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The Relationship Between Environmental Factors And Acute Respiratory Infections In Rural Areas: A Literature Review

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ABSTRACT

Background: The incidence of acute respiratory infections (ARI) is a significant global public health issue. One of the risk factors affecting ARI is the environment. The environment and ARI have a cross relationship. This study was conducted to clearly determine the relationship between the environment and the incidence of ARI in rural areas. **Method:** The article review was conducted by searching for articles through electronic databases (Google Scholar, PubMed, and Semantic Scholar) using the keywords environment, respiratory tract infection, and environmental factors for acute respiratory infection in rural areas. The inclusion criteria used were original articles in national and international accredited journals, the year of publication of the article between 2019 - 2024, full text, free access, and cross sectional research design. Exclusion criteria in this study were literature review or systematic review meta-analysis, related to covid-19, and urban areas. Five articles were selected for analysis. Articles were analyzed by following the Prisma Guidelines. **Results:** Poor environmental conditions have been identified as a significant risk factor that contributes to the increased prevalence of acute respiratory infections (ARI), particularly in the context of exposure to air pollutants. Furthermore, inadequate environmental conditions have been demonstrated to exacerbate the severity of acute respiratory infections (ARI), as irritated respiratory tracts become more susceptible to invasion by environmental pathogens. These findings underscore the pivotal role of environmental quality, particularly in rural areas, as a crucial predictor of ARI risk and impact.

Introduction

Acute respiratory infection (ARI) is a common infectious disease and one of the leading causes of morbidity and mortality in many countries, especially in developing countries. This disease can be caused by various microorganisms, such as viruses and bacteria, which attack the upper and lower respiratory tract. According to WHO data, ARI accounts for more than 3 million deaths annually worldwide with a particularly significant impact on vulnerable age groups

such as children and the elderly, with the majority of cases occurring in environments that have certain risk factors, such as air pollution, humidity and residential density (1).

Environmental factors are known to play an important role in increasing the risk of ARI. Studies have shown that environmental factors, such as air pollution, overcrowding, ventilation, and water quality, are associated with an increased risk of ARI (2) (3). Long-term exposure to air pollutants such as fine dust particles (PM2.5 and PM10), nitrogen dioxide gas (NO_2), and sulfur dioxide (SO_2) can irritate the respiratory tract and increase susceptibility to infection (4). The presence of indoor air pollution caused by cigarette smoke, biomass burning, and poor ventilation also plays a significant role in increasing the risk of respiratory infections, especially in rural and densely populated areas (5).

In addition to air pollution, environmental sanitation quality, occupancy density, and indoor air ventilation are also significant risk factors in the spread of the disease (6). High humidity levels are associated with increased pathogen growth and spread of respiratory viruses that trigger respiratory infections (7). In the cold and rainy seasons, the risk of ARI increases as low temperatures and high humidity create an ideal environment for the development of respiratory pathogens (8). Decreased sanitation quality and lack of access to clean water contribute to high rates of respiratory infections in some regions (9). While numerous studies have explored environmental factors and ARI, there is a need for a systematic synthesis of evidence focusing specifically on rural settings. However, the evidence remains scattered and has not been systematically synthesized, particularly with a specific focus on rural settings or integrating findings from various housing factors. Consequently, the present study is of paramount importance, as it undertakes a synthesis and provides a more profound understanding of the intricate interactions of environmental factors, specifically sanitation quality, housing density, and indoor air ventilation, which contribute to the risk of acute respiratory infections (ARI) in rural areas. This knowledge will facilitate the development of more effective policies and prevention strategies to reduce ARI incidents, particularly in regions with environmental conditions conducive to disease propagation.

Materials and Method

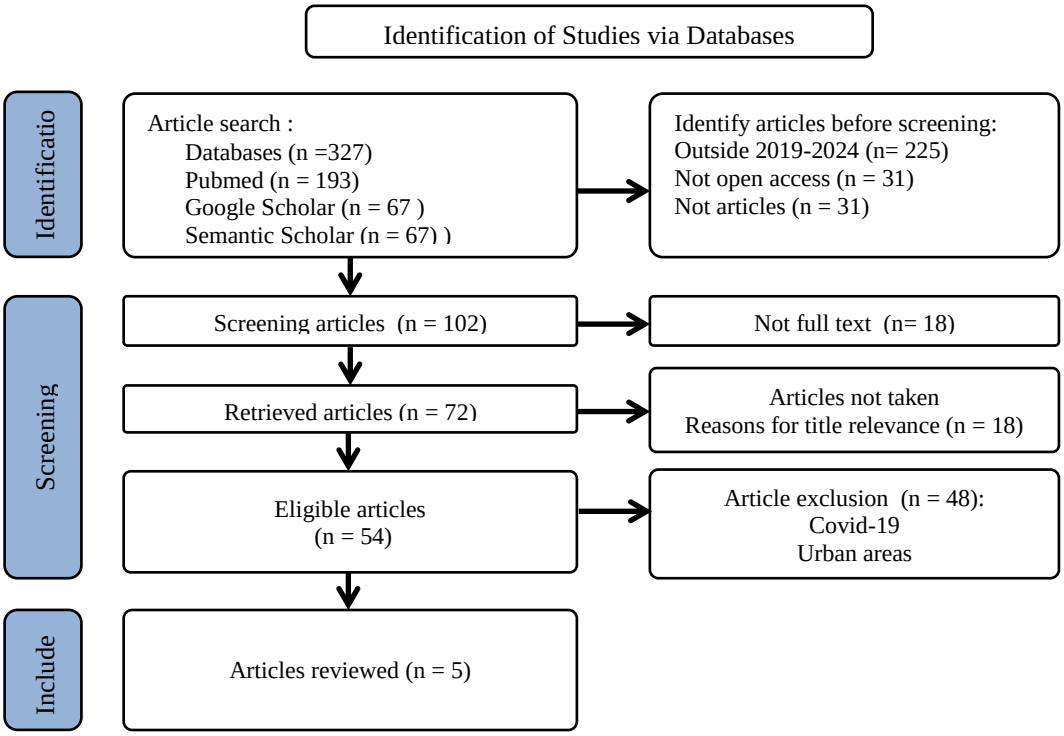

Figure 1. Schematic of article selection using the PRISMA

This article review uses the PRISMA method to obtain information about the environment associated with ARI. Data was collected through databases such as Google Scholar, PubMed, Semantic Scholar. The keywords used were “environment”, “respiratory tract infection”, and

"environmental factors for acute respiratory infection in rural areas". The inclusion criteria in this study used scientific publications with a cross-sectional design from 2019 to 2024, national and international accreditation, full text, and original work. Exclusion criteria in this study were literature review or systematic review meta-analysis, related to covid-19, and urban areas. Thus, 5 out of 327 articles were selected for assessment (see Figure 1).

The articles underwent a critical appraisal process using JBI to assess the quality of the research and the appropriateness of the articles used according to the research design, in this case cross sectional. JBI consists of 8 questions in the form of a checklist, each of which is given a score of 1 for "Yes" and 0 for "no" or "not applicable", the results of which are categorized into three, namely high (score ≥85%), medium (score 60-85%), and low (score <60%)

Results

Table 1. Analysis of Article Synthesis

No	Citation	Method	Sample/place	Result
1	Wulandhani, S., & Purnamasari, A. B. (2019).	*Cross-sectional*	Sample : 59 respondents Place : 12 village in Bontoala sub-distrinct	There was a significant association at the 95% confidence interval between occupancy density (OR=2.030, RR=0.635), ventilation (OR=0.814, RR=1.138), floor type (OR=0.768, RR=1.173), wall type (OR=5.294, RR=0.324) distance between house and road (OR=1.167, RR=0.909) and house dusting habit (OR=1.228, RR=0.879) with the incidence of ARI.
2	Azanaw, J., Weldegebriel, F., & Malede, A. (2024).	*Cross-sectional*	Sample : 10,006 participants Place : Etiophia	Children under 13 months and 13-29 months of age had higher odds (AOR = 1.73; AOR = 1.60) of experiencing ARI symptoms compared to children aged 45-59 months. Children under five years of age using solid fuels had higher odds (OR = 1.74) of experiencing acute respiratory symptoms compared to children using clean fuels. Children under five years of age living in houses with natural main walls had a higher chance (AOR = 2.10) of experiencing ARI symptoms compared to houses using ready-made building materials. Children under five living in homes with natural main floors were more likely (AOR = 4.30) to experience ARI symptoms compared to those living in homes with finished main floors. Children living in rural areas were more likely to experience ARI symptoms (AOR = 3.95) than those living in urban areas.
3	Fauziah, D. R., & Fajariyah, N. (2023).	*Cross-Sectional*	Sample : 96 respondents Place : Cipedak	Home environment (p-value = 0.034) and parental behavior (p-value = 0.046) were significantly associated with the incidence of ARI among under-fives in Cipedak Urban Village.
4	Sabila, R., Amin, F. A. ., & Hasnur, H. (2023).	*Cross-Sectional*	Sample : 61 respondents Place : Peusangan	Occupancy density (p-value = 0.004), air pollution (p-value = 0.001), humidity (p-value = 0.002), and lighting conditions (p-value = 0.019) were significantly associated with ARI incidence.
5	Hariningsih, S., Prasetyo, A., & Sujangi. (2023).	*Cross-Sectional*	Sample : 130 respondents Place : Pangkur	The physical components of the house provide a high risk (OR = 8.636; RR = 0.020) of ARI occurrence. The behavior of the occupants of the house provides a high risk (OR = 2.017; RR = 0.124) for the incidence of ARI disease. Housing components and behavior contributed 55.3% to the incidence of ARI.

Based on the search results of five articles, 4 out of 5 studies were conducted in rural area, and the rest were conducted in Ethiopia with 80% of the population living in rural areas. The five articles were quantitative studies with a cross-sectional design, four of which tested the risk between environmental factors and ARI incidence, while the rest tested the association. The articles were then analyzed using matrix tables to identify each variable studied in relation to the relationship between the environment and ARI incidence in rural areas.

Literature studies from the five focused and analyzed literatures proved that the environment is associated with ARI incidence. Previous research explains that the variable that influences the incidence of ARI is the environment. A person with a poor environment has a higher risk of suffering from ARI compared to people who do not have these risk factors. The variable of focus in this literature review is the relationship between environmental conditions and ARI incidence. The analysis of the articles found that environmental conditions increase the incidence of ARI (see Table 1).

Discussion

A literature study of five focused and analyzed literatures proves that the environment is related to the incidence of ARI. People with a poor physical environment have a 4.55 times risk of suffering from respiratory tract infections compared to those with a good physical environment (15). Previous research shows that subjects with a poor physical environment experience more cases of acute respiratory infections, this is in accordance with the theory that environmental factors affect as much as 40% (16). In general, the environment can be an important benchmark in determining disease transmission (17). A poor physical environment can lead to acute respiratory infections as pathogens emerge and multiply (18) (19).

Previous research explains that the component that most influences the incidence of ARI is the physical environment of the house. Individuals with a poor home physical environment are at higher risk of developing ARI than individuals who do not have these risk factors. The physical environment of the house such as occupancy density, humidity, lighting, ventilation, floor and wall types, house distance, activities in the house that cause smoke, among other factors will affect the respiratory system and even weaken a person's immune system so that it is susceptible to infectious diseases such as ARI (20) (21). The physical environment can determine a person's health condition against emerging diseases (17).

High residential density will risk increased transmission of respiratory pathogens due to limited space which complicates isolation of sick individuals and accelerates droplet transmission between residents. Houses with high occupancy density have almost twice the risk of developing ARI (22). Factors such as poor ventilation and exposure to cigarette smoke also compound the impact. Better ventilation systems, such as chimneys or windows, can significantly reduce the risk of ARI (23) (24). Smoke and pollutants from cooking methods that often rely on biomass fuels such as wood or dung for cooking tend to accumulate due to inadequate ventilation systems, leading to prolonged exposure among household members. Fine particulate matter (PM2.5) and carbon monoxide from combustion activities can be inhaled deep into the lungs, causing inflammation, and exacerbating immune responses thereby increasing the risk of ARI. Biomass fuels have indoor air pollution levels up to 20 times higher than safe thresholds, compounded by the presence during such activities of risk of ARI (25) (26) (27). Humidity that is too high or too low can exacerbate the risk of respiratory infections due to the spread of airborne pathogens. Low humidity can cause dryness of the respiratory tract, reducing the effectiveness of the mucociliary defense system, making it more susceptible to pathogen attack. Conversely, high humidity creates a favorable environment for the growth of microorganisms such as fungi and bacteria, which can trigger or exacerbate ARI (28) (29). Lighting below 60 lux increases the risk of ARI by 2 times with each decrease (30). Natural light through adequate ventilation can help kill pathogenic bacteria and reduce humidity in the home. Conversely, homes with poor lighting and limited air circulation increase exposure to pollutants (31). Natural or unfinished or damaged flooring allows for increased dust, allergens and moisture retention, which can worsen indoor air quality and act as a reservoir for respiratory pathogens. Finished flooring materials, such as tiles or cement, are associated with better respiratory health outcomes, as they are easier to clean and reduce dust accumulation. On the other hand, the presence of furry and bulky materials such as carpets can trap dust, allergens and mites, contributing to poorer respiratory health, especially when combined with poor ventilation (32) (33). Natural walls such as mud, pounded earth, or bricks without proper plastering tend to retain moisture, harbor mold and can increase the risk of respiratory disorders, including ARI (32) (34). The distance between houses in rural areas can affect the incidence of ARI. Houses that are close together and have poor ventilation and

sanitation can lead to poor air circulation and increased exposure to indoor air pollution, putting people at risk of ARI (23) (35).

There is a cross-correlation between the environment and the risk of contracting ARI. A poor physical home environment will increase the risk of ARI (19). On the other hand, ARI will be transmitted to other residents due to the poor physical environment of the house. ARI caused by viruses can cause an abnormal increase in mucosal fluid which will damage the respiratory protection system against pathogenic bacteria, causing mucus secretion to increase and block the respiratory tract. On the other hand, indoor habits that produce smoke contribute to the physical environment of the home, increasing the risk of ARI (27).

Literature studies also explain the relationship between the physical environment of homes in rural areas and ARI. Based on other studies, the physical condition of the house in rural areas is not a risk factor for the incidence of ARI in children. This can occur in children with a positive or negative diagnosis of ARI who have a good physical home environment due to immunization status, nutritional status, breastfeeding and access to health services (17) (19) (24). In this case, what needs to be considered is the consistency of maintaining and maintaining clean and healthy individual behavior. Poor individual daily behaviors can reduce resistance to ARI in children and adults. On the other hand, in rural areas socio-economic factors moderate the relationship between physical environment and ARI risk, as well as the long-term impact of physical environment changes on reducing ARI incidence (36) (37).

This study does not fully reveal the causal relationship between environmental factors and ARI incidence because the article uses a cross-sectional design that only captures the relationship at one point in time. It is necessary to consider confounding factors such as children's nutritional status, smoking behavior of family members, or socioeconomic conditions that may affect the results. Variations in methodology, such as differences in measurement tools and definitions of physical environment variables, also pose challenges in comparing findings across articles. With strengths in the analysis of specific risk factors and weaknesses in the design and coverage of variables, this review shows the importance of further research that can integrate longitudinal designs, multidisciplinary approaches, and adjustments for confounding factors to produce a more comprehensive and representative understanding for rural areas.

Conclusion

Based on the results of the study, it can be explained that the environment has a cross relationship with acute respiratory infections. A poor environment will increase the risk of acute respiratory infections due to pollutants in the air. On the other hand, acute respiratory infections will be exacerbated by a poor environment because the already injured respiratory tract will make it easier for pathogens in the environment to enter. Given the cross-talk between the environment and acute respiratory infections, it is recommended that comprehensive health interventions addressing environmental conditions be conducted, with a focus on improving the quality of the home environment in rural areas to reduce the risk of respiratory infections, while ensuring environmental care for individuals who have contracted such infections to reduce their impact on public health

Declaration

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Conflicts of Interest: There is no conflict of interest in this research

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