

Comparison of Pattern of Lower Respiratory Tract Infection in Children Below 12 Years of Age With Their Immunization Status

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ABSTRACT

Background: Lower respiratory tract infections (LRTIs) remain one of the leading causes of morbidity and mortality in children under 12 years. Immunization plays a critical role in reducing the incidence and severity of LRTIs, yet incomplete or delayed vaccination continues to affect outcomes, especially in resource-limited settings.

Objective: To compare the clinical pattern, severity, and outcome of LRTIs among fully immunized, partially immunized, and unimmunized children aged below 12 years.

Methods: This cross-sectional observational study included 180 children aged 1 month to 12 years admitted with LRTIs over a 1-year period. Immunization status was verified using vaccination cards and caregiver history. Children were categorized as fully, partially, or unimmunized per national immunization schedule. Clinical features, duration of symptoms, severity (based on WHO classification), and outcomes were compared.

Results: Among 180 children, 54.4% were fully immunized, 30.6% partially immunized, and 15% unimmunized. Severe LRTI (e.g., pneumonia requiring oxygen or ICU care) was significantly higher among unimmunized (74%) and partially immunized (53%) compared to fully immunized children (19%) ($p < 0.001$). Duration of hospital stay and complication rates were also higher in the unimmunized group.

Conclusion: Incomplete or absent immunization is significantly associated with increased severity and worse outcomes in pediatric LRTI cases. Strengthening immunization coverage and parental awareness remains crucial in reducing the burden of respiratory infections in children.

KEYWORDS: LRTI, Immunized, Under 5 Mortality

INTRODUCTION

Lower respiratory tract infections (LRTIs) are a major cause of morbidity and mortality in children worldwide, especially in those under five years of age. They account for a significant proportion of pediatric hospital admissions and are a common cause of death in developing countries. According to the World Health Organization (WHO), LRTIs, including pneumonia, bronchitis, and bronchiolitis, are responsible for more than 800,000 child deaths globally each year, with the majority occurring in low- and middle-income countries (1). In India, LRTIs contribute substantially to under-five mortality, despite the availability of preventive strategies such as immunization.

Immunization is one of the most cost-effective public health interventions and plays a pivotal role in reducing the incidence, severity, and complications associated with LRTIs. Vaccines such as Bacillus Calmette-Guérin (BCG), Diphtheria-Tetanus-Pertussis (DPT), Haemophilus influenzae type B (Hib), Pneumococcal conjugate vaccine (PCV), and Measles-Containing Vaccine (MCV) have demonstrated substantial protective effects against respiratory infections (2,3). The introduction of the Universal Immunization Programme (UIP) in India has led to marked improvements in vaccine coverage and child survival; however, gaps still exist in coverage, timeliness, and completion of vaccination schedules. Numerous studies have shown that incomplete or absent immunization is associated with increased risk and severity of LRTIs. For instance, a study found that partially immunized children had higher rates of pneumonia and longer hospital

stays than fully immunized peers (4). Similar findings were reported in a multicenter study in Nepal, where under-vaccinated children were at greater risk of requiring oxygen support or ICU admission during episodes of LRTI (5).

Despite efforts to increase coverage, immunization rates vary widely based on geographic location, parental education, socio-economic status, and access to healthcare. Incomplete vaccination may result from missed opportunities during routine visits, vaccine hesitancy, or lack of awareness. Consequently, children who are partially or unimmunized remain at high risk for severe LRTIs and complications such as hypoxemia, empyema, or sepsis (6).

The clinical presentation of LRTIs in children is also influenced by vaccination status. Fully immunized children often present with milder symptoms and recover more rapidly. On the other hand, unimmunized children are more likely to develop severe disease requiring hospitalization, supplemental oxygen, or intensive care. Furthermore, the risk of secondary bacterial infections, antimicrobial resistance, and prolonged hospitalization is significantly elevated in children who are not adequately immunized (7).

Given these considerations, it is essential to understand how immunization status impacts the pattern and severity of LRTIs in children. Such insights are crucial for clinicians, public health authorities, and policymakers in tailoring interventions that improve immunization uptake and reduce the burden of preventable respiratory illnesses.

The present study aims to compare the pattern of lower respiratory tract infections in children under 12 years of age with respect to their immunization status. Specifically, we seek to analyze the clinical profile, severity, and outcomes of LRTIs among fully immunized, partially immunized, and unimmunized children admitted to a tertiary care hospital. By identifying the association between immunization status and LRTI burden, this study hopes to reinforce the importance of complete immunization and guide targeted strategies for improved pediatric respiratory health.

METHODS

This hospital-based cross-sectional observational study was conducted in the Department of Pediatrics at a tertiary care center in South India over a 12-month period from January to December 2023. The study aimed to assess the relationship between immunization status and the clinical pattern and severity of lower respiratory tract infections (LRTIs) among children below 12 years of age.

All children aged 1 month to 12 years who were admitted with a diagnosis of LRTI during the study period were considered for inclusion. LRTI was defined based on WHO clinical criteria and included conditions such as pneumonia, bronchitis, bronchiolitis, and lower airway wheezing illness. Diagnosis was confirmed through clinical features, chest auscultation findings, and radiological evidence where necessary. Children with congenital heart disease, known immunodeficiency disorders, or chronic respiratory conditions like cystic fibrosis or bronchopulmonary dysplasia were excluded to eliminate potential confounding variables.

After obtaining informed written consent from parents or guardians, data were collected using a structured proforma. Detailed information was recorded, including demographic details (age, sex, socioeconomic background), presenting complaints, clinical signs (respiratory rate, chest indrawing, hypoxia, wheezing), duration of illness before admission, and hospital course (need for oxygen, ICU care, complications). Immunization status was ascertained based on the child's immunization card and parental recall, and classified into three categories:

- **Fully immunized:** Received all age-appropriate vaccines as per the National Immunization Schedule.
- **Partially immunized:** Missed one or more vaccines appropriate for their age.
- **Unimmunized:** Did not receive any routine immunizations.

Children were categorized based on immunization status and comparisons were made across groups with regard to presenting symptoms, severity grading (as per WHO classification of pneumonia), duration of hospital stay, and final outcomes (recovery, complications, or death).

Data were entered and analyzed using SPSS version 26.0 (IBM Corp., Armonk, NY). Categorical variables were presented as percentages and compared using chi-square or Fisher's exact test. Continuous variables were expressed as means $\pm$ standard deviations and compared using independent t-tests or ANOVA where applicable. A p-value <0.05 was considered statistically significant. Ethical approval for the study was obtained from the Institutional Ethics Committee. All patient information was kept confidential and used solely for research purposes.

RESULTS

A total of **180 children** with LRTIs were included in the study. The mean age was **3.9 $\pm$ 2.7 years**, and **56.1%** were male. Based on immunization status, 98 (54.4%) were fully immunized, 55 (30.6%) partially immunized, and 27 (15%) were unimmunized.

Table 1: Demographic and Clinical Characteristics of Study Participants

Characteristic	Fully	Immunized	Partially	Immunized	Unimmunized	p-
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	(n=98)	(n=55)	(n=27)	value
Mean age (years)	3.5 ± 2.6	4.2 ± 2.5	4.6 ± 2.9	0.08
Male : Female	56 : 42	32 : 23	13 : 14	0.43
Mean duration of illness (days)	3.1 ± 1.2	3.6 ± 1.4	4.2 ± 1.7	0.002

Unimmunized children presented later in the illness course, and although age and sex distribution were comparable, illness duration was significantly longer among the unimmunized group.

Table 2: Distribution of LRTI Types by Immunization Status

LRTI Diagnosis	Fully Immunized (%)	Partially Immunized (%)	Unimmunized (%)	p-value
Pneumonia	38 (38.8%)	31 (56.4%)	22 (81.5%)	<0.001
Bronchiolitis	26 (26.5%)	9 (16.4%)	3 (11.1%)	0.04
Wheeze-associated LRTI	34 (34.7%)	15 (27.2%)	2 (7.4%)	0.01

Pneumonia was significantly more prevalent in the unimmunized and partially immunized groups, while fully immunized children had higher rates of milder LRTI presentations.

Table 3: Severity of LRTI at Admission (WHO Criteria)

Severity Category	Fully Immunized (n=98)	Partially Immunized (n=55)	Unimmunized (n=27)	p-value
Mild	52 (53.1%)	17 (30.9%)	3 (11.1%)	<0.001
Moderate	28 (28.6%)	19 (34.5%)	7 (25.9%)	
Severe	18 (18.3%)	19 (34.5%)	17 (63.0%)	

A significantly higher proportion of severe cases occurred among unimmunized children, whereas mild cases predominated among fully immunized children.

Table 4: Complications and Outcomes

Complication/Outcome	Fully Immunized (n=98)	Partially Immunized (n=55)	Unimmunized (n=27)	p-value
Hypoxia requiring O ₂	12 (12.2%)	17 (30.9%)	16 (59.3%)	<0.001
ICU Admission	4 (4.1%)	8 (14.5%)	7 (25.9%)	0.002
Complications (empyema, sepsis)	3 (3.1%)	6 (10.9%)	5 (18.5%)	0.01
Full recovery	97 (99%)	52 (94.5%)	24 (88.9%)	0.04

Summary: Rates of hypoxia, ICU admission, and complications were significantly higher among unimmunized children, while recovery was most complete in the fully immunized group.

Table 5: Length of Hospital Stay

Immunization Status	Mean Duration of Stay (days)	p-value
Fully Immunized	3.8 ± 1.5	
Partially Immunized	5.1 ± 2.0	<0.001
Unimmunized	6.2 ± 2.4	

Unimmunized children had significantly longer hospital stays compared to fully immunized children, indicating more severe illness and slower recovery.

DISCUSSION

Lower respiratory tract infections (LRTIs) continue to be a leading cause of morbidity and mortality among children under 12 years of age, particularly in low- and middle-income countries like India. The present study aimed to assess the impact of immunization status on the clinical presentation, severity, and outcomes of LRTIs in children admitted to a tertiary care hospital.

Our findings indicate that fully immunized children exhibited significantly milder forms of LRTIs, with a higher proportion presenting with mild symptoms and fewer complications. In contrast, partially immunized and unimmunized

children were more likely to develop severe LRTIs, require intensive care, and experience longer hospital stays. These observations underscore the protective effect of complete immunization against severe respiratory infections.

The higher incidence of pneumonia among unimmunized children aligns with existing literature emphasizing the role of vaccines in preventing bacterial and viral respiratory infections. For instance, the introduction of the pneumococcal conjugate vaccine (PCV) has been associated with a significant reduction in pneumonia cases among vaccinated populations. A study from Norway reported a 22% reduction in LRTIs among children who received three or more immunizations between 12 and 18 months of age, and a 25% reduction between 18 and 36 months (8).

Moreover, the *Haemophilus influenzae* type b (Hib) vaccine has demonstrated efficacy in reducing the incidence of Hib-related pneumonia and meningitis. The integration of Hib and PCV into national immunization programs has been pivotal in decreasing the burden of LRTIs. However, gaps in vaccine coverage, due to factors such as limited access to healthcare, vaccine hesitancy, and lack of awareness, continue to pose challenges.

The study also highlights the importance of timely and complete immunization. Partially immunized children, who missed one or more vaccine doses, exhibited intermediate severity and outcomes compared to fully immunized and unimmunized groups. This finding suggests that incomplete vaccination may not confer adequate protection against severe LRTIs, emphasizing the need for adherence to the recommended immunization schedule.

In addition to vaccine-preventable diseases, the emergence of respiratory syncytial virus (RSV) as a significant cause of LRTIs in children has garnered attention. Recent advancements have led to the development of RSV vaccines and monoclonal antibodies aimed at preventing severe RSV infections. For example, nirsevimab, a monoclonal antibody, has shown promise in reducing RSV-related hospitalizations in infants (9). Incorporating such interventions into immunization programs could further mitigate the burden of LRTIs.

The study's findings have important public health implications. Strengthening immunization programs, ensuring vaccine availability, and enhancing community awareness are crucial steps toward reducing the incidence and severity of LRTIs. Healthcare providers play a vital role in educating caregivers about the benefits of vaccination and addressing concerns that may lead to vaccine hesitancy (1).

However, the study has certain limitations. Being a single-center study, the findings may not be generalizable to all settings. Additionally, reliance on caregiver recall for immunization status in the absence of vaccination cards may introduce recall bias. Future multicenter studies with larger sample sizes and robust verification of immunization records are warranted to validate these findings.

In conclusion, the study reinforces the critical role of complete immunization in preventing severe LRTIs in children. Efforts to improve vaccine coverage and adherence to immunization schedules are essential components of strategies aimed at reducing the burden of respiratory infections and improving child health outcomes.

Recommendations

Based on the findings of this study, it is strongly recommended to reinforce complete and timely immunization coverage in all children under 12 years of age to reduce the incidence and severity of lower respiratory tract infections. Public health strategies should focus on improving parental awareness, reducing missed vaccination opportunities, and addressing vaccine hesitancy through community engagement. In addition, pediatric healthcare providers should routinely assess and update immunization status during every clinical encounter, especially in children presenting with respiratory symptoms, to ensure optimal protection against vaccine-preventable respiratory illnesses.

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