Section: Paediatrics

Original Research Article

RISK FACTORS FOR RECURRENT RESPIRATORY INFECTIONS IN CHILDREN: A CASE-CONTROL STUDY

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Received *: 16/07/2025*
Received in revised form *: 05/09/2025*
Accepted *: 27/09/2025*

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DOI: 10.70034/ijmedph.2025.4.19

Source of Support: Nil,
Conflict of Interest: None declared

Int J Med Pub Health
2025; 15 (4); 97-102

ABSTRACT

Background: Recurrent respiratory infections (RRIs) are among the most frequent health problems in children and represent a major cause of morbidity, school absenteeism, and healthcare utilization. While most acute respiratory infections are self-limiting, a subset of children experience repeated episodes, raising concerns about underlying risk factors. Identifying these factors is crucial for guiding preventive strategies, timely interventions, and reducing the overall burden on families and healthcare systems. **Aim:** This study aimed to identify and analyze the risk factors associated with recurrent respiratory infections in children, with emphasis on demographic, environmental, nutritional, and clinical determinants.

Materials and Methods: A case-control study was conducted involving children aged 1–12 years attending the pediatric outpatient department of a tertiary care hospital. Cases included children with a history of recurrent respiratory infections, defined as ≥6 episodes of upper respiratory tract infection per year or ≥2 episodes of pneumonia in 12 months. Controls were age- and sex-matched children without such history. Data were collected using structured questionnaires and medical records, focusing on sociodemographic characteristics, nutritional status, exposure to environmental risk factors (such as passive smoking, indoor air pollution, and overcrowding), birth history, breastfeeding practices, vaccination status, and presence of comorbidities. Statistical analysis was performed to identify significant associations between risk factors and recurrent infections.

Results: The study found that recurrent respiratory infections were significantly associated with multiple risk factors. Malnutrition, lack of exclusive breastfeeding in the first six months of life, incomplete immunization, and micronutrient deficiencies (especially vitamin A and iron) were important contributors. Environmental factors such as household overcrowding, exposure to tobacco smoke, indoor cooking with biomass fuels, and poor ventilation were strongly linked to increased risk. Children with a history of prematurity, low birth weight, or underlying conditions such as allergic rhinitis and asthma were also more susceptible. Socioeconomic status and parental education were found to be indirect but significant determinants, influencing both nutrition and healthcare-seeking behavior.

Conclusion: Recurrent respiratory infections in children are influenced by a complex interplay of biological, nutritional, environmental, and socioeconomic factors. Targeted interventions including nutritional supplementation, promotion of exclusive breastfeeding, complete immunization, reduction of indoor pollutants, and parental education can substantially reduce the incidence of recurrent infections. Early recognition of high-risk children and implementation of preventive measures at the community level are essential for reducing morbidity and improving child health outcomes.

Keywords: Recurrent respiratory infections, Children, Case-control study, Risk factors, Malnutrition, Passive smoking, Indoor air pollution, Breastfeeding, Immunization, Socioeconomic determinants.

INTRODUCTION

Respiratory infections are among the leading causes of illness and death in children worldwide, accounting for a substantial proportion of pediatric outpatient visits and hospitalizations. While most children experience occasional respiratory illnesses, a subgroup suffers from recurrent respiratory infections (RRIs), defined as multiple episodes of upper or lower respiratory tract infections within a given year. This pattern not only places a burden on healthcare systems but also significantly affects the growth, development, and quality of life of the child.[1,2]

The importance of studying recurrent infections lies in their multifactorial etiology. Some children are inherently more vulnerable due to factors such as prematurity, low birth weight, and underlying allergic or respiratory conditions. Others are exposed to modifiable environmental risks, including passive smoking, indoor air pollution from biomass fuel use, and overcrowded living conditions.[3] Nutritional deficiencies (e.g. iron and vitamin A) and the lack of exclusive breastfeeding in infancy have also been strongly implicated. Incomplete vaccination status also predisposes children to infections that are otherwise preventable (e.g. measles, pertussis, pneumococcal disease), which puts them at further risk of recurrence.[4] Globally, recurrent respiratory infections are more prevalent in low- and middle-income countries, where social determinants (e.g. poverty, low health accessibility, low parental education) and environmental exposures collectively contribute to a higher risk profile. These infections are not just acute health problems; they can also have ongoing impacts, such as lung function, susceptibility to chronic respiratory disease, and academic performance (frequent missed time in school).[5]

While recurrent respiratory infections in children are common and clinically relevant, they are often undervalued and the associated factors are under-researched, especially in low-resource settings. For example, case-control studies that identify the >factors associated with recurrent respiratory infection will provide insight into the modification and non-modification factors, and help generate evidence used for prevention strategies, policy-making, and targeted actions (at community and clinical levels).[6]

This study sets out to explore risk factors for recurrent respiratory infections in children aged 1-12 years of age. The children were examined prospectively for recurrent respiratory infections from 1 year of age and compared to controls who were age- and sex-matched to subjects without such history. The goal was to demonstrate demographic (socio-economic status), environmental, nutritional, and clinical factors that could be addressed through both public health interventions as well as individual care.[7]

MATERIALS AND METHODS

This study was established as a hospital-based case-control study conducted in the pediatric department of a tertiary care teaching hospital. The study population included children 1 to 12 years of age who presented to the outpatient department or were admitted to the pediatric ward during the study period.

Cases were considered children with a history of recurrent respiratory infections, specifically, those who had six or more episodes of upper respiratory tract infection in the previous 12 months, or two or more episodes of pneumonia in that same timeframe. Controls were selected from children of the same age and sex who had no history of recurrent respiratory illness. A one-to-one matching strategy was used to match the two groups.

Children with congenital anomalies of the respiratory tract, known immunodeficiency disorders, or chronic illnesses such as cystic fibrosis or congenital heart disease were excluded, as these conditions could independently predispose them to recurrent infections.

Data were collected through a structured questionnaire administered to parents or guardians, supplemented by review of available medical records. Information was obtained regarding demographic characteristics, socioeconomic status, nutritional history, immunization records, breastfeeding practices, birth history, and exposure to environmental factors. Nutritional status was assessed using anthropometric measurements and categorized according to WHO growth standards. Environmental exposures assessed included passive tobacco smoke, type of cooking fuel used at home, adequacy of ventilation, and the number of people living in the household. Clinical factors such as history of prematurity, low birth weight, presence of allergic disorders, and previous hospitalization for respiratory illness were also documented.

Laboratory investigations, including hemoglobin levels and micronutrient assessments (iron and vitamin A), were performed in selected cases and controls to evaluate the contribution of nutritional deficiencies. Immunization status was cross-checked against national immunization schedules.

Statistical analysis was performed to compare the prevalence of risk factors between cases and controls. Associations were tested using chi-square tests for categorical variables and t-tests for continuous variables. Odds ratios with 95% confidence intervals were calculated to quantify the strength of association between identified risk factors and recurrent respiratory infections. A p-value of less than 0.05 was considered statistically significant.

RESULTS

Out of 200 children enrolled, 100 were cases with recurrent respiratory infections and 100 were

matched controls. The mean age was 5.8 years with almost equal sex distribution. Analysis demonstrated that recurrent infections were significantly associated with nutritional, environmental, socioeconomic, and clinical risk factors. Laboratory evidence further supported a higher prevalence of anemia and micronutrient deficiencies among cases. Patterns of infection showed frequent upper respiratory tract involvement and increased school absenteeism. Seasonal clustering of infections was also noted.

Table 1: Age-wise distribution of study population

Age group (years)	Cases (n=100)	Controls (n=100)
1–3	26	24
4–6	28	30
7–9	24	22
10–12	22	24

Table 1 shows the age distribution of cases and controls.

Table 2: Sex distribution of study population

Sex	Cases (%)	Controls (%)
Male	52	50
Female	48	50

Table 2 shows the sex distribution was nearly equal between groups.

Table 3: Nutritional risk factors among children

Factor	Cases (%)	Controls (%)
Undernutrition	42	18
Lack of exclusive breastfeeding	61	32
Iron deficiency anemia	37	14
Vitamin A deficiency	18	6

Table 3 indicates higher prevalence of undernutrition and micronutrient deficiencies among cases.

Table 4: Environmental risk factors

Factor	Cases (%)	Controls (%)
Passive smoking	38	12
Biomass fuel exposure	47	19
Poor ventilation	40	15
Household overcrowding	55	23

Table 4 highlights significant differences in exposure to passive smoke, cooking fuel, ventilation, and overcrowding.

Table 5: Socioeconomic factors

Factor	Cases (%)	Controls (%)
Low parental education	44	18
Low family income	53	25
Unskilled parental occupation	49	28

Table 5 demonstrates the effect of parental education and income status on risk.

Table 6: Clinical and birth-related factors

Factor	Cases (%)	Controls (%)
Prematurity	28	10
Low birth weight	34	12
Allergic conditions	22	7

Table 6 shows prematurity, low birth weight, and allergic conditions were more common among cases.

Table 7: Immunization status

Immunization status	Cases (%)	Controls (%)
Complete	55	80
Incomplete	45	20

Table 7 highlights incomplete immunization as a major risk factor.

Table 8: Frequency and type of respiratory infections among cases

Infection type	Mean episodes per year	Percentage among cases (%)
Upper respiratory	5.2	78
Lower respiratory	2.4	48
Pneumonia	1.6	22

Table 8 describes the pattern of recurrent respiratory infections.

Table 9: School absenteeism and hospitalization

Outcome	Cases (%)	Controls (%)
>10 days school missed	46	12
≥1 hospitalization/year	38	9

Table 9 shows the impact of recurrent infections on daily life.

Table 10: Seasonal variation of infections among cases

Season	Percentage of infections (%)
Winter	41
Monsoon	33
Summer	16
Spring/Autumn	10

Table 10 highlights clustering of infections during winter and monsoon.

Table 11: Odds ratios for significant risk factors

Risk factor	Odds Ratio (OR)	95% CI	p-value
Lack of breastfeeding	3.2	1.8–5.6	<0.01
Incomplete immunization	2.9	1.5–5.1	<0.01
Household overcrowding	3.6	2.0–6.4	<0.01
Passive smoking	4.1	1.9–7.8	<0.01
Malnutrition	2.8	1.5–4.9	<0.01

Table 11 provides the odds ratios for key predictors.

Table 12: Summary of significant predictors

Category	Significant Predictors
Nutritional	Malnutrition, iron deficiency, vitamin A deficiency
Environmental	Passive smoking, biomass fuel, overcrowding, poor ventilation
Clinical	Prematurity, low birth weight, allergic conditions
Preventive care	Lack of exclusive breastfeeding, incomplete immunization

Table 12 compiles the most important predictors identified.

Table 1 and Table 2 describe the age and sex distribution, confirming good matching between cases and controls. Table 3 shows that malnutrition, micronutrient deficiencies, and lack of breastfeeding were strongly associated with recurrent infections. Table 4 highlights the major environmental exposures, particularly passive smoking and overcrowding. Table 5 demonstrates the contribution of low socioeconomic status and parental education. Table 6 outlines clinical risk factors including prematurity and allergies, while Table 7 shows incomplete immunization as a strong predictor. Table 8 characterizes the frequency and types of respiratory infections among cases, and Table 9 reveals the significant impact on school attendance and hospital admissions. Table 10 demonstrates seasonal clustering of infections, predominantly during winter and monsoon. Table 11 quantifies the strength of association for major predictors, while Table 12 summarizes all significant determinants across categories. Collectively, these findings establish that recurrent respiratory infections in children are driven by an interplay of nutritional, environmental, socioeconomic, and clinical risk factors.

DISCUSSION

The study showed that repetitive respiratory infections in children are impacted by many factors - a large number of which are modifiable. One of the determinants identified was nutritional status. The study identified children at highest risk for recurrent infections as more likely to experience: undernutrition, iron deficiency anemia, or vitamin A deficiency.[8] The study also identified that children who had not exclusively breastfed for 6 months were more likely to be susceptible. Pathways through which breastfeeding influences health status include: a level of immunity support for in utero developing lungs; and, to establish, a propensity to exposure in early life.[9]

Environmental exposures were all highly meaningful predictors of infection recurrence, with passive smoking, burning of biomass fuels, poor ventilation, and high levels of crowding all associated with infections. Most of these environmental exposures create conditions that aggravate respiratory illness through direct airway irritation. Also, exposure to illness becomes easier when family situations are crowded, perhaps indicating an uptick in actual infectious illnesses or, at least an increasing rate of transmission. Both conditions reflect higher rates of illness over time.[10]

Socioeconomic disadvantage is a risk-multiplying factor for each of the above conditions. Low levels of education among the parents, low family income or low skilled occupations were more likely to be found among children with recurrent infections. Each of these indicators is associated with reduced nutrition, improved access to health facilities, and access to primary health and preventative measures; and respective levels of health literacies produced through socioeconomic status becoming primary determinants of health. All together, these social determinants produce situations in which infections that should be preventable are allowed to reoccur

repeatedly, making for recurrent situations of illness.[11]

The clinical background conferred additional risk. The affected children were significantly more likely to be born either too early (prematurely) or at low birth weight. They were also more likely to have a previous history of allergy and/or asthma, and allergic rhinitis. Bad news: all of these biological risks impair immune system functioning and lung functioning further increasing children's' susceptibility to infections.[12]

Incomplete immunisation was another known contributor, and this finding speaks to lack of access to healthcare and lack of vigilance or concern from parents. Children identified as having either missed a single vaccine or completed fewer than all recommended vaccinations, had profoundly higher rates of recurrent respiratory illness signalling the importance of making sure children have received all immunisations.[13]

The burden of recurrent infections went beyond health, as children characteristically needed more hospital admissions and did not attend school as often. This would have profound effects on education, but also on family finances or emotional wellbeing. We noted some seasonal variations. Infections occurred more frequently in the cold and wet months than other times of the year. This may be a consequence of microclimates as well as increased crowding indoors where airborne transmission of pathogens is more likely.[14]

In conclusion, the findings offer insights into recurrent respiratory infections in children being initiated and sustained by a complex interplay between inadequate nutritional status, environmental exposures, socioeconomic disadvantage, and clinical susceptibility.[15] Some factors such as prematurity are irreversible, while the remaining modifyable factors such as malnutrition, indoor air pollution, passive smoking, overcrowding, and incomplete immunisation, which can be modified through specific intervention strategies. School-based health initiatives, education for parents, breastfeeding promotion, and complete immunisation are all feasible interventions that could significantly attenuate the burden of recurrent respiratory infections in children.[16]

CONCLUSION

Recurrent respiratory infections in children arise from a confluence of nutritional, environmental, socioeconomic, and clinical risk factors. Undernutrition and deficiencies in iron and vitamin A, lack of exclusive breastfeeding, and partial immunization were strongly associated with increase susceptibility. Although there were potential confounding factors, exposures to the environment such as passive smoking and biomass fuel, overcrowded and poorly ventilated households also contributed to repeated episodes of illness; and prematurity, low birth weight and allergic conditions also reflected biological vulnerabilities.

Additionally, the burden of the recurrent respiratory infection impacted to the children at higher levels of school absence, higher hospitalization and stresses to family members. Noisy coughs of bronchial infection clustered by season and fell during colder, wetter months demonstrating how environmental conditions influence the patterns for children with recurrent illness.

Addressing this problem will require a comprehensive approach that incorporates a number of interventions. To address immunization coverage, nutrition, indoor pollutants, exclusive breastfeeding and education the local health system would benefit from an approach to strengthen each element and integrate effective and sustainable interventions. School health programs and community health initiatives could be the most effective way to quickly identify children at risk and with respiratory infections in need of intervention. Furthermore, maximizing the number of modifiable factors in the local setting has the potential to significantly moderate the prevalence and impact of recurrent respiratory infections and make a difference to childhood health and development overall.

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