ORIGINAL ARTICLE

Urban-Rural Disparities in Childhood Immunization Coverage: Evidence from Jaipur, India

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CITATION

Sharma SP, Badhala M, Tomar A, Baig VN. Urban-Rural Disparities in Childhood Immunization Coverage: Evidence from Jaipur, India. Indian J Comm Health. 2025;37(6):1101-1105.

https://doi.org/10.47203/IJCH.2025.v37i06.033

ARTICLE CYCLE

Received: 01/09/2025; Accepted: 15/12/2025; Published: 31/12/2025

ABSTRACT

Introduction: Childhood immunization coverage in India has improved nationally, yet urban-rural disparities persist, particularly in rapidly urbanizing states such as Rajasthan. Urban slum populations often face significant barriers, including limited mobility, restricted access to essential services, and vaccine hesitancy. **Objective:** To assess and compare the full immunization coverage among children aged 6-23 months in urban and rural areas of Jaipur district, Rajasthan. **Methods:** A community-based cross-sectional study was conducted from October 2023 to March 2024 in the rural (Dadiya) and urban (Jhalana) field practice areas of RUHS College of Medical Sciences, Jaipur. A sample of 711 children aged 6–23 months was selected using the WHO 30×7 cluster sampling method. Immunization status was verified using vaccination cards and caregiver history. Data were analyzed using SPSS v22.0 with descriptive statistics and chi-square tests. **Results:** Full immunization coverage (FIC) was significantly lower in urban areas (82.0%, 95% CI: 77.2–86.1%) compared to rural areas (92.3%, 95% CI: 89.5–94.5%) ($p<0.001$). Dose-specific analysis revealed a higher dropout rate for later vaccines, including Pentavalent 3 (urban 81.7% vs. rural 91.8%) and Measles (urban 85.0% vs. rural 93.2%). **Conclusions:** Rural Rajasthan's ASHA-led model achieved near-universal FIC, whereas urban slums experienced systemic barriers leading to higher dropout rates for later doses. Targeted interventions, such as slum-focused microplans, extended service hours, and urban community health workers, are urgently needed to reduce disparities.

KEYWORDS

Immunization Coverage, Vaccination, Urban-Rural Disparities, Jaipur, Rajasthan, ASHA, Child Health

INTRODUCTION

Despite notable global gains in vaccination coverage, significant differences continue to exist between rural and urban communities, particularly in low- and middle-income countries (1). In India, the NFHS-5 (2019–21) reported an overall full immunization coverage of 77%, yet this national figure conceals wide sub-regional variations, especially in states undergoing rapid urban expansion such as Rajasthan (2). Mission Indradhanush, launched in 2014, aimed to reduce these gaps; however, many urban poor settlements still show lower uptake due to frequent migration, inconsistent access to services, and concerns or misconceptions regarding vaccines (3).

Rajasthan reports 85.3% immunization coverage according to NFHS-5, but this average masks differences between rural and urban populations. Jaipur, a tier-two city with expanding slum clusters and distant village communities, illustrates these contrasting realities. Most previous research has focused on national patterns or isolated settings, leaving a gap in localized comparisons needed for targeted strategies (4).

Existing studies indicate rural–urban differences, but detailed dose-wise analyses remain limited. Urban areas often show sharper declines between

initial and later vaccine doses, suggesting programmatic and access-related barriers (5,6).

Aim

- To assess and compare full immunization coverage among children aged 6–23 months in rural and urban areas of Jaipur district, Rajasthan.

Objectives

- To estimate full immunization coverage among children aged 6–23 months in the selected areas.
- To compare dose-wise vaccine coverage between rural and urban settings.
- To identify sociodemographic and health-system factors associated with incomplete immunization.

MATERIAL & METHODS

Study Design and Setting: This investigation was a community-based, cross-sectional study carried out between October 2023 and March 2024 in two field practice areas under the Department of Community Medicine, RUHS College of Medical Sciences, Jaipur. The selected sites—Dadiya (rural) and Jhalana (urban)—were chosen to capture differences in service delivery contexts.

Urban site: Jhalana, housing approximately 20,783 individuals and characterized by highly mobile slum populations.

Rural site: Dadiya, with an estimated 34,679 residents, predominantly engaged in agriculture.

Sample Size Determination: Sample size estimation was performed using EPI Info (version 7.2), taking the NFHS-5 full immunization coverage for Rajasthan (85.3%) as the reference value. A 5% allowable error, 95% confidence level, design effect of 1.5 to account for cluster sampling, and an additional 10% for possible non-response were applied. The final required sample size was 711 children aged 6–23 months, comprising 431 from rural clusters and 280 from urban clusters.

Sampling Procedure: A cluster sampling strategy following the 30×7 WHO immunization survey methodology (7) was adopted. In Jhalana, Anganwadi centers served as primary sampling clusters, while in Dadiya, villages were utilized as cluster units. Eligible households within each cluster were visited sequentially until the predetermined number of participants was reached.

Eligibility Criteria

Inclusion

Children aged 6–23 months who had been living in the selected area for at least 12 months.

Mothers or primary caregivers aged 18 years or above who were present during household visits.

Exclusion

Children with known severe immunodeficiency or documented contraindications to vaccination.

Families who had lived in the area for less than 12 months.

Data Collection Instruments and Variables

Data were collected using a structured and pre-tested questionnaire.

Key components included:

Sociodemographic details: Child's age, caste, household income (classified using the updated BG Prasad socioeconomic scale, October 2023) (8).

Immunization information: Verified from vaccination cards or caregiver recall for BCG, OPV, Pentavalent series, and Measles-containing vaccines.

Reasons for incomplete vaccination: Child illness, fear of adverse effects, misconceptions, unavailability of services, and other relevant factors.

Operational Definitions (9)

Fully immunized: Child received all age-appropriate vaccines as per WHO recommendations.

Partially immunized: Child missed at least one scheduled vaccination dose.

Data Processing and Statistical Analysis: Data were entered independently by two trained personnel into MS Excel to ensure accuracy and resolve discrepancies. Statistical analysis was conducted using SPSS version 22.0. Descriptive measures included frequencies and percentages. Associations between variables were assessed using Chi-square tests or Fisher's exact test where applicable.

Ethical Considerations: Ethical approval for the study was secured from the Institutional Ethics Committee of RUHS-CMS (Approval No. RUHS-CMS/Ethics Comm./2023/239, dated 04/11/2023). Informed written consent was obtained from all participating caregivers prior to data collection.

RESULTS

Immunization Coverage by Residence

In the present study assessing immunization coverage disparities (urban vs. rural), we found that full Immunization Coverage (FIC) was 12.3 percentage points lower in urban (82.0%, 95% CI: 77.2–86.1%) compared to rural areas (92.3%, 95% CI: 89.5–94.5%) ($p<0.001$, Chi-square) (Table 1). This aligns with the "inverse equity hypothesis", where rural areas outperform urban slums due to:

- Stronger community health networks (e.g., ASHA workers in rural Jaipur).
- Urban challenges: transient populations, service fragmentation.

Dose-Wise Dropout Rates (Urban vs. Rural)

Dose-wise dropout analysis revealed that later doses (Pentavalent 3, Measles) showed wider urban-rural gaps than early doses (Table 2), reflecting:

- Programmatic fatigue: Urban parents may disengage after initial doses
- Access barriers: Rural areas benefit from fixed-day sessions, while urban slums face stockouts.

Figure 1 demonstrates higher dropout rates for later doses (Pentavalent 3 and Measles) in urban slums compared to rural areas.

Table 1. Immunization status of children aged 6–23 months by residence (N=711).

Status	Rural (n=431)	Urban (n=280)	Risk Difference (95% CI)	p-value
Fully immunized	92.3% (89.5–94.5%)	82.0% (77.2–86.1%)	−10.3% (−14.1% to −6.5%)	<0.001
Partially immunized	7.0% (4.9–9.8%)	16.0% (12.1–20.7%)	+9.0% (+4.8% to +13.2%)	<0.001
Unimmunized	0.7% (0.2–2.0%)	2.0% (0.9–4.3%)	+1.3% (−0.5% to +3.1%)	0.08

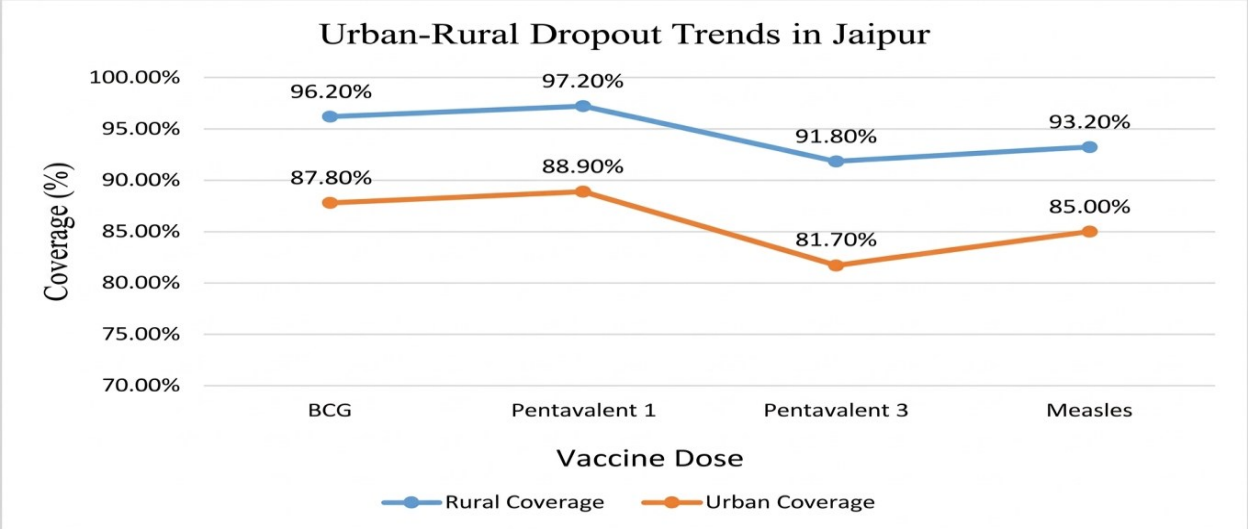
Rural areas demonstrated significantly higher full immunization coverage compared to urban areas (p<0.001).

Table 2. Dose-specific immunization coverage by residence.

Vaccine	Rural Coverage (95% CI)	Urban Coverage (95% CI)	Absolute Difference (95% CI)	p-value
BCG	96.2% (94.0–97.7%)	87.8% (83.5–91.2%)	−8.4% (−12.3% to −4.5%)	<0.001
Pentavalent 3	91.8% (88.8–94.1%)	81.7% (76.8–85.9%)	−10.1% (−14.9% to −5.3%)	<0.001
Measles	93.2% (90.4–95.3%)	85.0% (80.4–88.8%)	−8.2% (−12.6% to −3.8%)	0.002

Urban children showed higher dropout rates for later doses (Pentavalent 3 and Measles) compared to rural children.

Figure 1. Urban vs. rural dropout trends in childhood immunization coverage in Jaipur.



Urban areas exhibit accelerated dropout rates for later doses, suggesting systemic bottlenecks in service delivery.

DISCUSSION

The present study identifies a 10.3-percentage-point difference in full immunization coverage (FIC) between rural (92.3%) and urban Jaipur (82%). Urban children showed notably weaker continuation to later doses, particularly Pentavalent 3 (81.7% urban vs. 91.8% rural) and Measles vaccine (85% vs. 93.2%). These patterns carry important implications for immunization planning in Rajasthan and other rapidly urbanizing regions of India (10).

Rural Immunization Advantage in Rajasthan

The rural field area demonstrated substantially higher FIC than both the state average (85.3%, NFHS-5) and the national rural estimate (76%, NFHS-5) (11). Several systemic strengths appear to have contributed to this achievement:

Mission Indradhanush and IMI Intensification

- Rajasthan, being a priority state under IMI (2017–2020), recorded an improvement of nearly 18.5% in high-risk districts (12).
- Continuous door-to-door follow-up by ASHAs likely supported completion of multi-dose schedules, reflected in higher Pentavalent 3 retention in rural areas (13).

Strength of ASHA-Driven Microplanning

- Detailed planning of fixed immunization days at village level reduced missed sessions and improved coverage.
- ASHAs, who belong to the same communities they serve, are often more effective in addressing fear, rumors, and misinformation than urban health functionaries (14).

Comparative Context from Other States

- **Kerala (96.2%):** Strong local self-government systems contribute to high immunization uptake (15).
- **Bihar (69%):** Limited supervision of ASHAs and weak follow-up mechanisms explain lower coverage (16).

Urban Jaipur's Lower Coverage

Despite the availability of better health infrastructure, the urban site in Jaipur showed poorer FIC. Multiple challenges emerged:

- A high proportion of migrant families (38%) among the under-immunized, compared to only 5% in rural areas, mirrors trends observed in Delhi slums.
- Urban health centers reported 1.35% dropouts due to vaccine stockouts, nearly absent in rural clinics—similar to gaps documented in Mumbai.
- Urban frontline workers covered significantly larger populations, serving nearly three times more children than their rural counterparts (3).

These systemic constraints appear to contribute substantially to the lower FIC observed in urban Jaipur.

Comparison with Other Urban Settings

- **Urban Kerala (91%)** benefits from strong municipal public health systems (17).
- **Delhi's slum FIC (79%)** closely resembles the present findings, indicating persistent structural issues in metropolitan and semi-urban areas (3).

Policy Insights Derived from Study Findings

A. Strengthening Urban Immunization Under NUHM

1. **Extending Service Hours**: Evening immunization sessions—successfully adopted in Manila with a 22% reduction in "no-time" defaulters—may benefit working urban families (18).
2. **Micro-Mapping of Slum Clusters**: Identifying underserved pockets and tailoring session sites can improve reach and continuity.
3. **Digitized Stock Monitoring**: caling up systems like eVIN, which have reduced stockouts by 80%, may address logistical gaps.

B. Sustaining Gains in Rural Rajasthan

1. **Performance-Linked ASHA Incentives**: States like Odisha reported a 12% increase in FIC when ASHAs were rewarded for tracking and recovering defaulters (16).
2. **Reinforcing Outreach Mechanisms**: Mobile vaccination vans, similar to Chhattisgarh's "Teeka Express," which raised FIC by 15%, may help remote hamlets retain high coverage (19).

CONCLUSION & RECOMMENDATION

The study demonstrates that rural Jaipur has nearly universal immunization coverage, largely driven by robust ASHA engagement and structured outreach activities. Conversely, urban slums continue to experience gaps, with higher dropouts in later-dose vaccines and several systemic bottlenecks affecting coverage.

Addressing these gaps requires a focused urban strategy—strengthening NUHM, improving micro-planning for slum settlements, offering flexible session timings, and incorporating community-based workers modeled on the ASHA system. Enhanced implementation of IMI strategies across urban clusters could significantly narrow the rural–urban divide and promote equitable immunization for every child.

LIMITATION OF THE STUDY

The urban sample may have underestimated the true burden of immunization gaps among migrant families, as transient populations are often missed in standard household surveys. The cross-sectional design also captures coverage at a single time point, limiting causal interpretations. Future assessments should consider time-location sampling or respondent-driven approaches to more accurately represent mobile populations.

RELEVANCE OF THE STUDY

This study directly contributes to India's immunization policy landscape by challenging the widely assumed "urban advantage." Instead, the findings reveal that urban poor populations remain a critical blind spot in the National Immunization Programme. By quantifying the coverage gap and identifying dose-specific dropout points, the study provides actionable insights that can guide state-level implementation of NUHM reforms in Rajasthan and similar settings.

AUTHORS CONTRIBUTION

All authors have contributed equally.

FINANCIAL SUPPORT AND SPONSORSHIP

None

CONFLICT OF INTEREST

None

ACKNOWLEDGEMENT

We extend our gratitude to the health teams at UHTC Jhalana and RHTC Dadiya for their invaluable assistance during fieldwork. We also acknowledge the cooperation of the participating families, without whom this study would not have been possible.

DECLARATION OF GENERATIVE AI AND AI ASSISTED TECHNOLOGIES IN THE WRITING PROCESS

During the preparation of this work, the authors used ChatGPT (OpenAI) to assist with language editing, grammar correction, and improvement of manuscript clarity. The authors carefully reviewed and edited the generated content and take full responsibility for the accuracy, integrity, and final content of the publication.

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