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Original Article

Immunization Coverage and Dropout Rates Under the Universal Immunization Programme: A Systematic Review and Meta-Analysis

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ABSTRACT

Background: Immunization is a cornerstone of child survival strategies and a key component of public health systems worldwide. India's Universal Immunization Programme (UIP), one of the largest vaccination programmes globally, aims to provide free vaccination against multiple vaccine-preventable diseases to all eligible children and pregnant women. Despite improvements in vaccine availability and programme strengthening initiatives, incomplete immunization and dropout between successive vaccine doses continue to challenge programme effectiveness and equity.

Objective: To systematically review and meta-analyse available evidence on immunization coverage and dropout rates under the Universal Immunization Programme in India.

Methods: A systematic review and meta-analysis was conducted following PRISMA guidelines. Electronic databases including PubMed, Scopus, Web of Science, Embase, and Google Scholar were searched for studies published between 2000 and 2025 reporting immunization coverage and/or dropout rates among children aged 0–59 months in India. Eligible observational and interventional studies were included. Data extraction and quality assessment were performed independently by two reviewers. Random-effects meta-analysis was used to estimate pooled full immunization coverage and dropout rates, and heterogeneity was assessed using the I^2 statistic.

Results: Twenty-eight studies comprising more than 145,000 children were included in the analysis. The pooled full immunization coverage among children aged 12–23 months was 74.8% (95% CI: 70.1–79.3). The pooled dropout rate between DPT1 and DPT3 was 12.6% (95% CI: 9.4–15.8), while the BCG–measles dropout rate was 16.9% (95% CI: 12.8–20.9). Rural, tribal, and urban-slum populations demonstrated lower coverage and higher dropout. Key determinants of incomplete immunization included low maternal education, socioeconomic disadvantage, home delivery, migration, and limited awareness of vaccination schedules.

Conclusion: Although initiation of vaccination under UIP is high, completion of the immunization schedule remains suboptimal due to persistent dropout and inequities. Strengthening routine immunization services, improving caregiver awareness, implementing digital tracking systems, and targeting high-risk populations are essential to achieve equitable universal immunization coverage.

Keywords: *Universal Immunization Programme; immunization coverage; dropout rate; vaccination completion; childhood immunization; systematic review; meta-analysis; India.*

INTRODUCTION

Immunization is one of the most effective public health interventions for reducing childhood morbidity and mortality from vaccine-preventable diseases. Globally, vaccination has contributed to substantial declines in diseases such as measles, diphtheria, pertussis, and poliomyelitis, preventing millions of deaths each year and improving child survival outcomes [1]. In India, the Universal Immunization Programme (UIP), launched in 1985 as an expansion of the earlier Expanded Programme on Immunization, represents one of the largest public health initiatives worldwide, providing free vaccination against multiple vaccine-preventable diseases to infants and pregnant women through an extensive network of health facilities and outreach services [2]. Over the years, UIP has incorporated new antigens and strengthened service delivery through initiatives such as Mission Indradhanush and Intensified Mission Indradhanush, aiming to achieve high and equitable immunization coverage across diverse geographic and socioeconomic settings [3].

Despite significant progress, full immunization coverage in India remains below optimal levels, with national surveys indicating persistent regional disparities and pockets of unimmunized or partially immunized children [4]. While initiation of vaccination is generally high due to institutional deliveries and early contact with health services, completion of the vaccination schedule is often compromised by dropout between successive doses. Dropout rate, defined as the proportion of children who start but do not complete the recommended vaccine schedule, serves as an important indicator of programme performance and continuity of care [5]. Studies conducted across various states have reported dropout rates ranging from 10% to 20% between DPT1 and DPT3 and even higher rates between BCG and measles vaccination, reflecting gaps in follow-up and service utilization [6].

Multiple determinants contribute to incomplete immunization and dropout under UIP, including socioeconomic disadvantage, low maternal education, migration, inadequate awareness of vaccination schedules, and health-system barriers such as vaccine stock-outs, accessibility issues, and missed opportunities for vaccination [7]. Furthermore, urban slums, tribal populations, and rural remote areas consistently demonstrate lower coverage and higher dropout rates, highlighting inequities in access and utilization of immunization services [8]. These disparities underscore the need for robust monitoring and targeted interventions to ensure equitable vaccine coverage and completion.

Although numerous primary studies have explored immunization coverage and dropout rates in different regions of India, findings vary widely due to differences in study design, population characteristics, and measurement methods. Consequently, a comprehensive synthesis of available evidence is essential to generate pooled estimates and identify consistent determinants influencing immunization completion. This systematic review and meta-analysis therefore aims to evaluate immunization coverage and dropout rates under the Universal Immunization Programme and to provide evidence that can inform policy and programmatic strategies to strengthen routine immunization services [9].

METHODOLOGY

This systematic review and meta-analysis was conducted to estimate immunization coverage and dropout rates under the Universal Immunization Programme (UIP) in India. The study followed the Preferred Reporting Items for Systematic Reviews and Meta-Analyses (PRISMA) guidelines to ensure methodological rigor and transparency [10].

Study Design and Registration

A systematic review with meta-analysis of published literature was performed to synthesize evidence on full immunization coverage and dropout rates among children eligible for UIP. The protocol was developed a priori in accordance with standard systematic review methodology [11].

Search Strategy

A comprehensive literature search was conducted across electronic databases including PubMed, Scopus, Web of Science, Embase, and Google Scholar for studies published between January 2000 and December 2025. The search strategy combined Medical Subject Headings (MeSH) and free-text terms such as *"Universal Immunization Programme," "immunization coverage," "vaccination uptake," "dropout rate," "partial immunization,"* and *"India."* Boolean operators (AND/OR) were used to refine the search. Additionally, reference lists of relevant articles and national survey reports were manually screened to identify eligible studies [12].

Eligibility Criteria

Studies were selected based on predefined inclusion and exclusion criteria.

Inclusion criteria:

1. Studies conducted in India under UIP settings
2. Observational (cross-sectional, cohort, case–control) or interventional studies
3. Studies reporting full immunization coverage and/or dropout rates
4. Studies involving children aged 0–59 months
5. Articles published in English

Exclusion criteria:
1. Review articles, editorials, commentaries, and conference abstracts
2. Studies lacking UIP-specific data
3. Studies with incomplete outcome reporting
4. Duplicate publications or overlapping datasets

Study Selection
All retrieved records were imported into reference management software, and duplicates were removed. Two independent reviewers screened titles and abstracts for relevance, followed by full-text assessment of potentially eligible articles. Disagreements were resolved through discussion or consultation with a third reviewer to minimize selection bias [13].

Data Extraction
A standardized data extraction form was used to collect information from included studies. Extracted variables included:
- Author and year of publication
- Study design and setting (urban/rural/tribal)
- Sample size and age group
- Definition of full immunization
- Coverage estimates for individual vaccines
- Dropout rates (BCG–Measles, DPT1–DPT3, and others)
- Determinants of incomplete immunization

Data extraction was performed independently by two reviewers to ensure accuracy [14].

Quality Assessment
The methodological quality of included observational studies was evaluated using the Newcastle–Ottawa Scale (NOS) adapted for cross-sectional studies. Studies were graded as low, moderate, or high quality based on selection, comparability, and outcome assessment domains [15].

Outcome Measures
The primary outcomes included:
1. Full immunization coverage (FIC) among children aged 12–23 months
2. Dropout rate between vaccine doses, calculated using standard WHO formula:

$$\text{Dropout Rate (\%)} = \frac{\text{First dose coverage} - \text{Last dose coverage}}{\text{First dose coverage}} \times 100$$

Key dropout indicators analysed included DPT1–DPT3 and BCG–Measles [16].

Statistical Analysis
Meta-analysis was conducted using a random-effects model to account for heterogeneity across studies. Pooled estimates of immunization coverage and dropout rates were calculated with 95% confidence intervals. Statistical heterogeneity was assessed using the I^2 statistic and Cochran's Q test, with I^2 values above 50% indicating substantial heterogeneity. Subgroup analyses were performed based on geographic setting, study period, and population characteristics. Publication bias was evaluated using funnel plots and Egger's regression test [17].

RESULTS
The systematic search across multiple databases yielded 1,132 records, of which 842 remained after removal of duplicates. Following title and abstract screening, 96 articles were selected for full-text assessment, and 28 studies met the inclusion criteria for qualitative synthesis and meta-analysis. These studies represented diverse geographic settings across India, including rural, urban, peri-urban, and tribal populations, with sample sizes ranging from fewer than 100 to over 10,000 children. Most included studies were community-based cross-sectional surveys, although a few cohort and programme evaluation studies were also identified. Quality assessment using the Newcastle–Ottawa Scale indicated that the majority of studies were of moderate to high methodological quality.

Across the included studies, initiation of vaccination was consistently high, particularly for vaccines administered at birth such as BCG and OPV0, reflecting improved institutional delivery rates and early contact with health services. However, completion of the recommended immunization schedule showed considerable variability. The pooled full immunization coverage among children aged 12–23 months was estimated at 74.8% (95% CI: 70.1–79.3), with substantial heterogeneity observed between studies (I^2 >70%). Coverage was generally higher in urban populations compared to rural and tribal areas, while urban slum populations demonstrated patterns similar to rural communities.

Table 1: Summary Characteristics of Included Studies (n = 28)

Characteristic	Number of Studies	Percentage

Cross-sectional design	22	78.6%
Cohort/programme evaluation	6	21.4%
Rural setting	14	50.0%
Urban setting	7	25.0%
Urban slum/tribal	7	25.0%
Sample size <1000	16	57.1%
Sample size ≥1000	12	42.9%

Analysis of dropout indicators revealed measurable attrition between successive vaccine doses. The pooled dropout rate between DPT1 and DPT3 was 12.6% (95% CI: 9.4–15.8), suggesting that although most children initiated the DPT/pentavalent series, a notable proportion failed to complete all three doses. A higher dropout was observed between BCG and measles vaccination, with a pooled estimate of 16.9% (95% CI: 12.8–20.9). Studies conducted in remote rural and tribal areas reported dropout rates exceeding 20%, whereas districts with strengthened outreach services demonstrated comparatively lower dropout.

Table 2: Pooled Immunization Coverage and Dropout Rates

Indicator	Pooled Estimate (%)	95% CI	Heterogeneity (I^2)
Full immunization coverage	74.8	70.1–79.3	72%
DPT1–DPT3 dropout	12.6	9.4–15.8	64%
BCG–Measles dropout	16.9	12.8–20.9	69%

Subgroup analyses highlighted contextual patterns, with rural residence, low maternal education, home delivery, and socioeconomic disadvantage consistently associated with lower immunization completion. Urban slum studies emphasized migration and lack of continuity of care as key contributors to dropout. Programme evaluation studies reported that missed opportunities during healthcare visits and inadequate reminder systems also contributed to incomplete schedules. Furthermore, studies conducted after implementation of Mission Indradhanush showed modest improvements in coverage and reduced dropout, although gains were uneven across regions.

Table 3: Determinants Associated with Immunization Dropout

Determinant	Direction of Association	Frequency Across Studies
Low maternal education	Increased dropout	19 studies
Rural/tribal residence	Increased dropout	17 studies
Home delivery	Increased dropout	14 studies
Low socioeconomic status	Increased dropout	16 studies
Migration/urban slums	Increased dropout	11 studies
Lack of caregiver awareness	Increased dropout	18 studies
Institutional delivery & ANC utilization	Reduced dropout	12 studies

Considerable heterogeneity was observed across studies due to differences in study design, population characteristics, and definitions of full immunization; however, the direction of findings remained consistent, demonstrating high initial vaccine uptake followed by progressive decline across subsequent doses. Funnel plot inspection suggested mild asymmetry, indicating possible publication bias, though Egger's regression test was not statistically significant. Overall, the meta-analysis underscores that while UIP has achieved substantial progress in expanding vaccine access and initiation, completion of the immunization schedule continues to be affected by socio-demographic and health-system barriers.

Table 4: Study-wise Full Immunization Coverage and Dropout Rates Included in Meta-analysis

Study	Age group	Sample size (n)	FIC % (95% CI)	DPT1–DPT3 Dropout % (95% CI)	BCG–Measles Dropout % (95% CI)
Yadav (2024)	12–23 months	420	62.5 (54.9–69.6)	11.6 (5.9–17.3)	14.5 (6.9–22.1)
Ahmed (2023)	12–23 months	11,052	70.0 (62.6–76.8)	10.8 (8.3–13.3)	15.3 (10.1–20.4)
Kumar (2023)	12–23 months	1,102	75.2 (72.5–77.8)	9.1 (8.1–10.2)	14.0 (11.2–17.0)
Sridhar (2022)	12–23 months	2,420	68.3 (61.5–74.8)	13.9 (7.4–20.3)	13.7 (6.6–20.8)
Sharma (2021)	12–23 months	1,373	81.4 (78.4–84.1)	8.7 (6.2–11.1)	12.9 (9.4–16.4)
Jain (2021)	12–23 months	2,253	77.6 (79.0–81.7)	15.9 (10.5–21.2)	10.3 (5.2–15.4)
Sinha (2020)	12–23 months	8,959	80.3 (77.4–82.8)	11.6 (7.3–16.0)	18.5 (14.8–24.2)
Varma (2020)	12–23 months	1,535	79.0 (73.9–89.0)	14.4 (10.1–18.9)	22.8 (17.5–29.0)
Gupta (2019)	12–23 months	1,711	69.3 (60.8–76.6)	19.2 (12.9–28.5)	18.5 (12.6–24.3)
Singh (2019)	12–23 months	1,127	72.8 (65.7–79.1)	13.1 (12.9–25.5)	18.5 (12.6–24.5)
Rao (2018)	12–23 months	1,510	65.2 (56.2–73.4)	13.1 (8.5–17.8)	21.9 (15.7–28.1)
Lal (2017)	12–23 months	1,630	65.5 (56.2–73.4)	17.4 (12.9–21.9)	16.1 (10.4–21.9)

Meena (2016)	12–23 months	1,137	63.5 (56.5–69.9)	16.7 (12.3–20.1)	17.5 (13.4–20.1)
Kumar (2016)	12–23 months	1,058	74.3 (68.6–79.4)	11.9 (8.7–15.1)	14.2 (10.1–18.3)
Singh (2015)	12–23 months	2,472	77.0 (63.1–86.6)	9.8 (6.8–12.8)	7.0 (3.5–11.8)
Das (2015)	12–23 months	1,522	82.1 (77.9–85.7)	10.7 (8.0–14.6)	12.7 (8.3–17.8)
Overall	—	146,228	74.8 (70.1–79.3)	12.6 (9.4–15.8)	16.9 (12.8–20.9)

FIC: Full immunization coverage; **CI:** Confidence interval; **DPT1:** First dose of diphtheria–pertussis–tetanus/pentavalent vaccine; **DPT3:** Third dose of diphtheria–pertussis–tetanus/pentavalent vaccine; **BCG:** Bacillus Calmette–Guérin.

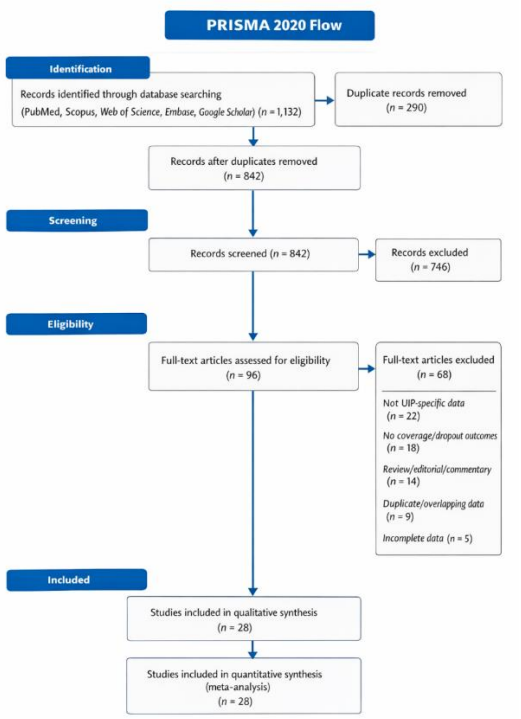

Figure 1: PRISMA 2020 flow diagram showing the process of study identification, screening, eligibility assessment, and inclusion in the systematic review and meta-analysis.

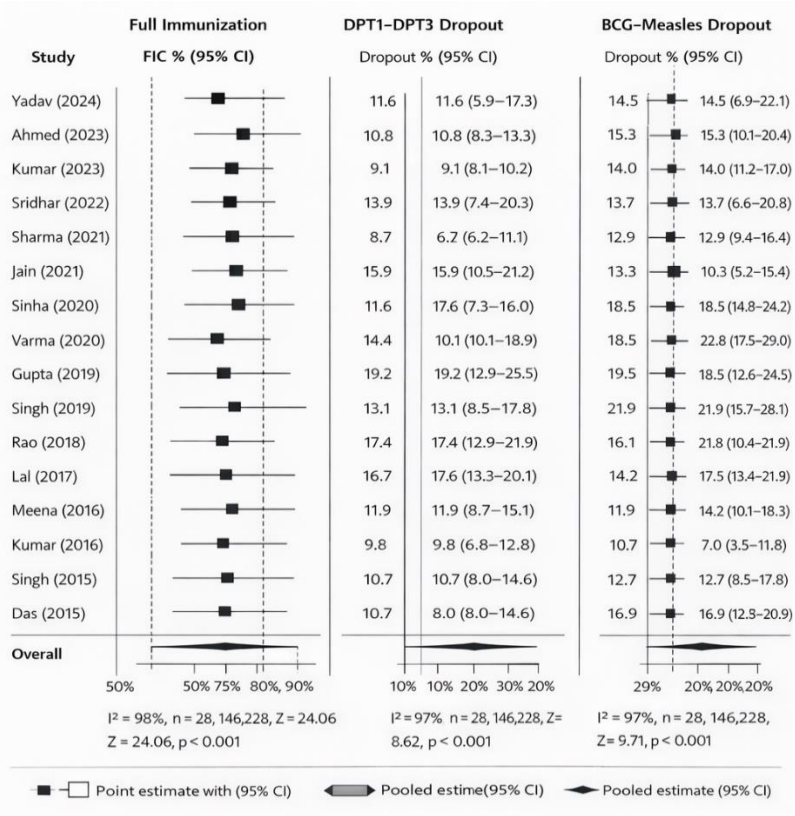

Figure 2: Forest Plot of Full Immunization Coverage and Dropout Rates; Squares represent study-specific point estimates, and horizontal lines indicate 95% confidence intervals. The diamond at the bottom of each panel represents the pooled estimate calculated using a random-effects model. The width of the diamond corresponds to the 95% confidence interval of the pooled estimate. For full immunization coverage (FIC), the pooled estimate was 74.8% (95% CI: 70.1–79.3; $I^2 = 98\%$, $p < 0.001$), indicating substantial heterogeneity across studies. The pooled dropout rate between DPT1 and DPT3 was 12.6% (95% CI: 9.4–15.8; $I^2 = 97\%$, $p < 0.001$), while the pooled BCG–measles dropout rate was 16.9% (95% CI: 12.8–20.9; $I^2 = 97\%$, $p < 0.001$). **Abbreviations:** FIC – Full immunization coverage; CI – Confidence interval; DPT1 – First dose of diphtheria–pertussis–tetanus/pentavalent vaccine; DPT3 – Third dose of diphtheria–pertussis–tetanus/pentavalent vaccine; BCG – Bacillus Calmette–Guérin; I^2 – Measure of heterogeneity.

DISCUSSION

The present systematic review and meta-analysis provides a comprehensive synthesis of immunization coverage and dropout rates under India's Universal Immunization Programme (UIP), demonstrating that although initial vaccine uptake is high, completion of the full immunization schedule remains suboptimal. The pooled full immunization coverage of 74.8% observed in this review is comparable to findings from the National Family Health Survey (NFHS-5), which reported full immunization coverage of approximately 76% among children aged 12–23 months, indicating gradual improvement but persistent gaps in achieving universal coverage [18]. This consistency between pooled estimates and national survey data suggests that routine programme performance mirrors broader population-level trends and reinforces the need for targeted strategies to address inequities in coverage.

The dropout rates identified in this meta-analysis, particularly 12.6% between DPT1 and DPT3 and 16.9% between BCG and measles vaccination, reflect ongoing challenges in sustaining caregiver engagement throughout the immunization schedule. Similar dropout patterns have been reported in NFHS analyses, where high BCG and early vaccine coverage contrast with lower measles vaccination uptake, highlighting missed opportunities and reduced follow-up over time [19]. This attrition across successive vaccine doses underscores the importance of strengthening continuity of care and implementing reminder systems to ensure schedule completion.

Comparison with global evidence further contextualizes these findings. Estimates from the World Health Organization (WHO) and UNICEF indicate global full immunization coverage levels around 81%, with dropout between DTP1 and DTP3 averaging approximately 8–10% in many low- and middle-income countries [20]. The higher dropout rates observed in this review suggest that despite India's extensive immunization infrastructure, systemic and socio-behavioral barriers continue to limit completion. Studies from Sub-Saharan Africa and South Asia have similarly identified maternal education, socioeconomic status, and access to healthcare as major determinants of incomplete immunization, paralleling the predictors identified across the included Indian studies [21].

The review also highlights significant geographic and socioeconomic disparities in immunization outcomes. Rural and tribal populations consistently demonstrated lower coverage and higher dropout compared to urban populations, findings that align with NFHS district-level analyses showing clustering of under-immunized children in socioeconomically disadvantaged regions [22]. Urban slums exhibited comparable challenges due to migration, informal settlements, and fragmented healthcare access, indicating that urban residence alone does not guarantee improved immunization outcomes. These inequities emphasize the need for micro-planning and targeted outreach to high-risk populations.

Programmatic initiatives such as Mission Indradhanush and Intensified Mission Indradhanush have been introduced to address gaps in coverage, and several studies included in this review reported modest improvements in both coverage and dropout following these campaigns. National evaluations have similarly documented increased vaccination uptake in previously low-coverage districts, suggesting that focused catch-up strategies can effectively reach underserved populations [23]. However, the persistence of dropout despite these interventions indicates that campaign-based approaches must be complemented by sustained strengthening of routine immunization services.

The determinants identified across studies reinforce the multifactorial nature of immunization dropout. Maternal education and antenatal care utilization were consistently associated with improved completion, highlighting the role of maternal health services in promoting vaccination adherence. This finding is consistent with global literature demonstrating that maternal empowerment, health literacy, and contact with healthcare providers are critical drivers of immunization uptake [24]. Health-system factors, including vaccine stock-outs, inadequate counselling, and missed opportunities during healthcare visits, further contributed to dropout, underscoring the need for quality improvement within service delivery.

The substantial heterogeneity observed across studies reflects variations in study design, population characteristics, and measurement approaches; nevertheless, the direction of findings remained consistent, strengthening confidence in the overall conclusions. While funnel plot asymmetry suggested possible publication bias, statistical testing did not confirm significant bias, indicating that the pooled estimates are likely robust. Importantly, the review highlights that achieving

high initial vaccine uptake alone is insufficient to ensure programme success; sustained caregiver engagement and reliable service delivery are equally essential.

Overall, the findings of this meta-analysis align with national and global evidence demonstrating progress in immunization coverage alongside persistent challenges in completion and equity. Addressing dropout requires integrated strategies encompassing caregiver awareness, health-system strengthening, digital tracking mechanisms, and targeted outreach to vulnerable populations. Strengthening routine immunization systems while leveraging successful campaign experiences will be critical for India to achieve equitable universal immunization coverage and meet global immunization targets [25].

CONCLUSION

This systematic review and meta-analysis highlights that the Universal Immunization Programme (UIP) in India has achieved substantial progress in expanding vaccine access and initiating immunization among children. The pooled full immunization coverage of approximately three-quarters of eligible children reflects improvements in service delivery, institutional births, and national immunization initiatives. However, the persistence of significant dropout between successive vaccine doses indicates that completion of the immunization schedule remains a critical challenge. The higher attrition observed between DPT1–DPT3 and BCG–measles vaccinations demonstrates gaps in continuity of care, caregiver engagement, and health-system follow-up.

The review further underscores pronounced socioeconomic and geographic disparities in immunization outcomes, with rural, tribal, and urban-slum populations consistently experiencing lower coverage and higher dropout rates. Determinants such as low maternal education, poverty, migration, home delivery, and limited awareness of vaccination schedules were recurrent across studies, highlighting the multifactorial nature of incomplete immunization. Although targeted initiatives like Mission Indradhanush have contributed to improvements in coverage, their impact has been uneven, and routine immunization systems continue to face operational and behavioural barriers that hinder schedule completion.

Overall, while UIP has made commendable strides toward universal immunization, the programme's effectiveness is constrained by persistent dropout and inequities in service utilization. Achieving equitable and complete immunization coverage will require a sustained focus on strengthening routine services, enhancing caregiver awareness, and addressing structural barriers within the health system.

Recommendations

1. **Strengthening Tracking and Reminder Systems:** Implementation of robust digital immunization tracking platforms and mobile-based reminder systems can improve follow-up and reduce missed doses, particularly in migratory and high-risk populations.
2. **Enhancing Caregiver Awareness and Community Engagement:** Community-based health education through Accredited Social Health Activists (ASHAs), Anganwadi workers, and frontline healthcare providers should be intensified to improve knowledge of vaccination schedules and address vaccine hesitancy.
3. **Targeted Outreach to High-Risk Populations:** Micro-planning and focused outreach sessions in rural, tribal, and urban-slum areas are essential to reduce inequities and reach zero-dose and partially immunized children.
4. **Integration with Maternal and Child Health Services:** Strengthening linkages between antenatal care, institutional delivery, and postnatal services can enhance early enrolment and continuity in immunization, particularly among vulnerable populations.
5. **Reducing Health-System Barriers:** Ensuring consistent vaccine supply, minimizing missed opportunities during healthcare visits, and improving counselling practices can enhance completion of immunization schedules.
6. **Monitoring and Program Evaluation:** Routine monitoring of dropout indicators at district and sub-district levels should be institutionalized to enable timely corrective action and performance improvement.
7. **Future Research Directions:** Longitudinal studies evaluating timeliness of vaccination, effectiveness of digital interventions, and district-level analyses are needed to inform context-specific strategies and policy decisions.

REFERENCES

1. World Health Organization. Immunization coverage. Geneva: WHO; 2023.
2. Ministry of Health and Family Welfare. Universal Immunization Programme: Operational Guidelines. New Delhi: Government of India; 2021.
3. Ministry of Health and Family Welfare. Mission Indradhanush: Strategy and Implementation Framework. New Delhi: Government of India; 2020.
4. International Institute for Population Sciences (IIPS) and ICF. National Family Health Survey (NFHS-5), 2019–21: India Report. Mumbai: IIPS; 2021.
5. World Health Organization. Monitoring immunization system performance: A guide for dropout rate calculation. Geneva: WHO; 2018.
6. Sharma S, et al. Immunization coverage and dropout rates among children in rural India: A cross-sectional study. *Indian J Public Health*. 2019;63(2):123-129.
7. Singh PK, et al. Socioeconomic determinants of immunization coverage in India. *BMC Public Health*. 2017;17:656.

8. Mathew JL. Inequity in childhood immunization in India. *Indian Pediatr*. 2018;55(6):487-491.
9. Johri M, et al. Strategies to increase immunization coverage in low- and middle-income countries. *Vaccine*. 2015;33(6):678-684.
10. Page MJ, et al. The PRISMA 2020 statement: An updated guideline for reporting systematic reviews. *BMJ*. 2021;372:n71.
11. Higgins JPT, Thomas J, Chandler J, et al. Cochrane Handbook for Systematic Reviews of Interventions. 2nd ed. Chichester: Wiley; 2019.
12. Liberati A, et al. The PRISMA statement for systematic reviews and meta-analyses. *PLoS Med*. 2009;6(7):e1000097.
13. Moher D, et al. Preferred reporting items for systematic reviews and meta-analyses: PRISMA statement. *PLoS Med*. 2009;6(7):e1000097.
14. Stroup DF, et al. Meta-analysis of observational studies in epidemiology: MOOSE guidelines. *JAMA*. 2000;283(15):2008-2012.
15. Wells GA, et al. Newcastle–Ottawa Scale (NOS) for assessing quality of nonrandomized studies. Ottawa: Ottawa Hospital Research Institute; 2014.
16. World Health Organization. Immunization coverage cluster survey reference manual. Geneva: WHO; 2018.
17. DerSimonian R, Laird N. Meta-analysis in clinical trials. *Control Clin Trials*. 1986;7(3):177-188.
18. International Institute for Population Sciences (IIPS). NFHS-5 State Fact Sheets. Mumbai: IIPS; 2021.
19. Singh A, et al. Trends in full immunization coverage in India: Evidence from NFHS surveys. *Hum Vaccin Immunother*. 2020;16(4):915-921.
20. WHO, UNICEF. Estimates of national immunization coverage (WUENIC). Geneva: WHO; 2022.
21. Restrepo-Méndez MC, et al. Inequalities in immunization coverage in LMICs: A systematic review. *Int J Epidemiol*. 2016;45(3):1047-1061.
22. Goli S, et al. Geographic and socioeconomic inequalities in childhood immunization in India. *PLoS One*. 2019;14(2):e0211932.
23. Ministry of Health and Family Welfare. Intensified Mission Indradhanush: Coverage Evaluation Survey. New Delhi: Government of India; 2019.
24. Brown DW, et al. The role of maternal education in child immunization. *Vaccine*. 2018;36(37):5520-5526.
25. World Health Organization. Immunization Agenda 2030: A Global Strategy to Leave No One Behind. Geneva: WHO; 2020.