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Risk Factors Associated with Common Pediatric Lower Respiratory Conditions: A Systematic Review

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Abstract

Background: Common pediatric lower respiratory conditions remain a leading cause of morbidity and mortality among children under five years of age globally. Despite numerous individual studies, a comprehensive synthesis of associated risk factors remains limited.
Objective: To identify the Risk factors associated with common pediatric lower respiratory conditions.
Methods: A comprehensive search was conducted on four databases (PubMed, Embase, CINAHL, and the Global Health Library). The study was conducted in tandem with the Preferred Reporting Items for Systematic Reviews and Meta-Analyses. The included studies were assessed for quality and risk of bias using the Newcastle Ottawa scale, Joanna and Briggs checklists and the GRADE criteria.
Results: A total of 36 studies examining 19 pediatric lower respiratory conditions were included. Seven risk factors were consistently associated with disease occurrence: low birth weight, lack of exclusive breastfeeding, overcrowding (i.e., more than 7 persons per household), indoor air pollution, incomplete immunization, undernutrition, and HIV infection.
Conclusion: The findings highlight several modifiable risk factors that significantly contribute to pediatric lower respiratory conditions. Since these risk factors are potentially preventable, addressing these through targeted public health interventions could substantially reduce disease burden and improve child survival outcomes.

Keywords: pediatric lower respiratory disorders, neonatal mortality, pneumonia, bronchitis.

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1. INTRODUCTION

Common pediatric lower respiratory conditions, including pneumonia, bronchitis, and bronchiolitis, remain significant contributors to morbidity and mortality in young children worldwide. Pneumonia, in particular, is one of the leading causes of death in children under the age of five. Despite advancements in medical treatments and immunization programs, lower respiratory infections continue to account for millions of cases annually, causing a significant burden on healthcare systems globally. According to estimates, approximately 156 million cases of pneumonia occur annually in children under five years old, leading to an estimated 1.4 million deaths (Lozano et al., 2012; Rudan et al., 2008). The mortality rate remains disproportionately high in low- and middle-income countries, where access to healthcare, vaccines, and proper treatment may be limited. The incidence and severity of pediatric lower respiratory conditions can be influenced by various risk factors, ranging from environmental exposures to biological and socio-economic determinants (Liu et al., 2012; WHO, 1991). Risk factors such as indoor air pollution, malnutrition, lack of breastfeeding, crowded living conditions, and exposure to tobacco smoke have been identified as critical contributors to the development of severe respiratory infections in children. Additionally, underlying health conditions, such as prematurity, low birth weight, and immunodeficiency, are often associated with an increased risk of complications in children suffering from respiratory infections (Ahmad et al., 2011; Coles et al., 2005; Madhi et al., 2000).

Over the past two decades, numerous studies have investigated these risk factors, but there remains a lack of comprehensive systematic reviews that assess the strength and consistency of associations between these factors and common pediatric lower respiratory conditions. While individual studies have identified potential risk factors, the findings have often been inconclusive or conflicting, and a thorough synthesis of the available evidence is necessary to guide preventive and interventional strategies. The study aims to synthesize the current evidence on risk factors associated with common pediatric lower respiratory conditions. This review will offer valuable insights into the most significant risk factors, allowing for more targeted public health interventions and better strategies for reducing the global burden of respiratory diseases in young children. Through this systematic review, we hope to contribute to the development of evidence-based policies and practices aimed at preventing and managing pediatric lower respiratory infections more effectively.

2. METHODOLOGY

The study adopted the suitable criteria of the "Preferred Reporting Items for Systematic Reviews and Meta-Analyses" (PRISMA) (Page et al., 2021), and the Population, Exposure, and Outcome (PEO) framework was adopted as a guide for this systematic review.

2.1 Literature Search

Between January 13, 2026, and February 27, 2026, two authors (JCI and CMN) independently searched four databases (PubMed/Medline, Embase, CINAHL, and the Global Health Library) to retrieve relevant articles. This was done using a combination of key terms such as "pediatric OR children", "lower respiratory conditions AND children", "lower respiratory conditions OR pneumonia OR asthma OR bronchiolitis", and "risk factors OR determinants OR causes," alongside socio-economic AND environmental OR genetic factors. Hand searching of relevant online journals was also conducted by reviewing the reference lists of pertinent articles.

2.2 Inclusion and Exclusion Criteria

The following inclusion criteria were considered: (a) studies that reported on severe pneumonia in children under five years of age, (b) randomized control trials (RCTs) and observational studies (cohort, case-control, or cross-sectional) assessing the relationship between common pediatric lower respiratory conditions and any identified risk factors, (c) articles published in the English language between 1990 and 2025, and (d) studies that used active community-based case ascertainment, where health workers visited households to identify cases, were considered differently from those with passive hospital-based case ascertainment, where children presented at health facilities. Studies with a sample size of fewer than 100 cases or studies with unclear or inconsistent case definitions, editorials, opinion pieces, meta-analyses, systematic reviews, case

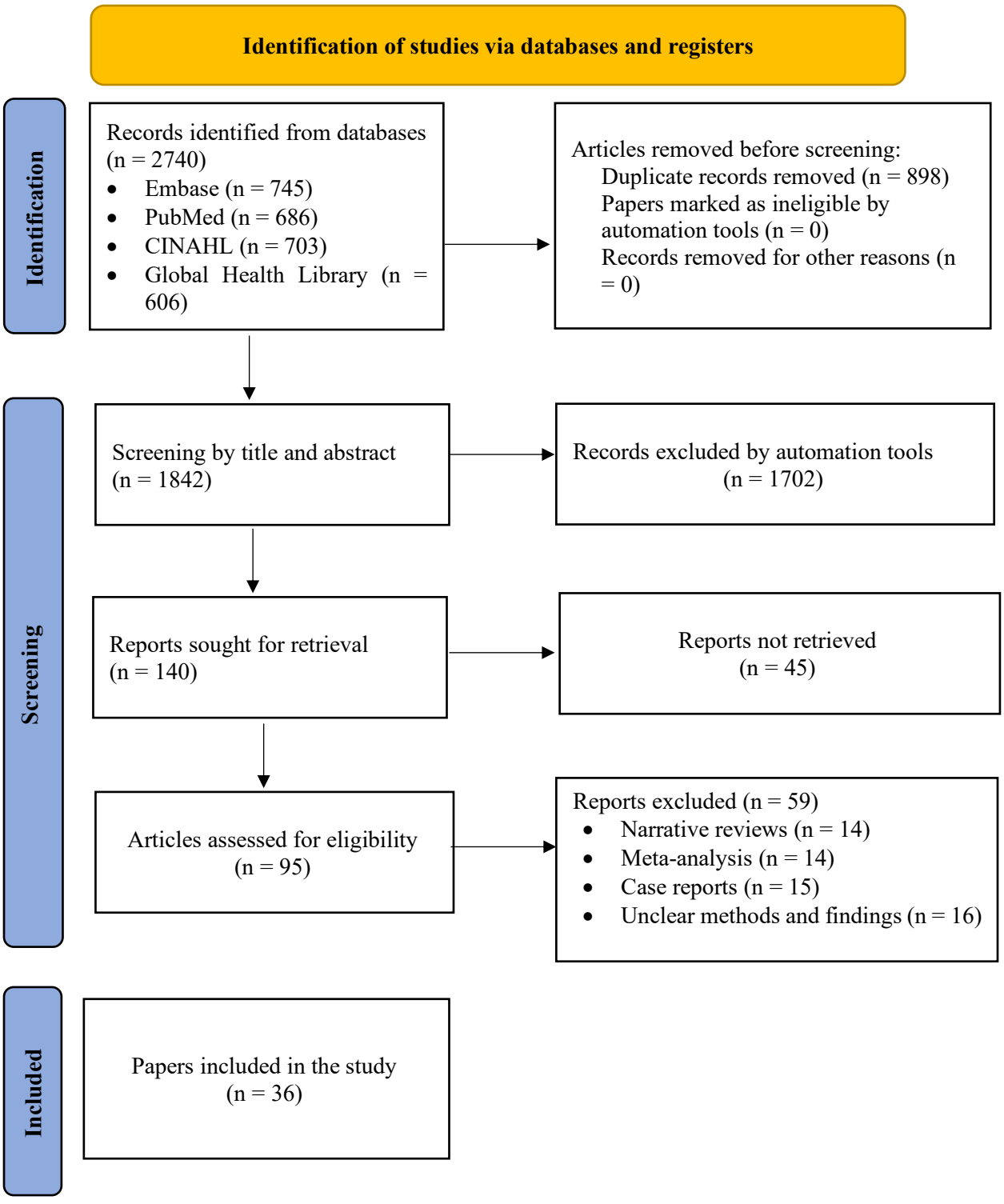

Fig 1. PRISMA diagram for included studies

Table 1: Summary of literature reviewed

Authors (reference)	Title	Method	Findings
Grant et al. (2012)	Risk factors for community-acquired pneumonia in preschool-aged children	Case-control study	Identified several risk factors, including age, respiratory infections in parents, and crowded living conditions
Broor et al. (2001)	Risk factors for severe acute lower respiratory tract infection in children under five	Case-control study	Found that low birth weight, malnutrition, and respiratory infections were significant risk factors
Mahalanabis et al. (2002)	Risk factors for pneumonia in infants and young children and the role of solid fuel for cooking	Case-control study	Solid fuel use was identified as a significant risk factor for pneumonia
Ahmad et al. (2011)	Risk factors for pneumonia among hospitalized children between 2 months and 5 years	Cross-sectional study	Found a significant association with malnutrition and environmental factors
Smith et al. (2011)	Effect of reduction in household air pollution on childhood pneumonia in Guatemala	Randomized controlled trial	Reduction in household air pollution significantly lowered the incidence of pneumonia
Cesar et al. (1999)	Impact of breastfeeding on admission for pneumonia during the post-neonatal period in Brazil	Nested case-control study	Breastfeeding was found to be protective against pneumonia during the post-neonatal period
Wayse et al. (2004)	Association of subclinical vitamin D deficiency with severe acute lower respiratory infection in Indian children	Cross-sectional study	Vitamin D deficiency was linked with an increased risk of severe respiratory infection
Sigauque et al. (2009)	Severe pneumonia in Mozambican young children: Clinical and radiological characteristics and risk factors	Cross-sectional study	Malnutrition and low birth weight were associated with increased pneumonia risk
Madhi et al. (2000)	Increased disease burden and antibiotic resistance of bacteria causing severe community-acquired lower respiratory tract infections in HIV-1-infected children	Observational study	HIV-infected children had higher disease burden and antibiotic resistance
Koyanagi et al. (2011)	Morbidity among HIV-exposed, HIV-infected, and	Cohort study	HIV exposure, both infected and uninfected, increased morbidity

	HIV-unexposed infants in Zimbabwe		compared to HIV-unexposed infants
Suzuki et al. (2009)	Association of environmental tobacco smoking exposure with an increased risk of hospital admissions for pneumonia in children under 5 years of age in Vietnam	Case-control study	Household smoking significantly increased the risk of pneumonia hospital admissions
Armstrong & Campbell (1991)	Indoor air pollution exposure and lower respiratory infections in young Gambian children	Cross-sectional study	Indoor air pollution was identified as a major risk factor for pneumonia in young children
Nafstad et al. (1996)	Breastfeeding, maternal smoking, and lower respiratory tract infections	Longitudinal study	Maternal smoking and lack of breastfeeding were identified as significant risk factors
Hjern et al. (2000)	Lower respiratory tract infections in an ethnic and social context	Cross-sectional study	Socioeconomic factors and ethnicity were significantly associated with respiratory infections
Malla et al. (2010)	Is low hemoglobin level a risk factor for acute lower respiratory tract infections?	Cross-sectional study	Low hemoglobin levels were found to be a significant risk factor for respiratory infections
Osendarp et al. (2002)	Effect of zinc supplementation between 1 and 6 months of life on growth and morbidity of Bangladeshi infants in urban slums	Randomized controlled trial	Zinc supplementation significantly reduced morbidity due to respiratory infections in infants
Baqui et al. (2003)	Simultaneous weekly supplementation of iron and zinc is associated with lower morbidity due to diarrhea and acute lower respiratory infection in Bangladeshi infants	Randomized controlled trial	Iron and zinc supplementation decreased morbidity from diarrhea and pneumonia in infants
Bhandari et al. (2002)	Effect of routine zinc supplementation on pneumonia in children aged 6 months to 3 years: Randomized controlled trial in an urban slum	Randomized controlled trial	Routine zinc supplementation reduced pneumonia incidence in children
Cardoso et al. (2004)	Crowding: Risk factor or protective factor for lower respiratory disease in young children?	Cohort study	Crowding was identified as both a risk and a protective factor, depending on the setting

reports, and studies published in other languages were excluded.

2.3 Study Selection and Eligibility

Studies were selected in two phases, namely (1) title and abstract screening, and (2) assessment of full texts for eligibility. Following the PRISMA guidelines and checklists, two reviewers (IA and AUM) were invited for an independent and blind review using the Rayyan software and tools (Pérez-Neri et al., 2024). Studies that did not mention multifaceted exposures or public health outcomes were excluded at this stage. Confounding observations and discrepancies were resolved by consensus, and where necessary, a third reviewer was consulted.

2.4 Study Quality and Risk of Bias Assessment

Two authors (JCI and IA) independently assessed the quality of the included studies and resolved any discrepancies by dialogue and consensus. This was done using JBI checklists, Newcastle Ottawa scale (NOS), and the modified GRADE scoring system for cross-sectional studies, cohort studies, observational studies, and RCTs, respectively.

2.5 Data Extraction and Analysis

Relevant data from each included study were extracted into a data extraction table in an Excel sheet by one reviewer (JCI) and cross-checked by a second reviewer (IA). Data extracted included the author's name, publication year, study design, and major findings. Generally, the narrative synthesis method was used to present the study's findings.

3. RESULTS

3.1 Selection of Studies

Through the systematic search, 2740 (Embase: 745, PubMed: 686, CINAHL: 703, and the Global Health Library: 606) articles were retrieved. Duplicate articles (n = 898) were removed before screening my title and abstract. Phase 1 screening excluded 1702 articles, leaving 140 articles for phase 2 screening (i.e., full-text assessment for specific inclusion). Of these, 45 papers were not retrieved due to unavailability; 59 articles were excluded for various reasons, and 36 studies were finally selected for the present study (Fig. 1).

3.2. Study Characteristics

The general characteristics of the included studies are described in Table 1. All articles were published in English between 1990 and 2025. Three articles were observational studies, five cohort studies, five case control studies, five RCTs, 10 papers were cross-sectional, and eight were prospective cohort studies. Of the 36 eligible studies, 27 studies reported odds ratios using multivariate analysis, and 25 studies used univariate analysis. Studies examining the association between HIV and vitamin A deficiency with pediatric lower respiratory conditions provided risk estimates through univariate analysis only. The quality of studies reporting the relationship between risk factors such as low birth weight, indoor air pollution, and lack of maternal education, and the outcome of pediatric lower respiratory conditions, was deemed good, with an average cumulative modified GRADE score of 2 or higher. In contrast, the quality of studies addressing risk factors such as incomplete immunization at one year and prematurity was poor, with an average cumulative modified GRADE score below 1.

3.3 Definite risk factors

The following risk factors were consistently associated with common pediatric lower respiratory conditions:

Low birth weight: Four hospital-based studies (Victora et al., 1994; Fonseca et al., 1997; Dharmage et al., 1996; Coles et al., 2005) reported an association between low birth weight and pediatric lower respiratory conditions using multivariate analysis. Three additional studies (Cerquiero et al., 1990; Goetghebuer et al., 2004; Grant et al., 2012) reported odds ratios for low birth weight and pediatric lower respiratory conditions using univariate analysis.

Indoor air pollution exposure: Five studies (Fonseca et al., 1997; Broor et al., 2001; Mahalanabis et al., 2002; Murray et al., 2012; Ahmad et al., 2011), all from developing regions, reported an association between exposure to indoor air pollution (use of solid and biomass fuels) and pediatric lower respiratory conditions using a multivariate analysis. Three additional studies (Cerquiero et al., 1990; Shah et al., 1994; Smith et al., 2011) reported the association using a univariate

analysis. The inclusion of these studies did not alter the odds ratio meta-estimate.

Breastfeeding: Ten hospital-based studies (Victora et al., 1994; Fonseca et al., 1997; Dharmage et al., 1996; Goetghebuer et al., 2004; Broor et al., 2001; Ahmad et al., 2011; Cesar et al., 1999; Wayse et al., 2004; Castro-Rodriguez et al., 2008; Banerji et al., 2009), eight of which were from poor nations, found a link between pediatric lower respiratory diseases and not exclusively breastfeeding, which is defined as consuming solely breast milk for the first four months of life. Using a univariate analysis, six other studies (Coles et al., 2005; Cerquiero et al., 1990; Grant et al., 2012; Pisacane et al., 1994; Savitha et al., 2007; Macedo et al., 2007) — four of which were from poor nations – reported a link between pediatric lower respiratory illnesses and not exclusively breastfeeding. In six studies (Victora et al., 1994; Fonseca et al., 1997; Goetghebuer et al., 2004; Ahmad et al., 2011; Cesar et al., 1999; Banerji et al., 2009), four of which are from underdeveloped countries, there is a correlation between not breastfeeding and lower respiratory diseases in children. Partial breastfeeding, defined as fewer than four months of nursing, has been linked to lower respiratory disorders in children (Dharmage et al., 1996; Broor et al., 2001; Wayse et al., 2004; Castro-Rodriguez et al., 2008).

Incomplete immunization: Since bronchopneumonia is a frequent consequence in children with measles and has a high case fatality rate, this research defined incomplete immunization as not having had a measles vaccination at the end of the first year of life (Singla et al., 2024; Hutasoit et al., 1991; Grais et al., 2007). Incomplete vaccination has been linked to lower respiratory disorders in children (Fatmi & White, 2002; Shah et al., 1994; Ahmad et al., 2011; Broor et al., 2001; Fonseca et al., 1997), all of which were conducted in underdeveloped nations. This connection was also documented by three other studies from developing areas (Cerquiero et al., 1990; Savitha et al., 2007; Hassan & Al-Sadoon, 2001). The odds ratio meta-estimate was unaffected by the inclusion of these studies. Using univariate analysis, two studies from an industrialized area (Grant et al., 2001; Leis et al., 2012) documented a link between partial immunization and pediatric lower respiratory diseases. However, there was no significant correlation between the risk factor and the result according to the odds ratio meta-estimate.

Crowding: Using a multivariate analysis, three studies (Victora et al., 1994; Fonseca et al., 1997; Wayse et al., 2004), two of which were from developing nations, found a link between crowding (more than seven people per home) and lower respiratory conditions in children. Using a univariate approach, three more studies (Cerquiero et al., 1990; Broor et al., 2001; Grais et al., 2007) from the developing area found a link between crowding (more than seven people per home) and lower respiratory conditions in children. Crowding was defined as more than two people sharing a child's bedroom in four studies (Dharmage et al., 1996; Shah et al., 1994; Macedo et al., 2007; Cardoso et al., 2004), all of which were conducted in developing nations. Using a multivariate or univariate analysis, a link between severe pediatric lower respiratory diseases and crowding (>2 people per room) was found.

Undernutrition: In the literature, undernutrition has been described in a number of ways, including wasted (weight for height <2), stunted (height for age <2), and underweight (weight for age <2). Using a multivariate analysis, six studies from developing regions found a link between underweight and the incidence of lower respiratory diseases in children. Using a univariate analysis, three more studies (Victora et al., 1994; Fatmi & White, 2002; Wayse et al., 2004) from developing regions found this connection. Furthermore, four studies from poor nations found a link between severe pediatric lower respiratory diseases and wasting (Fonseca et al., 1997; Broor et al., 2001; Fatmi & White, 2002; Muhe et al., 1997). This was documented in six other studies, four of which were from developing regions.

Passive smoking: A mixed relationship between lower respiratory conditions in children and the presence of smokers in the home was reported. In developing nations, several studies found a link between indoor exposure to tobacco smoke and lower respiratory diseases in children (Cerquiero et al., 1990; Victora et al., 1994; Fatmi & White, 2002). Studies from industrialized areas found a link between maternal smoking and severe acute lower respiratory infection (ALRI). In contrast,

Goetghebuer et al. (2004) did not show such a connection.

Vitamin D deficiency: Vitamin D deficiency was defined broadly as the presence of clinical rickets in studies that investigated an association between the risk factor and pediatric lower respiratory conditions. One study defined it as a level of Vit D_3 <22.5 nmol/L. Three studies (Ahmad et al., 2011; Wayse et al., 2004; Muhe et al., 1997), all from developing regions, demonstrated an association between the presence of rickets and severe ALRI. Two studies (Savitha et al., 1994; Leis et al., 2012) demonstrated a similar association.

Preterm birth: Two studies (Shah et al., 1994; Cesar et al., 1999), both from developing regions, did not demonstrate an association between preterm birth and pediatric lower respiratory conditions. Contrastingly, three studies (Cerquiero et al., 1990; Goetghebuer et al., 2004; Hassan & Al-Sadoon, 2001) reported possible associations between preterm and ALRI in later years of life.

Anemia: Anemia was inconsistently defined in the five studies. Only two studies defined this using the measurement of hemoglobin (Hb) in blood (but used different cut-off values of Hb to define anemia). In both industrialized and developing regions, studies demonstrated possible associations between anemia and pediatric lower respiratory conditions.

Zinc deficiency: An inverse association between zinc supplementation and pediatric lower respiratory conditions was reported. However, a study from a developing region reported no protective effect of zinc supplementation on pediatric lower respiratory conditions.

DISCUSSION

This study represents the first comprehensive effort to systematically evaluate a range of potential risk factors for pediatric lower respiratory conditions in children under five years old. The findings of this study identified a total of 11 risk factors reportedly linked to these conditions. Seven risk factors — low birth weight, undernutrition, indoor air pollution, incomplete immunization at one year, HIV, breastfeeding, and crowding, were found to have a consistent, significant association with pediatric lower respiratory conditions, classifying them as definite risk factors. Additionally, the study observed that seven other factors, i.e., parental smoking, lack of maternal education, vitamin D deficiency, male sex, preterm births, anemia, and zinc deficiency, had inconsistent associations with these conditions, rendering them as likely but not significant risk factors.

The review also revealed considerable variability in the quality of the studies included, which were critically assessed using a modified GRADE scoring system. The quality of studies varied from a score of 0.9 (for preterm births) to 4 (for daycare attendance). However, this score only partially reflects the true quality of the studies. Variability in case definitions and age groups across studies may have affected the findings. For example, although most studies defined low birth weight as less than 2500 g, some studies, like Victora et al. (1994), used a threshold of less than 2000 g, which could lead to differences in risk estimates. Moreover, age ranges varied significantly; while 19 studies reported data for the 0-59 months age range, 17 studies focused on narrower ranges such as 0-11 or 0-23 months. The heterogeneity of included studies was notable, and 28 out of the 36 studies based their data on interviews with mothers of the participants. While eight studies used records or laboratory diagnoses combined with maternal history, this approach introduced several biases, such as recall, interviewer, and misclassification biases. Furthermore, the extent to which studies adjusted for potential confounders varied. Only 9 studies adjusted for confounders such as poverty, which was found to be a significant influencing factor in many of the identified risk factors. Of the 36 studies, only 16 accounted for poverty, which can confound the relationship between risk factors and pediatric lower respiratory conditions.

Hospitalization due to ALRI in young children imposes a significant burden on healthcare systems, particularly in low-income countries (Lozano et al., 2012). However, the available evidence regarding risk factors for these conditions is sparse, of variable quality, and often not applicable to broader populations. Despite this, many of the identified

risk factors are potentially preventable. Governments should focus on reducing these risk factors and increasing the coverage of vaccines, particularly for Streptococcus pneumoniae and Haemophilus influenzae type B, as this could significantly reduce the incidence of childhood pneumonia in developing countries. Further research should focus on exploring the roles of poverty, HIV, and other risk factors currently categorized as "likely" or "possible," and should strive to provide more accurate risk estimates for "definite" risk factors by conducting studies with larger sample sizes, diverse settings, and more precise measurements of potential confounders.

CONCLUSION

Pediatric lower respiratory conditions remain a major public health concern, particularly in resource-limited settings. This review identifies key modifiable risk factors that contribute significantly to disease occurrence. Targeted public health strategies addressing these determinants have the potential to substantially reduce morbidity and mortality among children under five. Strengthening healthcare systems and implementing evidence-based interventions will be essential in achieving this goal.

AUTHORS CONTRIBUTION

IA: Conceptualization, supervision, writing - review & editing, validation; **JCI**: Methodology, visualization, investigation, formal analysis, writing - original draft, review & editing, validation; **CMN and AUM**: supervision, formal analysis, writing - review & editing, Validation.

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CONFLICT OF INTEREST

The authors declare that no conflict of interest exists in connection with this article.

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AVAILABILITY OF DATA

All datasets exploited are included in this study.

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