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House physical environment and incidence of acute respiratory tract infection: Regression test logistics for toddlers

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ABSTRACT

Acute respiratory tract infection (ARI) is a highly contagious disease, particularly among toddlers. The risk factors associated with this disease include environmental conditions, physical factors, and living in unhealthy house. Therefore, this study aimed to examine the environmental and physical characteristics of households in correlation with the incidence of ARI among toddlers. The method adopted was a quantitative cross-sectional design. A total sample of 91 was selected using a simple random sampling method. Data were collected through interviews and measurements, and the analysis was conducted using multivariate analysis and logistic regression testing. The results showed a significant relationship between lighting, humidity, and room temperature with the incidence of ARI. The most related variable was humidity. Respondents who resided in humid houses that did not meet the recommended conditions were more than 15 times as likely to be infected with ARI.

Keywords: infection channel; respiratory acute infection; lighting; humidity; temperature

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1. INTRODUCTION

Disease is a problem in public health and can cause pain, death, and disability. Improvement has been observed in cases of contagious disease, leading to more effective control and eradication measures. To prevent the spread, safeguarding the health of toddlers is essential, thereby enhancing a bright and quality future. It is important to note that acute respiratory tract infection (ARI) is often contracted by toddlers (Billa Novina Suhada et al., 2023).

The incidence of ARI ranges between 15 and 20 percent per year in developing countries with death rates above 40 per 1000 births life. World Health Organization (WHO) stated that more than 13 million deaths were recorded among toddlers yearly due to this disease.

ARI led to the death of more than 4 million toddlers yearly (Aulya Wahab et al., 2019). In Indonesia, approximately 56.51%, 52.9%, and 34.8% of cases were recorded in 2018, 2019, and 2020. In this context, West Java recorded 28.1% among toddlers (Wisudariani et al., 2022). Data from the Cirebon District Health Service shows that in 2020, ARI ranked third with 58,401 cases (8.18%), among the 10 most common diseases discovered in 57 community health centers. In the past 3 years, the Palimanan Community Health Center recorded 185 cases in 2020, 61 cases in 2021, and 161 cases in 2022. In addition, data shows 52, 41, and 55 instances of ARI

among toddlers in January, February, and March 2023, respectively.

The type of floor and walls, humidity, room temperature, density, lighting, and ventilation area are all indicators of house quality, which impacted the health of inhabitants and their physical environment. The household environment is a factor associated with the incidence of ARI, and the disease process of ARI is influenced by housing condition (Falah et al., 2023). An unhealthy environment can increase the risk of environmental trasmission of disease, thereby affecting the health of vulnerable toddlers (Lalu et al., 2020).

Air quality inside houses, building structures, and residential density are key factors that contribute to the increase in ARI cases. Room temperature and humidity significantly influence the health of residents. Meanwhile, the respiratory tract is not directly affected by room temperature, and moisture alone does not accelerate the spread of microorganisms such as ARI viruses and bacteria (Junilantivo et al., 2022).

The risk of ARI in toddlers is increased with poor ventilation, high residential density, and elevated air humidity, all of which are statistically significant risk factors (Hidayanti et al., 2019). A high incidence of ARI is also related to limited room air supply or inadequate ventilation (Nazaroff, 2021). Furthermore, poor housing is an important public health risk worldwide, with ARI in particular being a major health impact (Firdaus & Ahmad, 2013).

A preliminary study conducted on May 25, 2023, showed that only 40% of houses met appropriate lighting standard. Approximately 30% of houses exceed the standard temperature of 30°C or below 18°C, while 70% had acceptable indoor humidity. Residential density was inadequate in 80% of houses, with only 20% meeting the requirements of fewer than 2 people per 8 m^2, excluding children under 5 years old.

This study aimed to analyze the environmental housing factors contributing to the incidence of ARI in toddlers. Addressing these issues is necessary to mitigate the high prevalence of ARIs, a significant public health concern. The insight gained will help inform about strategies for preventing ARI, with an emphasis on the environmental factors of housing that influenced the risk of infection.

2. MATERIALS AND METHODS

The method adopted for this quantitative study was a cross-sectional design. The dependent variable included the incidence of ARI, while the independent variables were lighting, humidity, room temperature, and residential density. The study population consisted of 1022 toddlers aged 12–59 months residing in Palimanan, Cirebon Regency, West Java Province. From this population, 91 samples were selected using the random sampling method. The inclusion criteria were mothers with toddlers aged 12 to 59 months. The exclusion criteria included households where the house was undergoing renovation and toddlers suffering from ARI with accompanying diseases.

Data concerning the incidence of ARI in toddlers and overcrowded residences was obtained from interviews. Lighting, humidity, and room temperature were measured. House lighting is measured using a lux meter, house humidity is measured using a hygrometer, and house room temperature is measured using a room thermometer. Data was analyzed using multivariate analysis and logistic regression testing. Ethical permission was received from the Institute for Research Development and Community Service, Cirebon College of Health Sciences, with the Ethical Permit Number 042/B/STIKes Crb/III/2023.

According to the Decree of the Minister of Health of Indonesia Number: No.1077/MENKES/PER/V/2011, which outlines guidelines for indoor air health in houses. The standard comprised lighting of at least 60 lux, humidity between 40–60%, room temperature between 18–30°C, and residential desity of ≤ 2 people per 8 m^2. Additionally, ARI is classified into mild, moderate, and severe.

3. RESULT AND DISCUSSION

3.1 Identification

The systematic review procedure for selecting relevant publications involves three key stages. In the initial stage, keywords and synonymous terms were identified using thesauri, dictionaries, encyclopedias, and previous research. Search strings were then crafted from the Scopus and Web of Science (WoS) databases, as provided in Table 1, and all relevant keywords were identified. A total of 177 publications from both databases were gathered for the current study project in the initial phase of the systematic review procedure.

Table 1 showed that 53 (58.2%), 73 (80.2%), 62 (68.1%), and (58.2%) respondents did not meet the requirements for lightning, humidity, room temperature, and residential density, respectively. Among these, 59 toddlers (64.8%) were infected with ARI. There was a significant correlation between inadequate lighting and the incidence of ARI in toddlers (p = 0.001), as shown in Table 2. Among respondents whose house did not meeting the recommended lighting condition, 44 (83.0%) toddlers suffered from ARI, compared to 23 (60.5%) among those whose houses met the standard. Similarly, a significant correlation was found between humidity levels and the incidence of ARI (p = 0.001). Of the toddlers living in houses with substandard humidity, 54 (74.0%) suffered from ARI, while 13 (72.2%) of those resided in houses with standard humidity, also suffered from ARI.

Table 1. Distribution frequency lighting, humidity, room temperature, residential density, and the incidence of ARI

Variable	Frequency	Percentage
House lighting		
Does not meet the standard	53	58.2
Meets the standard	38	41.8
House humidity		
Does not meet the standard	73	80.2
Meets the standard	18	19.8
House room temperature		
Does not meet the standard	62	68.1
Meets the standard	29	31.9
Residential density		
Does not meet the standard	53	58.2
Meets the standard	38	41.8
ARI		
ARI	59	64.8
No ARI	32	35.2
Total	91	100

Table 2. Relationship between lighting, humidity, room temperature, and residential density with the incidence of ARI

Variable	The Incidence of ARI				Total		*p*-value
	ARI		No ARI				
	n	%	n	%	n	%	
Lighting							
Does not meet the standard	44	83.0	9	17.0	53	100.0	0.001
Meets the standard	15	39.5	23	60.5	38	100.0	
Total	59	64.8	32	35.2	91	100.0	
Humidity							
Does not meet the standard	54	74.0	19	26.0	73	100.0	0.001
Meets the standard	5	27.8	13	72.2	18	100.0	
Total	59	64.8	32	35.2	91	100.0	
Room temperature							
Does not meet the standard	47	75.8	15	24.2	62	100.0	0.003
Meets the standard	12	41.4	17	58.6	29	100.0	
Total	59	64.8	32	35.2	91	100.0	
Residential density							
Does not meet the standard	43	81.1	10	18.9	53	100.0	0.001
Meets the standard	16	42.1	22	57.9	38	100.0	
Total	59	64.8	32	35.2	91	100.0	

A significant relationship was found between room temperature and the incidence of ARI in toddlers (p = 0.003). Among toddlers living in houses with substandard room temperature, approximately 47 (75.8%) were infected with ARI, compared to 17 (58.6%) of those living in houses with standard room temperature. There was also a significant correlation between residential density and the incidence of ARI (p = 0.001). Among those residing in houses with substandard residential density, approximately 43 (81.1%) suffered from ARI, whereas 22 (57.9%) of those in houses with standard density were affected.

Based on the results from Table 3, room temperature has the most significant p-value, followed by the variable identified in the subsequent model.

Based on the results from Table 4, of multivariate analysis showed that humidity was the most influential variable affecting the incidence of ARI in children under 5, with an odds ratio (OR) of 15.202 (95% CI 3.607–64.071). This indicates that toddlers living in households that did not meet the recommended humidity requirements had a 15-fold increased risk of being infected with ARI compared to those living in homes with adequate humidity levels.

Table 3. Initial logistic regression modeling

Variable	B	*p*-value	OR	95% CI
1. House lighting	2.264	0.001	9.626	2.556–36.251
2. House humidity	2.581	0.003	13.206	2.341–74.516
3. House room temperature	1.828	0.011	6.223	1.519–25.492
4. Residential density	2.437	0.000	11.434	2.921–44.754

Table 4. Final logistic regression modeling

Variable	B	*p*-value	OR	95% CI
1. House humidity	2.721	0.001	15.202	3.607–64.071
2. Residential density	2.370	0.001	10.693	3.208–35.645

3.2 Connection between house lighting and incidence of ARI

Results show a significant correlation between lighting and the incidence of ARI in toddlers (p = 0.001). This is in line with the study conducted by Bura et al. (2021), where a relationship was observed between lighting in a room (p = 0.011) and ARI (Bura et al., 2021). The association between lighting and the incidence of ARI was significant with a p-value of 0.000 (Hastryadi Kurniansyah & Khayan, 2020), (Handayani & Basri, 2023). It is important to note that there was a relationship between the physical condition of lighting (p = 0.01) with ARI (Mahendrayasa & Farapti, 2018).

A minimum of 60 lux of natural and artificial lighting is required inside the house. Sunlight should enter the house through windows, vents, or roof tile glass to provide adequate lighting (Bura et al., 2021). Insufficient natural lighting, defined as less than 60 lux, can foster the growth of bacteria that cause diseases, such as ARI (Taha & Ryzdayani, 2018). According to Lestari et al. (2021), a house is considered healthy if it receives enough sunlight to inhibit the growth of pathogenic bacteria. In the present study, 53 houses (58.2%) did not meet the recommended lighting conditions. Field observations revealed that limited sunlight penetration, often due to the close proximity of houses, can contribute to poor respiratory health and increase the risk of ARI.

3.3 Connection between house humidity and the incidence of ARI

Study results show a significant relationship between humidity and the incidence of ARI among toddlers (p = 0.001). In line with the report by Frits Supit et al. (2016), there is a correlation between humidity and ARI cases, Pradani et al. (2015). Based on the analysis, humidity (p = 0.000) is related to the incidence of ARI (Handayani & Basri, 2023; Shihran & Sinaga, 2023).

Humidity, defined as the percentage of water vapor in the air, should ideally range from 40% to 60% for a healthy house (Suharno et al., 2019). Frits Supit et al. (2016) stated that humidity influenced the spread of ARI (Frits Supit et al., 2016). Bacteria and viruses that cause ARI thrive in moist conditions (Pradani et al., 2015). The study observed that 73 (80.2%) of respondents' houses did not meet the ideal humidity conditions. This was attributed to the overcrowded and stuffy environment, alongside insufficient lighting, leading to health issues such as ARI.

3.4 Connection between house room temperature and incidence of ARI

Study results show a significant correlation between the incidence of ARI among toddlers and room temperature (p = 0.003). This is in line with the report by Putri, (2020), where there is a correlation between room temperature and the incidence of ARI (p = 0.006) (Putri, 2020). When room temperature is less than the recommended standards, it will increase risk of ARI cases. The air temperature in a room should ideally not exceed 40°C, expecially in tropical regions, according to Husna et al. (2015).

Stated that high room temperatures can cause stagnation in air circulation and turnover, leading to trapped dust and increased risk of respiratory diseases (Suharno et al., 2019). In addition, low humidity can result in a thinner mucosal layer, making airway secretions more viscous and reducing ciliary movement. As a result, this can facilitate the spread of influenza viruses in the respiratory tract (Nur Adnin Janati & Siwiendrayanti, 2017).

According to study and field observation, 62 houses (68.1%) did not meet the recommended standard for room temperature. This was due to narrow and overcrowded spaces, which limited adequate air circulation.

3.5 Connection between residential density and incidence of ARI

Study results show a significant correlation between residential density and the incidence of ARI among toddlers (p = 0.001). This finding is in line with the report by Jeni et al. (2022), which found that 63% of the group suffering from ARI lived in house with residential density below the standard requirement (p = 0.006) (Jeni et al., 2022). Similarly, other studies have also demonstrated a relationship between residential density and the incidence of ARI among toddlers (p = 0.004) [20]. Residential density has a significant relationship with respiratory infections (p = 0.003) (Eka Putri et al., 2022; Krisnasari et al., 2022). When residential density falls below the recommended standard, toddlers are at 1.138 times greater risk of being infected with ARI (Rizaldi, 2023).

A healthy house should have sufficient space to accommodate all its inhabitants (Lubis et al., 2019). Ideally, bedroom is expected to have a minimum area of 8 m^2 and should not accommodate more than 2 people, except for toddlers under 5 years old) (Husna et al., 2015). Overcrowded or densely populated residence can hinder air exchange and increase indoor pollution, increasing the risk of ARI (Jeni et al., 2022). As the number of residents increases, so does the level of polluted air in the room. Residential density has shown positive correlation with the presence of infectious agents, including those causing ARI (Ridha et al., 2023). Moreover, the incidence of ARI in toddlers is associated with high residential density within settlement (Salmaddiina et al., 2022). In this study, based on field observations, 53 houses (58.2%) did not meet the recommended standards for residential density.

3.6 The most influential factor in the incidence of ARI

Study results show that household humidity is a significant contributor to ARI in toddlers (p = 0.001, OR = 15.202, 95% Cl 3.607–64.071). This means that respondents living in houses with humidity levels below the standard requirement have a substantially higher risk of infection.

According to the study by Jaya et al. (2022), houses with inadequate humidity levels are 11 times more likely to experience cases of ARI (Jaya et al., 2022). Similarly, Nur Adnin Janati & Siwiendrayanti (2017) reported that toddlers living in houses with humidity below the standard requirement were at 4.357 times greater risk of infection (p = 0.026, OR = 4.375) (Nur Adnin Janati & Siwiendrayanti, 2017). Endi MP (2022) stated that houses with poor humidity conditions posed a 5 times greater risk of ARI (p = 0.011, OR = 4.911). Respondents living in houses with humidity below the standard requirement are 3.625 times higher risk of respiratory infections (Endi MP, 2022).

Various diseases affecting the respiratory tract, including ARI (Sofia, 2017). Damp environment can harbor pests such as rats and cockroaches, which contribute to the spread of bacteria and viruses, that cause respiratory illnesses (Mas Yuniati & Gede Suyasa, 2019). It is important to recognize that substandard housing conditions contribute significantly to the transmission of respiratory infection (Fakunle et al., 2016).

Prevention of ARI requires attention to the physical condition of the house and its impact on health (Sakriani & Supardi, 2023). Poor housing construction such as leaking roofs, inadequate flooring and walls, lack of waterproofing, and insufficient natural or artificial lighting can increase humidity in the house, especially during the rainy season (Bura et al., 2021; Suharno et al., 2019).

Studies have shown that humidity is the most significant factor associated with the incidence of ARI in toddlers. This is often attributed to high residential density, which lead to congestion and stuffiness in the house, as well as inadequate natural lighting factors that collectively contribute to respiratory health issues, including ARI. High indoor humidity levels can result from climate variations and temperature fluctuations that increase moisture accumulation indoors. These conditions are further exacerbated by insufficient ventilation, which can potentially cause respiratory disturbances.

4. CONCLUSION

Approximately 53 respondents did not meet the standard requirement for lighting, 73 for humidity, 62 for room temperature, and 53 for residential density. Among these,

59 were found to be infected with ARI. There were significant association between ARI incidence and lighting, humidity, and room temperature. Of these factors, humidity was most influential variable. This implied that respondents living in houses with inadequate humidity levels had a 15 times higher risk of their toddlers suffering ARI.

To maintain healthy humidity levels at home, it is recommended to remove unused items, improve or maximize ventilation, and place indoor plants to reduce stuffiness. Health Centers should cooperate with the community to promote a healthy environment. Establishing cooperative programs can help ensure the cleanliness of the living environment. Villages, community health centers, PUPR Services, and local communities should work together to implement and maintain habitatable housing conditions (Rutilahu). In addition, individuals are encouraged to adopt healthy behavior by monitoring the physical environment and meeting house standards to help prevent ARI in toddlers.

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