https://doi.org/10.62587/AFRJMS.3.2.2026.128-135 ISSN: 3006-7421

African Research Journal of Medical Sciences

Journal homepage: https://www.afrjms.com

Research Paper **Open Access**

Childhood immunisation gaps and infectious disease outbreak surveillance in Fatehpur district, Uttar Pradesh, India: A secondary analysis of NFHS and IDSP data

Nidhi Pandey[1*] and Shubham Pandey[2]

[1]Department of Microbiology, Amar Shaheed Jodha Singh Ataiya Thakur Dariyao Singh Medical College, Fatehpur, Uttar Pradesh, India.
[2]Department of Community Medicine, Maharishi Devraha Baba Autonomous State Medical College, Deoria, Uttar Pradesh, India.

Article Info
Volume 3, Issue 2, July 2026
Received : 17 December 2025
Accepted : 10 August 2026
Published : 01 November 2026
doi: 10.62587/AFRJMS.3.2.2026.128-135

Abstract

Background: Childhood immunisation is a major public health intervention for preventing vaccine-preventable diseases. However, incomplete vaccination, delayed doses and geographical disparities may leave children susceptible to infections. Population surveys and public health surveillance reports provide complementary information for assessing immunisation coverage and documented disease events without collecting new laboratory data. **Objective:** To assess childhood immunisation indicators in Fatehpur district, Uttar Pradesh, using National Family Health Survey (NFHS-4 and NFHS-5) data and examine the relevance of reported infectious-disease events documented by the Integrated Disease Surveillance Programme (IDSP). **Methods:** A descriptive secondary-data analysis was designed using published NFHS district indicators and official IDSP weekly outbreak reports. Vaccination coverage indicators were compared between NFHS-4 (2015–2016) and NFHS-5 (2019–2021), where available. Absolute differences were calculated in percentage points. IDSP reports were reviewed for documented chickenpox outbreaks in Fatehpur in May 2022 and June 2023. No primary patient data, new laboratory investigations or identifiable medical records were used. **Results:** Full immunisation coverage among children aged 12–23 months increased from 48.4% in NFHS-4 to 55.7% in NFHS-5, an increase of 7.3 percentage points. BCG coverage increased from 87.0% to 90.0%, while coverage with three doses of pentavalent or DPT vaccine increased from 68.7% to 76.0%. Coverage with three doses of polio vaccine declined from 63.8% to 61.8%, and first-dose measles-containing vaccine coverage remained at 71.5%. NFHS-5 reported that 29.3% of children aged 24–35 months had received a second dose of measles-containing vaccine, while 20.2% of children aged 12–23 months had received three doses of rotavirus vaccine. IDSP reported three chickenpox cases in Fatehpur in May 2022, including one sample positive for varicella-zoster virus IgM by ELISA. A separate report in June 2023 documented five chickenpox cases; the available report did not establish laboratory confirmation of varicella in those cases. **Conclusion:** Although full immunisation coverage improved between the two NFHS rounds, important gaps remained in selected vaccine indicators. The documented chickenpox events illustrate the importance of disease surveillance, but the available records cannot establish a causal relationship between vaccination coverage and outbreak occurrence. Improved coverage monitoring, timely completion of vaccine schedules and better linkage of immunisation and surveillance data are recommended.

Keywords: *Childhood immunisation, NFHS, IDSP, Fatehpur, Uttar Pradesh, Chickenpox, Varicella-zoster virus, Vaccine-preventable diseases, Secondary data analysis*

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* *Corresponding author: Nidhi Pandey, Assistant Professor, Department of Microbiology, Amar Shaheed Jodha Singh Ataiya Thakur Dariyao Singh Medical College, Fatehpur, Uttar Pradesh, India.*

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1. Introduction

Vaccination is among the most effective public health strategies for preventing infectious diseases and reducing disease-associated morbidity and mortality (WHO, 2025). Childhood immunisation programmes protect against several serious infections, including tuberculosis, poliomyelitis, diphtheria, pertussis, tetanus, hepatitis B, *Haemophilus influenzae* type b disease, rotavirus disease and measles, depending on the vaccines included in the national schedule.

The effectiveness of an immunisation programme depends not only on vaccine availability but also on timely administration, completion of recommended doses, reliable cold-chain management, community awareness and effective surveillance. Even when national vaccine coverage improves, children who miss individual doses or remain unvaccinated may form susceptible groups in which infections can spread.

District-level coverage estimates are particularly useful for identifying gaps that may be concealed by state or national averages. In Uttar Pradesh, differences in access to health services, household circumstances and awareness of vaccination schedules may affect immunisation uptake. Fatehpur district provides an appropriate setting for examining these issues using existing population data.

The National Family Health Survey provides information on vaccination among children and other maternal and child health indicators. NFHS-4 was conducted during 2015–2016, while NFHS-5 was conducted during 2019–2021. Published Fatehpur district indicators allow descriptive comparisons of selected vaccine coverage estimates between these rounds (IIPS, 2017; IIPS, 2021).

Population surveys, however, cannot independently establish the cause of every infectious-disease event. The Integrated Disease Surveillance Programme complements survey information by collecting reports of suspected, presumptive and laboratory-confirmed diseases and supporting outbreak investigations (NCDC, 2022). Its weekly reports provide event-level information about selected disease outbreaks, including the number of cases and available laboratory findings.

Chickenpox, caused by varicella-zoster virus, is a useful example of a rash-associated infectious disease documented in district surveillance reports. Although varicella vaccines are available, chickenpox vaccination is not a routine component of India's Universal Immunisation Programme (MoHFW, n.d.). Therefore, chickenpox events should not automatically be interpreted as evidence of failure of routine national childhood vaccination.

This study examines immunisation coverage in Fatehpur using NFHS-4 and NFHS-5, together with selected IDSP-reported chickenpox events. It aims to identify public health priorities and demonstrate how existing datasets can support microbiology-related research without new laboratory investigations.

2. Aim and objectives

2.1. Aim

To assess childhood immunisation coverage and describe selected infectious-disease events reported through IDSP in Fatehpur district, Uttar Pradesh.

2.2. Objectives

1. To compare selected childhood immunisation indicators between NFHS-4 and NFHS-5.
2. To identify vaccine indicators with lower reported coverage.
3. To describe selected IDSP-reported chickenpox events in Fatehpur.
4. To discuss the complementary roles of vaccination coverage monitoring and infectious-disease surveillance.
5. To propose recommendations for improving immunisation uptake and public health surveillance.

3. Materials and methods

3.1. Study design

A descriptive secondary-data study was designed using publicly available survey indicators and official disease-surveillance reports. No primary clinical data, biological specimens, laboratory experiments or patient interviews were involved.

3.2. Study setting

The study focused on Fatehpur district, Uttar Pradesh, India. Government Medical College, Fatehpur, was considered the proposed academic setting for interpreting the results and discussing their implications for microbiology and public health.

The study describes district-level indicators and does not represent the vaccination status of patients attending the medical college.

3.3. Data sources

The principal sources were:

- **NFHS-4 district indicators:** Published childhood immunisation estimates for 2015–2016 (IIPS, 2017).
- **NFHS-5 district indicators:** Published childhood immunisation estimates for 2019–2021 (IIPS, 2021).
- **IDSP weekly outbreak reports:** Official reports documenting chickenpox events in Fatehpur during May 2022 and June 2023 (NCDC, 2022; NCDC, 2023).
- **National Centre for Disease Control:** Programme information describing the national disease-surveillance and outbreak-response system (NCDC, 2022).

3.4. Variables

Selected indicators included full immunisation among children aged 12–23 months, BCG coverage, three-dose polio coverage, three-dose pentavalent or DPT coverage, first-dose measles-containing vaccine coverage, second-dose measles-containing vaccine coverage and three-dose rotavirus vaccine coverage.

IDSP variables included reported disease, number of cases, deaths, outbreak dates and documented laboratory findings.

3.5. Statistical analysis

For vaccination indicators reported in both survey rounds, absolute changes were calculated as:

$$\text{Change in percentage points} = P_{\text{NFHS-5}} - P_{\text{NFHS-4}} \quad (1)$$

The resulting differences were interpreted descriptively. No hypothesis tests, confidence intervals or regression models were calculated. Outbreak records were summarised as documented events rather than used to estimate incidence.

3.6. Ethical considerations

Only publicly available aggregate information and official outbreak reports were used. No identifiable patient records or new human-subject data were collected.

4. Results

4.1. Changes in full immunisation coverage

The reported proportion of children aged 12–23 months who were fully immunised increased from 48.4% in NFHS-4 to 55.7% in NFHS-5 (IIPS, 2017; IIPS, 2021) (Table 1).

Table 1: Full immunisation coverage in Fatehpur district	
Survey round	**Children aged 12–23 months fully immunised (%)**
NFHS-4, 2015–2016	48.4
NFHS-5, 2019–2021	55.7
Absolute change	+7.3 percentage points

Source: NFHS-4 and NFHS-5 district indicators for Fatehpur (IIPS, 2017; IIPS, 2021).

The increase indicates improvement in the reported full-immunisation indicator. Nevertheless, the NFHS-5 estimate remained below 60%, suggesting that a substantial proportion of children were not classified as fully immunised under the survey definition.

The two rounds should be compared cautiously because vaccination indicator definitions and vaccine schedules may differ. The change is descriptive and does not independently establish statistical significance.

4.2. Coverage of individual vaccines

Selected individual vaccine indicators for the two survey rounds are presented in Table 2.

Table 2: Selected childhood immunisation indicators in Fatehpur			
Vaccine indicator	**NFHS-4 (%)**	**NFHS-5 (%)**	**Change (percentage points)**
BCG vaccination	87.0	90.0	+3.0
Three doses of polio vaccine	63.8	61.8	−2.0
Three doses of pentavalent or DPT vaccine	68.7	76.0	+7.3
First dose of measles-containing vaccine	71.5	71.5	0.0
Full immunisation	48.4	55.7	+7.3

Source: NFHS-4 and NFHS-5 district factsheets (IIPS, 2017; IIPS, 2021). Values refer to children aged 12–23 months unless otherwise specified. Definitions should be checked against each survey's indicator notes.

The data show improvement in BCG and pentavalent/DPT coverage, while three-dose polio coverage decreased slightly. First-dose measles-containing vaccine coverage remained unchanged at the displayed precision.

These findings suggest that overall progress did not occur uniformly across all vaccine indicators. Monitoring each dose separately may help identify where missed vaccinations or delays require additional attention.

4.3. Additional indicators reported in NFHS-5

NFHS-5 provides additional indicators relevant to the completion of childhood vaccine schedules (IIPS, 2021) (Table 3).

Table 3: Additional vaccination indicators in Fatehpur, NFHS-5	
Indicator	**Reported coverage (%)**
Children aged 12–23 months who received three doses of rotavirus vaccine	20.2
Children aged 24–35 months who received a second dose of measles-containing vaccine	29.3
Children aged 12–23 months who received BCG	90.0
Children aged 12–23 months who received three doses of pentavalent or DPT vaccine	76.0
Children aged 12–23 months who received the first dose of measles-containing vaccine	71.5

Source: NFHS-5 Fatehpur district indicators (IIPS, 2021). The age group differs for the second-dose measles-containing vaccine indicator and should be retained when interpreting the estimates.

The reported second-dose measles-containing vaccine coverage was 29.3% among children aged 24–35 months. Because this indicator uses an older age group than the first-dose indicator, the two percentages should not be directly subtracted to estimate dropout.

The reported rotavirus vaccine coverage also indicates an opportunity to strengthen completion of the recommended schedule. However, the estimates refer to the survey period and should not be interpreted as current 2026 coverage.

4.4. IDSP-reported chickenpox events

Two official IDSP reports document chickenpox events in Fatehpur in 2022 and 2023 (NCDC, 2022; NCDC, 2023) (Table 4).

Table 4: Selected chickenpox events reported through IDSP in Fatehpur			
Reporting period	**Cases**	**Deaths**	**Laboratory information**
Week 18, 2022; event reported 6 May 2022	3	0	Three blood samples were sent for testing; one was reported positive for varicella-zoster virus IgM by ELISA
Week 26, 2023; event reported 27–28 June 2023	5	0	Three serum samples were collected; the report notes one negative measles IgM ELISA result but does not establish laboratory confirmation of varicella

Sources: Official IDSP weekly outbreak reports for week 18 of 2022 and week 26 of 2023 (NCDC, 2022; NCDC, 2023). These are selected events, not an exhaustive district outbreak series.

The 2022 report documented three cases, with one sample positive for varicella-zoster virus IgM by ELISA. The 2023 report documented five cases presenting with fever and rash. However, the reported negative measles IgM result does not itself confirm varicella infection.

These reports illustrate the value of laboratory-supported outbreak investigation. They do not establish the population incidence of chickenpox or demonstrate a relationship between chickenpox occurrence and coverage of routine childhood vaccines.

4.5. Combined interpretation of survey and surveillance findings

The public health implications of the combined survey and surveillance findings are summarised in Table 5.

Table 5: Public health implications of the combined findings		
Finding	**Interpretation**	**Potential response**
Full immunisation increased from 48.4% to 55.7%	Progress occurred, but coverage remained incomplete	Strengthen routine immunisation and follow-up
Three-dose polio coverage decreased from 63.8% to 61.8%	Coverage did not improve uniformly	Review missed-dose and dropout patterns
First-dose measles-containing vaccine coverage remained at 71.5%	No increase was evident at displayed precision	Improve timely vaccination and coverage monitoring
Second-dose measles-containing vaccine coverage was 29.3% in the specified age group	Completion requires attention	Track second-dose uptake using the correct age and schedule definitions
Chickenpox events were reported in 2022 and 2023	Rash-associated disease events were detected by surveillance	Maintain timely reporting and appropriate diagnostic investigation
One 2022 sample was positive for varicella-zoster virus IgM	Laboratory evidence supported at least one case in the reported event	Use laboratory results alongside epidemiological evidence

5. Discussion

5.1. Progress and remaining gaps in childhood immunisation

The increase in full immunisation coverage from 48.4% to 55.7% suggests progress in Fatehpur between the NFHS-4 and NFHS-5 survey periods. Improvements in BCG and pentavalent/DPT coverage also indicate that some elements of the childhood vaccination schedule were reaching a greater proportion of children.

Nevertheless, full immunisation coverage remained incomplete. The findings support the need for continued efforts to ensure that children receive all recommended vaccines at the appropriate ages.

The decline in three-dose polio coverage and the unchanged first-dose measles-containing vaccine estimate show that improvements in one vaccine indicator should not be assumed to represent equivalent improvements across the entire schedule.

These comparisons are descriptive. Differences in survey definitions, sampling and vaccine schedules should be considered before attributing changes to programme performance.

5.2. Importance of dose completion

Immunisation coverage should be evaluated at both the individual-dose and schedule-completion levels. A child may receive an initial vaccine dose but fail to return for subsequent doses because of access barriers, caregiver concerns, mobility or missed opportunities during healthcare visits.

The NFHS-5 indicators for the second dose of measles-containing vaccine and the three-dose rotavirus schedule highlight the importance of monitoring completion, not just initiation. However, age groups and denominators must be considered carefully when interpreting these estimates.

Useful programme measures include the proportion of eligible children receiving each dose, dropout between successive doses, timeliness of vaccination and the distribution of coverage across rural and urban populations. Such indicators would provide a more detailed assessment than a single full-immunisation percentage.

5.3. Interpretation of chickenpox surveillance reports

The IDSP records demonstrate that chickenpox events were reported in Fatehpur in both 2022 and 2023. The 2022 report includes a positive varicella-zoster virus IgM result, while the 2023 report documents a clinical cluster without clearly reported laboratory confirmation of varicella.

The distinction is important because fever and rash may occur in several infectious diseases. Laboratory results, clinical presentation and epidemiological links should be interpreted together.

Chickenpox vaccination is available, but it is not a routine component of India's Universal Immunisation Programme (MoHFW, n.d.). Therefore, these reports should not be presented as evidence that the routine childhood immunisation programme failed to prevent chickenpox. They instead demonstrate the broader role of infectious-disease surveillance in detecting and investigating disease events.

5.4. Role of IDSP in public health microbiology

IDSP supports the reporting and investigation of epidemic-prone diseases through suspected, presumptive and laboratory-confirmed surveillance. Rapid response teams may investigate unusual disease patterns, while laboratory findings can help distinguish among possible causes (NCDC, 2022).

For a microbiology department, the programme provides an important link between clinical presentation, epidemiological investigation and laboratory evidence. The Fatehpur reports illustrate how selected laboratory tests can contribute to the interpretation of rash-associated outbreaks.

However, the two events examined here do not provide a complete picture of disease burden. A full district analysis would require systematic extraction of all relevant weekly reports over a predefined period, including follow-up reports and possible duplicate entries.

6. Strengths and limitations

6.1. Strengths

The study combines two major public data sources: population-based NFHS estimates and official IDSP outbreak reports. It requires no new specimen collection, laboratory testing or identifiable patient records.

The inclusion of individual vaccine indicators provides more detail than a single full-immunisation estimate. The surveillance section also distinguishes laboratory-confirmed findings from clinically reported events.

6.2. Limitations

First, NFHS estimates describe the survey periods and do not represent current 2026 vaccination coverage.

Second, the study uses published aggregate percentages rather than individual-level survey microdata. Confidence intervals, statistical significance and adjusted associations were not calculated.

Third, some vaccination indicators may differ in definition across survey rounds, particularly where vaccine schedules or indicator constructions changed.

Fourth, only selected IDSP chickenpox reports were examined. They cannot be used to calculate annual incidence or the total number of infectious-disease outbreaks in Fatehpur.

Fifth, a chickenpox outbreak is not a direct measure of the effectiveness of vaccines included in India's routine national immunisation schedule. No causal relationship between vaccination coverage and the reported chickenpox events can be established.

Finally, the findings describe district-level data and cannot be assumed to represent patients attending Government Medical College, Fatehpur.

7. Conclusion

Childhood immunisation coverage in Fatehpur improved between NFHS-4 and NFHS-5, but important gaps remained in full immunisation and selected individual vaccine indicators. The observed decrease in

three-dose polio coverage and the unchanged first-dose measles-containing vaccine estimate indicate that programme progress was not uniform across all measures.

IDSP reports document chickenpox events in Fatehpur in 2022 and 2023, including one reported varicella-zoster virus IgM-positive sample in the 2022 event. These findings demonstrate the importance of combining epidemiological surveillance with appropriate laboratory investigation, while recognising that the available records are not an exhaustive assessment of disease burden.

For Government Medical College, Fatehpur, this secondary-data study offers a practical framework for microbiology-related research without new laboratory data collection. Future work should systematically extract district surveillance reports and use consistently defined vaccination indicators to strengthen evidence-based public health planning.

Declarations

Acknowledgements: The authors acknowledge the public institutions responsible for making NFHS and IDSP information available.

Funding: No external funding was used to prepare this manuscript.

Conflicts of interest: The authors declare no conflict of interest.

Author contributions: Both authors contributed to the conception of the study, compilation and analysis of the data, and preparation of the manuscript, and approved the final version.

Ethics statement: The study uses publicly available aggregate data and does not involve primary data collection or identifiable patient records.

Data availability: All information used in this study is derived from publicly available NFHS district indicators and official IDSP outbreak reports.

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Cite this article as: Nidhi Pandey and Shubham Pandey (2026). Childhood immunisation gaps and infectious disease outbreak surveillance in Fatehpur district, Uttar Pradesh, India: A secondary analysis of NFHS and IDSP data. *African Research Journal of Medical Sciences*, 3(2): 128-135. doi: 10.62587/AFRJMS.3.2.2026.128-135.