*Journal of Air Pollution and Health (Winter 2023); 8(1): 103-116*

**Review Article**

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# House environmental conditions with the event of acute respiratory infection (ARI) in toddlers in Indonesian: A meta-analysis

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**ARTICLE INFORMATION**

*Article Chronology:*
Received 05 October 2022
Revised 16 January 2023
Accepted 01 March 2023
Published 29 March 2023

*Keywords:*
Humidity; Ventilation; Acute respiratory infection (ARI); Toddler

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**ABSTRACT**

Acute Respiratory Infection (ARI) is an infection that attacks the lower or upper respiratory tract and has the potential to be transmitted to other people. It depends on the causative pathogen and home environmental factors which affect it. The study analyzes the relationship between home environmental conditions, including ventilation, humidity, floors, residential density, and smoking habits, with the incidence of Acute Respiratory Infection (ARI) in Toddlers in Indonesia by conducting a meta-analysis of data from various research articles. The method in this study is a meta-analysis by finding the effect size value using JASP software. Articles performed a meta-analysis of 25 articles. The results of the meta-analysis found that the variable density of residential has 1,135 times larger, 1,665 times greater ventilation, 1.568 times greater, and the floor conditions 1,309 times larger, as well as the habit sapped. The conclusion from the results of this study shows that the condition of the home environment that has the most influence is the humidity of the house, and the one with the lowest risk is residential density. Suggestions for controlling risk, providing community education, and assistance for healthy homes.

## Review

Acute Respiratory Infection (ARI) is an infection that attacks the lower or upper respiratory tract and has the potential to be transmitted to other people so that it can cause an expansion of the disease ranging from asymptomatic to severe, the spread of the disease depends on the pathogen, environmental factors and host factors. However, ARI is also often defined as an acute respiratory tract disease caused by infectious agents transmitted from human to human [1]. Bacteria are the main cause of respiratory tract infections, whereas the bacteria that causes Streptococci pneumonia is the most common cause of pneumonia. However, most acute respiratory infections are caused by viruses or a mixture of viruses and bacteria. Acute respiratory infections have the potential to become endemic or even pandemic and may pose a public health risk [2].

Please cite this article as: Rizaldi MA. House environmental conditions with the event of acute respiratory infection (ARI) in toddlers in Indonesian: A meta-analysis. Journal of Air Pollution and Health. 2023;8(1): 103-116.

Acute Respiratory Tract Infection (ARI) causes the largest single infectious death in children worldwide. Data from World Health Organization (WHO) states that around 808,694 children under five died from ARI in 2017, accounting for around 15% of deaths of children under five. ARI is most common in South Asia and sub-Saharan Africa [3]. Based on what has been explained by the World Health Organization (WHO), Acute Respiratory Infection (ARI) is the main cause of morbidity and mortality due to infectious diseases in the world. Nearly 4 million people die from this infection yearly, of which lower respiratory tract infections cause nearly 98% of these deaths. Deaths from respiratory infections are usually at higher risk for infants, young children, and the elderly, especially those in low- and middle-income countries. ARI is one of the main causes of consultation or treatment in health care facilities, especially children's services [2].

The result from Indonesia Basic Health Research (Riskesdas) in 2013 showed that the incidence of ARI was 25%, while the highest occurred in the age group 1-4 years, namely 25.8%, 2014 ARI cases in toddlers were recorded at 657,490 cases or equivalent to 29.4% [4]. Data from the Indonesian Health Profile in 2019 shows an increase in the number of ARI cases in children under five, whereas, in 2019, 52.9% of ARI cases were found [5]. The mortality rate caused by ARI in children under five is 0.12% [6]. The research results showed that most ARI patients were found in the 12-60 month age group [7]. Based on the Indonesia Health Post in 2021, the scope of discovery of acute respiratory infection (ARI) cases still does not meet the target, meaning that many cases still have not been found. In 2021 the mortality rate due to pneumonia in toddlers was 0,16%. The mortality rate due to pneumonia in the infant group is almost double that in a group of children aged 1-4 years [8].

World Health Organization divides several factors that influence the occurrence of ARI. One of the causes is environmental conditions such as air pollution, household density, humidity, cleanliness, season, and temperature [9]. The incidence of ARI is influenced by environmental conditions, namely air pollution and home ventilation. Based on the results of research conducted in Padang, West Sumatra, that place of residence influences the incidence of ARI [7]. Another study stated that one of the environmental factors that affect the incidence of ARI is residential density [10]. Occupancy density is not a single factor that can affect the occurrence of ARI based on the results of research conducted in Mimika Papua showing that house ventilation has a significant relationship with respiratory tract infections in infants [11].

Physical components home environment is an important factor in impacting the health status of the house's occupants. Health requirements are needed because they are used for housing construction, which greatly influences the improvement of health status. Several factors that influence ARI to include nutritional status, exclusive breastfeeding, completeness of immunization, gender, ventilation, lighting, humidity, floors, walls, roofs, residential density, cooking fuel, smoking family members, mother's education, mot and her's occupation, and family income (Ministry of Health, Indonesia 2009). Research in Muna Regency shows that the condition of the home environment has a significant relationship with respiratory tract infections in infants [12].

This study aims to analyze the relationship between home environmental conditions, including ventilation, humidity, floors, and residential density, with the incidence of Acute Respiratory Infection (ARI) in Toddlers in Indonesia by conducting a meta-analysis of data from various research articles. Using the Meta-analysis method, researchers can combine a smaller study and make it a larger study so as to show the effect. In addition, meta-analysis can improve the accuracy of the results.

### *Methods*

The type of research that will be conducted is a meta-analysis study, a systematic study accompanied by statistical techniques to calculate several research results regarding the quality of home ventilation with ARI in toddlers. The study's literature searched was limited to only those who conducted research in Indonesia from 2017 to 2021.

The meta-analysis method has the advantage of being objective compared to other study methods and can estimate the effect size quantitatively and its significance. However, it is difficult to use this study to conclude because the combined studies were of different quality, there was publication bias, and the limitations of the data collected. So the meta-analysis research must apply several selections in the selected journal articles.

The data is then compiled and analyzed to be used as a solution to the problems carried out by the Meta-Analysis. The Fig. 1 is an image of a literature scattering diagram.

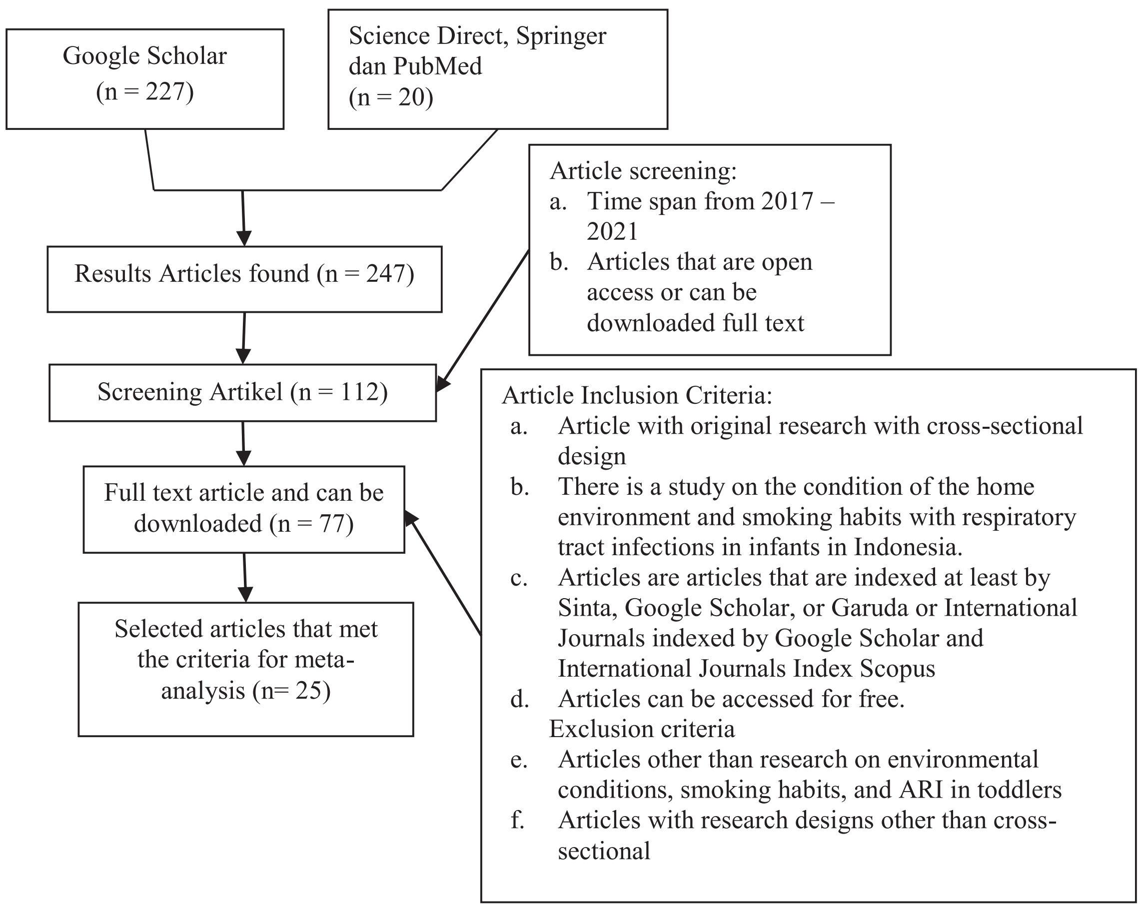


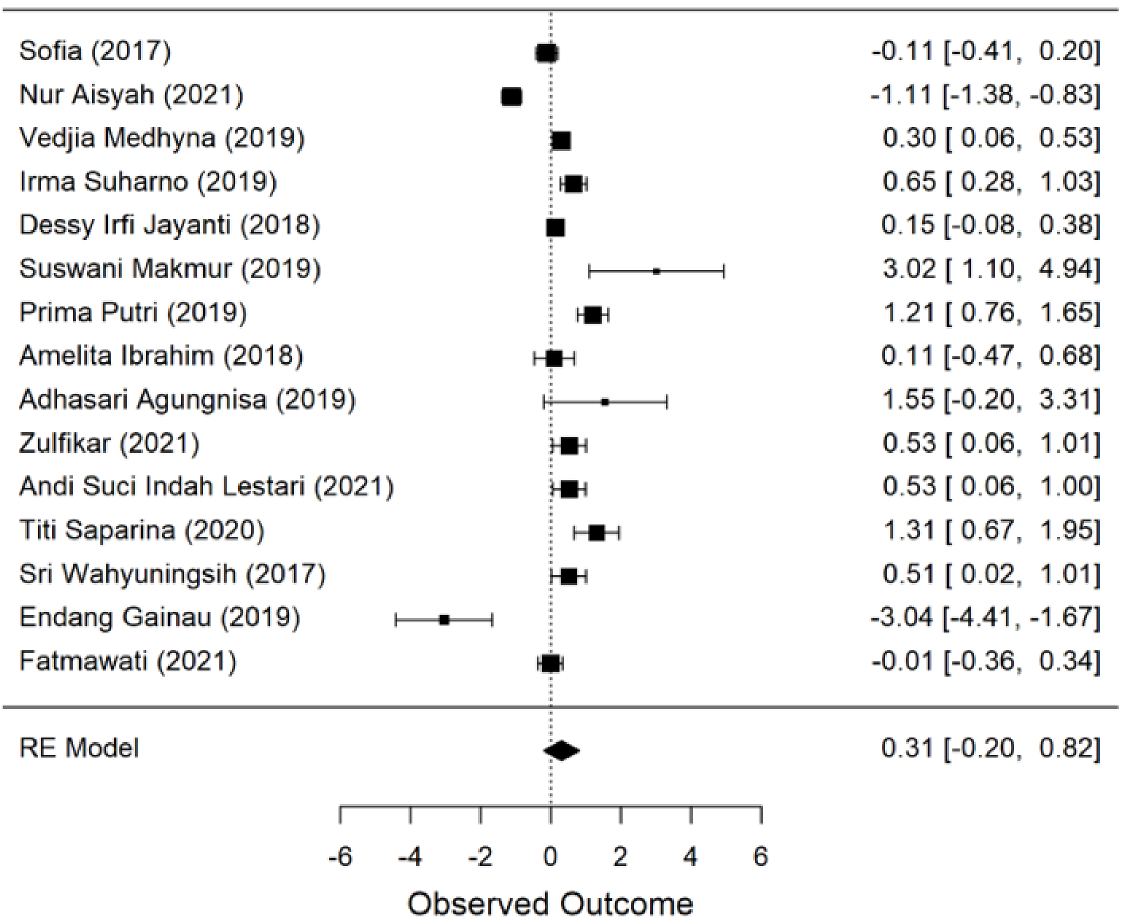

Fig. 1. An image of a literature scattering diagram

The articles that have been obtained are then carried out by a meta-analysis, with 25 research articles obtained. The analysis was carried out to obtain the pooled odds ratio estimate using the Mentel–Haenszel method for the fixed effect analysis model and the DerSimonian–land method for the random-effects model analysis. Meanwhile, if the variation between the variables is heterogeneous or the p-value of heterogeneity is smaller than 0.05, the analysis model used is the random-effects model. The meta-analysis calculates the Prevalence Ratio (PR) value as follows:

1. If the PR value>1 and the confidence interval range is not more than 1, the variable has a risk factor between House Environmental Conditions with respiratory tract infections in infants.

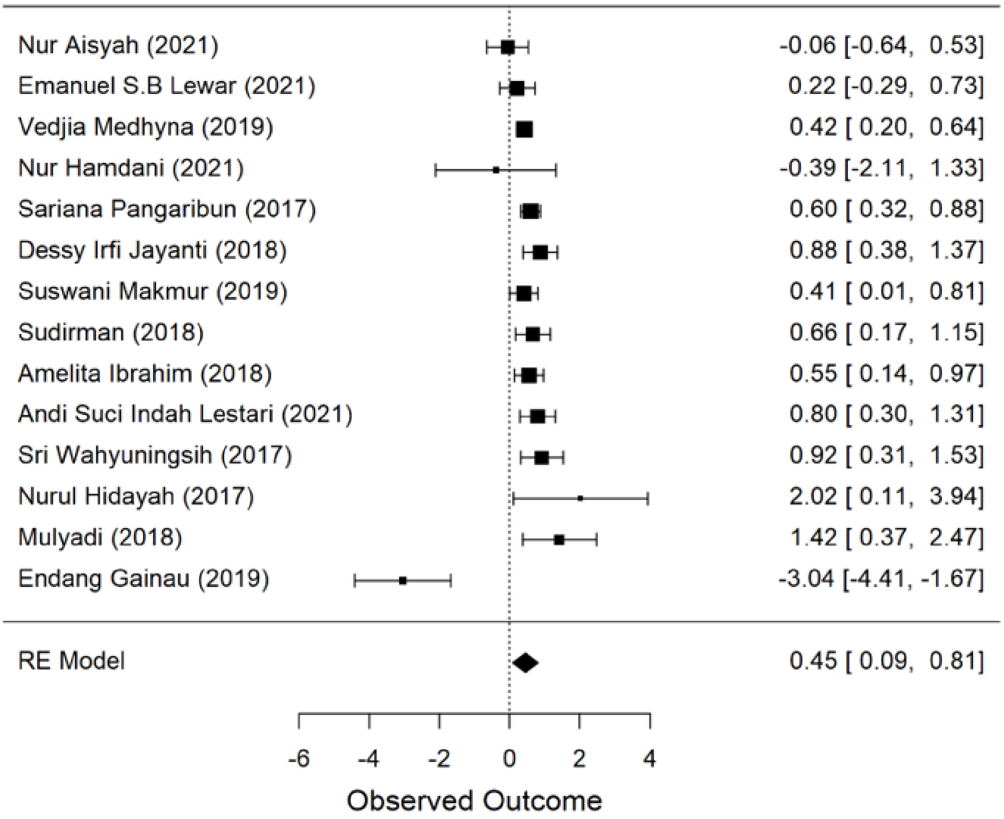
2. If the PR value<1 and the range of confidence intervals exceeds 1, this variable is a protective factor between the condition of house environmental conditions with respiratory tract infections in infants.

3. If the PR value=1 and the confidence interval range is not more than 1, then the variable has no significant relationship.

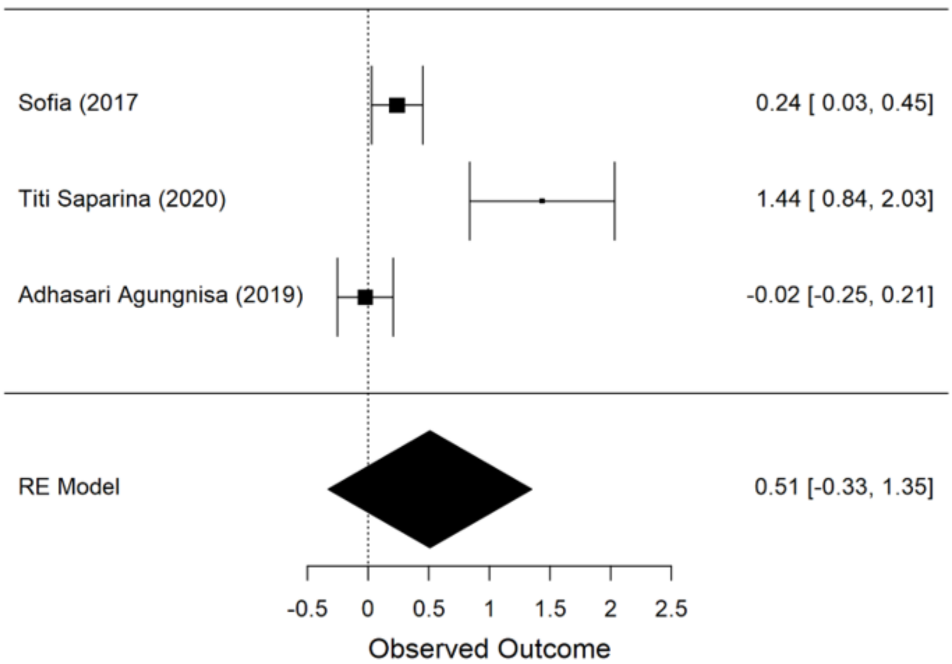



a) Accuracy density variable with ARI incidence in Toddlers

Fig. 2. An image of the result of Forest plot diagram about house environmental conditions (ventilation, occupancy density, humidity, lighting) with respiratory tract infections in infants

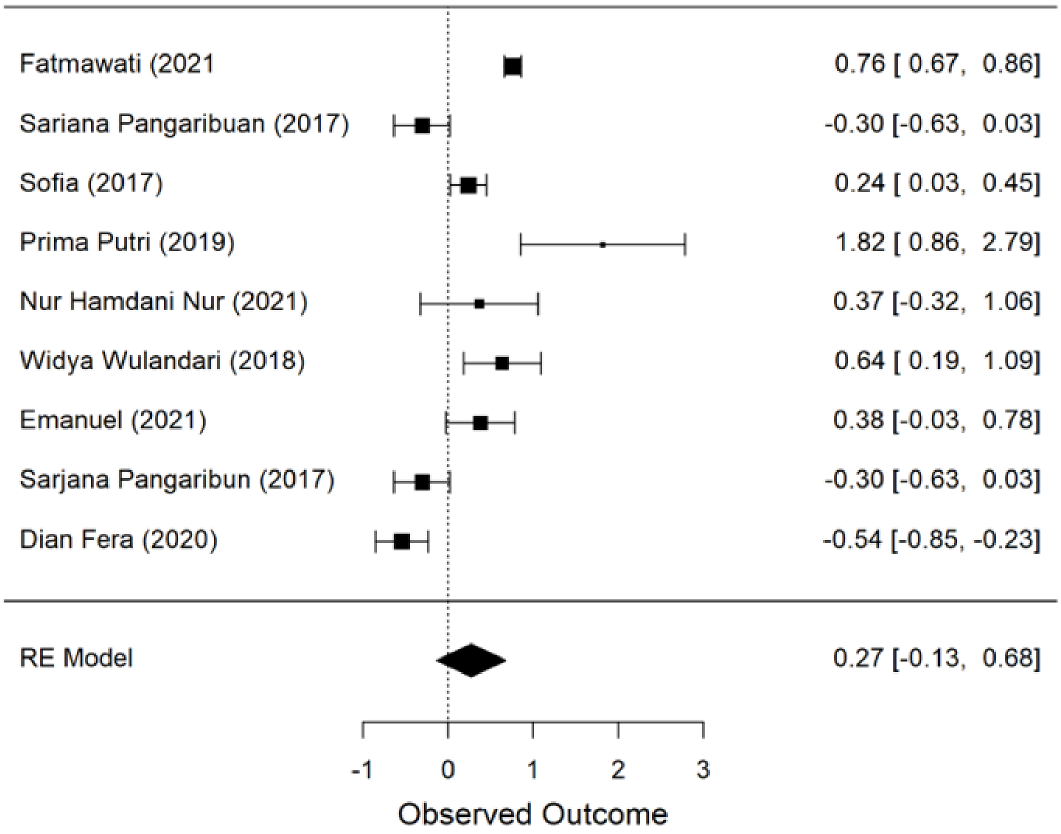



b) Variable Quality of Ventilation with Incidence of ARI in Toddlers




c) Variables of Humidity with the Incidence of ARI in Toddlers

Fig. 2. An image of the result of Forest plot diagram about house environmental conditions (ventilation, occupancy density, humidity, lighting) with respiratory tract infections in infants




d) Floor Quality Variable with ISPA Incidence in Toddlers

Fig. 2. An image of the result of Forest plot diagram about house environmental conditions (ventilation, occupancy density, humidity, lighting) with respiratory tract infections in infants

***Relationship of home environmental conditions (ventilation, occupancy density, humidity, lighting) with respiratory tract infections in infants***

a. Meta-Analysis of the Relationship between Occupancy Density and the incidence of ARI in Infants

The p-value in the heterogeneity test is smaller than the value of or less than 0.05, namely p=<0.001, which means that some of these studies have heterogeneous data, so the analysis uses a random-effects model. The results of the forest plot in Fig. 2a shows that the value of pooled PR = $e^{0.31}$ = 1.138 (95% CI -0.20 – 0.82).

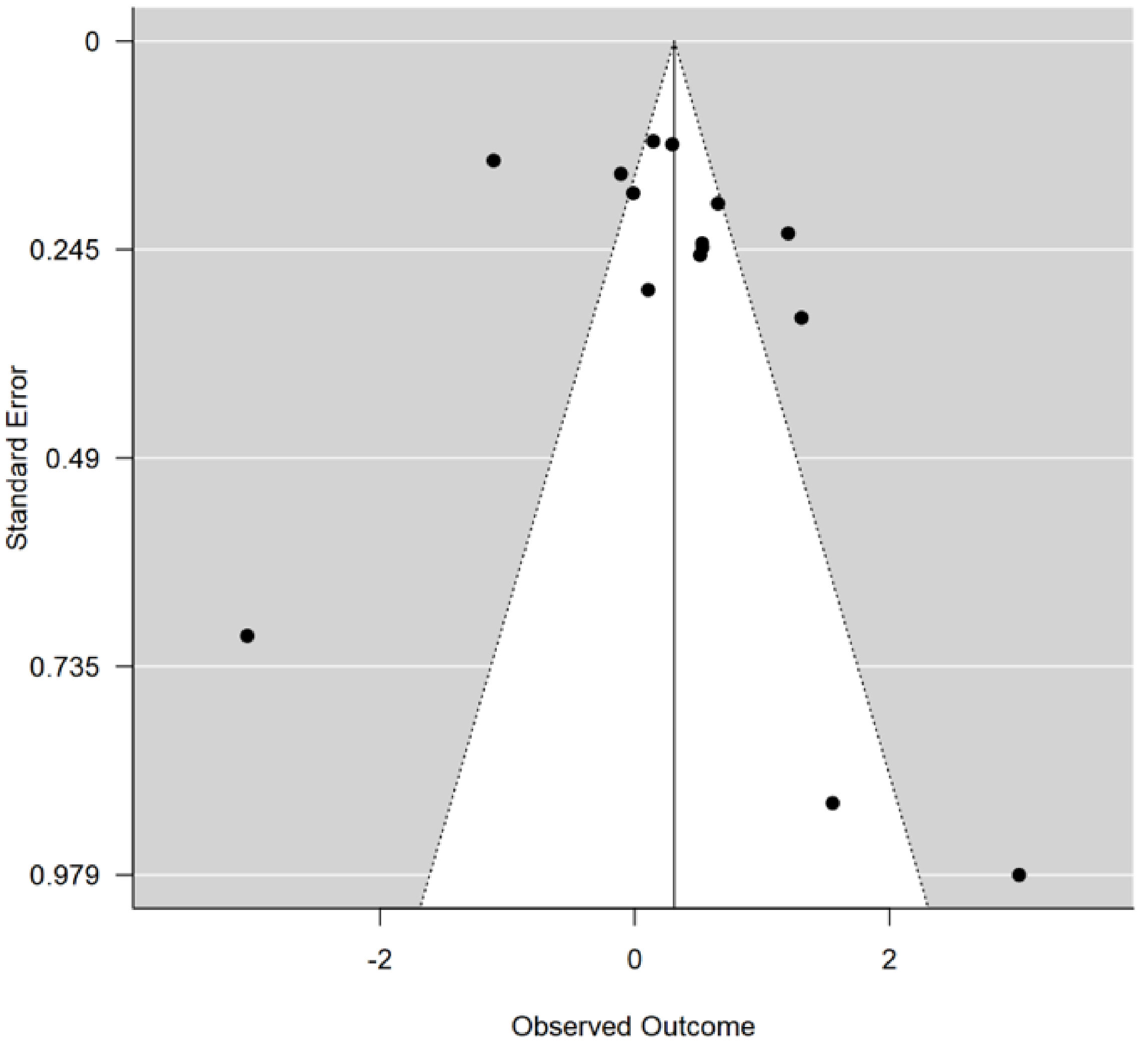



Fig. 3. An Image of the Funnel plot diagram occupancy density with the incidence of ARI in infants

Based on Fig. 3, it can be seen that several points come out of the triangle area, which means that there are indications of publication bias.

The p-value in Egger's test is greater than or more than 0.05, namely the p-value = 0.234, meaning there is no indication of publication bias.

The condition of the home environment, in this case, the density of housing that does not meet the requirements, has a risk of 1,138 times greater for with respiratory tract infections in infants compared to the condition of the density of housing that meets the requirements with a CI value of 95% and does not exceed the number 1 so that the difference between the two groups is a statistically significant risk. From the results of the meta-analysis in this study, poor ventilation can affect the incidence of ARI in infants by 1.138 times greater than good ventilation. This is in line with research that has been conducted, which shows that occupancy density has a significant relationship between ventilation quality and the incidence of ARI in toddlers [13].

This research is also in line with the results of research conducted in the coastal area of Kore village, where the research showed a relationship between settlement density and the incidence of ARI in toddlers [14]. In contrast, several studies conducted in Sorong, Papua, did not show a relationship between occupancy density and the incidence of ARI. The p-value was 0.519 or more which means there was no relationship. A study conducted in Bangladesh showed that the risk of hospitalization for ARI in children increased in children who lived with high occupancy densities, with a 3.6 times greater chance of having an infection compared to children who lived with low occupancy densities (COR 3.61, 95% CI 2.29–5.74) [15]. Based on research conducted in Nagas Raya Regency showed that occupancy density related to the events of acute respiratory infections with p-value<0.05 (0.006) and occupancy density of 1,845 times the chance of causing ARI in toddlers (PR 95% CI 1,184 -2,876) [16]. Other studies also showed the same results, where the density of occupancy has a relationship that follows the incidence of ARI with p-value<0.05 (p-value = 0.001) and 14.35 times can cause the risk of ARI in children under five (OR CI 95% 2.69-17.04) [17]. Another study conducted in Donggala showed that occupancy density had a significant relationship with respiratory tract infections in infants with a p-value<0.05 (p-value=0.003) [18].

b. Meta-analysis Relationship of ventilation quality with respiratory tract infections in infants The p-value is less than 0.05, meaning the p-value is <0.001 or less than 0.05, so it can be concluded that the air quality data with the incidence of ARI is heterogeneous. When the data is heterogeneous, the analysis uses a random-effects model. The results from the forest plot in Fig. 2b show that the Pooled PR=e=1.568 (95% CI 0.09–0.81).

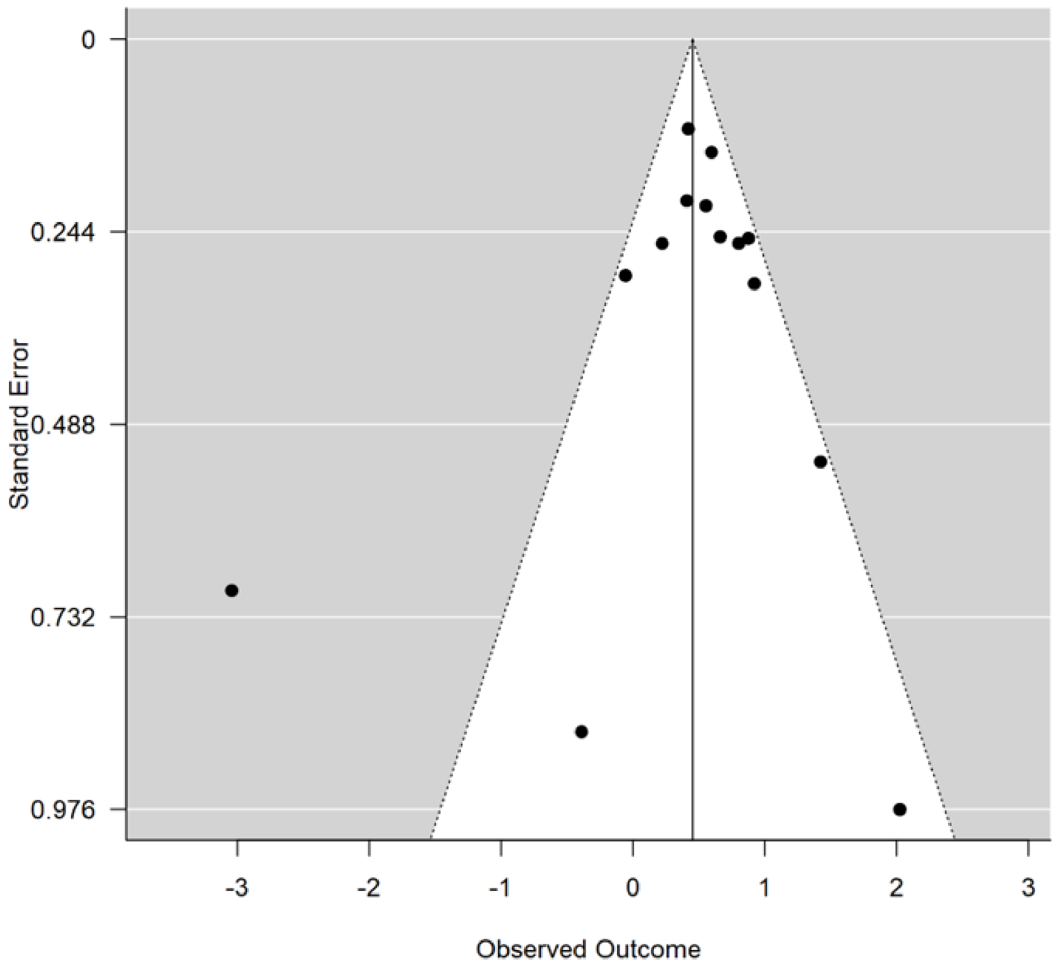



Fig. 4. An image of Funnel plot diagram of ventilation quality with respiratory tract in infants

Based on the picture above, it can be seen that there are points outside the triangle, which means that there is an indication of publication bias on the ventilation variable with the incidence of ARI.

The p-value value is less than 0.05, which means that there is an indication of publication bias on the natal variable with the incidence of ARI in toddlers.

The risk of ARI occurrence in infants with inadequate ventilation is 1.568 times greater than that of infants with adequate ventilation with a 95% CI value and a confidence interval of not more than 1, so the quality of ventilation has a significant relationship. Home ventilation is one of the factors that can affect the development of bacteria and viruses in the house, so it can potentially increase the incidence of ARI in toddlers. This is to the results of the meta-analysis that has been carried out that poor ventilation quality in the house can cause a 1,568 times greater risk of ARI in children under five.

Based on the results of research on Sapuli Island, South Sulawesi, that poor household ventilation is associated with ARI in toddlers, where the results of the study show a P-Value of 0.002 (<0.05) [19]. In line with the research above, the research conducted in Sibolga showed that there was a significant relationship between the quality of home ventilation and the incidence of ARI in toddlers where the P-Value value was 0.019 or less than 0.05, with a PR value of 1.208 which means that toddlers living in houses with ventilation that do not meet the requirements have a 1,208 times greater risk of getting ARI [20]. Another study conducted in Jakarta showed the same results, namely that home ventilation is related to the incidence of ARI in infants; it can be seen that the p-value is 0.000 (<0.05) with a PR value of 5.193, meaning that ventilation is a risk factor for respiratory tract infections in infants [21]. Another study showed that ventilation that did not meet the requirements had a significant relationship with respiratory tract infections in infants with a p-value of 0.000 (<0.05) [22].

In Africa, fossil fuels are still widely used for cooking, heating, and lighting equipment, but this is not accompanied by proper ventilation. Poor ventilation can increase the risk of ARI occurrence. In Ethiopia, a study conducted showed that those who live in houses that do not have windows significantly affect the incidence of ARI (Maor 4.03, 95% CI 1.74-9.35) [23, 24]. Another study conducted in Indonesia showed that ventilation had a significant relationship (p-value<0.05) with the incidence of respiratory infections, namely pneumonia in infants with P-Value = 0.000 [25]. So it can be concluded that home ventilation is a risk factor for the incidence of ARI in infants and toddlers who live in homes whose ventilation does not meet the requirements have a risk of getting ARI and a risk of admission to the hospital.

c. Meta-analysis of the relationship between house humidity and with respiratory tract infections in infants

The results of the forest plot in Fig. 2c shows that the value of pooled PR=$e^{0.51}$ =1.665 (95% CI-0.33–1.35). In the humidity variable with ARI, the publication is not biased because, in this variable, the meta-analysis data is not more than 10.

The humidity of the house that does not meet the requirements has a 1.665 times greater risk of ARI in children under five compared to the humidity of the house that meets the requirements. The results of the forest plot test above shows that the 95% CI value is more than 1, meaning that the humidity variable is a protective factor in this study. This means that the house's humidity can reduce the risk of ARI in toddlers.

Humidity in the house can affect the humidity of the floor of the house. Research conducted in Bilang Muko explained that moist floors are related to the incidence of ARI in toddlers [26]. Research on house humidity with the incidence of ARI in Toddlers has a significant relationship with respiratory tract infections in infants with a p-value value of 0.039 or less than (0.05) with a PR value=1.3 which means that house humidity that does not meet the requirements has a risk 1.3 times more likely to cause ARI in Toddlers [26]. The results of the study showed that the average heat index could also affect the severity of respiratory diseases, and high heat temperatures in the house can affect the humidity in the house [27]. Humidity in the home environment has a 5-fold risk of causing ARI in toddlers (OR=5.00; CI 95% 0,79-31,51) [17]. Unqualified home humidity can cause the risk of ARI in Toddlers. Research conducted in Lampung Tengah, Indonesia, shows that flatness has a significant relationship (p-value<0.05) with the incidence of ARI in toddlers (p-value 0.001) [28].

d. Meta-Analysis of the relationship between house floor conditions and the incidence of ARI in Toddlers

In the heterogeneity test, it can be seen that the p-value value is less than 0.05 or no more than, which means that the variable data on floor quality with the incidence of ARI is heterogeneous, so it must use a random effect model analysis.

In the Forest plot test in Fig. 2d, the value of Pooled PR= $e^{0.27}$ =1.309 (95% CI -0.13–0.68), which means that the quality of the floor of the house does not meet the requirements has a risk of 1.309 times greater influence with respiratory tract infections in infants compared with the quality of the floor that meets the requirements. In this case, the 95% CI value is not more than one, so the quality of the floor of the house with the incidence of ARI has a significant relationship. There is no publication bias on this variable because the data that did the meta-analysis were not more than 10.

This study shows that floors that do not meet the requirements have a risk of developing ARI in toddlers. This is in line with research conducted in Jakarta that the condition of the floor of the house has a significant relationship with respiratory tract infections in infants, where the p-value value is 0.019 or less than 0.05 with a PR value of 1.665 which means that the floor condition has a risk of 1.665 more. Causes the incidence of ARI in Toddlers [21].

This study is also in line with research conducted in Sibolga that the condition of the floor of the house is associated with respiratory tract infections in infants with a p-value of 0.013 or less than 0.05 with a PR value of 1.33 which means that it has a relationship of 1.33 times greater than good floor conditions [20]. Research conducted in Bilang Muko also shows that the quality of the floor of the house has a relationship with respiratory tract infections in infants with a p-value value of 0.014 or less than 0.05 with a PR value of 1.9 meaning that poor floor conditions cause 1,9 times greater incidence of ARI in children under five. Poor house floors cause dusty and damp floors, increasing the risk of ARI [26].

Toilet facilities, cooking gas, and taking intestinal parasite drugs are slightly related to ARI. Meanwhile, ARI has a significant relationship with (p-value<0.20) age, gender, stunting, economic conditions, living environment conditions, maternal age in childbirth, level of education, and Body Mass Index (BMI) of the mother [29]. The study showed that home environmental factors have a significant relationship with the incidence of ARI, so it can be concluded that home environmental factors such as house floors, ventilation, and others have a relationship in causing ARI.

So that the variable of home environmental conditions with the highest risk of causing the incidence of ARI in toddlers is air humidity, the results of the meta-analysis of house humidity with the incidence of ARI in toddlers have a 1.665 greater risk of causing the incidence of ARI. House humidity has a Pooled PR value greater than several other variables, namely occupancy density, ventilation, and house floors. However, in a meta-analysis, house humidity is also a protective factor in the incidence of ARI. This is because the 95% CI value exceeds 1, which means it is a protective factor.

## Conclusion

Based on the results of the meta-analysis, the highest risk factor for environmental conditions with respiratory tract infections in infants is the house humidity variable with a value of PR = $e^{0.51}$ =1.665 (95% CI-0.33-1.35). In contrast, the lowest variable is environmental conditions. House with respiratory tract infections in infants is the variable density of occupancy with a value of PR = $e^{0.31}$ =1.138 (95% CI-0.20–0.82).

Efforts that can be made to minimize the incidence of ARI are to control the risk of ARI, namely by not smoking in the house, keeping the house from being humid, and making good home ventilation so that it can minimize the occurrence of ARI in toddlers, for policyholders to conduct a healthy home survey and help the underprivileged in maintaining a healthy home environment, as well as providing education about the dangers of smoking in the house by family members.

## Financial supports

No external funding was received or used for this research study.

## Competing interests

The authors declare that they have no competing interests.

## Acknowledgements

We want to thank the Department of Environmental Health and the Master Program in Environmental Health, Faculty of Public Health, Airlangga University, which facilitated writing scientific articles for international journals. And we would like to thank the lecturers of the Master's Program in Environmental Health Universitas Airlangga who guided and corrected this scientific article we have compiled.

## Ethical considerations

"Ethical issues (Including plagiarism, Informed Consent, misconduct, data fabrication and/or falsification, double publication and/or submission, redundancy, etc.) have been completely ob-served by the authors."

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