The Impact of Physical Housing Conditions on Acute Respiratory Infection Among Toddlers in Urban-Industrial Cilegon, 2025

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Abstract. Acute Respiratory Infections (ARIs) remain a major public health challenge for children under five, particularly in environments with compromised residential conditions. This study aimed to determine the association between physical housing factors—residential density, ventilation, and humidity—and ARI incidence among toddlers in Bagendung, Cilegon. A cross-sectional study was conducted in 2025 among 83 under-five children selected via proportional simple random sampling. Data were obtained through structured interviews and environmental assessments at households. Variables included ARI symptoms (dependent), housing density, ventilation adequacy, and indoor humidity (independent). Univariate and bivariate analyses were conducted using the Chi-square test and Odds Ratio (OR) calculation with 95% CI. The prevalence of ARI was 56.6%. Most homes were inadequately ventilated (62.7%), had poor humidity levels (67.5%), and 45.8% were overcrowded. All three environmental factors were significantly associated with ARI incidence: unqualified residential density (p=0.000; OR=55.6), poor ventilation (p=0.000; OR=32.3), and poor humidity (p=0.000; OR=51.1). Environmental housing conditions contribute significantly to ARI among toddlers, especially when multiple risk factors co-occur. Interventions must focus on improving indoor air quality in urban-industrial settlements.

Keywords: ARI, Toddlers, Residential Density, Ventilation, Humidity, Environmental Health

1 Introduction

Acute Respiratory Infections (ARIs) have consistently been one of the most significant global public health challenges, particularly in the under-five age group (under five years). The World Health Organization (WHO) estimates that ARIs are responsible for millions of deaths of children under five each year, the vast majority of which can be prevented or effectively treated. In developing countries, including Indonesia, ARI ranks as the leading cause of childhood morbidity and mortality. National data shows that on average a toddler in Indonesia can experience three to six episodes of ARI per year, confirming the massive burden of the disease on the health system and society [1]

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Among the various risk factors that have been identified, the physical environment of the home plays a central role. Children, especially toddlers, spend most of their time indoors [2], making the quality of the indoor environment a major determinant of their respiratory health. Studies consistently show that poor housing conditions-such as high humidity, mold growth, inadequate ventilation, and high occupancy density-are directly correlated with an increased risk of respiratory disease [3]. High occupancy density, for example, not only facilitates person-to-person transmission of pathogens but also often coincides with poor sanitation and ventilation conditions, creating an ideal environment for the spread of infection [4,5]

The geographical context and external environment exacerbate this risk. Cilegon City, Banten Province, the location of this study, is known as one of Indonesia's heavy industrial centers. The presence of various factories and Steam Power Plants (PLTU) contribute to significant levels of ambient air pollution. Research in other cities in Indonesia has shown a strong link between air pollution, particularly fine particulate matter PM2.5), with increased incidence of ARI. In the Cilegon context, these external pollution exposures have the potential to seep into the home, where already poor indoor air quality due to internal factors will be further exacerbated [6,7]. This creates a "risk convergence zone" where threats from the indoor and outdoor environments converge, placing under-fives at a very high level of vulnerability.

Local data from the Cilegon Public Health Center (Puskesmas) confirms the urgency of this issue. In 2024, ISPA ranked first among the top ten reported diseases, with thousands of cases recorded among under-fives in its working area [8]. Kelurahan Bagendung, as one of the areas under the coverage of Puskesmas Cilegon, shows a high incidence rate and has diverse housing environment characteristics, making it a relevant location for an in-depth study. While the general relationship between the home environment and ARI is well known, the specific magnitude of risk posed by housing density, ventilation and humidity in urban areas exposed to industrial pollution such as Cilegon has not been well quantified. Therefore, this study aims to quantitatively analyze the relationship between these three home physical environmental factors and the incidence of ARI among children under five years of age in Bagendung urban village, Cilegon.

2 Methods

2.1 Study Design

This quantitative, cross-sectional study was conducted from March to June 2025 in Bagendung Village, part of the Cilegon Health Center service area in Banten Province. This study used a quantitative study design with a *cross-sectional* approach [9]. This design was chosen to study the dynamics of the correlation between independent variables (environmental risk factors) and dependent variables (ARI incidence) measured simultaneously at one *point in time* (*point time approach*). The study was conducted from March to June 2025 in Bagendung Village, which is part of the Cilegon Health Center working area, Cilegon City, Banten Province. This location was chosen due to the high number of reported cases of ARI in children under five years of age and the diversity of the physical environment of the community housing.

2.2. Sampling and Participants

The target population in this study were all mothers of children under five (aged 0-59 months) who live in Bagendung Village, with a total population of 885 children under five. Determination of the minimum sample size was carried out using the proportion estimation formula for cross-sectional studies, taking into account the results of previous research *cross-sectional* study, taking into account the results of previous research [10]. The target population was mothers of children aged 0–59 months (N = 885). Sample size was calculated using the formula:

$$n = \frac{Z^2 \cdot P \cdot Q}{d^2} = \frac{(1.96)^2 \cdot 0.5 \cdot 0.5}{0.1^2} = 96$$

Where: Z = 1.96 (CI 95%), P = 0.5, Q = 0.5, d = 0.1

Sampling used proportional simple random sampling across all Rukun Warga (RW), ensuring geographical representation. Names of mothers were drawn randomly using a lottery system. Based on the calculation, a minimum sample size of 75 respondents was determined. To anticipate the possibility of *dropping out*, the sample size was increased by 10%, so that the final total sample used in this study was 83 respondents.

The sampling technique used *simple random sampling* proportionally [11]. First, the number of samples to be taken from each Rukun Warga (RW) in Kelurahan Bagendung was calculated proportionally based on the number of toddlers in each RW. Furthermore, the selection of respondents in each RW was carried out by simple randomization using the lottery method from the list of names of mothers who had toddlers until the sample quota per RW was met.

2.3. Variable and Operational Definition

The variables in this study consisted of one dependent variable and three independent variables.

1. Dependent Variable:
   ARI occurrence: Defined as when a child under five was reported by their mother to have one or more acute respiratory symptoms, including cough, runny nose, difficulty breathing, or wheezing [12], with or without fever [13], within the last 14 days prior to the interview. This definition is in line with simple clinical criteria commonly used in community surveys. Data were collected through a questionnaire and categorized into "ARI" and "No ARI".
2. Independent Variables:
   a. Residential Density: Defined as the ratio between the floor area of the house (in square meters) and the number of family members living in the house [14]. Measurement is done by interview and direct measurement using a roll meter. Categories were assessed based on the Indonesian Ministry of Health standards, namely "Unqualified" if the floor area per person is less than 9 m2, and "Qualified" if the floor area per person is equal to or more than 9 m2.
   b. Home Ventilation: Defined as the ratio between the total area of openable ventilation openings (windows, vents) in a toddler's bedroom and the floor area of the bedroom. Measurement is done with a roll meter. Categories were assessed based on healthy home standards, i.e. "Unqualified" if the ventilation area was less than 10% of the floor area, and "Qualified" if the ventilation area was equal to or more than 10% of the floor area.
   c. Home Humidity: Defined as the water vapor content of the air in a toddler's bedroom [15]. Measurements were taken using a *digital hygrometer* during the visit. Categories were assessed based on the ideal range for respiratory health, i.e. "Poor" if the relative humidity (RH) was below 40% or above 60%, and "Good" if the humidity was within the range of 40% - 60% RH [16].

2.4. Data Collection and Analysis

Data collection was conducted using a combination of methods. Primary data was obtained through structured interviewswith mothers of children under five using a questionnaire to collect demographic data and history of ARI symptoms. In addition, direct observation and measurement were conducted for environmental variables, namely house area, ventilation area, and air humidity. Secondary data in the form of ARI case data in the Cilegon Health Center working area was used to provide initial context for the study.

After the data was collected, *data* processing was carried out which included *editing*, *coding*, *data entry* into the *Statistical Package for the Social Sciences* (SPSS) software, and *cleaning*. Data analysis was conducted in two stages. First, univariate analysis to describe the frequency distribution and percentage of each research variable. Second, bivariate analysis using the *Chi-Square* test to test the hypothesis of the relationship between each independent variable and the dependent variable. To measure the strength of the relationship and the magnitude of the risk, the *Odds Ratio* (OR) value and 95% *confidence* interval were calculated. The statistical significance level was set at $p<0.05$. Data were collected using a structured questionnaire and direct measurements. Instruments included a roll meter (for floor/ventilation area) and digital hygrometer (for humidity). The study received approval from the Research Ethics Committee of Faletehan University

3.Results

3.1 Prevalence of ARI and Characteristics of Respondents' Home Environment

Univariate analysis provided an initial alarming picture of the health conditions of under-fives and their living environment in Kelurahan Bagendung. The results on table 1 showed that more than half of the respondent toddlers (47 out of 83, or 56.6%) experienced ARI symptoms in the past two weeks. This high prevalence is in line with data from the Cilegon Health Center, which ranks ARI as the main disease in the area.

This condition is reinforced by the description of the physical environment of the house, which is generally not supportive of respiratory health. As presented in Table 1, most respondents' houses failed to meet the recommended health standards. Specifically, almost half of the houses (45.8%) were classified as overcrowded (ineligible). Ventilation conditions were even worse, with the majority of houses (62.7%) having inadequate ventilation. Humidity was the most dominant problem, with two-thirds of homes (67.5%) having poor humidity levels (outside the ideal range of 40%-60%). Further analysis of the raw data showed that the average humidity in respondents' homes was 71.6%, indicating that the main problem was excessive humidity, not dry air. This picture collectively paints a picture of a community living in a residential environment that is highly conducive to the transmission and development of respiratory diseases.

Table 1. Frequency Distribution of ARI Incidence and Home Physical Environment Variables (n=83)

Variables	Category	Frequency (n)	Percentage (%)
ARI occurrence	ARI	47	56,6
	No URI	36	43,4
Residential Density	Unqualified (<9 m2/person)	38	45,8
	Qualified (≥9 m2/person)	45	54,2

House Ventilation	Unqualified (<10% of floor area)	52	62,7
	Qualified (≥10% of floor area)	31	37,3
House Humidity	Poor (<40% or >60% RH)	56	67,5
	Good (40% - 60% RH)	27	32,5

3.2 Analysis of Environmental Risk Factors for ARI Incidence

Bivariate analysis was conducted to examine the association between each environmental factor and ARI incidence. The findings from this analysis revealed unusually strong associations, far beyond what is commonly reported in the literature, indicating a complex interplay of risks at the study site.

The results of the analysis on table 2 shows the relationship between occupancy density and the incidence of ARI are presented in Table 2. A highly statistically significant relationship was found (p=0.000). The magnitude of risk measured through the *Odds Ratio* (OR) is 55.6. This means that toddlers who live in homes with unqualified residential density have a 55.6 times greater chance of suffering from ARI compared to toddlers who live in homes that meet the requirements.

Table 2. Relationship between Residential Density and the Incidence of ARI in Toddlers

Residential Density	Incidence of ARI	Total	p-value	OR
	ARI	**No URI**		
	n (%)	n (%)	n (%)	
Not Eligible	36 (94,7)	2 (5,3)	38 (100)	0,000
Eligible	11 (24,4)	34 (75,6)	45 (100)	
Total	**47 (56,6)**	**36 (43,4)**	**83 (100)**	

This extremely high OR value indicates that overcrowding in the Cilegon context is not just a risk factor, but a powerful accelerator of pathogen transmission. The main mechanism is increased close and sustained physical contact between occupants, which drastically increases the probability of spreading infectious droplets when coughing or sneezing. Other studies have identified that crowding is not just about the number of people per house, but also specific practices such as *bed-sharing* with family members who are coughing, which was shown to be a strong risk factor for severe pneumonia with an OR of approximately 5.1 [17,18]. The OR value found in this study, which is more than tenfold higher, suggests that the residential density here may be a proxy for more extreme conditions, where exposure to pathogens occurs intensely, continuously, and is amplified by other factors such as poor ventilation that prevents pathogen dispersion.

3.3 Home Ventilation: Failure to Dilute Pollutants and Pathogens

Home ventilation showed a significant association with the incidence of ARI (p=0.000), with an OR value of 32.3, shown on table 3. Toddlers living in homes with inadequate ventilation had a 32.3 times higher risk of ARI than those living in homes with adequate ventilation.

Table 3. Relationship between Home Ventilation and the Incidence of ARI in Toddlers

Home Ventilation	Incidence of ARI	Total	p-value	OR
	URI	**No URI**		
	n (%)	n (%)	n (%)	
Not Eligible	43 (82,7)	9 (17,3)	52 (100)	0,000
Eligible	4 (12,9)	27 (87,1)	31 (100)	
Total	**47 (56,6)**	**36 (43,4)**	**83 (100)**	

The main function of ventilation is for air exchange, i.e. introducing fresh air from outside and removing contaminated indoor air Indoor air can be polluted by a variety of sources, including bioaerosols released by occupants (viruses, bacteria) and pollutants from domestic activities (cooking smoke, cigarette smoke) [19]. Poor ventilation leads to the accumulation of these pathogens and pollutants, increasing their concentration in the inhaled air [20,21]. Studies in childcare facilities show that every one unit increase in *Air Changes per Hour* (ACH) can reduce the incidence of respiratory infections by 12%.

In the context of Cilegon, inadequate ventilation is a "double-edged sword". On the one hand, it fails to expel pathogens concentrated due to high occupancy density. On the other hand, it also fails to protect residents from industrial air pollution seeping in from outside. A poorly ventilated house turns into a "*pollution sink*", trapping and accumulating both internal and external pollutants. This double burden on the respiratory tract of toddlers is likely the reason why the OR value for ventilation was so high in this study.

3.4 House Humidity: Ideal Environment for Mold and Bacteria

The house humidity factor also showed a very strong and significant association with the incidence of ARI (p=0.000), with the most extreme OR value among the three, which was 51.1, shown on table 4. This means that toddlers living in homes with poor humidity are 51.1 times more likely to develop ARI.

Table 4. Relationship between House Humidity and the Incidence of ARI in Toddlers

House Humidity	Incidence of ARI	Total	p-value	OR
	URI	**No URI**		
	n (%)	n (%)	n (%)	
Poor	45 (80,4)	11 (19,6)	56 (100)	0,000
Good	2 (7,4)	25 (92,6)	27 (100)	
Total	**47 (56,6)**	**36 (43,4)**	**83 (100)**	

As already mentioned, the main problem at the research site was high humidity (71.6% RH on average). Humidity levels above 60% create an ideal environment for the proliferation of biological contaminants such as mold, dust mites and bacteria. Exposure to mold and spores indoors has consistently been shown to be associated with a variety of respiratory symptoms in children, including coughing, wheezing and asthma exacerbations, with ORs reported in multi-country studies ranging from 1.3 to 1.5. The OR value of 51.1 in this study far exceeds this figure, indicating that exposure to biological contaminants due to high humidity is likely to be massive and act as a significant trigger of inflammation and airway defense damage in toddlers in this community. Persistent high humidity, combined with poor ventilation, creates indoor environmental conditions that are chronically unhealthy.

3.5 Synthesis: A Perfect Storm of Risk Factors in Urban-Industrial Environments

The unusually high magnitude of risk found for the three variables-occupancy density, ventilation and humidity-cannot be adequately explained if these factors are viewed in isolation. The findings rather point to the existence of strong synergistic interactions, a "perfect storm" of mutually reinforcing risk factors at the household level, which are further exacerbated by the external environmental context.

This interaction model can be visualized in figure 1, as follows:

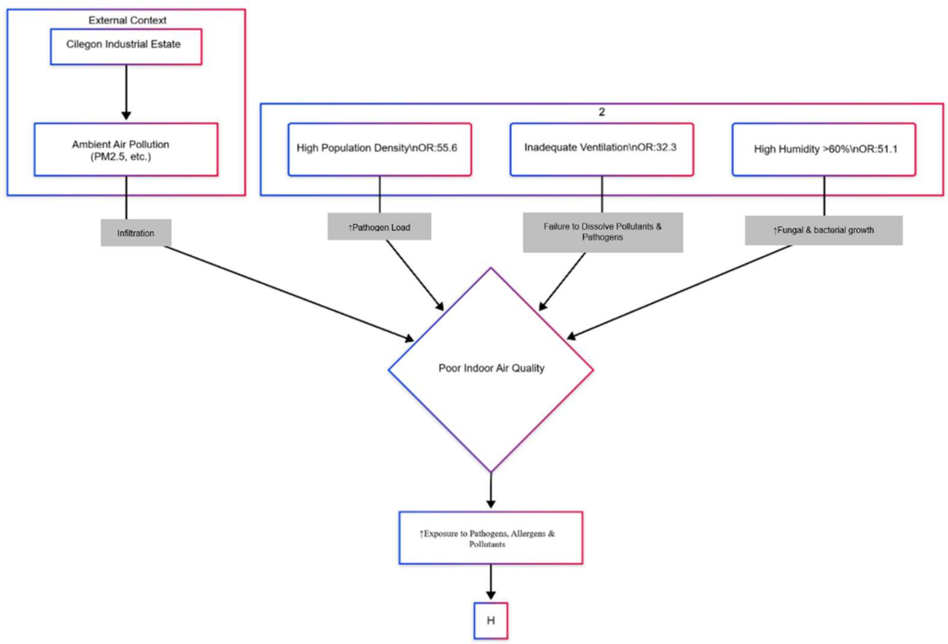

Fig. 1. Synergistic Model of ARI Risk Factors in Toddlers in Cilegon

The model in Figure 1 illustrates how these factors interact. High residential density (C) drastically increases the pathogen load and concentration inside the house. At the same time, inadequate ventilation (D) causes these pathogens, along with outside industrial pollutants (B) that infiltrate inside, to become trapped and undiluted. The condition is exacerbated by high humidity (E), which encourages the growth of fungi and bacteria, which not only add to the airborne contaminant load but also have the potential to irritate and weaken the child's respiratory defense system. The combination of these three internal factors creates extremely poor indoor air quality (F), leading to intensive and sustained exposure to a mix of pathogens, allergens and chemical pollutants (G). It is this multifactorial exposure that ultimately results in a very high risk of ARI (H), as reflected in the extreme OR values.

4 Discussions

The findings of this study reveal an alarming burden of Acute Respiratory Infection (ARI) among children under five in Kelurahan Bagendung, Cilegon City, accompanied by poor home environmental conditions. More than half of the respondents' children (56.6%) experienced ARI symptoms within the previous two weeks, a prevalence far higher than the national average. This pattern is consistent with local health service data identifying ARI as the leading cause of morbidity in the Cilegon area.

4.1 Environmental Determinants of ARI

The physical characteristics of respondents' homes clearly demonstrate that most households fail to meet basic environmental health standards. Nearly half (45.8%) of the houses were overcrowded, and the majority had inadequate ventilation (62.7%) and poor humidity (67.5%). The average indoor humidity (71.6%) exceeded the recommended range (40–60%), indicating excessive dampness. Such environmental deficits collectively create ideal conditions for the transmission and persistence of respiratory pathogens [16].

These results are consistent with previous studies showing that children living in overcrowded and poorly ventilated houses have a substantially higher risk of ARI. Overcrowding increases close physical contact and the probability of droplet transmission, particularly in households with symptomatic adults or siblings. Similar findings have been reported in Indonesia, India, and Kenya, where high population density per room is associated with a two- to six-fold increase in respiratory infections. However, the extremely high Odds Ratio (OR = 55.6) found in this study suggests that crowding in the Cilegon context represents an extreme form of exposure—likely involving continuous proximity, shared sleeping spaces, and simultaneous exposure to indoor air pollutants [16].

4.2 Ventilation and Air Exchange Failure

Ventilation also emerged as a critical determinant of ARI, with an OR of 32.3 for homes failing to meet ventilation standards. This finding confirms the central role of air exchange in diluting and removing airborne pathogens and pollutants. Poor ventilation allows the accumulation of bioaerosols and household contaminants such as cooking smoke and second-hand tobacco smoke, increasing the respiratory burden on young children. Studies from childcare centers in temperate climates show that each additional unit of air change per hour can reduce respiratory infection incidence by up to 12%, demonstrating the preventive potential of proper ventilation [15].

In the specific setting of Cilegon—an urban-industrial area—ventilation plays a dual role. On one hand, it is essential for reducing indoor contaminant concentrations. On the other hand, poorly designed or inadequate ventilation may also fail to prevent infiltration of outdoor industrial pollutants such as sulfur dioxide and particulate matter. This "double exposure" condition likely amplifies respiratory vulnerability, particularly among toddlers whose immune systems and respiratory tracts are still developing [13].

4.3 Humidity and Biological Contaminants

The household humidity factor showed the strongest association with ARI (OR = 51.1). Excessive humidity provides a conducive environment for the growth of fungi, dust mites, and bacteria. Numerous studies have confirmed that exposure to dampness and mold is associated with increased prevalence of coughing, wheezing, and asthma exacerbations, with reported ORs typically between 1.3 and 1.5. The magnitude observed in this study far exceeds those reported elsewhere, suggesting severe and sustained dampness, possibly compounded by inadequate ventilation and structural problems that prevent moisture dissipation. Chronic exposure to such environments may damage mucosal defense mechanisms, increase allergen sensitization, and promote chronic inflammation in the airways of young children [18].

4.3 Synergistic Risk Mechanisms

Rather than acting independently, these three factors—residential density, ventilation, and humidity—appear to interact synergistically, forming a "perfect storm" of household-level risks. High occupancy density increases pathogen load; poor ventilation traps and concentrates these pathogens indoors; and excessive humidity fosters microbial proliferation. This interaction produces chronically poor indoor air quality characterized by elevated concentrations of infectious, allergenic, and chemical particles. The cumulative effect of these exposures likely explains the unusually high OR values observed in this study [19].

This synergistic model mirrors the "multiple environmental burden" hypothesis described in studies of urban slums and industrial zones, where children are simultaneously exposed to biological and chemical pollutants. The Cilegon case provides a striking example of how internal (household) and external (industrial) environmental factors interact to produce a disproportionately high risk of ARI in children [18].

4.4 Public Health Implications

The implications of these findings are profound. Interventions should not focus solely on clinical management of ARI but must address the root environmental determinants at the household and community levels. Efforts should include:

1. Housing improvement programs, emphasizing optimal ventilation design and reduction of overcrowding through community-based infrastructure support.
2. Humidity control measures, including home maintenance education, improved drainage, and low-cost dehumidifying practices.
3. Integrated air quality management, combining indoor air health promotion with stronger enforcement of industrial emission standards.
4. Health education campaigns targeting parents and caregivers to increase awareness of the relationship between home environment and respiratory health.

Given the industrial character of Cilegon, cross-sector collaboration between health authorities, environmental agencies, and local governments is essential. Policy actions integrating health, housing, and environmental management could substantially reduce ARI incidence among under-fives and improve overall community respiratory health.

5 Conclusions

This study confirms that substandard housing conditions—overcrowding, insufficient ventilation, and high indoor humidity—are strongly associated with ARI incidence among under-fives in urban-industrial areas. The exceptionally high OR values indicate not only individual risk but also synergistic amplification of vulnerability due to environmental convergence. Public health responses must target indoor air quality improvement in industrial cities. Simple ventilation improvements, humidity control, and household decongestion strategies could yield significant health benefits. Future research should directly measure indoor pollutants (e.g., PM2.5, VOCs, mold spores), and evaluate specific interventions (e.g., installation of exhaust fans or dehumidifiers) through randomized trials. Qualitative research is also needed to understand barriers to healthy housing adoption in low-resource communities.

References

[1] Guarnieri G, Olivieri B, Senna G, Vianello A. Relative humidity and its impact on the immune system and infections. Int J Mol Sci 2023;24:9456.

[2] Bura T, Doke S, Sinaga M. Relationship between the physical environment of house and the incidence of acute respiratory infections in children under five in ngada regency. Lontar: Journal of Community Health 2021;3:20–30.

[3] Bahri B, Raharjo M, Suhartono S. Risk Factors for Physical Conditions in the Home Environment and Numbers of Bacteria with Toddlers Pneumonia Incidence. E3S Web of Conferences, vol. 448, EDP Sciences; 2023, p. 03065.

[4] Metkono A, Adu AA, Landi S. Risk Factors for the Incidence of ARI in Toddlers in Maubeli Village Kefamenanu City District North Central Timor Regency in 2022. Timorese Journal of Public Health 2024;6:40–51.

[5] Akbar Z, Renaldi R, Dewi O, Rany N, Hamid A. The behavior of acute respiratory infection (ISPA) prevention in the work area of Bunut Public Health Center Pelalawan Regency. 2023.

[6] Wellid I, Simbolon LM, Falahuddin MA, Nurfitriani N, Sumeru K, bin Sukri MF, et al. Evaluasi polusi udara PM2. 5 dan PM10 di kota Bandung serta kaitannya dengan infeksi saluran pernafasan akut. Jurnal Kesehatan Lingkungan Indonesia 2024;23:128–36.

[7] Hidayat MT, Jayadipraja EA, Asrullah M, Astawa KW. Time Trend Analysis of Ambient Air Quality and Increased ISPA in Kendari City. Miracle Journal of Public Health 2024;7:53–65.

[8] Hidayanti R, Yetti H, Putra AE. Risk factors for acute respiratory infection in children under five in Padang, Indonesia. Journal of Maternal and Child Health 2019;4:62–9.

[9] Van Turnhout K, Bennis A, Craenmehr S, Holwerda R, Jacobs M, Niels R, et al. Design patterns for mixed-method research in HCI. Proceedings of the 8th Nordic conference on human-computer interaction: Fun, fast, foundational, 2014, p. 361–70.

[10] Wibawa GNA, Somayasa W, Yahya I, Hidayat A, Abapihi B. A survey to estimate the proportion of Southeast Sulawesi elementary school students reading fluently. J Phys Conf Ser, vol. 1899, IOP Publishing; 2021, p. 012112.

[11] Firmansyah D. Dede.(2022). Common sampling techniques in research methodology: literature review. Scientific Journal of Holistic Education (JIPH) 2022;1:85–114.

[12] Rane S, Asiani G, Rahutami S. ANALISIS KEJADIAN ISPA PADA BALITA. Jurnal'Aisyiyah Medika 2024;9.

[13] Rafaditya SA, Saptanto A, Ratnaningrum K. Ventilasi dan Pencahayaan Rumah Berhubungan dengan Infeksi Saluran Pernapasan Akut (ISPA) pada Balita: Analisis Faktor Lingkungan Fisik. Medica Arteriana 2022;3:115–23.

[14] Sarwoko S. Hubungan Kepadatan Hunian, Ventilasi, dan Pencahayaan dengan Kejadian ISPA pada Balita di Desa Talang Jawa Wilayah Kerja UPTD Puskesmas Tanjung Agung Kecamatan Baturaja Barat Kabupaten Ogan Komering Ulu Tahun 2020. Cendekia Medika: Jurnal Stikes Al-Maarif Baturaja 2021;6:31–6.

[15] Wolkoff P. Indoor air humidity revisited: Impact on acute symptoms, work productivity, and risk of influenza and COVID-19 infection. Int J Hyg Environ Health 2024;256:114313.

[16] Sitanggang TW, Sari M, Putri KA, Setiadi S, Muliawati EC. Community Empowerment in Managing Household Hazardous Waste in Residential Neighbourhoods. Sustainable Applied Modification Evidence Community 2024;1:45–51.

[17] Yadate O, Yesuf A, Hunduma F, Habtu Y. Determinants of pneumonia among under-five children in Oromia region, Ethiopia: unmatched case-control study. Archives of Public Health 2023;81:87.
[18] Abebaw T-A, Aregay WK, Ashami MT. Risk factors for childhood pneumonia at Adama Hospital Medical College, Adama, Ethiopia: a case-control study. Pneumonia 2022;14:9.
[19] Ernada S, Ibrahim SM, Hidayat EY, Rohmadhani M, Radianto DO. Pengukuran dan Evaluasi Ventilasi Udara Berdasarkan SNI pada Laboratorium Motor Bakar Instansi Pendidikan di Surabaya. Journal of Student Research 2023;1:90–103.
[20] Mucha W, Mainka A, Brągoszewska E. Impact of ventilation system retrofitting on indoor air quality in a single-family building. Build Environ 2024;262:111830.
[21] Camelia A. Sick building syndrome and indoor air quality. Jurnal Ilmu Kesehatan Masyarakat 2011;2.