

Evaluation of Universal Immunization Programme Effectiveness in Reducing Vaccine-Preventable Diseases among Pediatric Patients

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Abstract

Background: The Universal Immunization Programme (UIP) is one of India's largest public health initiatives aimed at reducing childhood morbidity and mortality caused by vaccine-preventable diseases (VPDs). Although there have been significant gains in coverage, VPDs remain because people have not been vaccinated, or they have been postponed, and there are healthcare access gaps.

Materials and Methods: An observational cross-sectional study was conducted at the Department of Pediatrics in Lord Buddha Koshi Medical College and Hospital during September 2025 to February 2026 with 98 pediatric patients. A structured proforma was used to gather data on demographic parameters, immunization status, vaccination records, history of vaccine-preventable disease and hospitalization. Data was analyzed statistically in SPSS version 26.0, and descriptive analysis, chi-square test, Fisher's exact test, and odds ratio were used. A p-value <0.05 was regarded as statistically significant.

Results: Of the 98 children, 69.4% were fully immunized, 22.4% partially immunized and 8.2% were unimmunized. Vaccine-preventable diseases occurred 32.7% of participants; pneumonia and measles were the most prevalent diseases. A significant association was observed between incomplete vaccination and the presence of VPDs (p<0.001). Partially immunized and unimmunized children were more likely to be hospitalized and admitted to intensive care.

Conclusion: The introduction of the UIP was shown to be effective in decreasing the incidence of vaccine-preventable diseases and hospitalizations in children. Optimizing childhood immunization coverage requires the reinforcement of routine immunisation services, encouraging full vaccination, and increasing community awareness.

Keywords: Universal Immunization Programme, Vaccine-Preventable Diseases, Pediatric Immunization, Childhood Vaccination, Immunization Coverage, Public Health.

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Introduction

Immunization of children is one of the most successful and cost-effective public health interventions that help prevent infectious diseases and enhance child survival [1]. Vaccines have helped reduce the number of VPDs in the world over the last few decades, contributing to significant declines in childhood morbidity, disability and mortality [2]. Global estimates indicate that routine immunization prevents millions of deaths annually and protects children from life-threatening diseases like tuberculosis, diphtheria, pertussis, tetanus,

poliomyelitis, hepatitis B, measles and rubella [3]. Despite remarkable progress in vaccine development and expanded immunization coverage, VPDs remain a significant public health burden, especially in low and middle-income countries where access to health care, socioeconomic inequalities and immunization services gaps persist. Reduction of burden from VPDs is a national priority in India as these diseases are still contributing to preventable illness, hospitalization and mortality in children [4]. Completeness and

timely immunization thus critical for protecting child health and achieving national and global child health targets [5]. UIP launched in 1985, as one of the ambitious public health initiatives of India to expand free immunization services for major childhood diseases [6].

The programme has been gradually scaled up to include vaccines against tuberculosis (BCG), diphtheria, pertussis, tetanus, poliomyelitis, hepatitis B, Haemophilus influenzae type b (Hib), measles, rubella, rotavirus diarrhoea, and pneumococcal disease in targeted regions following the National Immunization Schedule [7,8]. For further strengthening of routine immunization services and delivering services to underserved populations, the Government of India has launched various initiatives like Intensified Mission Indradhanush and Mission Indradhanush that have led to significant improved in vaccination coverage at the country-level.

While national immunization levels have been rising steadily over the last few years, there are still regional, urban-rural and socioeconomic disparities in vaccine uptake [9,10]. The continued lack of complete immunisation, delayed vaccination, parental vaccine hesitancy, inadequate awareness, migration, and limited healthcare are all continuing to drive the maintenance of vaccine-preventable diseases in children [11,12].

Regular assessment of the performance of the UIP at the local level is important, given the continued presence of VPDs despite the availability of effective vaccines. Hospital-based assessments are useful to gain insights into immunization coverage, disease events and vaccination failure or missed vaccine opportunities. This evidence is crucial for resolving gaps in the program and improving preventive measures in health care.

The current study is designed to assess the efficacy of UIP in controlling vaccine-preventable diseases in the study period September 2025 – February 2026 in the interventional area of Lord Buddha Koshi Medical College and hospital. The results will be used to inform evidence-based interventions to strengthen routine immunization services and help reduce the burden of vaccine-preventable diseases in children.

Objectives

- To estimate the impact of the UIP on preventing vaccine-preventable diseases among children.
- To compare VPDs occurrence rates between fully immunized and partially/non-immunized children.
- To determine the immunization status of children.
- To detect demographic factors related with vaccine-preventable diseases.

Materials and Methods

Study Design: The observational cross-sectional study in a hospital setting to assess the impact of the UIP in the reduction of VPDs in children. The study was an observational design to examine the immunization status of children and its association with the occurrence of VPDs without any investigator intervention.

Study Setting, Area, and Duration: This study was conducted in the Department of Pediatrics, Lord Buddha Koshi Medical College and Hospital, within its designated interventional area. The study included both the pediatric patients who visited the Outpatient Department (OPD) and Inpatient Department (IPD). The data were gathered for 6 months from September 2025 to February 2026.

Study Population, Sample Size, and Sampling Technique: Study population was children aged 0-12 years visiting the pediatric OPD and admitted to the pediatric ward during the study period. A total of 98 pediatric patients met the inclusion criteria were enrolled. The sampling method used in this study was the convenience consecutive sampling technique whereby all children who appeared during the study period and were qualified for the study were selected consecutively until the desired sample size was obtained.

Eligibility Criteria: After obtaining written informed consent from the parent or legal guardian, children aged 0-12 years who had immunization records or a valid immunization card were included in the study. Children who had incomplete medical records, parents or guardians who refused to participate or children with significant congenital immunodeficiency disorders that would affect vaccination status or immune response were excluded from the study.

Data Collection: A predesigned and structured data collection proforma was used to collect data. Information was gathered by interviewing parents/guardians, reviewing immunization cards, and examining hospital medical records. Data collected included age, sex, socioeconomic status, place of birth, maternal education, immunization status, verification of immunization records, history of vaccine-preventable diseases, previous hospital admission for VPDs, and current clinical diagnosis. Immunization status was categorized based on the National Immunization Schedule, depending on the age of the child and documented vaccination status, as either fully immunized, partially immunized, or unimmunized.

Outcome Measures: The primary outcome measure was the occurrence of vaccine-preventable diseases among the enrolled pediatric patients. Secondary outcome measures included overall immunization coverage, hospitalization attributable to vaccine-

preventable diseases, and the association between immunization status and the occurrence of VPDs.

Ethical Considerations: The study protocol was reviewed and approved before commencement by the Institutional Ethics Committee of Lord Buddha Koshi Medical College and Hospital. Parents or legal guardians gave written informed consent for all children participating. Participant information was kept confidential throughout the study and all data collected was anonymous and only accessible to authorised research personnel.

Statistical Analysis: The data collected were analyzed using SPSS version 26.0. Data were presented as mean $\pm$ SD in case of continuous variables and frequencies and percentages in case of

categorical variables. The Chi-square test or Fisher's exact test was used, as appropriate, to assess associations between categorical variables. Odds ratios (ORs) and 95% Confidence Intervals (CIs) were computed to measure the size of associations. All statistical analyses were performed with a p-value of < 0.05 considered significant.

Results

A total of 98 pediatric patients were included in the study. Their demographic characteristics, immunization status, incidence of VPDs, pattern of hospitalization and factors associated with VPDs were analyzed.

Table 1: Demographic Characteristics of Study Participants

Variable	Category	Frequency (n)	Percentage (%)
Age Group (years)	<1	18	18.4
	1–5	44	44.9
	6–12	36	36.7
Gender	Male	56	57.1
	Female	42	42.9
Residence	Rural	66	67.3
	Urban	32	32.7
Socioeconomic Status	Lower	48	49.0
	Middle	38	38.8
	Upper	12	12.2

Most participants were aged 1–5 years (44.9%), followed by 6–12 years (36.7%). There was a male predominance of 57.1% of the study population. Most children lived in rural areas (67.3%) and almost half of the children came from lower socioeconomic households (49.0%).

Table 2: Distribution According to Immunization Status

Immunization Status	Frequency (n)	Percentage (%)
Fully immunized	68	69.4
Partially immunized	22	22.4
Unimmunized	8	8.2

Nearly seven out of ten children (69.4%) were fully immunized according to the National Immunization Schedule. However, 30.6% of participants were either partially immunized or unimmunized, indicating gaps in vaccination coverage.

Table 3: Frequency of Vaccine-Preventable Diseases among Study Participants

Vaccine-Preventable Disease	Frequency (n)	Percentage (%)
Measles	6	6.1
Pertussis	4	4.1
Hepatitis B	2	2.0
Tuberculosis	3	3.1
Diphtheria	1	1.0
Rotavirus diarrhoea	5	5.1
Pneumonia (Hib-related)	8	8.2
Others	3	3.1
No VPD	66	67.3

Overall, 32 children (32.7%) had one or more vaccine-preventable diseases. Measles (6.1%) and rotavirus diarrhoea (5.1%) were also common conditions, followed by pneumonia (8.2%). Two-thirds of the participants had no documented VPD during the study period.

Table 4: Association between Immunization Status and Occurrence of Vaccine-Preventable Diseases

Immunization Status	VPD Present n (%)	VPD Absent n (%)	Chi-square	p-value
Fully immunized (n=68)	12 (17.6)	56 (82.4)		
Partially immunized (n=22)	13 (59.1)	9 (40.9)		
Unimmunized (n=8)	7 (87.5)	1 (12.5)	24.86	<0.001

The occurrence of vaccine-preventable diseases increased significantly as immunization coverage decreased. Only 17.6% of fully immunized children developed VPDs compared with 59.1% of partially

immunized and 87.5% of unimmunized children. This association was statistically significant ($\chi^2 = 24.86$, $p < 0.001$), and was indicative of the protective effect of complete immunization.

Table 5: Hospital Admission According to Immunization Status

Immunization Status	General Admission n (%)	ICU Admission n (%)	No Admission n (%)
Fully immunized (n=68)	10 (14.7)	1 (1.5)	57 (83.8)
Partially immunized (n=22)	9 (40.9)	2 (9.1)	11 (50.0)
Unimmunized (n=8)	5 (62.5)	2 (25.0)	1 (12.5)

Partially immunized and unimmunized children were significantly more likely to be hospitalized. The unimmunized children had the highest rates of ICU admission (25.0%) compared to the fully immunized children (1.5%), which indicates that the level of immunization might be associated with disease severity and admission to the ICU.

Table 6: Factors Associated with Vaccine-Preventable Diseases

Variable	Category	VPD Present n (%)	VPD Absent n (%)	p-value
Mother's education	Primary or below	20 (50.0)	20 (50.0)	0.004*
	Secondary and above	12 (20.7)	46 (79.3)	
Residence	Rural	27 (40.9)	39 (59.1)	0.021*
	Urban	5 (15.6)	27 (84.4)	
Socioeconomic status	Lower	22 (45.8)	26 (54.2)	0.011*
	Middle/Upper	10 (20.0)	40 (80.0)	
Immunization status	Fully immunized	12 (17.6)	56 (82.4)	<0.001*
	Partially/Unimmunized	20 (66.7)	10 (33.3)	

*Statistically significant ($p < 0.05$).

Maternal education, rural residence, lower socioeconomic status and incomplete immunization were all strongly related to the prevalence of VPDs. Among these, immunization status showed the greatest association ($p < 0.001$), highlighting the critical role of complete vaccination in preventing childhood VPDs.

Discussion

The present hospital-based observational study evaluated the effectiveness of the UIP in reducing VPDs among 98 pediatric patients attending Lord Buddha Koshi Medical College and Hospital. The study revealed that 69.4% of children were fully immunized, 22.4% partially immunized and 8.2% unimmunized. Vaccine-preventable diseases were observed in 32.7% of participants and the most common diseases were pneumonia, measles and rotavirus diarrhoea. There was a statistically significant overall association between immunization status and the presence of VPDs ($p < 0.001$), and the number of infections was significantly lower in fully immunized children than in partially immunized or unimmunized children. Moreover, children who were under-immunized were more likely to be hospitalized or admitted to intensive care than were those who were fully

immunized, further confirming that routine immunization is protective against severe disease.

Comparison with Previous Studies: The findings of the present study are consistent with recent national and international studies that show that routine childhood immunization programmes are effective. India has witnessed increased progress in immunization coverage since the introduction of Mission Indradhanush and Intensified Mission Indradhanush, as observed in the national surveys, but with significant regional differences. Studies published from 2020 to 2026 have similarly reported that measles, pertussis, and other vaccine-preventable infections were significantly less common among fully immunized children versus incompletely vaccinated children [13]. Studies in other countries have also shown that long-term immunisation programmes have led to significant decreases in childhood morbidity, mortality and disease occurrences [14]. Recent studies have also identified a reduction in hospitalization after increases in vaccine coverage, and an association between incomplete vaccination and worse disease severity and hospitalisation [15]. The findings of the present study are consistent with other studies that found a relationship between lower maternal

education, rural living, socioeconomic status, and higher rates of VPD infections, thus demonstrating the impact of social determinants on vaccination rates and child health.

Public Health Implications: The results support the importance of comprehensive immunisation for preventing childhood infectious diseases and the need for reducing health service utilization. The UIP needs to be strengthened continuously to achieve equitable vaccine coverage, especially in the less served rural areas. Expanding community awareness of the value of timely vaccination, addressing vaccine hesitancy through health education, improving outreach immunization services and strengthening monitoring systems for vaccine compliance will further enhance programme performance. Regular evaluation of immunization coverage at healthcare facilities can also assist in identifying missed opportunities for vaccination and guide targeted public health interventions.

Strengths: The study provides real-world evidence on the effectiveness of the UIP based on hospital-based data collected from routine clinical practice. Using vaccination cards and medical records to verify immunization status increased the accuracy of exposure assessment, and a standardized data collection proforma ensured consistency and reduced information bias among study participants.

Limitations: There are a few limitations to the study. The results may be limited to other populations due to the relatively small sample size and single-centre design. Long-term vaccine effects and disease seasonality were not assessed because of the duration of the study six months' follow-up. Recall bias has been introduced in a few cases where vaccination cards were unavailable, but was verified with the hospital record wherever possible. Furthermore, the cross-sectional study design restricts causal inference between the immunization status and disease incidence and therefore larger, multicentered prospective studies with longer follow-up period are required.

Conclusion

The present study demonstrated that the UIP is effective in reducing VPDs, hospitalizations, and severe illness among pediatric patients. Complete and timely vaccination is important, as fully immunized children had significantly fewer vaccine-preventable diseases than partially immunized or unimmunized children. Enhancing routine immunization services through increased community awareness, outreach, and ongoing surveillance of immunization coverage is critical. Further validation and evidence-based immunization policies are recommended with the use of larger multicenter prospective trials with longer follow-up periods.

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