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Systematic Review: Effects of Residential Environmental Quality and Risks Acute Respiratory Tract Infections (ARI)

[1]Is Fitiyarin Chamida* , [2] Onny Setiani, [3] Budiyono,
[1] Department of Environmental Health, Faculty of Public Health, Universitas Diponegoro, Semarang, Indonesia* ; email: Isfitiyarin68@gmail.com
[2] Department of Environmental Health, Faculty of Public Health, Universitas Diponegoro, Semarang, Indonesia; email: onnysetiani@ymail.com
[3] Department of Environmental Health, Faculty of Public Health, Universitas Diponegoro, Semarang, Indonesia; email: budiyonofkm@lecturer.undip.ac.id
* Correspondence

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Abstract
Introduction: *Acute respiratory infection is one of the health problems that often occurs in the community, especially in residential environments with poor quality. Housing conditions that do not meet health requirements, such as inadequate ventilation, high occupancy density, poor lighting, and exposure to indoor air pollution, can increase the risk of respiratory infection. An unhealthy residential environment may facilitate the growth and spread of disease-causing microorganisms and affect the health of residents.* ***Objective:*** *To analyze the effect of residential environmental quality on the risk of acute respiratory infection.* ***Methods:*** *This study used a literature study method by examining several scientific articles discussing housing environmental conditions and the incidence of respiratory tract infection. Data were collected from relevant journals published between 2019 and 2024.* ***Results and Discussion:*** *Inadequate ventilation, high occupancy density, excessive humidity, poor lighting, and exposure to smoke and air pollution were the most common factors associated with respiratory infection. These conditions reduce indoor air quality and increase the possibility of disease transmission, especially among vulnerable groups such as children.* ***Conclusion:*** *Residential environmental quality affects the risk of acute respiratory infection. Improving housing conditions and environmental sanitation is necessary to reduce disease incidence and improve public health.*

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Introduction

Acute Respiratory Infection (ARI) is still categorized as a significant public health problem in various parts of the world, especially in developing countries that have many residential areas with environmental conditions that do not meet health requirements. International health agencies report that the group of infectious diseases of the respiratory system is one of the main contributors to the number of illnesses and deaths, especially in vulnerable populations such as children and the elderly. The high incidence is closely related to the characteristics of the residential environment, including the adequacy of ventilation, the level of occupancy density, room humidity, and the air quality in the house. A dense and unhealthy residential environment can increase the chances of the spread of pathogenic microorganisms through droplets and aerosols in enclosed spaces, especially in conditions with inadequate air circulation. (Syakur et al., 2021) said Prevention of ISPA disease must pay attention to good ventilation, especially in areas with high occupancy density and poor air quality · In addition, the findings of the study also show that individual mobility and density of activities in closed spaces are factors that contribute to increasing the risk of spreading respiratory diseases. (Wuand al., 2023) said this condition emphasizes that the quality of the residential environment plays an important role in influencing the incidence rate of ARI on a global scale

The quality of the residential environment refers to residential conditions that affect the health of residents and includes physical, biological, chemical, and social aspects. Physical components, such as ventilation, occupancy density, lighting, temperature, and humidity, are directly related to the mechanism of transmission of ISPA, so they are most often used as a focus in research because they are easy to measure and have strong empirical relevance. On the other hand, biological, chemical, and social components continue to contribute through the presence of microorganisms, exposure to pollutants such as cigarette smoke and cooking fuel, as well as socioeconomic conditions, nutritional status, and completeness of immunization. These factors act as confounding variables that can strengthen or weaken the relationship between the quality of the home environment and the incidence of ARI.

The results of health research (Syakur et al., 2021) the characteristics of the household environment are related to the high incidence of ARI in the community, especially the factors of occupancy density, the existence of ventilation, the type of floor of the house, and the exposure to smoke in the house .Research conducted by (Ulva & Finasti, 2022) revealed that home ventilation that does not meet health requirements and high occupancy density has a meaningful relationship with the incidence of ARI in toddlers. Similar findings were also reported by (Widya Ayu Pratiningsih et al., 2025) those showing that residential density and environmental social conditions contribute to increasing the risk of respiratory infections in patients in urban areas. In addition, (Birawida et al., 2023) it was stated that humidity, lighting, and air quality factors in the house also played a role in the increase in the number of ARI cases in the health center's work area. These findings confirm that the quality of the residential environment is one of the important determinants in the epidemiological pattern of ARI in Indonesia.

(Wardani & Astuti, 2022) said that the physical condition of the house that does not meet health standards has contributed to the occurrence of ISPA, but the study has not integrated various environmental components at the same time. The research conducted by (Soedjadi, 2022) also highlighted the relationship between residential density and the incidence of ISPA, but has not comprehensively examined the quality of residential environments. Meanwhile, (Rahmalila Putri & Nanda, 2023) it shows that

behavioral factors and housing environmental conditions have an influence on the incidence of ISPA, although the analysis has not been placed within the framework of the theory of residential environmental quality systematically.

This study is directed to examine the influence of residential environmental quality on the risk of Acute Respiratory Infection (ARI) through a more comprehensive analytical approach. This study does not limit the assessment to one environmental variable, but examines various indicators of residential environmental quality at the same time, which include the level of occupancy density, the availability of ventilation, the physical condition of the house building, and environmental factors in the space. Through this approach, it is hoped that a more systematic understanding can be obtained of the relationship between settlement characteristics and the risk of ARI occurrences, so as to be able to explain the mechanism of increasing cases in people living in low-quality environments.

This research is expected to contribute both to the theoretical and practical realms. From the theoretical side, the findings of this study are expected to strengthen the view that the quality of the residential environment is one of the important determinants in the epidemiology of infectious diseases influenced by environmental factors, especially ARI. From a practical perspective, the results of this research can be used as a basis for consideration for the government and health workers in developing environment-based intervention programs, especially those related to improving house conditions, controlling occupancy density, and improving healthy housing standards. In addition, the findings of this study can also be a reference in the formulation of public health policies aimed at reducing the risk of ARI through efforts to improve the quality of the residential environment.

Method

This study applied a systematic review design to identify, assess, and integrate research findings related to the relationship between the quality of residential environments and the incidence of Acute Respiratory Tract Infections (ARI). The preparation process is carried out in a structured manner with reference to the principles of transparency and replication, so that each stage of research can be traced back systematically.

Article searches are carried out electronically through several scientific databases, namely Google Scholar, PubMed, DOAJ, and Garuda, because these databases are widely used in public health and environmental health research. The keywords used in the search process were adjusted to the research variables "ARI", "Acute respiratory infection", "quality of the home environment", "residential environment", "home ventilation", "occupancy density", "home sanitation", "indoor air quality", "respiratory infection", "housing condition", "environmental health". Keywords are combined using Boolean operators such as AND and OR to obtain more specific and relevant articles to the research objectives.

Articles are included in the survey when they meet the following criteria:

1. Articles published in 2019–2025
2. Articles written in Indonesian or English
3. The study discussed the relationship between residential environmental quality, housing conditions, or environmental factors with the incidence of ARI

4. Research design in the form of observational (cross sectional, case control, cohort), analytical studies, or epidemiological research**,** as well as a review of relevant literature
5. Articles are available in full text so they can be analyzed in full
6. Articles from accredited scientific journals (at least SINTA or reputable international journals)

An article is not included in a review if it meets one of the following conditions:

1. The article does not discuss ARI or does not relate to the quality of the residential environment
2. Articles are only abstracts, short reports, or proceedings without complete research data
3. Articles are not accessible in full-text form
4. Duplicate articles from different databases
5. Articles that discuss respiratory diseases but do not examine the environmental factors of the home or settlement

Result and Discussion

1. Result

No	Author, Title & Year	Variable	Research Design	Sample	Results
1	Dursa (2020) The Relationship between Environmental Factors and the Incidence of ARI	Physical environment of the house, ventilation, occupancy density	Cross sectional	60 respondents	Home environmental factors are significantly related to the incidence of ARI
2	Haryani (2021) The Influence of the Physical Environment of the Home on the Incidence of ARI in Toddlers (2021)	Home environment, health behaviors	Pre-experiment	20 Toddler Mothers	Home environmental improvements reduce the risk of ARI
3	Falah (2022) The Physical Environment of the Homes of People ARI with Disabilities in Tasikmalaya City (2022)	Home conditions, lighting, ventilation, humidity	Descriptive	65 sufferers	Many homes do not meet health requirements high risk of ARI
4	Jain (2023) The Relationship of the Residential Environment with ARI	Air pollution, ventilation, density, kitchen smoke	Cross sectional	92 respondents	Dense residential environments and pollution increase ARI
5	Irma (2024) Physical Condition of the Home as a Determinant of ARI (2024)	Ventilation, floor type, density	Observational analytics	100 respondents	Unhealthy home conditions increase the incidence of ARI

2. Discussion

Ventilation

Ventilation is the most dominant and most consistent factor in influencing the occurrence of ARI. Research (Epi Dusra, 2021) shows that inadequate ventilation has a significant relationship with an increase in ARI cases. This condition is caused by suboptimal air circulation so that pathogenic microorganisms can survive longer indoors and increase the concentration of droplets that are infectious. These findings are strengthened by (Haryani et al., 2021) who stated that ventilation improvements contribute to reducing the incidence of ARI in toddlers. In addition, studies (Falah et al., 2023) and (Irma et al., 2024) also identified that ventilation that does not meet health standards is a common characteristic in the homes of people with ARI, thus showing that ventilation not only plays a role as a risk factor, but also as a protective factor when in good condition.

Theoretically, ventilation functions in controlling the air quality in the room through the process of dilution and air exchange. In the concept of environmental health, adequate ventilation is able to reduce the concentration of infectious agents by replacing contaminated air with fresh air. This is in line with the theory of airborne transmission which explains that respiratory diseases, including ARI, can be spread through droplets and aerosols that remain in the air for a period of time. Inadequate ventilation leads to the accumulation of infectious particles thus increasing the risk of exposure. In addition, the concept of indoor air quality emphasizes that good air circulation also plays a role in lowering the concentration of pollutants, such as carbon dioxide and fine particles, which have an impact on respiratory health.

Environmental health standards state that a minimum ventilation area of 10% of the floor area is required to maintain optimal air circulation. In addition, the air balance theory suggests that adequate air exchange can maintain temperature and humidity stability, thereby inhibiting the growth of microorganisms. Natural ventilation supported by sunlight lighting also contributes to lowering the number of pathogens through exposure to ultraviolet radiation. Therefore, ventilation is a key factor in controlling airborne diseases and needs to be the main focus in efforts to prevent ARI in residential environments.

Occupancy Density

Residential density is one of the important factors that plays a role in accelerating the ISPA transmission process. Research (Epi Dusra, 2021) and (Irma et al., 2024) show that high levels of occupancy density are associated with an increase in the incidence of ARI. This condition occurs because the more individuals occupy limited space, the greater the chance of contact and exposure to infectious agents. These findings are reinforced by (Jain et al., 2023) which states that residential environments with high levels of density contribute to an increased risk of ARI, especially in areas with dense populations.

Theoretically, residential density is related to the concept of disease transmission through contact and air. From an epidemiological perspective, increasing density will increase the contact rate between individuals, so that the chances of disease transmission are higher. Spaces with limited areas inhabited by many people can accelerate the spread of infectious droplets, especially in diseases that attack the respiratory system. In addition, the crowding effect theory explains that crowded housing conditions not only increase

the frequency of physical interactions, but also accelerate the spread of disease agents through the air in enclosed spaces.

Residential density also has implications for a decrease in indoor air quality. The high activity of the inhabitants leads to increased carbon dioxide production, temperature, and humidity, which can create environmental conditions that favor the growth of microorganisms. In the concept of indoor air quality, increased concentrations of pollutants and humidity due to residential density can worsen the condition of the respiratory tract. This impact is more significant in vulnerable groups such as toddlers, so housing density is an important factor that needs to be considered in efforts to prevent ARI.

Lighting and humidity

Lighting and humidity are physical environmental factors that contribute to the occurrence of ISPA, although the level of influence is not as large as ventilation and occupancy density. Research (Falah et al., 2023) shows that most homes with ARI have inadequate lighting as well as high humidity levels. These conditions create an environment that supports the survival of pathogenic microorganisms in the house, thereby increasing the risk of disorders in the respiratory system.

Theoretically, natural lighting, particularly sunlight, has disinfectant properties against microorganisms. Exposure to ultraviolet (UV) radiation is able to damage the DNA structure of microorganisms, thereby inhibiting growth and reducing their ability to infect. Therefore, homes with adequate lighting tend to have a lower risk of infection. Instead, poor lighting conditions will create dark and humid spaces, which support the survival of bacteria and viruses.

On the other hand, air humidity has an important role in maintaining the viability of microorganisms indoors. High humidity levels can prolong the resistance of viruses and support the growth of fungi and bacteria. In the concept of indoor air quality, these conditions can reduce air quality and increase the risk of exposure to infectious agents. The combination of inadequate lighting and high humidity can worsen the environmental conditions of the home, thereby increasing the likelihood of the occurrence of ARI, especially in vulnerable groups.

Disturbing factors

Disruptive factors in the incidence of ARI can be understood through a determinant of health model which explains that health status is the result of an interaction between environmental factors, behavior, and individual conditions. In addition to the physical aspect of the house, there are a number of other variables that can affect the relationship between the quality of the residential environment and the incidence of ARI. Indoor smoking is one of the main factors that increase indoor air pollution, especially through exposure to fine particles (PM2.5) and various toxic substances that have the potential to damage the respiratory tract. In addition, the use of biomass fuels such as wood or charcoal also produces harmful pollutants that can increase the risk of ARI.

On the other hand, individual factors such as nutritional status and immunization completeness also determine the level of susceptibility to infection. The theory of individual susceptibility explains that poor nutritional conditions and incomplete immunization can lower the immune system, making individuals more susceptible to infection. This circumstance causes the same exposure can have a different impact on

each individual. In addition, socio-economic factors also have an important role in determining the quality of the living environment and access to health services.

Not all studies were able to optimally control these disruptive factors, so that they can affect the strength of the relationship between environmental variables and the incidence of ISPA. Therefore, the presence of disruptive factors needs to be considered in the process of interpreting results, as they can strengthen or weaken the relationship between the quality of the residential environment and the risk of ARI.

Conclusion

Based on a review of a number of previous studies, it can be concluded that the quality of the residential environment has a significant relationship with the incidence of Acute Respiratory Infections (ARI). Studies have shown that some of the environmental factors that are most often associated with increased risk of ARI include home ventilation that does not meet health standards, high occupancy levels, room humidity, inadequate lighting, and exposure to indoor air pollution. Research shows that houses with inadequate ventilation and a dense number of occupants cause air circulation to not take place optimally, thus increasing the likelihood of airborne transmission of diseases. In addition, unhealthy home environmental conditions, such as high humidity levels and poor lighting, can support the growth of microorganisms that cause respiratory tract infections. Exposure to smoke from cooking activities and air pollution in high-density areas has also been shown to increase the risk of ARI because it can reduce the ability of the respiratory tract to defend against infection

Other research results show that the quality of the home environment is a controlling factor, so that efforts to improve the physical condition of the home have the potential to reduce the incidence of ARI, especially in vulnerable groups such as toddlers. Houses with adequate ventilation, maintained cleanliness, and appropriate housing density have been proven to reduce the risk of respiratory infections. Although there were differences in the variables considered to be the most dominant in each study, all findings suggest that residential environments that do not meet health requirements are important risk factors for the occurrence of ARI. Therefore, efforts to prevent ARI are not only focused on the treatment aspect, but also need to be directed at improving the quality of the residential environment to support the improvement of the overall public health degree.

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