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Management of Acute Respiratory Infections (ARI) in Children and Environmental Risk Factors: A Literature Review

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Abstract

Background: Acute Respiratory Infections (ARI) are among the leading health problems contributing to the high mortality rate in children under five, both globally and in developing countries. ARI is a common respiratory disease that poses significant global concern due to its high morbidity and mortality rates, especially among children and the elderly. Common respiratory infections include the common cold, upper respiratory tract infections, influenza-like illnesses, and flu, which are caused by bacterial, viral, and fungal pathogens.
Purpose: The purpose of this review is to examine Acute Respiratory Infections (ARI) in children and to identify associated environmental risk factors.
Methods: A systematic literature search was conducted using several databases, including ScienceDirect and Google Scholar. The selected articles provided information on study sample size, research findings, and levels of evidence.
Results: The search process yielded 10 eligible journals that met the predetermined keywords and inclusion criteria.
Conclusion: ARI affects both the upper and lower respiratory tracts, with viral and bacterial infections being the primary causes, which are easily transmitted through airborne particles or direct contact.

Background

As one of the leading causes of under-five mortality worldwide, Acute Respiratory Infections (ARI) represent a serious public health concern, particularly in developing countries such as Indonesia (Andas et al., 2024). According to data from the World Health Organization (WHO), the incidence of ARI in underdeveloped countries is reported to be 30 to 70 times higher than in industrialized nations (Wahyuni, S et al., 2022). In these regions, ARI accounts for approximately 26% to 30% of all under-five deaths—equivalent to one in every five early childhood deaths (Nurkhalisah et al., 2021).

It is estimated that 4 million children die from ARI each year, with complications such as pneumonia, bronchitis, and emphysema contributing to around 98% of these fatalities (Andas et al., 2022). Low- and middle-income countries have the highest under-five mortality rates due to ARI. To this day, ARI remains one of the leading reasons children are brought to healthcare facilities, particularly to pediatric units (World Health Organization, 2020).

Globally, of the 13 million people affected by ARI annually, approximately one million are children. In terms of case numbers, Indonesia ranks highest in the ASEAN region and has one of the highest ARI rates in Southeast Asia. In North Sumatra, for example, the prevalence of ARI reaches 8.09%, making it a common health issue (Siregar & Zaluchu, 2024).

ARI is a short-term infectious condition that affects the respiratory tract. It is typically caused by viruses or bacteria and is a major contributor to the global morbidity and mortality burden in children (Hadju et al., 2024)Common clinical signs include cough, fever, runny nose, sore throat, and difficulty breathing. In severe cases, ARI can lead to serious complications such as pneumonia or bronchitis, which may result in respiratory (Purnamasari et al., 2024).

In addition to its direct health impacts on children, ARI can lead to severe consequences, including death, if not properly treated. Although young children's immune systems are relatively strong and capable of fighting various ARI pathogens, this underscores the importance of understanding the link between ARI and household environmental quality and domestic activities. Such knowledge can be utilized to design more effective prevention and health promotion programs to reduce the incidence of ARI in children (Kasmadi et al., 2025).

Method

A comprehensive literature search was conducted across several databases, including ScienceDirect and Google Scholar. The review focused on information regarding research sample sizes, study findings, and levels of evidence related to the selected publications.

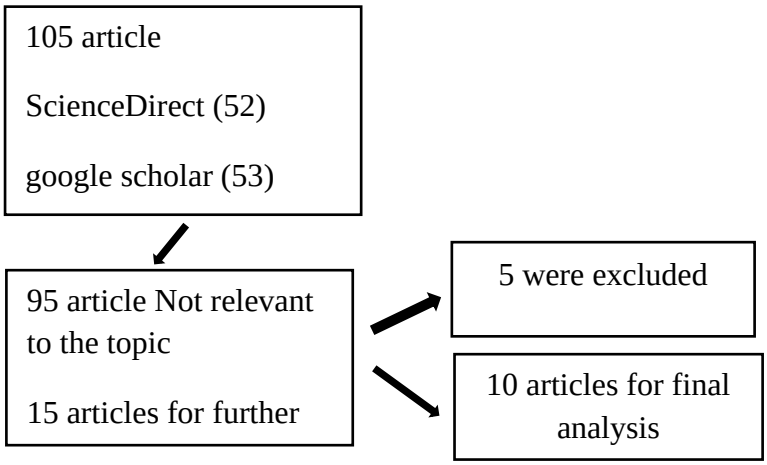

Figure 1. Literature Search Diagram

The authors systematically searched for scientific articles using the PICO method as follows.

Patient : Children

Intervention : Environmental risk factors

Comparison : -

Outcome : Acute Respiratory Tract Infection

Further literature searching was performed using Boolean terms and specific limitations to identify the most relevant articles. The Boolean terms applied included: “Acute Respiratory

Tract Infection" AND "children," with inclusion criteria limited to full-text articles published between 2022 and 2025.

Results

The first journal explains the assessment of children in day care centers (DCCs) who suffer from acute respiratory infections (ARI). This strategy was chosen to synthesize findings from various investigations into viral transmission mechanisms and the effectiveness of non-pharmaceutical interventions in reducing infection rates. According to the data, five major viruses—rhinovirus, respiratory syncytial virus, influenza virus, coronavirus, and adenovirus—account for approximately 95% of respiratory illnesses. Transmission of these viruses is predominantly airborne, especially via aerosols or microdroplets generated through breathing, talking, coughing, and sneezing. Therefore, the most effective non-pharmaceutical intervention for preventing spread is improving indoor air quality through adequate ventilation. In addition, controlling humidity and room temperature, reducing child density, increasing outdoor activities, and promoting mask-wearing and hand hygiene have also proven to reduce infection risk. Knowledge gained during the COVID-19 pandemic reinforces the importance of these strategies in high-density settings such as DCCs. In conclusion, improving the physical environment and hygienic behaviors are key factors in reducing the burden of ARI in day care centers (Andrup et al., 2024).

The second journal investigates several factors that trigger ARI in toddlers using a quantitative methodology, involving 100 mothers of toddlers as respondents. The analysis showed that five main factors were significantly associated with ARI: environmental conditions (p=0.009), individual child characteristics such as age and birth weight (p=0.000), nutritional status (p=0.005), family socioeconomic level (p=0.002), and parental smoking habits (p=0.038). The risk of ARI increases drastically, especially among children in poor environmental conditions (up to 7 times higher) and with unfavorable individual characteristics (up to 83 times higher). Poor nutrition, low economic status, and exposure to cigarette smoke at home also increase the risk. Meanwhile, immunization status showed no significant association. This study highlights the importance of improving living environments, fulfilling children's nutritional needs, enhancing family welfare, and educating parents about the dangers of smoking as preventive measures against ARI in toddlers (Siregar & Zaluchu, 2024).

The third journal adopts a cross-sectional study approach involving 47 mothers with toddlers in the working area of Lailangga Public Health Center. The study found that factors such as indoor air quality, home ventilation systems, and the mothers' health knowledge, attitudes, and behaviors were significantly associated with ARI incidence in toddlers. Household exposure to cigarette smoke, cooking fumes, and indoor dust significantly increased the likelihood of ARI. Poor ventilation also contributed to the high case rate. From a behavioral perspective, children cared for by mothers with adequate knowledge, supportive attitudes, and proper preventive practices tended to have a lower risk of ARI. This research underscores the importance of health education and improving home environmental quality as key strategies to reduce ARI incidence, especially in areas with limited infrastructure and resources (Kasmadi et al., 2025).

The fourth journal concludes that a machine learning–based approach is effective in predicting ARI risk in children under five. By integrating sociodemographic, environmental, and nutritional data, the predictive model accurately identified key risk factors. These findings provide important insights for evidence-based health policy formulation, particularly in improving sanitation, maternal education, access to clean fuels, and addressing malnutrition.

The study also emphasizes the need for targeted multidimensional interventions, especially in rural areas, to significantly reduce the ARI burden (Kalayou et al., 2024).

The fifth journal discusses the efficacy and safety of ARI treatment in children using standardized herbal phytopharmaceuticals in a systematic review. Rising demand for safe and effective alternative therapies and growing concerns about excessive antibiotic use and potential antibiotic resistance prompted this study (Kamin et al., 2025). Forty-five eligible reports were included in the review. In addition to various herbal combinations, the study investigated single active phytopharmaceuticals such as Pelargonium sidoides root extract (EPs 7630), ivy leaf extract (Hedera helix), and Echinacea purpurea. Among all products analyzed, EPs 7630 had the strongest evidence base, supported by several double-blind, placebo-controlled trials, meta-analyses, and observational studies demonstrating efficacy in speeding up recovery and alleviating ARI symptoms in children. Most phytopharmaceuticals also showed good tolerability with no serious adverse effects (Kamin et al., 2025).

The sixth journal explores the role of *Bifidobacterium lactis* Probio-M8 in reducing ARI incidence in children, showing that probiotic intervention can modulate gut microbiota, increase beneficial bacteria, and reduce pathogenic bacteria such as *Escherichia coli*. Metagenomic analysis revealed that after four weeks of intervention, there was an increase in gut microbiota diversity and levels of bioactive metabolites contributing to improved immune response. This intervention not only reduced ARI symptoms but also showed potential to enhance overall respiratory health. The findings provide new insight into the use of probiotics as an adjunct therapy in managing acute respiratory infections in children (Isaeva et al., 2025).

The seventh journal examines the impact of PM2.5 exposure from forest fires on ARI incidence across 48 low- and middle-income countries. The findings revealed a 3.2% increased risk of ARI for every 1 μg/m³ increase in PM2.5 caused by fires. This effect is equivalent to a 5 μg/m³ increase from non-fire sources, suggesting that PM2.5 from fires is more hazardous than from other sources. The analysis also showed that the association between ARI and total PM2.5 was significantly mediated by the proportion of particles originating from fires. This study highlights the need for interventions to reduce children's exposure to wildfire smoke, particularly in countries vulnerable to land fires (Amadu et al., 2023).

The eighth journal shows that the high incidence of acute respiratory infections (ARI) among toddlers in Bangladesh is closely linked to domestic environmental conditions. Factors such as overcrowding (more than three people per room), use of health-unfriendly cooking fuels, indoor cigarette smoke exposure, and poor sanitation significantly increase the risk of ARI. Additionally, children with high birth order and premature birth are also at greater risk of developing ARI. However, exclusive breastfeeding has been proven to protect children from these risks. Therefore, ARI prevention initiatives should focus on improving home environments, promoting healthy and hygienic lifestyles, and raising awareness of the importance of exclusive breastfeeding, particularly in low-income communities (Islam et al., 2024).

The ninth journal discusses the impact of urbanization and the type of cooking fuel used at home on ARI symptoms in toddlers across Sub-Saharan Africa. The results show that toddlers from urban families using unclean fuels experienced more frequent coughing compared to those in rural areas using clean fuels. Meanwhile, children living in rural areas and exposed to dirty fuels had higher rates of rapid breathing (Li et al., 2024).

The tenth journal reports the results of a randomized trial in Kyrgyzstan evaluating the use of CRP testing in the primary care of children with ARI. The findings show that CRP testing significantly reduced antibiotic use without affecting recovery time or hospitalization rates. A 24% reduction in antibiotic use indicates that CRP testing can help distinguish between viral and mild bacterial infections, preventing unnecessary antibiotic prescriptions. Although there was a slight increase in follow-up consultations, the use of this test is still considered safe and effective. The study supports the integration of CRP testing into national strategies to reduce antimicrobial resistance (Li et al., 2023).

Table 1. Journal Literature Review

No	Author	Title	Objective	Method	Result	Conclusion
1	(Andrup et al., 2024)	Reduction of acute respiratory infections in day-care by non-pharmaceutical interventions: a narrative review.	To evaluate the effectiveness of non-pharmaceutical preventive measures in reducing ARI in such settings.	Narrative review of scientific literature from PubMed and Web of Science, focusing on daycare centers, viral transmission mechanisms, and non-pharmaceutical mitigation strategies.	Five main viruses—rhinovirus, RSV, influenza, coronavirus, and adenovirus—account for ~95% of ARI cases. Transmission primarily occurs through aerosols rather than surface contact.	ARI in daycare is mostly transmitted via air; thus, improving ventilation and reducing crowd density are the most effective non-pharmaceutical prevention measures.
2	(Siregar & Zaluchu, 2024)	Analysis of Factors Related to the Incidence of Acute Respiratory Infection in Toddlers in the Area of Tuntungan Community Health Center, Deli Serdang Regency 2024.	To identify various factors associated with the incidence of ARI among toddlers in the Tuntungan PHC area.	Quantitative study using a case study approach. Data were collected via questionnaires distributed to mothers of toddlers and analyzed using chi-square and logistic regression.	Significant factors related to ARI include environmental conditions, child characteristics, nutritional status, socioeconomic status, and parental smoking behavior. Immunization showed no significant association.	Poor environment, undernutrition, low economic status, and parental smoking increase ARI risk among toddlers, while immunization had no significant effect.
3	(Kasmadi et al., 2025)	The Influence of Physical Environmental Conditions and Maternal Practices on Acute Respiratory Infections in Toddlers: Evidence from Lailangga Community Health Center, Indonesia.	To investigate the relationship between physical environmental conditions and maternal practices with ARI incidence in toddlers.	Quantitative study with a cross-sectional design. Sample: 47 mothers with toddlers. Data collected through interviews and observations, analyzed statistically.	Significant associations were found between ARI and indoor air pollution, poor ventilation, and maternal knowledge, attitude, and practices. Maternal education, child nutrition, and health practices also had influence.	ARI in toddlers is closely related to unhealthy environments and inadequate maternal practices, particularly concerning home ventilation and ARI prevention awareness.
4	(Kalayou et al., 2024)	Empowering Child Health: Harnessing	To determine the prevalence	Analysis of 2016 Ethiopian Demographic and	ARI prevalence: 7.2%. The best model (ensemble	ARI in Ethiopian toddlers is influenced by

No	Author	Title	Objective	Method	Result	Conclusion
		Machine Learning to Predict Acute Respiratory Infections in Ethiopia.	and predictive factors of ARI among under-five children in Ethiopia using machine learning algorithms.	Health Survey data (9,501 children). Various machine learning models (e.g., SVM, XGBoost, GBoost) were tested to predict ARI and identify risk factors.	of SVM, GB, XGB) achieved 86% accuracy. Key factors: child age, diarrhea history, wealth index, maternal education, toilet type, cooking fuel, and breastfeeding duration.	sociodemographic, environmental, and nutritional factors. Machine learning helps identify at-risk groups and guide evidence-based interventions.
5	(Kamin et al., 2025)	Phytotherapy for acute respiratory tract infections in children: a systematically conducted, comprehensive review.	To evaluate scientific evidence on the effectiveness and safety of phytomedicines in treating ARI in children.	Systematic review based on PRISMA guidelines; literature search in PubMed and Cochrane Library. Included clinical trials, meta-analyses, and observational studies on phytotherapy for pediatric ARI.	Of 8,192 records, 45 studies were eligible. Some phytomedicines (e.g., Pelargonium sidoides extract, Echinacea purpurea, ivy leaf extract) showed symptom relief with good tolerability. EPs 7630 had the strongest evidence.	Certain phytomedicines, especially EPs 7630, are effective and safe as adjunct therapy for pediatric ARI. Phytotherapy can reduce inappropriate antibiotic use, though more research is needed.
6	(Isaeva et al., 2025)	*Bifidobacterium lactis* Probio-M8 relieved acute respiratory tract infections in children possibly by modulating the gut microbes and metabolites.	To assess whether *Bifidobacterium lactis* Probio-M8 can relieve ARI symptoms in children by modulating gut microbiota and metabolites.	Double-blind randomized clinical trial on 99 children with ARI, divided into probiotic and placebo groups; stool metagenomics used for analysis.	Probio-M8 increased beneficial gut bacteria, reduced pathogenic bacteria, raised anti-inflammatory metabolites, and relieved ARI symptoms while enhancing immunity (IL-10).	Probio-M8 is effective in reducing pediatric ARI symptoms by modulating gut microbiota balance and immune response.
7	(Amadu et al., 2023)	Landscape fire smoke enhances the association between fine particulate matter exposure and acute respiratory infection among children under 5 years of age.	To assess whether fine particulate matter (PM2.5) from landscape fire smoke is more harmful to children with ARI than other PM2.5 sources.	Case-crossover study using data from 36,432 children in 48 low- and middle-income countries; PM2.5 exposure estimated via GEOS-Chem atmospheric model (2003–2014).	Each 1 μg/m³ increase in PM2.5 from fire smoke increased ARI risk by 3.2%, higher than from non-fire sources. Risk increased with higher fire-related PM2.5 proportion.	PM2.5 from landscape fires is more toxic to children's respiratory health than other sources. Reducing land burning is crucial to protect child health in developing countries.
8	(Islam et al., 2024)	In-house environmental factors and childhood acute respiratory	To assess the relationship between household environmenta	Hospital-based matched case-control study at Dhaka Shishu Hospital (Mar–	Increased ARI risk associated with >3 persons per room, indoor smoking, and poor	ARI in toddlers is associated with poor home environments, smoking, high

No	Author	Title	Objective	Method	Result	Conclusion
		infections in under-five children: a hospital-based matched case-control study in Bangladesh.	l factors and ARI prevalence in Bangladeshi toddlers, including housing density, indoor smoking, cooking fuel, and sanitation.	Sept 2019). 348 children (174 with ARI, 174 controls), matched by age and sex. Data via systematic questionnaire; conditional logistic regression used.	bathroom conditions. Other risk factors: prematurity and birth order ≥3. Exclusive breastfeeding reduced ARI risk.	occupant density, and sanitation. Prematurity and higher birth order also increase risk. Exclusive breastfeeding is protective. Home-based interventions are essential, especially in resource-limited settings.
9	(Li et al., 2024)	Assessing the combined effect of household cooking fuel and urbanicity on acute respiratory symptoms among under-five years in sub-Saharan Africa.	To investigate the relationship between urbanicity, biomass cooking fuel use, and ARI symptoms in under-five children in sub-Saharan Africa.	Cross-sectional data from DHS surveys in 31 sub-Saharan African countries. Analysis via negative log-log regression.	Children in urban areas using unclean fuel had higher ARI symptoms. In contrast, rural children using clean fuel showed lower symptom likelihood.	Urbanicity and biomass fuel use for cooking are associated with increased ARI risk among under-five children in sub-Saharan Africa. Reducing exposure to unclean cooking fuels can lessen respiratory disease burden.
10	(Li et al., 2023)	CRP test reduces unnecessary antibiotic use in pediatric respiratory infections in Kyrgyzstan.	To assess the safety and efficacy of CRP testing in reducing antibiotic use among children with upper respiratory infections (ARI).	Randomized study of 1,204 children aged 6 months–12 years with ARI. Two groups: standard treatment vs. standard plus CRP test over 14 days; antibiotic use and recovery time measured.	CRP testing reduced antibiotic use by 24% without affecting recovery time or causing serious side effects.	CRP testing in pediatric ARI in Kyrgyzstan is safe and effective in reducing unnecessary antibiotic use without compromising patient recovery.

Discussion

Based on the analysis of ten journals discussing acute respiratory infections (ARI) in children, several contributing factors to ARI have been identified.

Acute respiratory infections (ARI) are among the most common illnesses in children under five, particularly those in childcare settings. The five most frequent viruses causing ARI include rhinovirus, respiratory syncytial virus (RSV), influenza virus, coronavirus, and adenovirus. Most of these viruses are transmitted via airborne particles. Given their predominant mode of transmission, non-pharmacological approaches—such as optimizing room ventilation, regulating humidity and temperature, limiting the number of children in a room, increasing outdoor activities, wearing masks, and practicing good hand hygiene—have been proven to reduce the risk of transmission. The COVID-19 pandemic experience reinforced the importance of maintaining indoor air quality as a primary effort in ARI prevention (Andrup et al., 2024).

In addition to air quality, various other factors contribute to the increased risk of ARI in young children, such as the living environment, child's age, birth weight, nutritional status, family socioeconomic status, and exposure to cigarette smoke at home. Children living in slum areas, those who are malnourished, and those exposed to parental smoking are at a higher risk of contracting ARI. A low family socioeconomic status further exacerbates children's vulnerability to infections, even though immunization status was not found to have a significant impact. Therefore, prevention efforts should focus on improving the living environment, fulfilling nutritional needs, enhancing family welfare, and providing education about the dangers of indoor cigarette smoke (Siregar & Zaluchu, 2024).

Two other significant factors contributing to the high incidence of ARI are maternal behavior in childcare facilities and housing standards. The risk of infection increases significantly due to improper infant care practices and inadequate ventilation. Hence, improving housing conditions and educating mothers are proactive steps toward reducing ARI prevalence in children (Kasmadi et al., 2025).

Other risk factors include child's age, history of diarrhea, hygiene, maternal education level, energy sources for cooking, and family welfare. A study in Ethiopia showed that machine learning approaches could more accurately identify key ARI predictors, which could then be used to design more targeted and effective interventions (Kalayou et al., 2024).

Besides environmental and social-based preventive strategies, complementary treatments are also gaining attention. The use of phytomedicines such as eucalyptus oil, echinacea, and other herbs has shown potential in alleviating ARI symptoms like cough and runny nose, although their long-term effectiveness and safety still require further research (Kamin et al., 2025).

Moreover, the high incidence of ARI in children under five is significantly influenced by indoor environmental factors such as overcrowding, poor sanitation, exposure to cigarette smoke, and the use of unclean cooking fuels. Premature babies with higher birth orders are also more vulnerable to ARI. In contrast, exclusive breastfeeding has been proven to protect children against this risk. Therefore, improving home conditions, promoting exclusive breastfeeding, and increasing parental health education and awareness—especially in low-income areas—should be the primary focus in ARI prevention efforts (Islam et al., 2024).

Microbiota-based approaches such as supplementation with the probiotic Probio-M8 have also shown promising results. This probiotic works by modulating gut microbiota and producing bioactive metabolites that enhance the immune system and reduce respiratory tract inflammation, offering additional benefits in preventing and managing ARI in children (Isaeva et al., 2025).

Outdoor environmental factors such as air pollution also play a significant role. Exposure to fine particulate matter (PM2.5) from land fires in low- and middle-income countries has been proven to increase the risk of ARI, even more so than other sources of pollution. Each increase in PM2.5 concentration correlates with a rise in ARI cases, highlighting the need for mitigation efforts against land fire-related pollution (Amadu et al., 2023).

Urbanization and the use of unclean cooking fuels in Sub-Saharan Africa also contribute to the ARI burden among young children. ARI symptoms are more frequently observed in children living in metropolitan areas exposed to dirty fuels compared to those in

rural areas using clean fuels. This condition underscores the importance of transitioning to environmentally friendly household fuels (Li et al., 2024).

Finally, innovations in clinical management have also contributed to ARI control. The use of C-reactive protein (CRP) tests in primary care in Kyrgyzstan significantly reduced antibiotic use without compromising patient safety. This approach not only helps prevent antimicrobial resistance but also improves the quality of infection management in primary healthcare facilities (Li et al., 2023).

Conclusion

ARI affects both upper and lower respiratory tracts and is primarily caused by viral and bacterial infections that spread easily through air or direct contact. Environmental factors such as air pollution, cigarette smoke, the use of fossil fuels in households, and poor sanitation conditions are significant risk factors that exacerbate ARI incidence. Addressing ARI requires a comprehensive and integrated approach, including accurate diagnosis, rational medical therapy, non-pharmacological interventions, and active involvement of families and healthcare professionals in prevention and management efforts.

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