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# IMMUNIZATION COVERAGE AND DETERMINANTS OF IMMUNIZATION FAILURE AMONG CHILDREN AGED 0–5 YEARS ADMITTED TO A TERTIARY CARE HOSPITAL IN AHMEDABAD, WESTERN INDIA: A CROSS-SECTIONAL STUDY

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**ABSTRACT**

**Background:** Universal childhood immunization is one of the most cost-effective public health interventions. However, immunization coverage in India remains below the 85% target under the Universal Immunization Programme (UIP), with dropout and missed opportunities contributing to preventable childhood morbidity and mortality.

**Objectives:** To assess the immunization status of children aged 0–5 years admitted to the paediatric department of a tertiary care hospital in Ahmedabad, determine its association with socio-demographic factors, and identify reasons for incomplete or absent immunization.

**Methods:** A hospital-based cross-sectional study using purposive sampling was conducted in the Department of Paediatrics of a tertiary care hospital in Ahmedabad from December 2016 to November 2018. Five hundred children aged 0–60 months were enrolled. Immunization status was assessed through structured parental interviews and verified using immunization (Mamta) cards. Children were classified as completely, partially, or non-immunized according to the National Immunization Schedule. Data were analysed using Microsoft Excel and Pearson's chi-square test, with $p<0.05$ considered statistically significant.

**Results:** Among 500 children, 266 (53.2%) were male and 234 (46.8%) female. Overall, 66.6% were completely immunized, 27.2% partially immunized, and 6.2% non-immunized. Coverage was highest for birth doses (BCG, OPV and Hepatitis B) at 85.8% and lowest for measles-2/booster-1 at 57.7%. BCG-to-measles-1 and Pentavalent-1-to-3 dropout rates were 16.2% and 11.4%, respectively. Complete immunization was significantly associated with joint family structure, institutional delivery, doctor-attended delivery, higher parental education, and higher family income ($p<0.05$). Major reported reasons for incomplete immunization were unawareness of subsequent vaccination (26.3%), child sickness (14.4%), and lack of faith in immunization (11.9%).

**Conclusion:** Childhood immunization coverage remained below the UIP target. Strengthening parental counselling, reminder and tracking systems, and frontline health-worker communication may improve completion rates.

***Keywords:*** *Immunization coverage; Universal Immunization Programme; vaccine dropout; missed opportunity; childhood vaccination; knowledge-attitude-practice; India.*



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## INTRODUCTION

Immunization is one of the most cost-effective public health interventions available, protecting children from vaccine-preventable diseases (VPDs) that remain leading causes of childhood morbidity and mortality in resource-limited settings [1]. The World Health Organization estimates that vaccination currently averts 2.5 million deaths annually, and that universal coverage with fully effective vaccines could prevent one in every seven deaths among young children worldwide [2]. India, contributing disproportionately to the global under-five mortality burden, introduced six antigens under the Expanded Programme of Immunization in 1978 and subsequently launched the Universal Immunization Programme (UIP) in 1985 to provide free vaccination against vaccine-preventable diseases through the National Immunization Schedule [1,3].

Despite more than three decades of programmatic effort, the UIP has been able to fully immunize only around 65% of children in their first year of life nationally, and coverage gains have plateaued in several states [3]. The fourth National Family Health Survey (NFHS-4, 2015-16) recorded complete immunization of only 62% of children aged 12-23 months, underscoring the persistent shortfall against the 85% programmatic target [38].

Incomplete immunization arises through two overlapping pathways: children who are never brought for vaccination (left-out), and children who begin the schedule but do not complete it (dropout). Dropout, in particular, reflects missed opportunities within the health system - contacts during which an eligible child was not vaccinated - and is a sensitive marker of health-system performance, parental knowledge, and service accessibility [16]. Both left-out and dropout patterns are shaped by a complex interplay of socio-demographic factors (place of delivery, birth attendant, family structure, parental literacy and income), and knowledge-attitude-practice (KAP) barriers such as unawareness of the vaccination schedule, fear of adverse events following immunization, inconvenient timing or location of services, and a false perception that a mildly unwell child cannot be vaccinated [20,21]. Despite sustained governmental and non-governmental efforts, geographic and social pockets of low coverage persist in India, including in Gujarat [16, 17].

A hospitalised paediatric population offers a unique, resource-efficient window to concurrently audit immunization status against documentary evidence and to probe, through direct parental interview, the specific reasons underlying partial or non-immunization - information that is difficult to capture through routine coverage surveys alone. We therefore undertook this study to evaluate the immunization coverage and its socio-demographic correlates, and to characterise the reasons for immunization failure, among children aged 0-5 years admitted to the paediatric ward of a tertiary care hospital in Ahmedabad, with the intention of informing locally relevant, actionable interventions to improve coverage and reduce dropout.

## MATERIALS AND METHODS

### Study design and setting

This was a hospital-based, observational, cross-sectional study conducted in the Department of Paediatrics of a tertiary care teaching hospital in Ahmedabad, Gujarat, India. This report follows the STROBE (Strengthening the Reporting of Observational Studies in Epidemiology) guidance for cross-sectional studies.

### Study duration and sampling

All children aged 0 to 5 years admitted to the paediatric ward over a 24-month period, from December 2016 to November 2018, were considered for enrolment using a purposive (consecutive, non-probability) sampling method. A total of 500 children who satisfied the eligibility criteria and whose parents consented were enrolled.

### Inclusion and exclusion criteria

**Inclusion criteria:** (i) children aged 0 to 5 years admitted to the paediatric ward during the study period; (ii) parents/guardians willing to participate in the study.

**Exclusion criteria:** (i) children older than 5 years admitted during the study period; (ii) parents/guardians unwilling to participate.

### Data collection

A detailed bio-data of each child, including name, age, gender, address, and parental income and education, was recorded by oral questionnaire. Written informed consent was obtained from a parent or legally acceptable representative prior to enrolment, and adequate privacy and confidentiality were maintained throughout. The mother was the primary respondent; where she was unavailable or unaware of the child's immunization status, the father was interviewed. Information on vaccines received was cross-verified against the child's immunization (Mamta) card wherever available, to minimise recall bias. A pretested, structured proforma was used to record socio-demographic variables (type of family, place of delivery, birth attendant, birth order, parental education, monthly family income, immunization-card availability) together with a knowledge-attitude-practice (KAP) module comprising yes/no questions addressing awareness of immunization, of subsequent doses, of the place of immunization, and of pulse-polio and injectable vaccines (knowledge domain); perceived need for immunization, convenience of scheduled timing, fear of side effects, and exposure to misinformation (attitude domain); and child illness at the scheduled time, inconvenient location, service availability, and financial constraints (practice domain). Parents of partially or non-immunized children were additionally asked an open question on the principal reason for missed vaccination, and about the source of immunization information and the usual place of immunization.

### Immunization assessment criteria

**Completely immunized:** a child aged 0-60 months who had received all vaccines appropriate for age as per the National Immunization Schedule (children enrolled before the introduction of IPV in Gujarat in November 2015, or of fractional IPV in 2017, and who had not received these specific doses solely because they pre-dated introduction, were still classified as completely immunized).

**Partially immunized:** a child who had missed one or more age-appropriate vaccine doses.

**Non-immunized:** a child who had received no vaccine other than OPV administered during pulse-polio rounds.

**Left-out rate:** the proportion of children who had not received any vaccination.

**Dropout rate:** the percentage difference between the number of children receiving the maximum-antigen dose and the minimum-antigen dose in a series, expressed as a percentage of coverage with the maximum-antigen dose (for example, dropout from BCG to measles = [BCG coverage - measles coverage] / BCG coverage × 100).

### Statistical analysis

Data were entered and tabulated in Microsoft Excel. Categorical variables were summarised as frequencies and percentages. Associations between immunization status and categorical socio-demographic variables were tested using Pearson's chi-square test for independence. A two-sided p-value <0.05 was considered statistically significant.

## RESULTS

### Demographic profile of the study population

A total of 500 children aged 0-60 months were enrolled, of whom 266 (53.2%) were male and 234 (46.8%) were female. The socio-demographic characteristics of the study population are summarised in Table 1.

Table 01: Socio-demographic characteristics of the study population (N=500)

| Characteristic | Category | n | % |
|---|---|---|---|
| Gender | Male | 266 | 53.2 |
| | Female | 234 | 46.8 |
| Type of family | Joint | 334 | 66.8 |
| | Nuclear | 166 | 33.2 |
| Place of delivery | Hospital | 310 | 62.0 |
| | Home | 190 | 38.0 |
| Birth attendant | Doctor | 366 | 73.2 |
| | Trained dai | 98 | 19.6 |
| | Untrained dai | 33 | 6.6 |
| Birth order | ≤2 | 340 | 68.0 |
| | >2 | 160 | 32.0 |
| Father's education | ≤Primary | 209 | 41.8 |
| | >Primary | 291 | 58.2 |
| Mother's education | ≤Primary | 287 | 57.4 |
| | >Primary | 213 | 42.6 |
| Monthly family income | ≤₹5000 | 333 | 66.6 |
| | ₹5000–10,000 | 111 | 22.2 |
| | >₹10,000 | 56 | 11.2 |
| Immunization card available | Yes | 442 | 88.4 |
| | No | 58 | 11.6 |

### Overall immunization status

Overall, 333 children (66.6%) were completely immunized, 136 (27.2%) were partially immunized, and 31 (6.2%) were non-immunized (Table 02, Figure 01). This falls short of the 85% coverage target of the UIP.

**Table 02: Immunization status of study children, overall and by gender**

| Immunization status | Male, n (%) | Female, n (%) | Total, n | % of total |
|---|---|---|---|---|
| Completely immunized | 179 (67.2) | 154 (65.8) | 333 | 66.6 |
| Partially immunized | 74 (27.8) | 62 (26.4) | 136 | 27.2 |
| Non-immunized | 13 (4.8) | 18 (7.6) | 31 | 6.2 |
| Total | 266 (100) | 234 (100) | 500 | 100.0 |

Complete-immunization rates were marginally higher among boys than girls (67.2% vs 65.8%), but this difference was not statistically significant ($\chi 2$ test, p=0.427). The Gender Disparity Ratio (GDR), calculated as the ratio of male-to-female immunization rates ×100, was 102.12 in this study, indicating a mild disadvantage for girls; comparable GDR values of 115.27 and 105.4 have been reported in other Indian studies [41, 42].

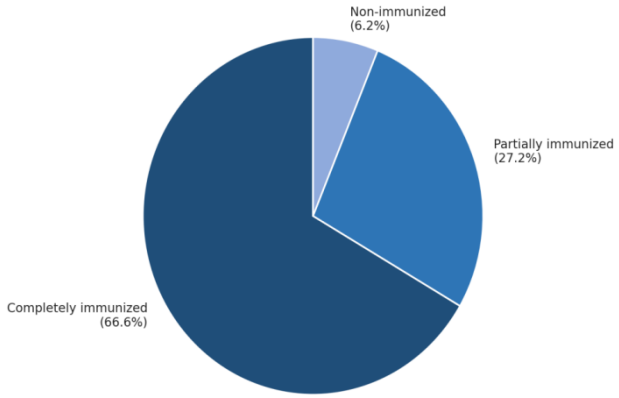


Figure 01: Overall immunization status of study children (N=500).

### Vaccine-wise coverage and dropout

With regard to individual antigens, coverage was highest for the birth dose (BCG+OPV+HepB, 85.8%) and the first dose of Pentavalent vaccine plus OPV (P1+OPV1, 83.9%), and lowest for the second dose of measles and the first booster (both 57.7%) (Table 03, Figure 02). Only 72.7% of children received the third dose of Pentavalent/OPV, and coverage fell further for measles-2 and booster doses, indicating substantial attrition as the schedule progressed.

Table 03: Vaccine-wise immunization coverage in the study population (N=500)

| Vaccine | n vaccinated | N eligible | Coverage (%) |
|---|---|---|---|
| Birth vaccine (BCG+OPV+HepB) | 429 | 500 | 85.8 |
| Pentavalent-1 + OPV-1 | 413 | 492 | 83.9 |
| Pentavalent-2 + OPV-2 | 370 | 460 | 80.4 |
| Pentavalent-3 + OPV-3 | 325 | 447 | 72.7 |
| IPV | 370 | 447 | 82.7 |
| Measles-1 | 258 | 374 | 68.9 |
| Measles-2 | 154 | 267 | 57.7 |
| Booster-1 (DPT) | 154 | 267 | 57.7 |
| Booster-2 | 32 | 38 | 84.2 |

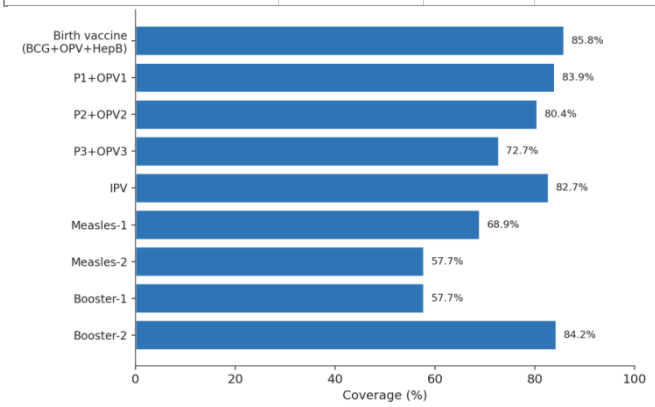


Figure 02: Vaccine-wise immunization coverage (N=500).

Dropout analysis showed a BCG-to-measles-1 dropout rate of 16.2% and a Pentavalent-1-to-3 dropout rate of 11.4%; the composite BCG-to-Pentavalent-3 dropout was 14.2% and the left-out rate (children receiving no vaccination at all) was 6.2% (Table 04, Figure 03). These values are comparable to the 15% and 13% dropout reported for the same intervals in the 2009 Coverage Evaluation Survey (CES) [16].

Table 04: Vaccine dropout and left-out rates

| Indicator | Rate (%) |
|---|---|
| BCG to Measles-1 dropout | 16.2 |
| Pentavalent-1(P1) to Measles-1 dropout | 15.4 |
| Measles-1 to Measles-2 dropout | 15.3 |
| BCG to Pentavalent-3 dropout | 14.2 |
| Pentavalent-1 to Pentavalent-3 dropout | 11.4 |
| Pentavalent-2 to Pentavalent-3 dropout | 9.2 |
| Left-out rate (no vaccination received) | 6.2 |

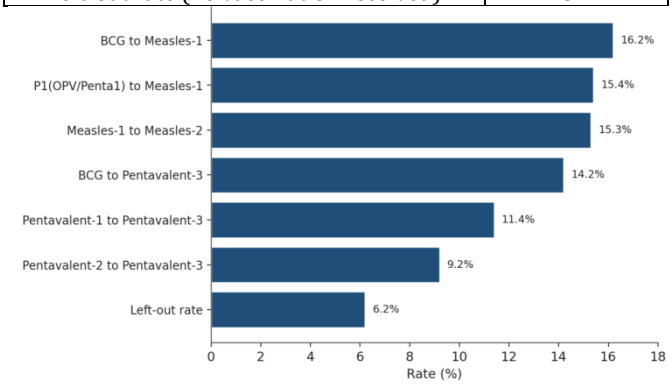


Figure 03: Vaccine dropout and left-out rates (N=500).

**Association of immunization status with socio-demographic determinants**

Complete immunization was significantly associated with type of family, place of delivery, birth attendant, parental education, and monthly family income (all p<0.05 on chi-square testing). Gender (p=0.427), birth order (p=0.18), and possession of an immunization card (statistically non-significant) were not significantly associated with complete immunization status in this cohort (Table 05).

Table 05: Association between complete immunization status and socio-demographic determinants

| Determinant | Category | Completely immunized, n (%) | p-value |
|---|---|---|---|
| Gender | Male | 179 (67.2) | 0.427 |
| | Female | 154 (65.8) | |
| Type of family | Joint (n=334) | 241 (72.2) | <0.05 |
| | Nuclear (n=166) | 32 (55.4)* | |
| Place of delivery | Hospital (n=310) | 261 (84.2) | <0.05 |
| | Home (n=190) | 72 (37.9) | |
| Birth attendant | Doctor (n=366) | 265 (72.4) | <0.00001 |
| | Trained dai (n=98) | 58 (59.2) | |
| | Untrained dai (n=33) | 9 (27.3) | |
| Birth order | ≤2 (n=340) | 233 (68.5) | 0.18 |
| | >2 (n=160) | 100 (62.5) | |
| Father's education | ≤Primary (n=209) | 98 (46.9) | <0.05 |
| | >Primary (n=291) | 235 (80.8) | |
| Mother's education | ≤Primary (n=287) | 151 (52.6) | <0.05 |
| | >Primary (n=213) | 182 (85.4) | |
| Family income/month | ≤₹5000 (n=333) | 176 (52.9) | <0.05 |
| | ₹5000–10,000 (n=111) | 106 (95.5) | |
| | >₹10,000 (n=56) | 51 (91.1) | |
| Immunization card available | Yes (n=442) | 320 (72.4) | NS |
| | No (n=58) | 13 (22.4) | |

**Percentage recalculated from source frequencies reported in the parent thesis (32/58, joint-family figures reported as 241/334 [72.2%]).*

Children delivered in a hospital setting had markedly higher complete-immunization rates than those delivered at home (84.2% vs 37.9%, p<0.05), and this pattern was mirrored for deliveries attended by a doctor compared with an untrained dai. Maternal and paternal education above primary level were each associated with a roughly 30-percentage-point increase in complete immunization relative to ≤primary education (mother: 85.4% vs 52.6%; father: 80.8% vs 46.9%; both p<0.05). Complete immunization rose steeply with family income, from 52.9% in families earning ≤₹5000/month to over 91% in families earning >₹5000/month (p<0.05). Although families possessing an immunization card had numerically higher complete-immunization rates (72.4% vs 22.4%), this difference did not reach the pre-specified significance threshold in the original analysis.

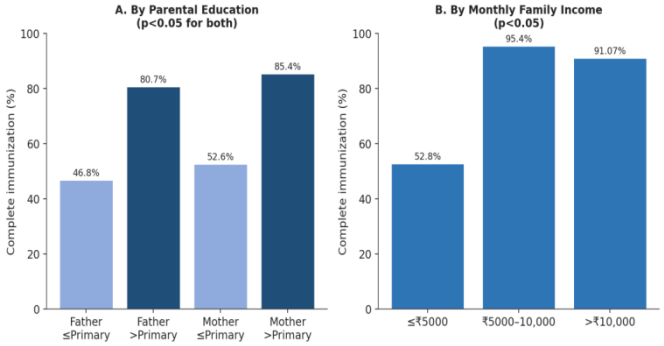


Figure 05: Complete immunization by parental education (Panel A) and monthly family income (Panel B).

**Knowledge, attitude and practice barriers**

Among the 167 partially or non-immunized children, 21 parents (12.5%) were entirely unaware of the immunization process, and 70 (42%) were unaware of the need for subsequent doses (p=0.00001) - the single most consistent knowledge gap identified. On the attitude domain, 47.9% of parents reported having received misleading advice about immunization from a third party, 47.3% cited fear of side effects, and 26.3% found the scheduled timing inconvenient (p<0.00001). On the practice domain, illness of the child at the scheduled time was the most frequently cited barrier, affecting 69% (116/167) of partially/non-immunized children (p<0.00001), followed by an inconvenient location (25%), poor availability of services (21.5%), and financial constraints (5.9%). A composite summary of all KAP barriers, ranked by frequency, is presented in Table 06.

Table 06: Knowledge, attitude and practice-related barriers among partially/non-immunized children (n=167)

| Barrier | n/167 | % |
|---|---|---|
| Child sick at the scheduled time | 116 | 69.0 |
| Received wrong/misleading advice regarding immunization | 80 | 47.9 |
| Fear of side effects of immunization | 79 | 47.3 |
| Unaware of subsequent immunization | 70 | 42.0 |
| Scheduled time for immunization inconvenient | 44 | 26.3 |
| Place of immunization too far/inconvenient | 42 | 25.0 |
| Problem with availability of immunization services | 36 | 21.5 |
| Did not feel the need for immunization | 23 | 13.8 |
| Unaware of the place of immunization | 22 | 13.0 |
| Totally unaware of immunization | 21 | 12.5 |
| Unaware of injectable vaccines | 11 | 6.5 |
| Unaware of pulse-polio immunization | 11 | 6.5 |
| Financial problem in visiting the immunization centre | 10 | 5.9 |

**Reasons for missed opportunity and immunization failure**

When parents of the 167 partially/non-immunized children were asked to identify the single principal reason for missed vaccination, the three leading responses were unawareness of the need for a subsequent vaccine (26.3%), child sickness at the scheduled time (14.4%), and lack of faith in immunization (11.9%), followed by fear of side effects (9.6%), inconvenient timing or location (8.9%), migration (7.2%), the mistaken belief that OPV is the only vaccine required (5.9%), lack of motivation (4.2%), forgetfulness (4.2%), family problems (2.9%), the child being brought unwell but not immunized (2.4%), and social inhibition (1.8%) (Figure 04).

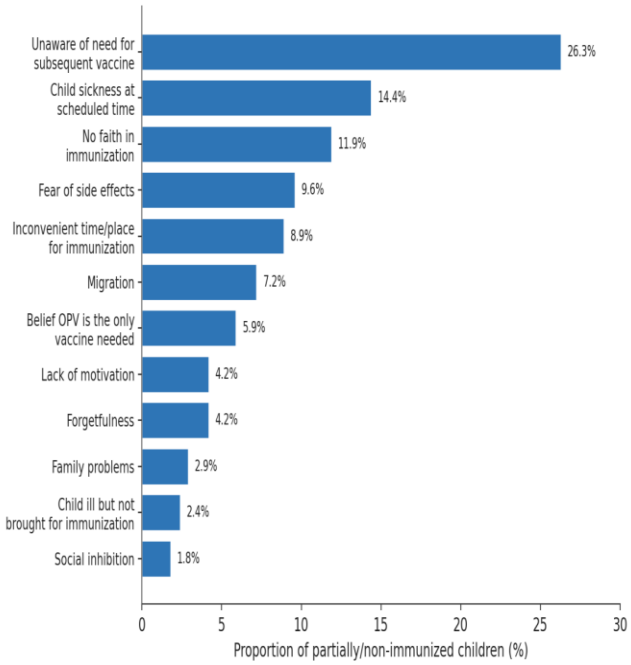


Figure 04: Parent-reported reasons for immunization failure among partially/non-immunized children (n=167).

**Source of information and place of immunization**

Doctors were the most frequently cited source of immunization information (48%), followed by paramedical workers (29%), community leaders (13%), and posters/television (10%); doctors were the leading information source for 51% of completely immunized children specifically. Anganwadi centres were the commonest reported place of immunization (56%), followed by government hospitals (30.8%) and private hospitals (13.2%), broadly consistent with the national pattern described in the Rapid Survey on Children (RSOC) 2013-14, in which Anganwadi centres and government facilities together accounted for 85% of immunizations nationally [14].

## DISCUSSION

In this hospital-based cohort of 500 children aged 0-60 months, complete immunization coverage was 66.6%, appreciably below the 85% UIP target but broadly consistent with contemporaneous national and state estimates. The 2009

Coverage Evaluation Survey (CES) reported 61% complete immunization and 7.6% non-immunization, RSOC 2013-14 reported 65.3% and 6.6% respectively, and NFHS-4 (2015-16) reported 62% and 6% respectively(14,16,38) - figures closely paralleling our findings of 66.6% and 6.2%. Similarly high coverage has been reported by Yadav et al. in urban slums of Jamnagar (73.3% fully immunized) [37], and by Kadri et al. and Khokhar et al. in other urban Indian settings.(28,36) Taken together, these comparisons suggest that despite three decades of the UIP, a stable one-third of Indian children remain incompletely protected, a gap that has proven resistant to purely supply-side interventions.

Vaccine-wise, coverage declined progressively across the schedule, from 85.8% for the birth dose to 57.7% for measles-2/booster-1, a pattern mirrored in RSOC 2013-14, where dropout from the first to the third dose of DPT, OPV and hepatitis B was 16%, 18% and 48% respectively [14]. Our BCG-to-measles dropout of 16.2% and Pentavalent-1-to-3 dropout of 11.4% closely match the 15% and 13% reported by CES 2009 for the same intervals, [16] and are comparable to the 14% BCG-to-measles dropout reported by Jariwala in a Gujarat slum population [39]. Persistent dropout, as opposed to complete non-uptake, implicates health-system contact failures - children are being brought into contact with the system but not retained through to schedule completion - and is therefore a specific and actionable target for intervention, for example through active tracking and back-tracing of due and overdue children, as has also been recommended elsewhere [16].

The modest male excess in complete immunization (67.2% vs 65.8%) was not statistically significant, but the calculated Gender Disparity Ratio of 102.12 indicates a mild disadvantage for girls, consistent with GDR values of 115.27 and 105.4 reported by Mugada et al. and Shanawaz et al. respectively [41, 42]. Even where absolute differences are small, persistently skewed GDR values across multiple Indian studies suggest a systematic, if subtle, gender bias in health-seeking behaviour for immunization that merits continued monitoring and targeted female-child health promotion.

Institutional delivery and delivery attended by a doctor were both strongly associated with subsequent complete immunization, mirroring findings from Yadav et al. in Jamnagar [37], Nath et al. in Lucknow (who found home-delivered children significantly less likely to be vaccinated at all) [40], and Kumar et al. in Delhi [30]. This association plausibly reflects early sensitisation of parents to immunization during antenatal and intrapartum hospital contact, as well as the near-universal administration of birth-dose BCG and OPV at the point of institutional delivery - a single contact that anchors the child within the vaccination system. Conversely, children delivered at home, particularly by an untrained dai, represent a population at the interface of two vulnerabilities (low institutional contact and low health literacy) and were disproportionately represented among the non-immunized in our cohort, echoing Kumar et al.'s similar observation [30].

Parental education, and particularly maternal education, showed a strong graded association with complete immunization, consistent with Agrwal and Kumari (86.36% complete immunization with maternal education above primary vs 35.53% at or below primary) [29] and with the CES 2009 finding that only 45.3% of children of illiterate mothers were fully immunized compared with 76.6% of children of mothers with higher secondary education or above [16]. This gradient is biologically and socially plausible: maternal literacy is closely linked to health-seeking behaviour, comprehension of vaccination schedules, and receptivity to health worker counselling. Family income showed a similarly graded, statistically significant association, consistent with the wealth-quintile gradient described in RSOC 2013-14 [14]. Birth order and possession of an immunization card were not significantly associated with complete immunization in our cohort; while card possession is widely reported as facilitating tracking and reducing recall bias,(31) its lack of significant association here may reflect the relatively high card-retention rate in our sample (88.4%), limiting statistical power to detect a difference.

The KAP analysis identified illness of the child at the scheduled time as the single most common practical barrier (69% of partially/non-immunized children), reflecting a persistent and remediable misconception - among both parents and, at times, health workers - that minor illness is a contraindication to vaccination. Similar barriers, including inadequate knowledge of subsequent dosing, fear of side effects, lack of faith in immunization, and logistic inconvenience, have been reported by Kumar et al., Mukherjee et al., Manjunath and Pareek, and Gupta et al. across diverse Indian settings.(32-35) Unawareness of the need for a subsequent vaccine emerged as the leading single reason for missed opportunity in our cohort (26.3%), underscoring that many caregivers who initiate the schedule are not adequately counselled about its completion - a finding with direct implications for the content and timing of health-worker communication at each contact.

Doctors and paramedical workers were the dominant sources of immunization information in our study (48% and 29% respectively), similar to the findings of Gulati et al. in Delhi, who also identified health staff as the most influential information source [43]. Anganwadi workers were the leading providers of immunization services (56%), broadly consistent with the national pattern in RSOC 2013-14 [41]. Because Anganwadi and frontline health workers maintain sustained, trust-based contact with families, they are well positioned to deliver the four key counselling messages recommended at each visit: what vaccine is being given and which disease it prevents; what minor adverse events might occur and how to manage them; when and where to return for the next dose; and the importance of safeguarding the immunization card.

## STRENGTHS AND LIMITATIONS

Strengths of this study include a reasonably large sample size, cross-verification of parental recall against documentary immunization records, and a structured KAP framework that allowed reasons for failure to be disaggregated into knowledge, attitude, and practice domains. Limitations include the hospital-based sampling frame, which selects for children unwell enough to require admission and may not be fully representative of the general community; the purposive (non-random) sampling method; potential residual recall bias in the 11.6% of families without a retained immunization card; and

the cross-sectional design, which precludes causal inference regarding the socio-demographic associations identified.

## CONCLUSION

Two-thirds of children admitted to this tertiary care paediatric department were completely immunized, a coverage level below the UIP target and comparable to contemporaneous national survey estimates. Complete immunization was significantly associated with institutional delivery, delivery by a skilled attendant, higher parental education, higher family income, and joint family structure. Failure of immunization was driven predominantly by modifiable knowledge and attitude barriers - chiefly unawareness of the need for subsequent doses, misconceptions about vaccinating a mildly unwell child, fear of side effects, and logistic inconvenience - rather than by unavailability of vaccines. These findings indicate that further gains in coverage are likely to come less from expanding vaccine supply and more from strengthening demand-side counselling, tracking, and communication.

## RECOMMENDATIONS

1. **Antenatal and peripartum counselling:** Initiate immunization counselling during antenatal visits and encourage institutional delivery, which reliably ensures birth-dose BCG and OPV and anchors families within the vaccination system.
2. **Strengthen the role of birth attendants:** Train and involve traditional and skilled birth attendants (TBAs) in referring home-delivered infants for timely first-contact vaccination.
3. **Structured parental counselling at every contact:** At each visit, explicitly communicate the timing of the next dose, explain that minor illness is not a contraindication to vaccination, and pre-emptively address common minor side effects to reduce fear-driven default.
4. **Reminder and vaccine-tracking systems:** Implement active tracking and back-tracing of due/overdue children, supported by SMS, telephone, or community-based reminder systems where feasible, and encourage retention and safekeeping of the immunization card, which facilitates follow-up and reduces dropout.
5. **Address gender and equity gaps:** Target outreach toward girl children and toward families with lower parental education and income, where coverage gaps are widest, through female literacy promotion and equitable service provision.
6. **Strengthen health-worker and IEC communication:** Build the interpersonal communication capacity of Anganwadi and frontline health workers - the most frequently cited sources of immunization information and providers of services - and scale up Information, Education and Communication (IEC) activities via mass media, posters, and role-play in community settings.
7. **Improve access and convenience:** Ensure immunization sessions are held at convenient times and easily accessible locations, particularly for daily-wage and lower-socioeconomic-status families, and provide low-cost transport options to immunization centres where distance is a barrier.
8. **Anchor the measles/complementary-feeding contact:** Schedule at least one additional health-facility visit between 6 and 7 months of age, after the third Pentavalent/OPV dose, to motivate uptake of the measles dose and reinforce complementary feeding counselling.

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## ACKNOWLEDGEMENT

Not Applicable

## CONFLICT OF INTEREST

None

## INFORMED CONSENT

Taken

## ETHICAL STATEMENT

Not applicable

## AUTHOR CONTRIBUTION

Both authors had done all aspects of work together

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