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Research Article

Clinico-Epidemiological Profile and Outcome of Acute Lower Respiratory Infections among Hospitalized Children Age 2 Months to 5 Years: A Prospective Observational Study from a Tertiary Care Centre in North-Western India

Dr Abhishek[1], Dr Rinku Saini[2], Dr Priti Saini[3], Dr Yashvi Gehlot[4], Dr Lovesh Saini[5*]
[1]Post Graduate Student, Department of Pediatric Medicine, SMS Medical College & Attached Group of Hospitals, Jaipur.
[2]Professor, Department of Pediatric Medicine, SMS Medical College & Attached Group of Hospitals, Jaipur.
[3]Professor, Department of Pathology, SMS Medical College & Attached Group of Hospitals, Jaipur.
[4]Senior Demonstrator, Department of Pathology, SMS Medical College & Attached Group of Hospitals, Jaipur.
[5*]Associate Professor, Department of Preventive & Social Medicine, SMS Medical College & Attached Group of Hospitals, Jaipur.
Corresponding Author: Dr Lovesh Saini
Associate Professor, Department of Preventive & Social Medicine, SMS Medical College & Attached Group of Hospitals, Jaipur.
Address: C 23, Tiwari ka bagh, Ashok Chowk, Adarsh Nagar, Jaipur.
Email: dr.lovesh82@gmail.com
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ABSTRACT
Background: Acute lower respiratory infections (ALRIs) remain one of the leading causes of childhood morbidity and mortality, particularly in low- and middle-income countries. Identification of factors associated with severe disease is essential for improving clinical outcomes.
Objective: To evaluate the clinico-epidemiological profile, associated risk factors, and clinical outcome of children admitted with acute lower respiratory infections.
Methods: This prospective observational study included 210 children aged 2 months to 5 years admitted with ALRIs at the Department of Paediatric Medicine, SMS Medical College and Attached Group of Hospitals, Jaipur. Demographic characteristics, nutritional status, immunization status, environmental exposures, laboratory investigations, disease severity, treatment requirements, and outcomes were recorded. Statistical analysis was performed using SPSS, and multivariable logistic regression identified independent predictors of severe disease.
Results: Severe pneumonia was the most common presentation (59.5%), followed by very severe pneumonia (21.4%). Low birth weight, poor maternal literacy, incomplete immunization, malnutrition, anaemia, use of non-gas cooking fuel, and attached kitchen were significantly associated with greater disease severity ($p<0.05$). Multivariable logistic regression identified malnutrition, anaemia, incomplete immunization, low birth weight, maternal literacy, cooking fuel, attached kitchen, and increasing age as independent predictors of severe pneumonia. Oxygen therapy and mechanical ventilation requirements increased significantly with disease severity. Overall mortality was 1.4%, with all deaths occurring among children with very severe pneumonia.
Conclusion: Nutritional deficiencies, inadequate immunization, adverse household environmental conditions, and low birth weight independently increase the risk of severe ALRIs in children. Early identification of these modifiable factors, together with timely treatment and preventive interventions, may substantially reduce disease severity and improve clinical outcome.

Keywords: Acute Lower Respiratory Infection, Pneumonia, Children, Risk Factors, Malnutrition, Clinical Outcome.

INTRODUCTION

Acute lower respiratory tract infections (ALRTIs) remain one of the leading causes of morbidity and mortality among children under five years of age worldwide. Despite remarkable advances in immunization, antimicrobial therapy, nutrition, and healthcare delivery, ALRTIs continue to impose a substantial burden

on health systems, particularly in low- and middle-income countries. Pneumonia and bronchiolitis constitute the most important clinical entities within the spectrum of ALRTIs and are responsible for a considerable proportion of pediatric hospital admissions and childhood deaths (1,2).

Globally, ALRTIs account for nearly one-fifth of all deaths among children younger than five years. It has been estimated that approximately 156 million new episodes of childhood ALRTIs occur annually, with the overwhelming majority arising in developing countries. India contributes significantly to this burden, reporting millions of new ALRTI episodes every year and one of the highest numbers of pneumonia-related childhood deaths worldwide. Although improvements in vaccination coverage, nutritional status, and access to healthcare have reduced mortality over recent decades, ALRTIs continue to represent a major public health challenge (3,5).

Acute lower respiratory tract infections comprise a heterogeneous group of infectious diseases involving the bronchi, bronchioles, and pulmonary parenchyma. The principal clinical manifestations include pneumonia, bronchiolitis, bronchitis, and other lower airway infections, with pneumonia accounting for the majority of severe illness and mortality. The etiological spectrum includes both viral and bacterial pathogens. Respiratory syncytial virus (RSV), influenza virus, *Streptococcus pneumoniae*, and *Haemophilus influenzae* type b (Hib) are among the most frequently implicated organisms, while mixed viral-bacterial infections are increasingly recognized, particularly in hospitalized children (4,6).

The severity of ALRTIs is influenced by multiple demographic, nutritional, socioeconomic, and environmental determinants. Younger age, low birth weight, malnutrition, inadequate breastfeeding, incomplete immunization, maternal illiteracy, overcrowded living conditions, exposure to indoor air pollution, biomass fuel use, parental smoking, and poor socioeconomic status have consistently been identified as important risk factors associated with increased disease occurrence and adverse clinical outcomes. These factors often coexist in resource-limited settings, thereby increasing children's vulnerability to severe respiratory infections and hospitalization (4,7).

Early recognition of disease severity remains fundamental to reducing morbidity and mortality. The World Health Organization (WHO) recommends the diagnosis of childhood pneumonia based primarily on simple clinical features, including cough or difficulty breathing associated with age-specific tachypnea. The presence of lower chest wall indrawing, hypoxemia, inability to feed, lethargy, convulsions, or central cyanosis indicates severe or very severe disease requiring immediate hospitalization and appropriate supportive management, including oxygen therapy and intensive care when indicated (2,8).

Several epidemiological studies have investigated the clinical profile and risk factors associated with childhood ALRTIs. However, considerable regional variations exist in disease epidemiology because of differences in nutritional status, environmental exposures, healthcare accessibility, vaccination coverage, and socioeconomic conditions. Most available studies have focused on individual determinants such as nutritional status or microbiological etiology, whereas relatively few have comprehensively evaluated the combined influence of demographic, environmental, nutritional, and clinical factors on disease severity and outcomes among hospitalized children. Furthermore, data from North-Western India, particularly Rajasthan, remain limited despite the substantial burden of pediatric respiratory infections in this region (4,9).

The present prospective observational study was therefore undertaken to evaluate the clinico-epidemiological profile, associated risk factors, and clinical outcome of children age 2 months to 5 years admitted with acute lower respiratory tract infections at a tertiary care teaching hospital in Jaipur, Rajasthan. Identifying the factors independently associated with severe disease may facilitate early risk stratification, strengthen preventive strategies, and improve clinical management, thereby contributing to better outcomes in children with ALRTIs.

MATERIALS AND METHODS

Study Design and Setting

This hospital-based prospective observational study was conducted in the Department of Paediatric Medicine, Sir Padampat Institute of Neonatology and Paediatric Health (S.P.I.N.P.H.), SMS Medical College and Attached Group of Hospitals, Jaipur, Rajasthan, India.

Study Population

Children age 2 months to 5 years admitted with a diagnosis of acute lower respiratory tract infection to the Department of Paediatric Medicine were screened for eligibility. Consecutive sampling was adopted, and all eligible children fulfilling the inclusion criteria were enrolled after obtaining written informed consent from their parents or legal guardians. A total of 210 children constituted the final study population.

The sample size was calculated assuming a prevalence of 23% for very severe pneumonia among children with ALRTIs based on the study by Vinaykumar et al., using a confidence level of 95% and an absolute allowable error of 6%. The sample size was calculated using the following formula:

$$N = \frac{Z^2 pq}{d^2}$$

Where:

- **N** = Required sample size
- **Z** = Standard normal deviate at 95% confidence interval (1.96)
- **p** = Expected prevalence (23%)
- **q** = 100 − p (77%)
- **d** = Absolute allowable error (6%)

Accordingly, the required sample size was calculated to be 210 children.

Inclusion and Exclusion Criteria

Children age between 2 months and 5 years admitted with acute lower respiratory tract infections whose parents or guardians were willing to provide written informed consent were included in the study.

Children with respiratory distress secondary to pulmonary tuberculosis, congenital heart disease, neurological disorders, foreign body aspiration, chemical pneumonitis, drowning, inborn errors of metabolism, metabolic disorders, or immunosuppressive conditions were excluded to minimize confounding and ensure inclusion of patients with primary acute lower respiratory tract infections only.

Study Procedure

Eligible children were enrolled consecutively after admission. Detailed demographic information including age, sex, birth weight, religion, maternal education, socioeconomic status, immunization history, feeding practices, and environmental characteristics was recorded using a predesigned structured case record proforma.

A comprehensive clinical history was obtained, including duration of illness, fever, cough, rapid breathing, chest indrawing, refusal to feed, wheezing, lethargy, previous similar episodes, and family history of respiratory tract infection. Information regarding exclusive breastfeeding, complementary feeding, exposure to parental smoking, overcrowding, household cooking fuel, and type of kitchen was also collected.

Each participant underwent a detailed clinical examination comprising general physical examination, anthropometric assessment, and systemic examination. Respiratory evaluation included respiratory rate, oxygen saturation (SpO_2) measured using pulse oximetry, presence of chest indrawing, nasal flaring, use of accessory respiratory muscles, grunting, cyanosis, and auscultatory findings. Nutritional status was assessed according to the Indian Academy of Paediatrics (IAP) classification of protein-energy malnutrition.

Operational Definitions

Acute lower respiratory tract infection was defined according to the World Health Organization (WHO) criteria as cough and/or difficulty in breathing of less than 30 days duration associated with age-specific tachypnea.

Pneumonia was defined as cough or difficulty in breathing accompanied by age-specific tachypnea with or without chest indrawing after excluding other causes of respiratory illness.

Severe pneumonia was defined as pneumonia associated with lower chest indrawing and/or WHO general danger signs, including inability to drink or breastfeed, persistent vomiting, convulsions, lethargy or unconsciousness, severe respiratory distress, or oxygen saturation below 90%.

Very severe pneumonia was defined as pneumonia accompanied by life-threatening manifestations such as central cyanosis, severe respiratory distress, hypoxemia (SpO_2 <90%), altered sensorium, convulsions, shock, respiratory failure, or the need for intensive care.

Socioeconomic status was classified according to the Modified Kuppuswamy Socioeconomic Scale (2025). Overcrowding was defined as more than two persons residing per habitable room. Anaemia was defined according to WHO criteria as haemoglobin <11 g/dL, while leucocytosis was defined as a total leukocyte count >15,000 cells/mm^3.

Laboratory Investigations

Baseline laboratory investigations included complete blood count, haemoglobin estimation, total leukocyte count, renal function tests, liver

function tests, serum electrolytes, blood culture, and chest radiography. Additional investigations were performed whenever clinically indicated according to the treating physician's discretion.

Blood culture findings were documented for microbiological evaluation, while chest radiography was performed in all enrolled children to support the diagnosis of lower respiratory tract infection. All observations were systematically recorded in the study proforma before statistical analysis.

Outcome Measures

The primary outcome of the study was the severity of pneumonia categorized as pneumonia, severe pneumonia, and very severe pneumonia according to WHO criteria.

Secondary outcome measures included oxygen therapy requirement, mechanical ventilation, blood culture findings, duration of hospitalization, and final clinical outcome categorized as improved or death.

Statistical Analysis

All collected data were entered into Microsoft Excel and analyzed using Statistical Package for the Social Sciences (SPSS) software. Continuous variables were expressed as mean ± standard deviation (SD), whereas categorical variables were summarized as frequencies and percentages. Continuous variables were compared using the unpaired Student's *t*-test, while categorical variables were analyzed using the Chi-square test or Fisher's exact test wherever appropriate.

Variables demonstrating statistical significance on univariate analysis were subsequently entered into a multivariable logistic regression model to identify independent predictors of severe and very severe pneumonia. Adjusted odds ratios (AORs) with corresponding 95% confidence intervals (CIs) were calculated. A two-tailed p-value <0.05 was considered statistically significant for all analyses.

RESULTS

Table 1. Baseline demographic characteristics and severity of pneumonia

Variable	Total (n=210)	P-value
Age ≤12 months	35	0.002
13–24 months	35	
25–36 months	51	
37–48 months	57	
49–60 months	32	
Female	131	0.06
Male	79	
Low birth weight (≤2.5 kg)	64	0.02
Normal birth weight	146	

Table 2. Environmental and nutritional risk factors associated with pneumonia severity

Variable	P-value
Maternal literacy	0.007
Socioeconomic status	0.31
Smoking exposure	0.35
Overcrowding	0.29
Incomplete immunization	0.01
Non-gas cooking fuel	<0.001
Attached kitchen	<0.001
Malnutrition	<0.001
Anaemia	<0.001
Leucocytosis	0.11
Blood culture positivity	0.16

Table 3. Clinical management and outcome

Variable	number (%)	P-value
Oxygen therapy	147 (70.0)	<0.001
Mechanical ventilation	22 (10.5)	<0.001

Improved	207 (98.6)	
Death	3 (1.4)	0.08

Table 4. Distribution of clinical diagnoses

Diagnosis	**number (%)**
Bronchiolitis	98 (46.7)
Bronchopneumonia	44 (21.0)
Lobar pneumonia	40 (19.0)
WALRTI	18 (8.6)
Acute laryngotracheobronchitis	10 (4.8)

Table 5. Multivariable logistic regression analysis

Variable	**AOR (95% CI)**	**P-value**
Increasing age	1.03 (1.01–1.05)	0.003
Low birth weight	2.00 (1.14–3.52)	0.016
Low maternal literacy	2.27 (1.17–4.43)	0.015
Incomplete immunization	2.03 (1.19–3.47)	0.010
Moderate/severe malnutrition	3.98 (2.18–7.24)	<0.001
Anaemia	2.49 (1.43–4.34)	0.001
Non-gas cooking fuel	2.32 (1.36–3.95)	0.002
Attached kitchen	2.58 (1.40–4.76)	0.021
Overcrowding	1.27 (0.82–1.98)	0.284

DISCUSSION

The present prospective observational study evaluated the clinico-epidemiological profile, associated risk factors, and clinical outcome of acute lower respiratory tract infections (ALRTIs) among hospitalized children age 2 months to 5 years. Severe pneumonia constituted the largest proportion of admissions (59.5%), followed by very severe pneumonia (21.4%). The study demonstrated that low birth weight, poor maternal literacy, incomplete immunization, malnutrition, anaemia, use of non-gas cooking fuel, and an attached kitchen were independently associated with severe disease, whereas gender, socioeconomic status, smoking exposure, overcrowding, leucocytosis, and blood culture positivity were not significantly associated with disease severity (10).

Increasing age showed a significant association with pneumonia severity in the present study. Older children demonstrated a greater proportion of very severe pneumonia, although younger children constituted a substantial proportion of hospital admissions. Similar observations were reported by Vinaykumar et al., who also identified a greater frequency of severe pneumonia among older children, although the association did not achieve statistical significance in their study (10). The observed variation may reflect regional differences in referral patterns, healthcare accessibility, and timing of hospital presentation.

Low birth weight emerged as an important determinant of disease severity. Children weighing ≤2.5 kg at birth had approximately two-fold higher odds of developing severe pneumonia than those with normal birth weight. Comparable findings have been reported by Mahato and Roy, who observed that low birth weight was an important contributor to severe childhood pneumonia (11). Reduced pulmonary reserve, impaired immune function, and increased susceptibility to respiratory pathogens may explain the greater disease severity observed among low birth weight children.

Maternal literacy was another significant predictor of disease severity. Children born to mothers with lower educational attainment experienced a greater proportion of very severe pneumonia. Maternal education influences health-seeking behaviour, vaccination compliance, nutritional practices, and early recognition of respiratory symptoms. Similar findings have been reported by Kumar et al., who demonstrated better clinical outcomes among children of educated mothers, emphasizing the importance of maternal awareness in reducing childhood respiratory morbidity (12).

Incomplete immunization was independently associated with severe disease in the present study. Fully immunized children experienced

considerably lower frequencies of severe and very severe pneumonia than incompletely immunized children. These findings are consistent with previous reports demonstrating that routine childhood immunization substantially reduces the incidence and severity of pneumonia by preventing infections caused by vaccine-preventable respiratory pathogens (10,13). Strengthening immunization coverage therefore remains one of the most effective public health interventions for reducing childhood ALRTIs.

Among all evaluated variables, malnutrition emerged as the strongest independent predictor of severe pneumonia, increasing the odds of severe disease almost four-fold. Progressive worsening of nutritional status was accompanied by increasing frequencies of severe and very severe pneumonia. Similar observations have been reported by Bari et al., who demonstrated significantly poorer clinical outcomes among severely malnourished children hospitalized with respiratory illnesses (14). Malnutrition adversely affects both innate and adaptive immune responses, predisposing children to prolonged infection, greater disease severity, and delayed recovery.

Anaemia was also significantly associated with severe pneumonia in the present study. Anaemic children demonstrated approximately 2.5-fold greater odds of severe disease than non-anaemic children. Comparable findings were reported by Simanjuntak and Saragih, who observed that anaemia nearly doubled the risk of severe pneumonia among hospitalized children (15). Reduced oxygen-carrying capacity combined with impaired immune competence may contribute to poorer respiratory function and increased disease severity in anaemic patients.

Environmental exposures also played a significant role. Use of biomass or other non-gas cooking fuels and the presence of an attached kitchen independently increased the likelihood of severe pneumonia. Indoor air pollution generated during cooking may impair mucociliary clearance, promote airway inflammation, and increase susceptibility to respiratory infections. These findings support previous evidence emphasizing cleaner household fuel and improved ventilation as effective preventive strategies for childhood respiratory illnesses (10,14).

Although household smoking exposure, socioeconomic status, overcrowding, leucocytosis, and blood culture positivity were not significantly associated with disease severity in this study, these variables remain clinically relevant because they have been associated with childhood respiratory morbidity in other populations (10,11). The absence of statistical significance in the present study may be attributable to regional differences, sample characteristics, or limited statistical power for selected variables.

The clinical course reflected disease severity. Oxygen supplementation and mechanical ventilation were required significantly more frequently among children with severe and very severe pneumonia. Nearly all children with very severe pneumonia required oxygen therapy, and mechanical ventilation was predominantly required among critically ill patients. Despite the high proportion of severe disease, the overall clinical outcome was favourable, with 98.6% of children recovering following appropriate management. All three deaths occurred among children with very severe pneumonia, highlighting the importance of early diagnosis, prompt referral, and timely intensive care for children presenting with advanced disease (12).

CONCLUSION

Acute lower respiratory tract infections remain a major cause of hospitalization among children age 2 months to 5 years. In the present study, severe pneumonia accounted for the majority of admissions, highlighting the substantial burden of advanced respiratory disease in this age group. Several demographic, nutritional, immunological, and environmental factors significantly influenced disease severity.

Low birth weight, poor maternal literacy, incomplete immunization, malnutrition, anaemia, use of non-gas cooking fuel, and the presence of an attached kitchen were identified as independent predictors of severe pneumonia. Among these, malnutrition emerged as the strongest risk factor. In contrast, gender, socioeconomic status, smoking exposure, overcrowding, leucocytosis, and blood culture positivity were not independently associated with disease severity.

The requirement for oxygen therapy and mechanical ventilation increased significantly with increasing pneumonia severity, emphasizing their importance as indicators of advanced disease. Although the overall clinical outcome was favorable, mortality occurred exclusively among children with very severe pneumonia, underscoring the need for early recognition and timely intensive management.

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