Home Environmental factors with the Incidence of ISPA in Toddlers Indonesia: Literature Review

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ARTICLE INFO	ABSTRACT
	Background: ARI or acute respiratory infections can occur in the upper and lower respiratory tract. Toddlers are at risk of ARI due to indoor air pollution. Indonesia has the highest mortality rate of children under 5 years old due to ARI caused by several unqualified environmental factors such as ventilation area, occupancy density, air humidity, and lighting of toddlers' homes that do not meet the requirements of healthy homes. This literature review aims to analyse the association between home environmental factors and the incidence of ARI in children under five years of age in Indonesia.
	Method: Using the literature review method by reviewing scientific articles published in the Google Scholar, Researchgate, Sciencedirect and PubMed databases using the search keywords OR factors using boolean operators AND ARI in toddlers OR Accute Respisitory Infections under five years. The study was conducted from June to August 2024 in Indonesia. **Result:** 12 articles were found that met the inclusion criteria of the study. of the 12 articles reviewed showed that air temperature, air humidity, lighting intensity, ventilation area, residential density in the house, use of fuel for cooking, the presence of family members who smoke in the house are associated with the incidence of ARI in Indonesia. **Conclusion:** The most dominant factor associated is the presence of family members who smoke. Some other factors that are interconnected are the availability of adequate ventilation with air humidity in the house. Many of the toddlers affected by ARI live in homes that do not have adequate ventilation so that the humidity in the house becomes high and creates an environment that supports the growth of pathogenic germs that can increase the risk of ARI in toddlers.

INTRODUCTION

ARI or acute respiratory infection can occur in the upper and lower respiratory tract, is an infection caused by trace bodies or bacteria, Haemophiles influenzae type B (Hib) virus, without or with lung parenchyma (1). Symptoms usually appear within hours to days after infection. Symptoms of ARI may include fever, body aches, runny nose and cough. The most common symptoms are throat irritation, coryza, shortness of breath, wheezing, or difficulty breathing. Pneumococcal and tuberculosis bacteria contribute to the disease, along with influenza and parainfluenza viruses, rhinovirus, respiratory syncytial virus, and severe acute respiratory syndrome coronavirus (2). Toddlers are at risk of developing ARI due to indoor air pollution because their respiratory tracts are smaller, they breathe faster, they inhale more air relative to their body weight, and they have immature immune systems in addition to spending most of their time in and around the home (3,4,5)

Indonesia has the highest mortality rate of children under 5 years old due to ARI. According to the Indonesian mortality survey, ARI accounts for 22.30% of all deaths under 5 years old. The results of the 2018 Basic Health Research showed that children under five years old had the highest incidence of ARI (6). The high incidence of ARI in toddlers is caused by several unqualified environmental factors such as PM10 and PM2.5 concentrations that exceed the quality standard threshold, ventilation area, occupancy density, air humidity, and lighting in toddlers' homes that do not meet the requirements of healthy homes (7). According to the study, people living in high-density housing have a 6.167 times chance of experiencing the incidence of ARI disease compared to occupancy density that meets the requirements. These results are reinforced by research that reports that exposure to high household air pollution will cause toddlers to be 5 times more likely to suffer from ARI and even develop pneumonia (8,9).

WHO estimates that around 3 billion people use solid fuels for heating and cooking in their homes. They cook using basic stoves and open fires, burning coal and biomass (crop waste, wood and animal waste). Cooking with solid fuels pollutes the air, leading to the premature death of more than 4 million people from related diseases (10). Research shows that inhaled particulates from household air pollution are responsible for more than 50% of premature deaths in children under 5 years old due to respiratory infections. Air humidity and occupancy density have a significant association with the incidence of ARI in children under 5 years old (11). Unqualified room temperature has a 2.29 times greater risk of ARI compared to qualified room temperature (12). Unqualified ventilation will trigger high humidity in the room, high humidity will be a good medium for the growth of disease-causing bacteria (13). Children living in a ventilated house are less likely to develop ARI compared to children living in a poorly ventilated house.

In addition, the presence of smokers in the house causes indoor air pollution and increases the incidence of ARI in children. The more smokers in the house, the greater the risk of ARI in children (14). Therefore, the main objective of this study was to observe the relationship between environmental quality factors in the home and the incidence of ARI in children under five years of age in Indonesia.

METHOD

This study uses the literature review method by examining scientific articles published in the Google Scholar, Researchgate, Sciencedirect and PubMed databases using the search keywords OR factors using boolean operators AND ARI Toddlers OR Accute Respisitory Infections under five years. The study was conducted from June to August 2024 in Indonesia.

Inclusion criteria for this study are: 1) Research articles published in 2014-2024. 2) The type of research design is an observational study which includes cross sectional, case control and cohort. 3) The research article discusses the relationship between the quality of the home environment and the incidence of ARI in toddlers. 4) Independent variables in the research article are air temperature, air humidity, lighting intensity, ventilation area, occupancy density in the house, use of fuel for cooking, the presence of family members who smoke in the house. 5) The dependent variable in the research article is the incidence of ARI in toddlers. 6) The research was conducted in Indonesia. 7) The article was published in English / Bahasa Indonesia.

RESULTS

Based on article searches that have been conducted through databases on the internet, 3,463 articles were found that are relevant to the search keywords that have been determined. The detailed results of the article consist of science direct as many as 2,090 articles, scopus as many as 7 articles, researchgate as many as 1,230 articles, and google scholar as many as 136 articles. Then checking was carried out so that 830 articles were found to be duplicated, so that as many as 2,633 articles were screened again based on their titles. A total of 2,387 articles, the title is not about the relationship between environmental quality in the house with the incidence of ARI in toddlers. Furthermore, 246 articles were screened again whether there was full-text, and found as many as 163 articles were not available full-text. Then found as many as 47 articles were excluded because the article did not examine the relationship between the quality of the home environment with the incidence of ARI in toddlers, as many as 24 articles were excluded because they used the study design Systematic review/Literature review. So there are 12 articles that will be reviewed in this study.
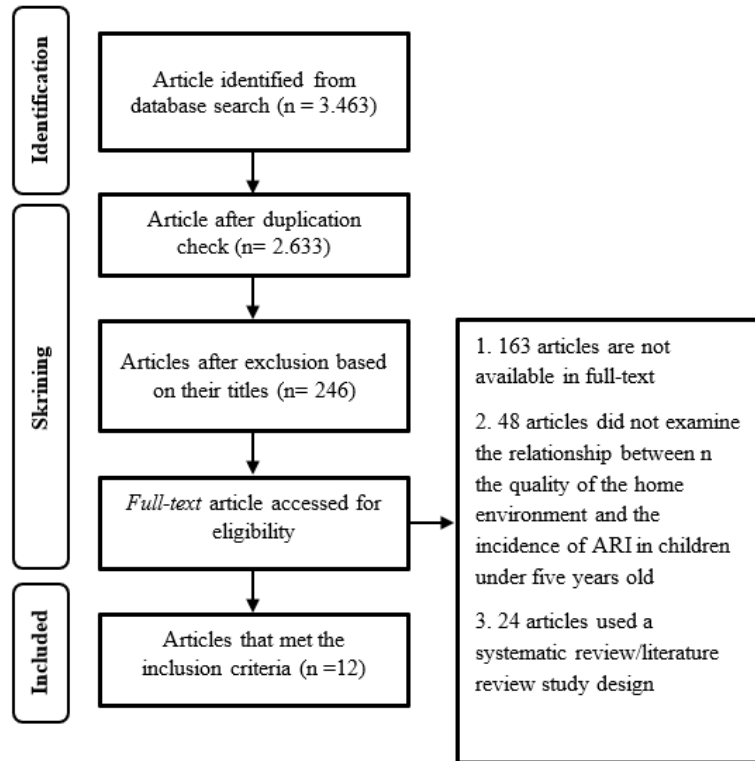
Figure 1. Flowchart of Literature Review

Table 1. Literature Search Results

Researcher	Year	Study Design	Sampel	Variable	Result
Maulana et al (15)	2023	*Case control*	40^c 40^d	Independen: nutritional status, LBW history, immunisation, smoking, use of mosquito coils, lighting, humidity, particulate dust content Dependen : ARI in toddlers	Risk factors for ARI in toddlers: immunisation status (p=0.000 OR=9.791), family members smoking (p=0.000 OR=14.939), humidity (p=0.002 OR=5.667), and particulate dust levels (p=0.034 OR=2.176).
Maksuk et al (16)	2022	*Cross sectional*	106	Independen: Lighting intensity, humidity, room temperature, occupancy density, ventilation area, housing status. Dependen : ARI in toddlers	Risk factors for ARI in toddlers is the intensity of lighting in the house (*p-value* = 0.0005)
Trisno, B (17)	2020	*Cross sectional*	144	Independen: air ventilation, floor type, wall type, occupancy density, and smoking habits. Dependen : ARI in toddlers	Smoking habits are associated with the incidence of ARI in toddlers.
Safarina, L (13)	2014	*Cross sectional*	437	Independen : smoking habits in the home Dependen : ARI in toddlers	Smoking habits in the home are associated with the incidence of ARI in children under five.
Putri et al (18)	2017	*Cross sectional*	103	Independen: age, sex, nutritional status, exclusive breastfeeding, immunisation, temperature, humidity, lighting, ventilation area,	age characteristics of toddlers and physical sanitation of the house have an association with ARI cases

Researcher	Year	Study Design	Sampel	Variable	Result
				occupancy density, and PM2.5 Dependen : ARI in toddlers	
Marita et al(19)	2022	*Cross sectional*	76	Independen: Use of Firewood for Cooking, Use of Mosquito Coil, Smoking Habits of Family Members in the Home Dependen : ARI in toddlers	There is an association between the habit of using firewood for cooking, the habit of using mosquito coils, the smoking habit of family members in the house with the incidence of pneumonia among children under five years of age.
Agungnisa A (20)	2017	*Cross sectional*	60	Independen: ventilation area, occupancy density, air temperature, humidity, lighting, and PM2.5 dust levels. Dependen : ARI in toddlers	room occupancy density (p=0.004) affects the incidence of ARI in toddlers, while ventilation area (p=0.239), air temperature (p=0.750), humidity (p=0.720), and lighting (p=0.612) do not affect the incidence of ARI in toddlers.
Azhar et al (21)	2014	*Cross sectional*	106	Independen: density of house occupancy, ventilation conditions, presence of smokers in the house, use of mosquito coils/spray, type of floor covering, type of wall, type of ceiling, type of fuel used for cooking and location of kitchen, pm 2.5 levels, air humidity Dependen : ARI in toddlers	69.9% of children under five with ARI symptoms lived in homes with insufficient ventilation and 74.2% of children under five lived in homes with kitchens attached to other rooms. The mean level of PM2.5 in the house was 70 μg/m3. There was a significant difference between the mean PM2.5 levels in homes in high-traffic areas and non-congested areas (p=0.02).
Garmini et al (22)	2017	*Cross sectional*	94	Independen: Mosquito repellent use, indoor smokers, ventilation, indoor SO2 levels Dependen : ARI in toddlers	the use of mosquito repellent, smoking in the house, ventilation, nutritional status and immunisation status statistically showed a significant relationship with the incidence of ARI in toddlers, while the variable SO2 levels had no relationship.
Sari et al (23)	2021	*Cross sectional*	154	Independen: smoking habits, mosquito repellent use habits and rubbish burning habits Dependen : ARI in toddlers	There is an association between the habit of burning garbage in the home environment, the habit of smoking in the house, the habit of using mosquito coils with the incidence of ARI in toddlers.
Zolanda et al (7)	2021	*Cross sectional*	96	Independen: PM10, SO2, indoor air viscosity, humidity, lighting, Occupancy density, ventilation area Dependen : ARI in toddlers	Environmental factors associated with the incidence of ARI in toddlers, namely: PM10 concentration (p=0.009), ventilation area (p=0.000), occupancy density (p=0.029), humidity (0.000), and lighting (p=0.000).
Yeimo et al (9)	2018	*Case control*	88[c] 96[d]	Independen: immunisation status, family income, indoor air pollution, environmental sanitation Dependen: ARI in toddlers	The risk of pneumonia in children under five years old was increased by the absence of BCG immunisation (OR= 6.15; 95% CI= 2.78 to 13.61; p<0.001), poor household air pollution (OR= 5.68; 95% CI= 2.63 to 12.26; p<0.001), and poor sanitation (OR= 5.06; 95% CI= 2.16 to 11.83; p<0.001).

DISCUSSION

Relationship between indoor air temperature and the incidence of ARI in toddlers

Based on the Regulation of the Minister of Health of the Republic of Indonesia Number 2 of 2023 concerning Guidelines for Air Health in Home Rooms states that air temperature is one of the important indicators in assessing air quality in the house. The air temperature in a healthy home is 18-30°C (24). A decrease in temperature results in an increase in the relative humidity of the air, which in turn exacerbates the corrosive effects of pollutants in areas affected by air pollution. Poor air quality can lead to various diseases related to the respiratory system, such as acute respiratory infections (ARI).

The temperature in the house has a relationship with the incidence of ARI in toddlers in the Puskesmas I South Denpasar work area with the results of 55.8% of respondents' homes having temperatures in the house that do not meet the requirements (25). This is in line with research conducted by Maksuk, et al (2022) in the work area of Puskesmas Empat Ulu Kota Palembang which states that the incidence of ARI is found more in homes with room temperature that does not meet the requirements (16). However, this is not in line with research conducted by Agungnisa (2017) with the results of the majority of the temperature in the respondent's house in Kalianget Timur Village, Sumenep Regency which is 31.05 ° C so that it exceeds the maximum limit required by the Ministry of Health (30 ° C), but the air temperature in the house is not associated with the incidence of ARI in toddlers because air temperature measurements are only carried out in one location, namely in rooms that are often used by toddlers, such as living rooms or bedrooms, due to limited resources and time owned by researchers (20).

Relationship between indoor air humidity and the incidence of ARI in toddlers

Air humidity in the house that is less than 40% Rh or exceeds 60% Rh can weaken the immune system and increase the risk of developing diseases, especially infectious diseases. In addition, high humidity also extends the life span of disease-causing bacteria (25).

Humidity is a risk factor for the incidence of ARI in toddlers with an OR value of 5.667 (95% CI: 1.951-16.462) which means that poor humidity in the house has a 5.667 times greater risk of getting sick with acute respiratory infections compared to toddlers with good humidity in the house. This study was conducted in the working area of Puskesmas Jenggot Pekalongan City, Central Java Province (2023) (15). This is in line with research conducted by Maksuk, et al (2024), namely the lighting variable has a significant relationship with the incidence of ARI in toddlers, because the condition of the measured physical environment of the house, such as humidity that does not meet the standards, is influenced by the fact that most houses are rental properties. This makes it difficult to modify the physical environment of the house to meet the requirements of a healthy home (16). The proportion of ARI incidence among under-fives living in homes with inadequate humidity was higher than among under-fives living in homes with adequate humidity. Toddlers exposed to unhealthy humidity have a 5.091 times higher risk of developing ARI than toddlers living in homes with humidity between 40-60% (12).

Relationship between Lighting Intensity in the House with the Incidence of ARI in Toddlers

Lighting that does not meet the requirements in the house can cause toddlers to be more susceptible to ARI. Insufficient lighting can make residents uncomfortable and become a medium for the development of bacteria, viruses and parasites. Lighting always affects the humidity and temperature of the air in the house, because one of the roles of natural lighting is to regulate the humidity and temperature of the air in the room. Daylighting is essential for lighting homes to reduce air humidity. A healthy house must have access to sunlight from the west and east for at least 15%-20% of the floor area of the house (26).

Oktarina, et al (2020) stated that as many as 53.8% of houses with ARI patients had room lighting that did not meet the requirements in the working area of Puskesmas I, South Denpasar District. The lack of lighting is caused by the infrequent opening of windows and curtains, as well as inadequate ventilation, so that insufficient sunlight enters the room and the room becomes dark (25). However, the results show that the majority of respondents have lighting that is in accordance with health standards based on Permenkes RI 1077/2011 concerning Guidelines for Indoor Air Health in Kalianget Timur Village, with an average lighting of 139.8 lux. The natural lighting in the respondents' houses mostly met the requirements, as the majority of the houses had white-coloured walls which helped to increase lighting despite inadequate ventilation (20) There is a significant relationship between lighting and the incidence of ARI in children under five years old in Lubuk Kilangan Sub-district, Padang City. The PR value : 20.625 (95% CI:

7.018-60.614) indicates that toddlers living in homes with inadequate lighting have a 20.625 times greater risk of developing ARI than toddlers living in homes with adequate lighting (7).

Relationship between Ventilation Area and the Incidence of ARI in Toddlers

Houses need to be equipped with ventilation with a minimum area of 10% of the total floor area so that air circulation in the house runs well. If ventilation is used in accordance with its function, the sunlight entering the house will not be blocked by the ventilation itself. Poor ventilation can cause health problems, especially in the respiratory system. Home ventilation that does not meet health standards can cause high humidity indoors, creating an environment that favours the growth of pathogenic germs, thus increasing the risk of ARI in children under five. The results showed that although some respondents' houses had ventilation, the majority of houses were not equipped with adequate ventilation. Ventilation is only found in the front room, while the living room and several other rooms do not have ventilation, which can cause health problems (7).

The results showed that the p-value was 0.000 <0.05, indicating a significant relationship between ventilation area and the incidence of ARI in toddlers in Lubuk Kilangan Sub-district, Padang City. With a PR value of 7.418 (95% CI: 2.991-18.398), it means that toddlers who live in homes with unqualified ventilation area have a 7.418 times greater risk of getting ARI compared to toddlers in homes with qualified ventilation (7). This is in line with research conducted by Azhar, et al (2014), namely Of the 87.7% of toddlers who have symptoms of ARI, 69.9% of toddlers live in homes where ventilation does not meet the requirements (21). Research conducted by Garmini, et al (2020) states that houses that have inadequate ventilation are a risk factor for the incidence of ARI in toddlers. The negative impact of lack of ventilation includes a decrease in oxygen levels, an increase in CO_2 gas levels, the appearance of a stuffy odour, an increase in indoor air temperature, and an increase in indoor air humidity (22).

The Relationship between Occupancy Density in the House with the Incidence of ARI in Toddlers

The requirements for a healthy home and living environment include an adequate floor area of the house according to the number of occupants. If the building area does not match the number of occupants,overcrowded conditions will occur. Bedrooms should have a minimum area of 8 m² and should ideally be occupied by no more than two people except for husband and wife and children under 2 years old. This is important to maintain the health of the occupants, as lack of oxygen consumption and the risk of transmission of infection between family members can occur under these conditions. An unhealthy housing environment risks triggering the transmission of certain diseases, such as ARI. In addition, inadequate air circulation can increase the growth of microorganisms that have a negative impact on human health (8).

Research conducted by Zolanda, et al (2020) states that there is a relationship between residential density in the house and the incidence of ARI in toddlers. Toddlers who live in homes with unqualified residential density have a 2.993 times greater risk of developing ARI than toddlers in homes with qualified residential density. there are still many respondents' homes that are inhabited by more than 3 people, including occupants there are toddlers. Occupancy density that does not meet the requirements will interfere with health, especially for toddlers, lack of oxygen and facilitate the transmission of diseases through the air, making toddlers vulnerable to ARI (7). This is in line with research conducted by Agungnisa (2017) that there is a significant relationship between the density of occupancy in the toddler's room with the incidence of ARI in toddlers in Kalianget Timur Village (20).

Relationship between the use of cooking fuel and the incidence of ARI among under-fives

The use of fuel for cooking in the household greatly influences the risk of ARI. Firewood and kerosene will produce smoke when heated at 100-110°C, even up to more than 282°C (especially for firewood). The smoke contains substances such as methane, methanol, carbon monoxide (CO), and carbon dioxide (CO_2) from wood preservatives and petroleum that can interfere with human respiratory health. The use of fuels in home kitchens is one of the factors that cause respiratory infections (URTIs) because family members can inhale the smoke produced from these fuels. Some types of biomass fuels commonly used by the community include kerosene, firewood, and LPG. The level of pollution produced by wood fuels is significantly higher than that of gas-based fuels.

Research conducted by Marita, et al (2023) stated that there was a significant association between the habit of using firewood for cooking and the incidence of pneumonia in toddlers with a p value of 0.000 (19). The smoke from burning firewood has a negative impact on health. Mothers' habit of bringing their children to the kitchen increases

the risk of pneumonia in toddlers, as toddlers are often exposed to pollutants from burning in the kitchen. Similarly, houses with kitchens that are adjacent to or integrated with living and dining rooms, and without ventilation, also increase the risk of pneumonia among children under five in the household. However, research conducted by Mataputun, et al (2021) stated that there was no statistically significant relationship between cooking fuels and the incidence of ARI. The researcher assumed that many respondents who used firewood did not use it in their daily lives. However, based on theory, it proves that the smoke released from combustion contains many polluting gases and particles that pose a risk to human health, especially families with toddlers (27).

Relationship between the Presence of Smoking Family Members and the Incidence of ARI in Toddlers

Cigarette smoke is an air pollutant consisting of a complex mixture of compounds produced by burning tobacco and addictive substances. In addition to nicotine as a stimulant, cigarette smoke also contains tar with more than 4,000 chemicals, including about 60 dangerous carcinogenic chemicals. Almost all of these substances are potentially deadly. This content is what triggers various serious diseases such as lung, heart, emphysema, and other dangerous diseases. Cigarette smoke that comes straight out of the end of a burning cigarette (sidestream) is more harmful than smoke exhaled from the smoker's mouth (mainstream), because sidestream has not gone through the filtering process, while mainstream has undergone filtering through the smoker's breathing and the cigarette itself. In certain amounts, cigarette smoke is very detrimental to health, such as causing respiratory problems and coughing. Children under five who live in homes with family members who smoke in the house become passive smokers and will experience the negative effects of cigarette smoke. Children in smoking families have twice the risk of suffering from ARI compared to children from non-smoking families.

Research conducted by Sari, et al (2023) states that there is a significant relationship between family smoking habits in the house with the incidence of ARI in toddlers with a p-value : 0.000. It was found that there were family members who smoked next to toddlers and a lack of public knowledge about the harmful effects of cigarette smoke for toddlers (23). This is in line with research conducted by Marita, et al (2022) there is a significant relationship between the smoking habits of family members in the house with the incidence of pneumonia in toddlers with a p-value : 0.020 (19). Several studies stated that family members who smoke at home and have ISPA incidents in toddlers were 195 respondents (67.2%). Meanwhile, respondents whose family members do not smoke at home and have toddlers who do not experience ISPA incidents were 63 respondents (42.9%). The p-value: 0.049 means that there is a relationship between family members' smoking habits and ISPA incidents in toddlers in Cimareme Village, West Bandung (28–36).

Limitations and Cautions

Despite the strength of this study that the relationship between environmental quality factors in the home and the incidence of ARI in toddlers is studied comprehensively within a single theoretical framework, there are still some limitations that must be acknowledged. The first limitation of this study is that this study was only conducted in several regions in Indonesia.

However, the researcher assumes a reasonable sample representation because all samples taken in this study were toddlers who had symptoms of ARI.

Recommendations for Future Research

Further research is needed to investigate the long-term effects of factors such as air temperature, air humidity, lighting intensity, ventilation area, occupancy density in the house, use of fuel for cooking, the presence of family members who smoke in the house with the incidence of ARI in toddlers.

CONCLUSION

This study showed an association between the factors of air temperature, air humidity, lighting intensity, ventilation area, residential density in the house, the use of fuel for cooking, the presence of family members who smoke in the house with the incidence of ARI in toddlers in Indonesia. The most dominant factor associated is the presence of family members who smoke. In some studies, it was found that there were family members who deliberately smoked near or next to toddlers. Some other factors that are interconnected are the availability of

adequate ventilation with air humidity in the house. Many of the toddlers affected by ARI live in homes that do not have adequate ventilation so that the humidity in the house becomes high and creates an environment that supports the growth of pathogenic germs that can increase the risk of ARI in toddlers.

With this study, it is recommended for families who have toddlers at home not to smoke and if they want to smoke in a place that is far from the reach of toddlers and do not smoke in the house.

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