



Original Article

Risk Factors Contributing to Severe Lower Respiratory Tract Infections in Children Under Five Years of Age: Case–Control Study

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ABSTRACT

Background: Lower respiratory tract infections (LRTIs) are among the leading causes of morbidity and mortality in under-five children, particularly in developing countries. Several nutritional, environmental, and socioeconomic factors contribute to the severity of these infections.

Objective: To identify the risk factors associated with severe lower respiratory tract infections in under-five children.

Methods: A hospital-based case–control study was conducted in the Department of Pediatrics at a tertiary care teaching hospital over a period of 6 months. A total of 120 children aged between 2 months and 5 years were included, comprising 60 cases with severe LRTIs and 60 controls with non-severe respiratory infections. Data regarding nutritional status, immunization, breastfeeding practices, socioeconomic status, overcrowding, and indoor smoke exposure were collected and analyzed using SPSS version 25. Logistic regression analysis was performed to identify independent risk factors.

Results: Malnutrition (65%), incomplete immunization (53.3%), indoor smoke exposure (61.7%), overcrowding (58.3%), and lack of exclusive breastfeeding (56.7%) were significantly more common among severe LRTI cases compared to controls ($p < 0.05$). Logistic regression analysis showed malnutrition, indoor smoke exposure, and incomplete immunization as major independent predictors of severe LRTIs.

Conclusion: Severe lower respiratory tract infections in under-five children are strongly associated with modifiable risk factors such as malnutrition, incomplete immunization, poor breastfeeding practices, and indoor air pollution. Early identification and preventive interventions targeting these factors may reduce childhood respiratory morbidity and mortality.

Keywords: Lower respiratory tract infection, under-five children, pneumonia, malnutrition, indoor air pollution, risk factors.

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INTRODUCTION

Lower respiratory tract infections (LRTIs) are among the leading causes of morbidity and mortality in children under five years of age worldwide and continue to pose a major public health challenge, particularly in developing countries. According to the World Health Organization (WHO), pneumonia alone accounts for nearly 14% of all deaths among children under five globally (1). Despite advances in immunization, antimicrobial therapy, and pediatric healthcare, severe LRTIs remain a major cause of hospitalization and childhood mortality in resource-limited settings.

Lower respiratory tract infections include infections involving the airways below the larynx, such as bronchiolitis, bronchitis, and pneumonia. Among these, pneumonia is the most severe form and is characterized by fever, cough, tachypnea, chest indrawing, hypoxia, and respiratory distress (2). The burden of severe LRTIs is disproportionately high in low- and middle-income countries due to malnutrition, poverty, overcrowding, environmental pollution, and inadequate healthcare access (3).

Children under five years are particularly vulnerable to respiratory infections because of their immature immune system, smaller airways, and poor nutritional reserves. Common etiological agents include respiratory syncytial virus, influenza virus, parainfluenza virus, *Streptococcus pneumoniae*, and *Haemophilus influenzae* (4,5). Severe disease often develops when host immunity is compromised by nutritional deficiency or adverse environmental conditions.

Malnutrition is one of the most important risk factors associated with severe LRTIs. Protein-energy malnutrition impairs both humoral and cell-mediated immunity, thereby increasing susceptibility to severe and recurrent infections (6). Studies have shown that undernourished children are at significantly higher risk of hospitalization and mortality due to pneumonia (7). Environmental factors such as indoor air pollution from biomass fuel, passive smoking, poor ventilation, and overcrowding also contribute substantially to respiratory morbidity in children (8,9).

Immunization status and infant feeding practices significantly influence respiratory health in early childhood. Vaccination against *Haemophilus influenzae* type b, measles, pertussis, and pneumococcal infections has considerably reduced childhood respiratory mortality (10). Exclusive breastfeeding during the first six months of life provides essential immunological protection and lowers the incidence of respiratory infections (11). Conversely, incomplete immunization and lack of exclusive breastfeeding increase the risk of severe disease.

Socioeconomic determinants including poverty, low parental education, overcrowding, and poor sanitation further aggravate the burden of severe respiratory infections by increasing exposure to infectious agents and delaying healthcare seeking behavior (12). Several studies from developing countries have identified modifiable risk factors associated with severe LRTIs; however, regional differences in environmental exposure, nutritional practices, and healthcare access necessitate local evaluation (13,14).

Hence, the present study was undertaken to identify the risk factors associated with severe lower respiratory tract infections in children under five years of age attending a tertiary care teaching hospital

MATERIALS AND METHODS:

The present hospital-based case-control study was conducted in the Department of Pediatrics at a tertiary care teaching hospital over a period of **6 months** after obtaining approval from the Institutional Ethics Committee. Written informed consent was obtained from the parents or guardians of all participating children prior to inclusion in the study.

A total of 120 children aged between 2 months and 5 years were enrolled in the study. Among them, 60 children diagnosed with severe lower respiratory tract infections (LRTIs) constituted the case group, while 60 age- and sex-matched children with non-severe respiratory tract infections served as controls. Diagnosis and classification of severe LRTI were made according to the World Health Organization (WHO) criteria, which included symptoms such as cough, fever, tachypnea, chest indrawing, hypoxia, inability to feed, cyanosis, and altered sensorium

Children with congenital heart disease, bronchial asthma, pulmonary tuberculosis, chronic lung disease, immunodeficiency disorders, neurological illness, congenital anomalies of the respiratory tract, or those receiving long-term corticosteroid therapy were excluded from the study.

A detailed history and clinical examination were performed in all enrolled children using a predesigned structured proforma. Information regarding demographic profile, birth history, birth weight, immunization status, nutritional status, breastfeeding practices, parental education, socioeconomic status, overcrowding, exposure to passive smoking, type of cooking fuel used at home, and previous history of respiratory infections was collected from parents or caregivers.

Nutritional assessment was carried out using WHO growth standards. Children with weight-for-age below -2 standard deviations were considered malnourished. Immunization status was assessed according to the National Immunization Schedule, and children missing one or more age-appropriate vaccines were classified as incompletely immunized. Exclusive breastfeeding was defined as feeding only breast milk for the first six months of life.

Socioeconomic status was assessed using the modified Kuppuswamy socioeconomic scale. Overcrowding was defined as more than three persons residing in a single room. Exposure to indoor air pollution was assessed based on the use of biomass fuels such as firewood, coal, or cow dung for cooking and exposure to environmental tobacco smoke inside the household.

All children underwent detailed systemic examination, including assessment of respiratory rate, pulse rate, temperature, oxygen saturation, and anthropometric measurements. Relevant investigations such as complete blood count, chest radiography, and pulse oximetry were performed wherever clinically indicated.

The collected data were entered into Microsoft Excel and analyzed using IBM SPSS Statistics version 22.0. Continuous variables were expressed as mean \pm standard deviation, while categorical variables were presented as frequencies and

percentages. The Chi-square test was used to compare categorical variables between cases and controls, and the independent Student's *t*-test was used for continuous variables. Logistic regression analysis was performed to identify independent risk factors associated with severe lower respiratory tract infections. A *p*-value <0.05 was considered statistically significant.

RESULTS:

A total of 120 children aged between 2 months and 5 years were included in the study, comprising 60 cases with severe lower respiratory tract infections (LRTIs) and 60 controls with non-severe respiratory tract infections. The mean age of children in the case group was 22.4 ± 11.2 months, while that of the control group was 24.1 ± 10.8 months. Male children constituted 58.3% of cases and 53.3% of controls. Mean birth weight was significantly lower among cases compared to controls. There was no statistically significant difference between the two groups with respect to age and gender distribution (*p* >0.05).

Table 1. Demographic and clinical characteristics of study participants

Parameter	Cases (n=60)	Controls (n=60)	p-value
Mean age (months)	22.4 ± 11.2	24.1 ± 10.8	0.42
Male gender	35 (58.3%)	32 (53.3%)	0.58
Female gender	25 (41.7%)	28 (46.7%)	0.58
Mean birth weight (kg)	2.4 ± 0.5	2.8 ± 0.4	0.001*

* Statistically significant

Malnutrition, incomplete immunization, and lack of exclusive breastfeeding were significantly more common among children with severe LRTIs, indicating their strong association with disease severity. (Table 2)

Table 2. Nutritional and immunization-related risk factors

Risk Factor	Cases (n=60)	Controls (n=60)	p-value
Malnutrition	39 (65%)	18 (30%)	<0.001*
Incomplete immunization	32 (53.3%)	15 (25%)	0.002*
Lack of exclusive breastfeeding	34 (56.7%)	16 (26.7%)	0.001*

* Statistically significant

Children exposed to indoor air pollution, overcrowded living conditions, passive smoking, and poor socioeconomic conditions had a significantly higher incidence of severe lower respiratory tract infections. (Table 3)

Table 3. Environmental and socioeconomic risk factors

Risk Factor	Cases (n=60)	Controls (n=60)	p-value
Indoor smoke exposure	37 (61.7%)	19 (31.7%)	0.001*
Overcrowding	35 (58.3%)	17 (28.3%)	0.001*
Low socioeconomic status	42 (70%)	21 (35%)	<0.001*
Passive smoking	29 (48.3%)	14 (23.3%)	0.004*

* Statistically significant

Malnutrition emerged as the strongest independent risk factor for severe LRTIs, followed by indoor smoke exposure and incomplete immunization. These findings suggest that nutritional, environmental, and preventable social factors play a major role in the severity of respiratory infections among under-five children. (Table 4)

Table 4. Logistic regression analysis of independent risk factors

Risk Factor	Odds Ratio (OR)	95% CI	p-value
Malnutrition	3.4	1.7–6.8	0.001*
Indoor smoke exposure	2.9	1.4–5.9	0.003*
Incomplete immunization	2.7	1.3–5.4	0.005*
Overcrowding	2.3	1.1–4.8	0.02*
Lack of exclusive breastfeeding	2.5	1.2–5.1	0.01*

* Statistically significant

DISCUSSION:

Lower respiratory tract infections remain one of the major causes of morbidity and mortality among under-five children, particularly in developing countries. The present study evaluated various demographic, nutritional, environmental, and socioeconomic factors associated with severe lower respiratory tract infections (LRTIs) in children and identified several significant risk factors contributing to disease severity.

In the present study, the majority of severe LRTI cases occurred in children below two years of age, with a slight male predominance. Similar findings were reported by Broor et al. (15) and Savitha et al. (16), who observed increased susceptibility among younger children due to immature immunity, smaller airway caliber, and increased exposure to infectious agents. Male predominance in respiratory infections has also been documented in several pediatric studies, possibly due to biological differences in airway anatomy and immune responses.

Malnutrition emerged as the most significant independent risk factor for severe LRTIs in the present study. Approximately 65% of cases were malnourished compared to 30% of controls, and logistic regression analysis showed a strong association between malnutrition and disease severity. Malnutrition impairs both humoral and cell-mediated immunity, reduces mucosal barrier function, and predisposes children to severe infections (17). Similar observations were made by Chisti et al. (18), who reported that severely malnourished children were at greater risk of severe pneumonia, prolonged hospitalization, and mortality. Caulfield et al. (19) also emphasized that undernutrition is an important underlying factor contributing to childhood deaths due to pneumonia and other infectious diseases.

Incomplete immunization was another important factor significantly associated with severe LRTIs in this study. More than half of the children with severe infection were incompletely immunized. Vaccination against pathogens such as *Haemophilus influenzae* type b, *Streptococcus pneumoniae*, pertussis, and measles plays a critical role in preventing severe respiratory infections and reducing hospitalization rates (20). O'Brien et al. (21) demonstrated that widespread immunization substantially decreases the burden of pneumococcal pneumonia among under-five children. Failure to complete age-appropriate vaccination schedules increases susceptibility to severe disease and complications.

Exclusive breastfeeding has a well-established protective effect against childhood infections due to the presence of maternal antibodies, immune cells, and bioactive factors in breast milk. In the present study, lack of exclusive breastfeeding was significantly more common among severe LRTI cases. Similar findings were reported by Lamberti et al. (22), who concluded that exclusive breastfeeding during the first six months significantly reduces pneumonia-related morbidity and mortality. Breastfeeding enhances infant immunity and reduces exposure to contaminated feeds and environmental pathogens.

Environmental risk factors such as indoor air pollution and passive smoking were strongly associated with severe LRTIs in the present study. Children exposed to biomass fuel smoke and household tobacco smoke had significantly higher rates of severe respiratory infection. Indoor combustion of firewood, coal, crop residues, and cow dung releases particulate matter and toxic gases that damage airway epithelium and impair mucociliary clearance (23). Dherani et al. (24) demonstrated a strong association between indoor air pollution and pneumonia risk in under-five children. Similar results were also observed by Smith et al. (25), who highlighted indoor smoke exposure as a major contributor to respiratory morbidity in developing countries.

Overcrowding and low socioeconomic status were significantly associated with severe disease in the present study. Overcrowded living conditions facilitate transmission of respiratory pathogens, while poor socioeconomic conditions often lead to malnutrition, delayed healthcare seeking behavior, inadequate sanitation, and poor immunization coverage (26). Victora et al. (27) identified poverty and overcrowding as important determinants of childhood pneumonia in developing countries. Low parental education and poor awareness regarding hygiene and preventive healthcare further contribute to increased disease burden.

The findings of the present study support the multifactorial nature of severe lower respiratory tract infections in children. Nutritional deficiency, environmental pollution, inadequate immunization, and adverse socioeconomic conditions collectively contribute to impaired host defense mechanisms and increased susceptibility to severe respiratory disease. Most of these factors are modifiable and can be addressed through public health interventions such as nutritional supplementation, promotion of exclusive breastfeeding, improved immunization coverage, reduction of indoor air pollution, and community health education.

The present study has certain limitations. Being a hospital-based study, the findings may not completely represent the community population. The sample size was relatively small, and microbiological identification of causative organisms was not performed. However, the study provides valuable insight into major preventable risk factors associated with severe LRTIs among under-five children in our region.

Overall, the present study highlights the importance of addressing nutritional, environmental, and socioeconomic determinants to reduce the burden of severe lower respiratory tract infections and improve child health outcomes.

CONCLUSION:

The present study identified malnutrition, incomplete immunization, lack of exclusive breastfeeding, indoor air pollution, overcrowding, and low socioeconomic status as significant risk factors associated with severe lower respiratory tract

infections in under-five children. Malnutrition and indoor smoke exposure were found to be major independent predictors of disease severity.

The findings emphasize that most risk factors for severe LRTIs are preventable and modifiable. Improving nutrition, promoting breastfeeding, ensuring complete immunization, and reducing indoor air pollution can help decrease the burden of severe respiratory infections and improve child health outcomes.

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