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**Risk factors for hospital readmission of children patients with pneumonia:
A systematic review**

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Abstract

Background: Readmission is an undesirable event influenced by various conditions. While readmission risk factors in pneumonia patients have been widely studied in adults, evidence in children remains limited.

Purpose: To identify various risk factors on the rate of hospital readmissions in children with pneumonia.

Method: Systematic search following PRISMA guidelines was conducted in PubMed Central, ScienceDirect, Scopus, ProQuest, Wiley, and Google Scholar databases and search engines from inception until September 2025. We used the Joanna Briggs Institute Critical Appraisal Checklist to assess the quality of published studies until they were concluded.

Results: Readmission rates in children with pneumonia range from 7% to 16% within 30 to 90 days after hospital discharge. Age risk factors consistently show that younger age (infants to toddlers) significantly increases the risk of childhood pneumonia readmission. Besides that, comorbid conditions and chronic conditions are strong predictors of readmission.

Conclusions: Young age and specific chronic comorbid conditions were found to be significant risk factors for hospital readmission among pneumonia patients.

Keywords: Children; Pediatric; Pneumonia; Readmission; Systematic Review.

INTRODUCTION

Pneumonia is an infectious disease that attacks the lower respiratory tract and is a leading cause of death in children. Pneumonia is a bacterial, viral, or fungal infection of one or both lungs, causing the sacs, or alveoli, in the lungs to fill with fluid or pus (Aprilia, & Faisal, 2024). According to 2019 data from the World Health Organization (WHO), pneumonia claimed the lives of approximately 740,180 children under the age of five, accounting for 14% of all global infant deaths and 22% of deaths among children aged 1 to 5 years (World Health Organization, 2022). By 2023, it was estimated that around 4.8 million children under five would die from pneumonia. United Nation International Children's Emergency Fund (UNICEF) reported a child succumbs to pneumonia every 43 seconds. Among infectious diseases, pneumonia remains the leading cause of death in young children, resulting in more than 700,000 deaths each year—equivalent to about 2,000 daily deaths among those under five. Globally, pneumonia incidence exceeds 1,400 cases per 100,000 children, meaning roughly one in every 71 children develops the disease each year. The highest prevalence rates are observed in South Asia (2,500 cases per 100,000) and in West and Central Africa (1,620 cases per 100,000). Importantly, the majority of pneumonia-related deaths are preventable through effective and timely interventions (United Nation International Children's Emergency Fund, 2025).

Pneumonia is an infectious disease and a leading cause of hospitalization and death worldwide. Many factors influence the increased incidence of pneumonia in infants, including individual factors such as malnutrition and a history of low birth weight. Parental behavior, especially maternal, medical history, and comorbid conditions such as congenital heart disease, cerebral palsy, and asthma are also risk factors that can increase a child's susceptibility to pneumonia. Incomplete basic immunizations also contribute to the high incidence of pneumonia in children (Lisa & Arini, 2024). Delays in hospitalization, comorbidities, especially malnutrition, and lack of immunizations are factors that can increase the length of hospital stay. Approximately 8% of children with pneumonia experience readmission within 30 days of hospital discharge. Young children and children with chronic medical problems are more likely to

experience readmission (Lokida, Farida, Triasih, Mardian, Kosasih, Naysilla, & Lane, 2022).

Hospital readmission is when a patient is declared to have been discharged from the hospital but is readmitted to treatment within a certain time period (30, 60, or 90 days) (Australian Commission on Safety and Quality in Health Care, 2020). Various timeframes have been used to define readmission, but the most common are 30-day, 90-day, and 1-year readmissions. Hospital readmissions can pose significant challenges for both healthcare providers and patients (Dhaliwal & Dang, 2024; Jack, Chetty, Anthony, Greenwald, Sanchez, Johnson, & Culpepper, 2009). Readmissions at any health care facility are an indicator of the quality of health care services (Toomey, Peltz, Loren, Tracy, Williams, Pengeroth, & Schuster, 2016). Health care quality factors, including the natural course of the disease, family and community support, and sociodemographic factors, may influence readmission (Nakamura, Zaslavsky, Toomey, Petty, Bryant, Geanacopoulos, & Schuster, 2017; Zhou, Roberts, Dhaliwal, & Della, 2019). In general, readmissions can be classified into two main categories: those related to routine care and those that are unplanned and potentially preventable (Australian Commission on Safety and Quality in Health Care, 2020). Unplanned 30-day readmissions in pediatric patients due to all causes are potentially preventable because they place a significant financial burden on the healthcare system (Toomey et al., 2016; Zhou et al., 2019).

Readmissions with conditions or complications of disease that are usually considered preventable include pressure injuries, infections, surgical complications, respiratory complications (pneumonia, respiratory failure, etc.), medication-related complications, delirium, cardiac complications, constipation, nausea and vomiting, and kidney failure (Australian Commission on Safety and Quality in Health Care, 2020). Many pneumonia patients experience readmission due to various factors. Approximately 1 in 5 pediatric patients with pneumonia readmits within 30 days of hospital discharge, and most readmissions are not due to pneumonia-related causes (De Alba & Amin, 2014; Shorr, Zilberberg, Reichley, Kan, Hoban, Hoffman, & Kollef, 2013). The aim of this systematic review was

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to identify risk factors that may influence readmission in pediatric patients with pneumonia.

RESEARCH METHOD

This systematic review was conducted in accordance with the Preferred Reporting Items for Systematic Reviews and Meta-Analyses (PRISMA) guidelines (Page, McKenzie, Bossuyt, Boutron, Hoffmann, Mulrow, & Moher, 2021). Study identification followed the PEOS framework, which defined the population as children aged 0–18 years diagnosed with pneumonia, the exposure as clinical, demographic, and comorbid risk factors, the outcome as hospital readmission within 30–90 days after discharge, and the study design as retrospective observational studies.

A comprehensive search strategy was applied across six major databases—PubMed Central, ScienceDirect, Scopus, ProQuest, Wiley, and Google Scholar—supplemented by handsearching. Search terms combined keywords and Medical Subject Headings (MeSH), including: (children OR pediatric) AND (pneumonia OR acute respiratory infection) AND (rehospitalization OR readmission OR readmission factors). All records were managed using EndNote 21, with duplicates removed both automatically and manually prior to screening.

From 12,138 records initially identified, most were excluded due to irrelevance in topic, design, population, or outcomes. Following full-text eligibility assessment, five retrospective cohort studies met the inclusion criteria. Eligible studies were restricted to

English-language publications available in full text up to September 2025. Inclusion criteria required: (1) participants aged 0–18 years hospitalized with pneumonia, (2) exposure to clinical, demographic, or comorbid factors potentially influencing readmission, (3) outcomes defined as readmission within 30–90 days post-discharge, and (4) retrospective cohort design. Exclusion criteria encompassed studies involving adult populations, articles without full-text access, case reports, editorials, systematic reviews, and studies lacking readmission outcomes.

Methodological quality of the included studies was assessed using the Joanna Briggs Institute (JBI) Critical Appraisal Checklist for retrospective observational studies (Joanna Briggs Institute, 2020). This instrument evaluates domains such as baseline group similarity, clarity and consistency of exposure measurement, identification and control of confounding factors, validity and reliability of outcome measurement, appropriateness of follow-up, reasons for attrition, and adequacy of statistical analyses. Two reviewers independently conducted the appraisal, coding each item as “Yes,” “No,” “Unclear,” or “Not Applicable.” Discrepancies were resolved through discussion until consensus was achieved. Studies achieving a score $\geq 70\%$ were deemed methodologically sound and included in the final synthesis. This rigorous appraisal process ensured that only studies with sufficient methodological integrity were analyzed, thereby enhancing the validity and reliability of the review’s findings.

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RESEARCH RESULTS

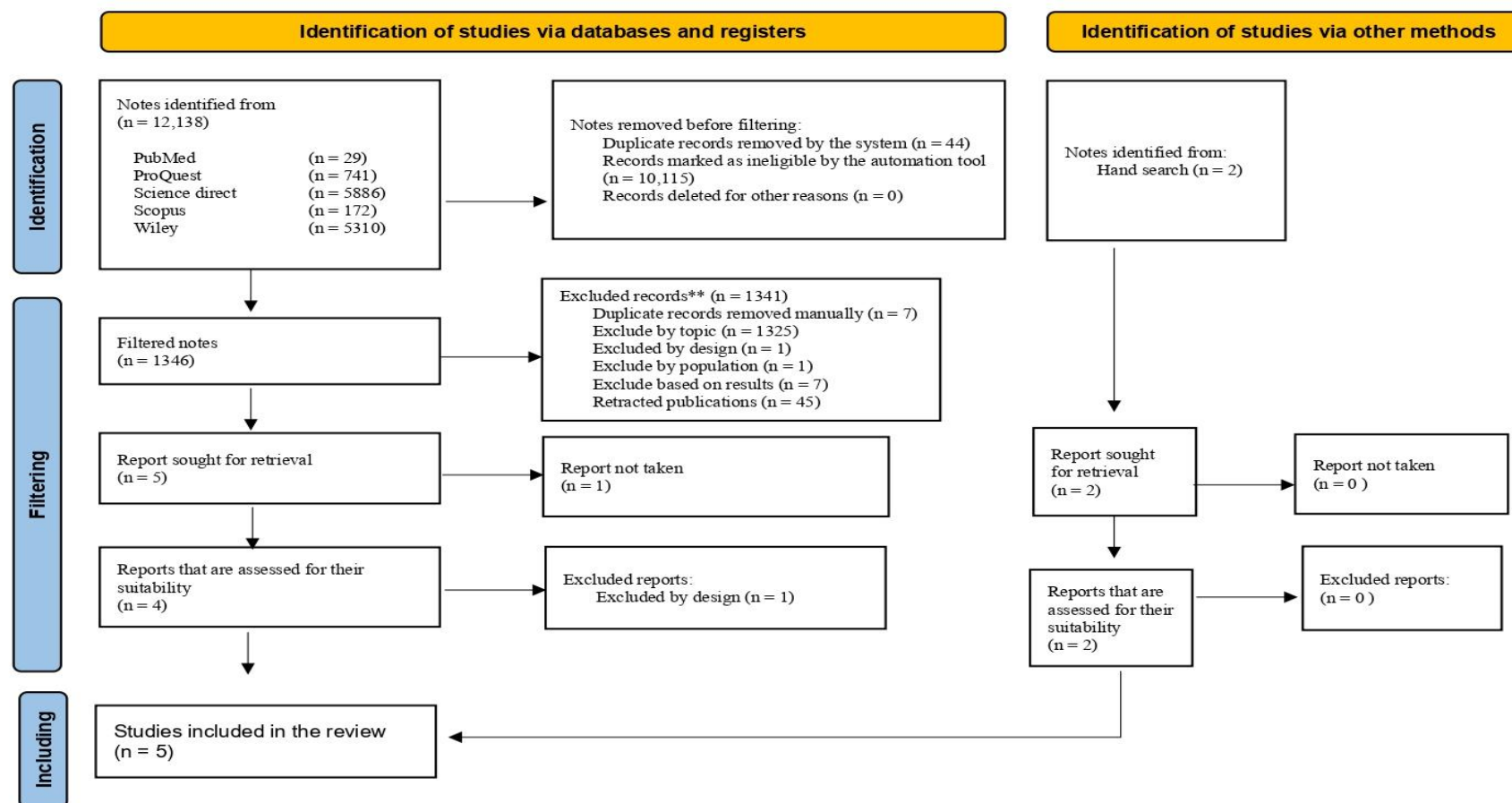


Fig. PRISMA 2020 Flow Diagram

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Table 1. Characteristics of Selected Studies

Author (Year), Country	Purpose	Design	Respondents	Instrument	Results	Readmission Factors	Readmission
Marangu-Boore et al. (2024), (Kenya)	To determine factors associated with readmission, investigative practices and clinical management of readmission, and explore risk factors for mortality in children who readmit.	Retrospective cohort study	N: 20,603 children aged 2 months- 14 years	Clinical Information Network (CIN)	• Prevalence of readmissions • Readmission risk factors • Risk factors for death • Management (investigation and therapy). • Inpatient mortality rate	• Age • Malnutrition • Wheezing • Neurological disorder	30-90 days
Awyal (2024) (Bangladesh)	To analyze hospital readmissions and associated factors in pediatric pneumonia cases during the period 2022-2023 in Bangladesh.	Retrospective cohort study	N: 250 children (ages 0-18 years)	• Electronic medical record data. • Assessment of clinical characteristics, therapy, comorbidities, and 30-day readmission status.	• Readmission time within 30 days • Readmission factor • Oral/IV/combotherapy modalities	• Age • Comorbidities (e.g. asthma, congenital heart disease). • Degree of pneumonia. • Therapy modalities	30 days
Neuman et al. (2014), (United States)	To characterize 30-day readmission, associated patient and hospital factors, and readmission-related costs in children hospitalized for pneumonia.	Retrospective cohort study	N: 82,566 children	Child Health Information System Data based on ICD-9	• Readmission time within 30 days • Readmission risk factors. • Readmission fees	• Age • Chronic medical conditions. • Previous history of hospitalization (1, 2, ≥3 times in 1 year). • Initial length of stay is 3–7 days and >7 days.	30 days

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Risk factors for hospital readmission of children patients with pneumonia: A systematic review

Author (Year), Country	Purpose	Design	Respondents	Instrument	Results	Readmission Factors	Readmission
						• Complications of pneumonia	
Wang et al. (2019), (China)	To assess the incidence, clinical characteristics, and risk factors for 90-day readmission after MPP hospitalization in children, and to compare readmitted and non-readmitted patients.	Retrospective cohort study	N: 424 children aged ≤14 years.	Clinical, laboratory, and radiological variables from medical records at admission	• Readmission due to pneumonia within 90 days. • Readmission risk factors	• Age (older is protective; meaning younger children are more at risk). • Body temperature upon entry. • Influenza A coinfection	90 days
Hong et al. (2017), (South Korea)	To analyze the risk factors that influence readmission of children with pneumonia.	Retrospective cohort study	N: 158 children aged <15 years	Pediatric patient medical report	• Proportion of patients readmitted for pneumonia within 30 days. • Readmission factors. • Insignificant factors in readmission	• Toddler age • Concomitant diseases (especially respiratory diseases such as asthma, other chronic diseases)	30 days

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Table 1. Summary of Risk of Bias Assessment of Joanna Briggs Institute's Cohort Critical Appraisal (N=5)

Reference	Q1	Q2	Q3	Q4	Q5	Q6	Q7	Q8	Q9	Q10	Q11	%	Conclusion
Marangu-Boore et al. (2024)	Yes	Yes	No Clear	Yes	Yes	Yes	Yes	Yes	No	Yes	Yes	81.8%	Inclusion
Awyal (2024)	Yes	Yes	Yes	Yes	No Clear	No	Yes	Yes	Yes	Yes	Yes	81.8%	Inclusion
Neuman et al. (2014)	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	No Valid	Yes	90.9%	Inclusion
Wang et al. (2019)	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	No Valid	Yes	90.9%	Inclusion
Hong et al. (2017)	Yes	Yes	Yes	Yes	No Clear	Yes	Yes	Yes	Yes	Yes	Yes	90.9%	Inclusion

Note: Q1: Similar Groups; Q2: Exposure Measured in the Same Manner; Q3: Valid Exposure Measurement; Q4: Confounding Factors Identified; Q5: Confounding Factor Management; Q6: Outcome Free at Baseline; Q7: Valid Outcome Measurement; Q8: Time to Follow-Up Reported; Q9: Reasons for Loss to Follow-Up; Q10: Management of Incomplete Follow-Up; Q11: Appropriate Statistical Analysis; Y: Yes; N: No; NA: Not Applicable; UC: Unclear.

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DISCUSSION

The five included studies primarily examined readmission within 30–90 days and associated risk factors in children with pneumonia. Readmission was relatively common, with rates ranging from 7% to 16% post-discharge. Most studies used a 30-day cutoff, except one in China that extended follow-up to 90 days for *Mycoplasma pneumoniae pneumonia*. Younger children and those with comorbidities were consistently identified as the most vulnerable groups.

Comorbidities, particularly chronic diseases, were strong predictors of readmission across nearly all studies. In Kenya, neurological disorders and severe malnutrition significantly increased risks of both readmission and mortality (Marangu-Boore, Mwaniki, Isaaka, Njoroge, Mumelo, Kimego, & Agweyu, 2024). U.S. data similarly showed that children with one or more comorbidities were more likely to be readmitted (Neuman, Hall, Gay, Blaschke, Williams, Parikh, & Shah, 2014), while South Korean findings confirmed higher readmission rates among children with comorbidities (Hong, Choi, & Park, 2017). In Bangladesh, asthma was the most common comorbidity, though some studies suggested a protective effect after adjustment (Awyal, 2024). The Chinese study highlighted severe clinical presentation, viral coinfections, and abnormal laboratory findings as predictors of 90-day readmission (Wang, Feng, Shuai, Liu, & Li, 2019).

Age was another consistent determinant. Infants and toddlers had significantly higher odds of readmission compared to older children, with statistical significance across all studies. Several models confirmed that younger age increased the probability of rehospitalization, underscoring its importance in discharge planning and follow-up.

Additional clinical and laboratory variables also contributed to risk. In Kenya, wheezing (aOR 1.17) and malnutrition—severe (aOR 2.05) and moderate (aOR 1.37)—were independent predictors. In China, influenza A coinfection increased 90-day readmission risk (OR 4.746). In the U.S., complicated pneumonia without pleural drainage raised pneumonia-specific readmission likelihood by 80% (aOR 1.82). Readmissions accounted for 16.3% of total pneumonia-related costs despite representing only 7.7% of hospitalizations.

Kenyan data further showed longer median hospital stays among readmitted children (5 vs. 4

days) and greater use of interventions such as chest radiography, second-line antibiotics, TB medications, salbutamol, and prednisolone. Pulse oximetry documentation was less frequent in readmitted cases. Mortality rates were high but not significantly different between first admissions and readmissions. Independent predictors of mortality included severe malnutrition (aHR 1.87), moderate malnutrition (aHR 1.46), and anemia/pallor (aHR 2.14).

This systematic review shows that hospital readmissions for children with pneumonia are a relatively common and consistent clinical problem across countries, despite differences in health system contexts and sample characteristics. The resulting readmission rates highlight that some children are not fully stable at discharge or still have unaddressed risk factors, leading to readmission (Australian Commission on Safety and Quality in Health Care, 2020; Zhou et al., 2019). This finding aligns with global literature, which states that pneumonia is a disease that can lead to readmission and can impact the cost burden, family quality of life, and the performance of health care facilities (De Alba & Amin, 2014).

Special attention to the age group of children with pneumonia is crucial in discharge planning and follow-up to reduce readmission rates. Consistently, nearly all studies in this review demonstrate that young age (infants and toddlers) is a significant determinant of readmission in childhood pneumonia (Zhou et al., 2019). This is in line with the results of research conducted by Lisa and Arini in 2024, which stated that the risk of readmission tends to be higher in toddlers aged 2–36 months (Lisa & Arini, 2024). This can be explained by the physiological vulnerability of the early age group, such as the immaturity of the immune system, smaller airway diameter, and high dependence on caregivers for medication and nutritional management, so that minor respiratory disorders can more quickly develop into conditions requiring re-hospitalization (Lisa & Arini, 2024; Zhou et al., 2019). The finding that younger age increases readmissions reinforces the importance of more rigorous risk assessment and comprehensive family education before infant/toddler patients are discharged (Zhou et al., 2019).

Our finding that chronic comorbidities are a strong predictor of readmission (Zhou et al., 2019). Children with chronic medical conditions are approximately

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three times more likely to experience a 30-day readmission than children without comorbidities (Neuman et al., 2014). In addition to age and comorbidities, several clinical and laboratory factors have also been found to be associated with readmission, such as the presence of wheezing, anemia, and the severity of pneumonia during initial hospitalization. Therefore, interpretation of laboratory results and clinical findings at admission/discharge should be used as a basis for determining the need for more intensive follow-up, including early post-discharge follow-up and symptom monitoring at home.

Our study has several limitations. There was significant inter-study variability that may limit the extrapolation of the results. Most of the included studies were retrospective, making it difficult to establish a causal relationship between exposure and disease. Furthermore, research on readmissions in pneumonia patients was more frequently conducted in adults or older adults than in children. Therefore, more longitudinal studies are needed to identify accurate and reliable effect estimates and make evidence-based recommendations for developing potential interventions in the hospital setting.

CONCLUSION

Overall, the results of this systematic review indicate that readmission can occur within 30 to 90 days, with various risk factors in children, predominantly influenced by young age (toddlers) and the presence of chronic comorbidities such as asthma, neurological disorders, and severe malnutrition. Our results can help determine targeted interventions and provide anticipatory guidance for clinicians and patients at highest risk of hospital readmission, but this requires further refinement.

RECOMMENDATIONS

These findings lead to recommendations for pre-discharge risk screening, nutritional optimization and comorbidity management, family education, and close post-discharge monitoring to reduce the risk of readmission in children with pneumonia. Recommendations for family education, nutritional interventions, optimized comorbidity management, and early post-discharge monitoring have been shown to be globally relevant prevention strategies. Recommended active prevention and intervention

efforts include optimized discharge education, risk factor screening, nutritional management, close post-discharge monitoring, and comprehensive comorbidity management.

The clinical implications of these results are the need for a more structured discharge planning approach for children with pneumonia, particularly in the younger age group and those with comorbidities. Recommended strategies include comprehensive family education about warning signs, nutritional optimization, aggressive comorbidity management, pre-discharge risk factor screening, and scheduling a follow-up visit or telehealth follow-up within the first 7–14 days after discharge. By integrating these risk findings into clinical pathways and hospital policies, it is hoped that the rate of pneumonia readmissions in children can be reduced, costs reduced, and the quality of life for both children and families can be improved.

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