may over-represent families with better care-seeking than community non-attenders, limiting generalizability to the broader catchment. Third, immunization status and reasons for defaulting relied partly on caregiver recall when cards were unavailable, introducing recall and social-desirability bias; BCG scar assessment may also misclassify vaccinated children who did not form a visible scar. Fourth, potential information bias exists because doses were not independently verified against electronic/primary facility registers, and 'distance to vaccination point' was self-reported without GIS or travel-time validation. Fifth, residual confounding cannot be excluded (e.g., paternal involvement, household decision-making, vaccine session density, migration dynamics), and multiple between-group comparisons raise the risk of type-I error (no adjustment for multiplicity was applied).

Conclusion

In this hospital-based cross-sectional study of 850 children aged 1–5 years, 72.0% were fully immunized for age while 28.0% were defaulters, with card possession (72.9%) and BCG scar prevalence (89.4%) broadly reflecting good—but incomplete—programme reach. Defaulting clustered among younger children, rural residents, lower socioeconomic strata, and those with mothers of lower educational attainment; higher birth order, inadequate ANC (<4 visits), longer travel distance (>5 km), home delivery, lack of an immunization card, and absence of a BCG scar were additional correlates.

These findings underscore that both demand- and supply-side determinants continue to shape completion of the routine schedule despite high institutional delivery rates and substantial fixed-facility coverage. Strengthening defaulter tracking and reminder–recall, ensuring reliable session calendars and vaccine availability, promoting card retention and caregiver counselling (especially in the second year of life), and prioritizing rural, low-SES, high-parity households can meaningfully reduce missed doses. Integrating these actions within ongoing ANC, delivery, and postnatal touchpoints—and leveraging outreach strategically to connect hard-to-reach families back to fixed-site services—should improve series completion and advance equitable immunization coverage in the catchment population.

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