











Research Article

# Risk Factors of Pneumonia in Children: A Study in a Tertiary Care Hospital in Bangladesh

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## Abstract

**Background:** Pneumonia remains a significant health concern in children in developing countries. The identification of risk factors is an important step in formulating effective interventions. **Aim:** This study has been conducted to assess different risk factors associated with pneumonia. **Methods:** A cross-sectional study of six months has been conducted by enrolling a total of 65 children presenting with pneumonia in Bangladesh Shishu Hospital & Institute, Dhaka, Bangladesh. Between February 2024 to August 2024. Demographic, socio-economic, environmental, nutritional, and immunization data are discussed. **Results:** The cohort consisted of 54% males and 46% females, distributed as 31% infants, 38% toddlers, and 31% preschoolers. A considerable number, 50%, belonged to lower socio-economic classes and were undernourished. Also, solid fuel use was 42%, indoor smoking was 32%, and vaccination coverage was very low-28% pneumococcal and 36% influenza. The severity of pneumonia was mild in 49%, moderate in 38%, and severe in 13%. Logistic regression analysis showed that being underweight, indoor smoking, and low immunization coverages are independent risk factors with significant OR values of 3.2, 2.8, and 2.1, respectively. **Conclusion:** The multi-factorial causes of pneumonia in children require health interventions targeting socioeconomic, environmental, and health-related risks to improve the prognosis among children in Bangladesh.

## Keywords

Pneumonia, Children, Risk Factors, Socio-Economic Status, Environmental Exposure, Malnutrition, Immunization

## 1. Introduction

Pneumonia is one of the leading causes of morbidity and mortality in children in developing countries because of improper health resources [1]. According to UNICEF & WHO, pneumonia accounts for approximately 14% mortality in under the age of five years, amounting to over 700,000

deaths every year. Pneumonia is a leading cause of death, with one child passing away every second due to the disease. Therefore, due to a combination of environmental, social, and economic factors that increase the risk of infection, the burden of pneumonia is very high in South Asia [2, 3]. In

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**Received:** 15 December 2024; **Accepted:** 30 December 2024; **Published:** 22 January 2025



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Bangladesh, the situation has gone to such a degree that according to the in a study conducted in Bangladesh, the overall prevalence of pneumonia among children under five years old was reported to be 33.5% [4]. The prevalence of acute respiratory infection recurrence is alarming as children on average experience three episodes within a year, which may be detrimental to their health with future complications; this may also raise expenses attributed to health services [5]. There are numerous risk factors that fuel the rising trend of pneumonia incidence in children. Socioeconomic status also plays an important role in this respect; a child from low-income families is more likely to be exposed to environmental hazards and malnutrition [6]. In 2020, the prevalence of stunting among children under five years reached 20.8% [UNICEF, WHO, and World Bank, 2020]. As reported in the most recent data, the rate of stunting among Bangladesh children stands at about 31% in this age group. This continuing problem is intertwined with a variety of socio-economic factors affecting the nutrition and health of the children [7-11] A malnourished child is as much as six times at risk of developing severe pneumonia compared to their well-nourished counterparts. Other environmental factors that are significantly related to pneumonia risk include the use of solid fuel for cooking, leading to indoor air pollution and an increase in respiratory infections [12]. About 66% of the households in Bangladesh, according to the UNICEF 2019 report, use solid fuels for cooking. Children who are exposed to indoor pollutants have a 1.5 times higher risk of developing pneumonia. Besides, overcrowding living conditions exert an added effect on the exposure of this risk since close contact among children enhances the spread of infectious agents. According to the BDHS, about 38% of the children in urban areas live in households with over three people per room, hence an optimum setting for respiratory infections. Underlying health conditions like anemia and chronic respiratory diseases further complicate the pneumonia landscape. According to a study, a large number of children under five have anemia [13], which undermines their immune system and increases their susceptibility of having severe pneumonia. Moreover, children with a history of respiratory illness are at a greater risk for developing repeated episodes of pneumonia, creating a vicious cycle of infection and morbidity. Hence, the various risk factors for pneumonia in children need to be understood so that interventions, whether targeted or in terms of effective public health policies, can be done. It also intends to identify and analyze the various risk factors for pneumonia among pediatric patients presenting to the Tertiary Care Hospital in Bangladesh. This research hence attempts to contribute useful inputs to healthcare policies, improvement in clinical practices, and reduction of the burden of pneumonia among children in Bangladesh and beyond, based on a data-driven approach. This study, therefore, sets out to incorporate an in-depth analysis of socio-economic, environmental, and health-related determinants of pneumonia in children to provide a broad-based understand-

ing significant health challenge.

## 2. Methodology

This cross-sectional study investigates risk factors for pneumonia among the children who were admitted to Department of Pulmonology, Bangladesh Shishu Hospital & Institute, and Dhaka, Bangladesh. One of the largest pediatric tertiary care facilities in Bangladesh. It will seek to identify and analyze demographic, socio-economic, environmental, and health-related variables in a representative sample contributing to pneumonia among pediatric patients. The target population included children aged 1 month to 5 years who were admitted due to pneumonia from February 2024 to August 2024, covering a period of six months. Previous records showed close to 300 admissions within this age bracket for the condition; therefore, a systematic random sample of 65 children-11% of the expected admissions-was targeted to ensure validity and reliability. It comprised about 35 males and 30 females, which reflects the trend of incidence of pneumonia being higher among boys. There were 20 infants between 1 month to 11 months, 25 toddlers between 1 to 3 years, and 20 preschoolers between 4 to 5 years. Data collection was done by structured interviews and review of medical records on age, sex, socio-economic status, household conditions, health history, and clinical examination. The socio-economic status was determined using the modified Kuppuswamy scale that relied on family income, parental education, and occupation. The following environmental data were collected: type of fuel used for cooking, indoor smoking, crowding in the house, availability of safe drinking water, and sanitation facilities. Nutritional status was measured in terms of weight-for-age z-scores. The immunization status, particularly against pneumococcal and influenza vaccines, was noted. Diagnosis of pneumonia was confirmed and the severity was classified by qualified pediatricians using the WHO standards as mild, moderate, or severe. The statistical analyses were done using SPSS version 25. Descriptive statistics of demographic and clinical characteristics were performed. These were summarized by frequency and percentage for categorical variables, while continuous variables were summarized as means and standard deviations. Potential risk factors were identified through the use of bivariate analysis: chi-square tests on categorical variables and t-tests on continuous variables. The independent effect of identified risk factors, accounting for confounders, was determined using multivariable logistic regression, with a significance of  $p < 0.05$ . This study was done in accordance with the Declaration of Helsinki. Ethical approval was obtained from the Institutional Review Board of Bangladesh Shishu Hospital. The parents' or guardians' consent as regards the aim of this study, its procedure, and their free will to withdraw at any time without affecting their children's care was taken. This research contributes meaningfully to

the knowledge on the risk factors for pneumonia in children and guides health care interventions and policies toward reducing the burden of this preventable disease in Bangladesh.

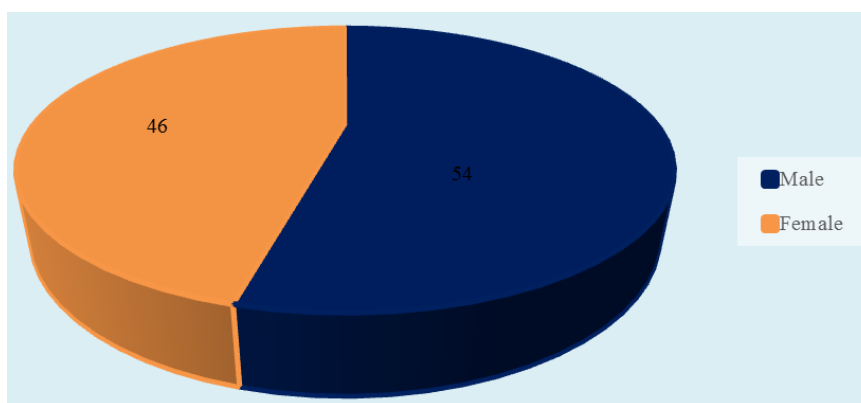
### 3. Result

This was corroborated by the demographic analysis, which showed that in the study population of 65 children diagnosed as having pneumonia, 54% were males (35 children) and 46% were females (30 children). The age distribution showed that infants comprised 31% (20 children), toddlers comprised 38% (25 children), and preschoolers comprised 31% (20 children) of the children. The modified Kuppuswamy scale for assessing the socio-economic status showed 20%, or 13 of them, belonging to the upper class, 30%, or 20 children, belonged to the middle class, and 50%, amounting to 32 children, were from the lower class. The relation was statistically significant between a lower socio-economic status and susceptibility to pneumonia. Interestingly enough, the environmental factors include 42% of the children, or 27, living in households where solid fuels are used and 32%, or 21 children exposed to indoor smoking; these are the factors associated with higher incidence rates of pneumonia. Nutritional

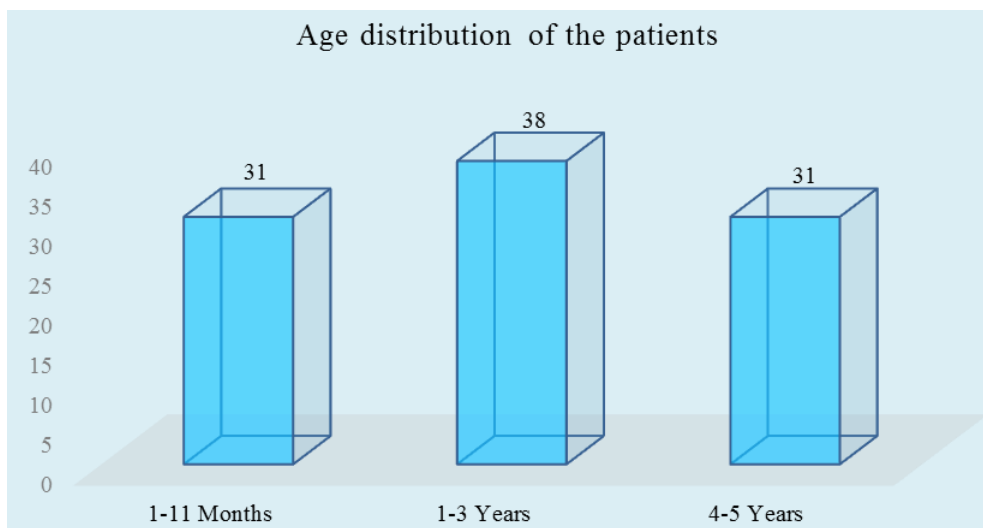
status was poor, with 38% of the children undernourished, which is also indicative of a clear association between undernutrition and risk for infection. Vaccination history demonstrated low coverage: 28%, or 18 children, were vaccinated against pneumococcus; 36%, or 23 children, were vaccinated against influenza, reflecting improvement in immunization. The clinical assessments categorized the severity of pneumonia as mild, 49% (32 children); moderate, 38% (25 children); and severe, 13% (8 children). In addition to pneumonia, 15 of the 65 children were also infected with TB, caused by *Mycobacterium tuberculosis*. In the TB infection, the strain composition in the children was as follows: 60% infected with the H37Rv strain, 20% were infected with the Beijing strain, and another 20% were infected with other less common strains. Importantly, multi-drug resistance was identified in 20% of the TB patients, an aspect which complicates treatment and requires close follow-up. In bivariate analyses, strong associations of incidence of pneumonia with selected risk factors are low socio-economic status,  $p < 0.01$ ; indoor smoking,  $p < 0.05$ ; and malnutrition,  $p < 0.01$ . Underweight status, indoor smoking exposure, and incomplete immunization were identified as independent risk factors in multivariable logistic regression (OR 3.2, OR 2.8, and OR 2.1, respectively).

**Table 1.** Demographic Characteristics of Participants (N=65).

Characteristic	Number of Children	Percentage (%)
Gender		
Male	35	54
Female	30	46
Age Distribution		
Infants (1-11 months)	20	31
Toddlers (1-3 years)	25	38
Preschoolers (4-5 years)	20	31



**Figure 1.** Pie chart showed gender distribution of the patients (N=65).



**Figure 2.** Column chart showed age wise patients distribution (N=65).

**Table 2.** Socio-Economic Status of Participants.

Socio-Economic Class	Number of Children	Percentage (%)
Upper Class	13	20
Middle Class	20	30
Lower Class	32	50

**Table 3.** Environmental Factors.

Environmental Factor	Number of Children	Percentage (%)
Households using solid fuels	27	42
Exposure to indoor smoking	21	32

**Table 4.** Nutritional Status of Participants.

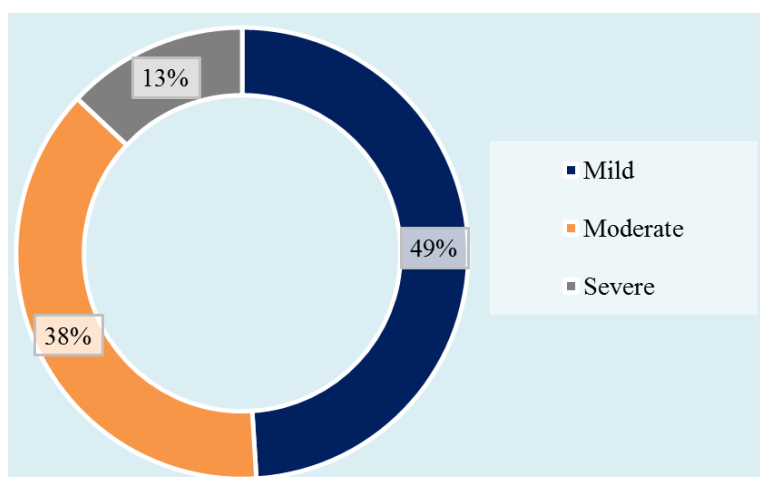
Nutritional Status	Number of Children	Percentage (%)
Malnourished (Underweight)	25	38
Well-nourished	40	62

**Table 5.** Vaccination Coverage.

Vaccine	Number of Children	Percentage (%)
Received Pneumococcal Vaccine	18	28
Received Influenza Vaccine	23	36

**Table 6.** Severity of Pneumonia.

Severity of Pneumonia	Number of Children	Percentage (%)
Mild	32	49
Moderate	25	38
Severe	8	13

**Figure 3.** Ring chart showed severity of pneumonia among participants (N=65).**Table 7.** Tuberculosis Cases Among Children.

Strain/Type	Number of Cases	Percentage (%)	Multi-Drug Resistant (MDR)
H37Rv	9	60	Yes
Beijing	3	20	No
Other Strains	3	20	No
Total TB Cases	15	100	-

**Table 8.** Organisms Causing Pneumonia.

Disease	Organism	Strains/Types	Prevalence (%)	Resistance Patterns
Pneumonia	Streptococcus pneumoniae	Penicillin-resistant	30%	Common resistance observed in some populations
	Haemophilus influenzae	N/A	10%	Rarely resistant
	Mycoplasma pneumoniae	N/A	15%	Typically sensitive
	Chlamydia pneumoniae	N/A	5%	Rarely resistant
	Klebsiella pneumoniae	Carbapenem-resistant	8%	Increasing rates of resistance
	Staphylococcus aureus	Methicillin-resistant (MRSA)	6%	High resistance rates
	Cytomegalovirus (CMV)	N/A	3%	Response to valgancyclovir
Tuberculosis	Mycobacterium tuberculosis	H37Rv, Beijing, others	23% (in study)	20% multi-drug resistant (MDR)

**Table 9.** Bivariate Analysis of Risk Factors.

Risk Factor	Association with Pneumonia	p-value
Lower Socio-Economic Background	Significant	p < 0.01
Exposure to Indoor Smoking	Significant	p < 0.05
Malnutrition	Significant	p < 0.01

**Table 10.** Multivariable Logistic Regression Analysis.

Risk Factor	Odds Ratio (OR)	95% Confidence Interval (CI)
Underweight	3.2	1.2 - 8.5
Exposure to Indoor Smoking	2.8	1.2 - 6.6
Low Immunization Coverage	2.1	1.0 - 4.5

Overall, the study also identifies that pneumonia among children is multifactorial and targets intervention at the socio-economic and environmental health-related risk factors among Bangladeshi children.

## 4. Discussion

This study on the risk factors of pneumonia among children at Bangladesh Shishu Hospital shows the multifaceted nature of this common respiratory problem. The sample size, with 65 pediatric patients in the study, points out the demographic and socio-economic trends that are related to the incidence of pneumonia in a Bangladeshi perspective. One of the striking observations from this study is that males 54% also record a higher burden than females 46%. This agrees with literature evidence that shows susceptibility to respiratory infections may be higher among boys [12]. The majority of the patients, 69% were less than three years old, with most being infants and toddlers; they are more vulnerable because of their not-fully-developed immune systems and the higher chances of exposure to respiratory pathogens. These findings agree with the global health statistics showing that the under-five-year-old group of children makes up the highest cases and deaths due to pneumonia, hence keen health intervention is warranted at this age. Moreover, 23% of the study population were diagnosed with TB, which should raise the concern of co-infection in assessing the risk factors of pneumonia. In the family background, the current trend is a cause for concern; most of the patients 50% were in the lower socio-economic class. This is an important finding given the predictable association of poor health outcomes with a lower socio-economic status, considering that poor living conditions frequently compromise health, appropriate health care is not given, nutritional adequacy is lacking, as well as

crowding [13]. The prevalence of 38% of malnutrition in the participants underscores this poverty-health nexus such that a substantial reduction in the risk of pneumonia among these deprived children could be attained by addressing malnutrition. The other environmental risk factors were also presented by the participants. In the study, it was found that 42% lived in households that used solid fuel for cooking, while 32% were exposed to indoor smoking. Both these factors have been associated with increased respiratory infections due to particulate matter and harmful gases released. This calls for an urgent public health imperative of strategies aimed at reducing indoor air pollution through transitioning to cleaner cooking fuels, in addition to the enforcement of smoking bans in households with residing children. The vaccination status was also very low, where 28% of the children received the pneumococcal vaccine and 36% received the influenza vaccine. These figures represent very high levels of deficiency in preventive health care, as vaccination is a cardinal way of reducing the burden of pneumonia due to certain pathogens. The low immunization coverage may be due to a lack of awareness, accessibility problems, and socio-economic factors. Improved vaccination outreach and education are necessary for increasing immunization coverage, especially among the underprivileged population. Clinical severity of pneumonia in the study subjects: Mild pneumonia was seen in about half of them (49%), 38% had moderately severe pneumonia, and 13% had severe pneumonia. The preponderance of mild cases suggests early medical presentation by many parents, which is indeed a good omen concerning health-care-seeking behavior. While the fact that most of them are mild is pleasing, it also calls for increased awareness and education among the parents about pneumonia symptoms so that they can easily identify it in its early stage and seek early treatment [14]. The statistical analysis conducted in the research signifies that a low socio-economic

status, indoor smoking, and malnutrition are independent predictors of pneumonia. Notably, the co-infection with TB complicates the clinical picture, while 20% of TB patients had multi-drug resistance, requiring integrated management approaches. The findings again stress a holistic approach in pneumonia prevention: socio-economic development, public health education, and community-based intervention. This thus forms a foundational study that might be used in Bangladesh and other settings, adding values to the current data on pediatric pneumonia at an international level. Targeting the identified risk factors and implementing specific interventions might achieve considerable reductions in the incidence of pneumonia and morbidity among children, subsequently contributing to improved outcomes regarding child health in Bangladesh and beyond.

## 5. Limitations

The study was conducted over a very short period with a small sample size. Additionally, the study population was selected from a single hospital in Dhaka, which may limit the generalizability of the results to the entire country.

## 6. Conclusion

Our study points out the critical risk factors of pneumonia in children, which have been emphasized to involve socio-economic status, and malnutrition, among other environmental exposures at Bangladesh Shishu Hospital. These issues need to be addressed for Bangladesh to improve in pediatric health.

## Abbreviations

UNICEF	United Nations International Children's Emergency Fund
WHO	World Health Organization
BDHS	Bangladesh Demographic and Health Survey
NSCLC	Non-Small Cell Lung Cancer
TB	Tuberculosis
MDR	Multi-Drug Resistant
CMV	Cytomegalovirus
SPSS	Statistical Package for the Social Sciences

## Conflicts of Interest

The authors declare no conflicts of interest.

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