



ANALYSIS OF FACTORS RELATED TO THE INCIDENCE OF ACUTE RESPIRATORY INFECTIONS IN STUDENTS AT MA'HAD IBNUL MUBAROK ISLAMIC BOARDING SCHOOL SAMARINDA CITY 2025

Yusfa Iswinda Itaqullah^{a*} ; Suhat^b ; Agus Riyanto^c ; Dyan K. Nugrahaeni^d ; Novie Elvinawaty Mauliku^e

^{a,b,c,d,e} Jenderal Achmad Yani University; Jl. Terusan Jenderal Sudirman ; Cimahi and 4028 ; Indonesia

Abstract

Acute Respiratory Infection (ARI) represented a prevalent health issue in Islamic boarding school (pesantren) environments due to communal living systems and high activity density. This study aimed to analyze host and environmental factors associated with the ARI incidence among students (santri) at the Ma'had Ibnul Mubarak Islamic Boarding School in Samarinda City in 2025. This quantitative research employed an observational analytic approach with a case-control design. The research sample consisted of 110 santri selected through a purposive sampling technique. Data collection was conducted using structured questionnaires, anthropometric measurements, and direct environmental observations. Bivariate analysis using the chi-square test showed significant associations between age ($p < 0.001$), comorbidity ($p = 0.022$), room ventilation ($p < 0.001$), and environmental cleanliness ($p = 0.030$) with ARI incidence. Multivariate analysis via multiple logistic regression revealed that room ventilation was the most dominant factor with an Odds Ratio of 103.737 (95% CI: 7.851–1370.656). This wide confidence interval reflected a very strong environmental effect observed within a relatively small sample size. Boarding school management was recommended to improve room ventilation systems and enhance environmental cleanliness to strategically reduce ARI incidence.

Keywords: *Acute Respiratory Infection (ARI) ; Islamic Boarding School Students (Santri) ; Pesantren.*

1. Introduction

Acute Respiratory Infections remain a significant public health issue and a leading cause of morbidity and mortality worldwide, particularly among vulnerable populations living in high-density residential environments (Leigh & Vannelli, 2021). The World Health Organization (WHO) reports that ARI contributes to approximately 4 million deaths annually globally, with nearly 98% of these caused by lower respiratory tract infections (World Health Organization, 2013). In Indonesia, the Indonesian Health Survey (SKI) of 2023 recorded 877,531 ARI cases across various age groups, indicating that this disease continues to be a significant national health burden (Kementerian Kesehatan RI, 2024). The high incidence rate underscores the need for sustained environmental and behavioral-based prevention and control efforts.

At the regional level, Samarinda City faces similar challenges. Data from the Samarinda City Government's One-Data Information System Portal (SIPOSSUT) in 2024 shows that ARI has the highest number of cases, reaching 35,595 cases in one year, surpassing other infectious diseases such as diarrhea, tuberculosis, and dengue fever (Kementerian Kesehatan RI, 2024). This high figure indicates the persistent and active transmission of respiratory diseases within the community, particularly in environments characterized by high mobility and significant residential density. This situation demands serious

attention, especially for populations living in communal

^{*)} Corresponding Author (Yusfa Iswinda Itaqullah)
E-mail: yusfaiswinda25@gmail.com

settings, such as students (santri) in Islamic boarding schools (pondok pesantren) (Makmun et al., 2025).

The pesantren environment has unique characteristics that can potentially increase the risk of ARI transmission compared to other communal settings like boarding houses, boarding schools, or training camps. While those settings share high occupancy density and shared facility usage, the uniqueness of pesantren lies in its absolute and continuous 24-hour cultural and spiritual activities, where intensive interaction among residents occurs uniformly across all daily cycles including mandatory collective prayers, large-scale group learning, and shared dining routines that leave no structural or temporal space for social distancing. This unbroken chain of high-contact religious and academic communal behaviors creates a distinct and prolonged exposure pattern that accelerates pathogen transmission among the students (Makmun et al., 2025). Managing infectious disease threats within highly structured and close-knit communities is essential for safeguarding collective health and maintaining daily operational readiness (Seay, Matsuno, Buechel, Tannenbaum, & Wells, 2022). Clinical data from the Ma'had Ibnul Mubarak Islamic Boarding School in Samarinda reported 620 student visits related to ARI complaints over the past two years, comprising 345 cases of acute nasopharyngitis, 189 cases of acute pharyngitis, and 86 cases of acute upper respiratory infection. The high number of cases indicates that ARI is a dominant health issue within the pesantren environment, necessitating an in-depth study to identify the contributing factors.

Theoretically, the occurrence of infectious diseases, including ARI, can be explained through the Epidemiologic Triad model, which emphasizes the interaction between host, agent, and environmental factors (Stadnytskyi, Anfinrud, & Bax, 2021). Host factors include age, nutritional status, and the presence of comorbidities, which affect an individual's immune response (Asyiroh, Setyoningrum, Fatmaningrum, & Utomo, 2021). Environmental factors encompass occupancy density, ventilation quality, and environmental hygiene, which can influence pathogen concentration in the air and accelerate transmission (Meli, Junias, & Limbu, 2021). Environments with poor ventilation, inadequate sanitation, and high occupancy density allow respiratory droplets to remain airborne longer, thereby increasing the risk of ARI transmission, especially in communal residences like student dormitories (Lara, Sunarsih, & Faisya, 2015).

Previous research has demonstrated the significant role of physical environmental and behavioral factors in ARI incidence, as evidenced by studies conducted in Surabaya pesantren environments (Fahham, 2019; Istifaiyah, Adriansyah, & Handayani, 2019), Ngada residential communities (Meli et al., 2021), and Ogan Ilir female student dormitories (Lara et al., 2015). Studies by (Fahham, 2019; Istifaiyah et al., 2019) found a significant correlation between ventilation, occupancy density, and ARI incidence among students in pesantren. Other research by Meli et al. (2021) confirmed that environmental hygiene, nutritional status, and occupancy density are significantly associated with ARI occurrence. While previous literature has examined respiratory health, existing studies often isolate a single physical factor such as room ventilation rather than conducting a comprehensive assessment. Other existing investigations focus predominantly on household toddler demographics or the general population outside of congregate settings. Most pesantren-based studies utilize cross-sectional designs that fail to simultaneously integrate internal host factors specifically age, nutritional status, and comorbidity with physical environmental determinants. Consequently, there is an absence of an integrated epidemiological framework evaluating how these host and environmental factors interact within the unique 24-hour communal living structures specific to these student cohorts. This study directly addresses this gap by establishing a case-control framework to determine the precise risk associations of both host and environmental determinants within the pesantren context.

Given this context, a comprehensive study is needed to analyze the factors associated with ARI incidence among students at the Ma'had Ibnul Mubarak Islamic Boarding School in Samarinda City. This research aims to examine the relationship between age, nutritional status, comorbidities, room ventilation quality, occupancy density, and environmental hygiene with ARI incidence, and to identify the most dominant contributing factors. This specific context is crucial because generic public health guidelines often fail to address the distinct infrastructure challenges, high occupancy density, and mandated communal facility usage unique to these settings. Therefore, tailored interventions are required to modify environmental risk factors within dormitories without disrupting the intensive daily learning processes and collective religious routines of the students.

2. Method

This research employs an observational analytic design with a case-control approach to analyze the relationship between host factors (age, nutritional status, and comorbidities) and environmental factors (occupancy density, ventilation quality, and environmental hygiene) with the incidence of Acute Respiratory Infections among students at the Ma'had Ibnul Mubarak Islamic Boarding School in Samarinda City in 2025. This study did not use cross-sectional interpretation methods, as it was strictly a case-control design because subjects were explicitly sampled and classified at baseline based on their known disease status dividing them into a defined group of cases (confirmed ARI cases) and a defined group of controls (non-ARI individuals) rather than assessing exposure and outcome simultaneously in a single random cross-section of the population. A retrospective evaluation was then conducted to trace past environmental and host exposures between the two groups. The case-control design was chosen for its efficiency in studying diseases that have already occurred, enabling the simultaneous identification of multiple risk factors while conserving research time and resources (Fitria, Amin, & Hasnur, 2024). The research paradigm is constructed based on the Epidemiologic Triad concept, which views disease occurrence as the result of interaction between host, agent, and environment, thus forming the foundation for the conceptual framework and research hypotheses.

The population in this study consists of all 300 students residing at the Ma'had Ibnul Mubarak Islamic Boarding School in Samarinda City. The minimum sample size was determined using a case-control formula, referencing the study by (Lara et al., 2015). This yielded a minimum sample of 110 respondents, comprising 55 cases and 55 controls with a 1:1 ratio. The sampling technique employed was purposive sampling based on inclusion and exclusion criteria, which may introduce selection bias as a potential limitation. Data collection was conducted using structured questionnaires and observation sheets to obtain primary data regarding respondent characteristics and the environmental conditions of the students' residences. Questionnaires were chosen for efficiency and suitability in case-control research, allowing for standardized data collection within a relatively short timeframe (Fadhillah, Widiyanti, & Arsyad, 2024).

The variables in this study were operationally defined to ensure measurable categorization during data collection. Age was divided into Early Adolescence (12-15 years old) and Late Adolescence (16-25 years old) wrapped under the host characteristics framework (Kementerian Kesehatan RI, 2024). Nutritional status was categorized into normal and underweight/overweight based on the body mass index calculations. Comorbidity was determined by the presence or absence of a history of respiratory tract hypersensitivity or chronic diseases. Room ventilation was evaluated based on the ratio of ventilation opening area to the total floor area of the dormitory. Occupancy density was determined by comparing the total room area against the number of residing students. Environmental cleanliness was measured through physical indicators of hygiene, dust accumulation, and trash disposal compliance within the living quarters.

The collected data were processed through the stages of editing, coding, entry, and cleaning using SPSS software. Data analysis was conducted in stages, encompassing univariate, bivariate, and multivariate analysis. Univariate analysis aimed to describe the frequency distribution and percentage of each research variable. Bivariate analysis was used to examine the relationship between independent variables and the incidence of ARI using the Chi-Square test; the Fisher Exact test was used if any cell had an expected count of <5 . The strength of the association was expressed as an Odds Ratio (OR) value with a 95% confidence level, and a p-value < 0.05 was considered statistically significant.

Multivariate analysis was performed using multiple logistic regression with the enter method to identify the most dominant factors associated with the incidence of ARI while simultaneously controlling for confounding variables. Variables entered into the model were those with a p-value < 0.25 in the bivariate analysis, allowing the model to adjust for all potential confounders concurrently. The analysis results are presented as OR values, 95% Confidence Interval (CI), and p-values. Variables with a p-value < 0.05 were declared to have a statistically significant relationship with the incidence of ARI. The entire research process was conducted in adherence to the principles of health research ethics, which include respect for persons, beneficence, non-maleficence, and justice, in accordance with the guidelines of the Indonesian Ministry of Health.

3. Result and Discussion

The distribution of Acute Respiratory Infections incidence based on the evaluated host and environmental factors among the students is presented in Table 1.1. It is evident that cases of ARI were more frequently found among students in early adolescence, those with comorbidities, those residing in

rooms with inadequate ventilation, those in densely occupied dwellings, and those in less clean environments. The factors of room ventilation, occupancy density, and environmental cleanliness showed the highest proportions in the ARI group, at 70.9%, 76.4%, and 72.7%, respectively. In contrast, nutritional status did not show a stark difference in proportion between the ARI and non-ARI groups. This finding indicates that environmental factors play a dominant role in the incidence of ARI among students in the Islamic boarding school environment, supported by the highly significant statistical association of room ventilation in both bivariate ($p < 0.001$) and multivariate analyses ($p = 0.000$).

Table 1. Description of Acute Respiratory Infections Incidence Based on Age, Nutritional Status, Comorbidity, Room Ventilation, Occupancy Density, and Environmental Cleanliness among Students at Ma'had Ibnul Mubarak Islamic Boarding School in Samarinda City in 2025.

Variabel & Category	ARI N(%)	Non ARI N(%)	Total
Age			
Early Adolescence	38 (69.1)	12 (21.8)	50 (45.5)
Late Adolescence	17 (30.9)	43 (78.2)	60 (54.5)
Nutritional Status			
Underweight/ Overweight	13 (23.6)	16 (29.1)	29 (26.4)
Normal	42 (76.4)	39 (70.9)	81 (73.6)
Comorbidity			
Yes	11 (20.0)	3 (5.5)	14 (12.7)
No	44 (80.0)	52 (94.5)	96 (87.3)
Room Ventilation			
Inadequate	39 (70.9)	8 (14.5)	47 (42.7)
Adequate	6 (29.1)	47 (85.5)	63 (57.3)
Occupancy Density			
Dense	42 (76.4)	36 (65.5)	78 (70.9)
Non-Dense	13 (23.6)	19 (34.5)	32 (29.1)
Environmental Cleanliness			
Less Clean	40 (72.7)	29 (52.7)	69 (62.7)
Clean	15 (27.3)	26 (47.3)	41 (37.3)
Total			110(100)

These findings align with the Epidemiologic Triad concept, which states that disease occurrence is the result of an interaction between host and environmental factors. Early adolescence is a group whose immune systems are not yet optimally developed, making them more susceptible to respiratory tract infections (Müller, Di Benedetto, & Pawelec, 2019). This is consistent with the study by Asyiroh et al. (2021), which stated that younger age groups tend to have a higher risk of ARI compared to older age groups.

Regarding nutritional status, although the proportion of ARI cases was higher among students with normal nutritional status, abnormal nutritional status remains a risk factor because nutritional imbalance can affect the body's immune resistance (McCusker & Sidbury, 2016). Research by Fitria et al. (2024) indicates that abnormal nutritional status is associated with increased susceptibility to ARI. Additionally, the overall adoption of health-protective actions and preventative behaviors in congregate cohorts depends strongly on individual motivation and the reduction of health-related hesitancy (Puspaningrum & Samaria, 2023). Therefore, the results of this study demonstrate that nutritional status still needs to be considered a predisposing factor.

The presence of comorbidities was proven to contribute to an increased incidence of ARI ($p = 0.022$). Students with comorbidities had a higher proportion of ARI compared to those without comorbidities. This finding supports the study by Asyiroh et al. (2021), which showed that a history of comorbidity is a significant risk factor for the incidence of respiratory tract infections, as this condition can reduce the body's immune resistance and increase susceptibility to pathogens.

Environmental factors such as room ventilation, occupancy density, and environmental cleanliness showed the most dominant contribution. Inadequate ventilation can hinder air exchange, increase

pathogen concentration, and accelerate droplet transmission, as reported by Rafaditya, Saptanto, & Ratnaningrum (2022). Dense occupancy also increases contact between individuals, thereby raising the risk of disease transmission, in line with the findings of Ismiati & Wijayanti (2021). Furthermore, poor environmental hygiene potentially increases exposure to pathogenic microorganisms, which aligns with the study by Rahmat, Wicaksono, Hasanah, & Purwanza (2025). Thus, environmental factors are the primary determinants of ARI incidence among students in the Islamic boarding school environment.

Table 2. The Association Between Age and the Incidence of ARI

Age	Incidence of ARI		P- Value	PR (95% CI)
	ARI n (%)	Non-ARI n (%)		
Early Adolescence	38 (69.1)	12 (21.8)	<0.001	8.010 (3.396 – 18.895)
Late Adolescence	34 (69,4)	15 (30.6)		
Total	55 (100)	55 (100)		

Based on the results of the Chi-Square test, a p-value ($p < 0.05$) was obtained, indicating a statistically significant association between age and the incidence of Acute Respiratory Infections (ARI) among students at the Ma'had Ibnul Mubarak Islamic Boarding School in Samarinda City. The Odds Ratio (OR) value of 8.010 with a 95% confidence interval (3.396 – 18.895) shows that students in the early adolescence age group have approximately 8 times greater odds of experiencing ARI compared to students in the late adolescence age group.

The findings of this study indicate that age plays a significant role in the incidence of ARI among students (Taponi, Wahyudi, & Zaman, 2024). The early adolescent age group was found to be more susceptible to ARI compared to late adolescents, which is likely related to the suboptimal maturity of their immune system and limitations in consistently applying clean and healthy living behaviors. This finding aligns with the research by Putri, Qur'aniati, & Ni'mah (2022), which states that younger age groups have a higher risk of ARI due to their still-developing immune systems. This condition makes individuals more easily exposed to and infected by ARI-causing pathogens, especially in a communal living environment like an Islamic boarding school, which has a high intensity of social interaction. These findings are consistent with the research by (Kusparlina, 2023), which stated that younger age groups experience ARI more frequently than older age groups. This is related to the immaturity of the immune system and suboptimal health behaviors, such as a lack of awareness regarding personal and environmental hygiene. Furthermore, higher levels of physical activity and more intense contact frequency in early adolescence also increase the chances of disease transmission (Segaloff et al., 2021). Therefore, age is a significant host factor in the incidence of ARI, as explained by the Epidemiologic Triad concept, where individual characteristics influence the level of susceptibility to disease.

Table 3. The Association Between Nutritional Status and the Incidence of ARI

Nutritional Status	Incidence of ARI		P- Value	PR (95% CI)
	ARI n (%)	Non-ARI n (%)		
Underweight/Overweight	13 (23.6)	16 (29.1)	0.516	0.754 (0.322–1.768)
Normal	42 (76.4)	39 (70.9)		
Total	55 (100)	55 (100)		

Based on the results of the Chi-Square test, a p-value of 0.516 ($p > 0.05$) was obtained, indicating that there is no statistically significant association between nutritional status and the incidence of Acute Respiratory Infections (ARI) among students at the Ma'had Ibnul Mubarak Islamic Boarding School in Samarinda City. The Odds Ratio (OR) value of 0.754 with a 95% confidence interval (0.322 – 1.768) suggests that students with underweight or overweight nutritional status do not have a higher risk of experiencing ARI compared to students with normal nutritional status.

Descriptively, the proportion of ARI incidence among students with underweight or overweight nutritional status was 23.6%, while in the non-ARI group it was 29.1%. This finding shows that within the abnormal nutritional status group, the number of students who did not experience ARI was greater than those who did. The results indicate that nutritional status is not significantly associated with the incidence of ARI. This finding is consistent with the study by Santri et al. (2023), which suggests that ARI can still occur even when nutritional status is normal, as it is influenced by environmental and behavioral factors such as poor ventilation, high occupancy density, air pollution, and smoking habits in the surrounding

area. This result indicates that nutritional status is not a dominant factor directly associated with the incidence of ARI among students in this pesantren environment. Therefore, other factors, particularly physical environmental conditions and occupancy density, are suspected to have a greater contribution to the occurrence of ARI (Lutpiatina et al., 2022).

Table 4. The Association Between Comorbidity and the Incidence of ARI

Comorbidity	Incidence of ARI		P- Value	PR (95% CI)
	ARI n (%)	Non-ARI n (%)		
Early Adolescence	11 (20.0)	3 (5.5)	0.022	4.333 (1.137 – 16.520)
Late Adolescence	44 (80.0)	52 (94.5)		
Total	55 (100)	55 (100)		

The Chi-Square test yielded a p-value of 0.022 ($p < 0.05$), indicating a statistically significant association between comorbidity and the incidence of Acute Respiratory Infections (ARI) among students at Ma'had Ibnul Mubarak Islamic Boarding School in Samarinda City. The Odds Ratio (OR) of 4.333 with a 95% confidence interval (1.137 – 16.520) shows that students with comorbidities have approximately four times higher odds of experiencing ARI compared to those without comorbidities.

Descriptively, the proportion of students with ARI was higher in the group with comorbidities (20.0%) compared to those without (5.5%). This finding indicates that pre-existing health conditions contribute to an increased risk of ARI among students. Suboptimal health status can compromise immune resilience, facilitating infection by respiratory pathogens, particularly in high-contact communal settings such as boarding schools (Miswarti, Awaliah, Saied, Atikah, & Nabila, 2022). In evaluating such infectious risks, systematic monitoring of transient clinical and biochemical fluctuations remains essential for ensuring patient safety and accurate diagnosis (Kamau, Bennett, & Yadava, 2021). The presence of comorbidities has been shown to contribute to an increased risk of ARI. Underlying health conditions, particularly those related to the respiratory and immune systems, render individuals more susceptible to infection (Pacheco, Gálvez, Soto, Andrade, & Kalergis, 2021). This finding aligns with research by (Kissler et al., 2023), which states that individuals with comorbidities have a higher risk of contracting respiratory tract infections. This result aligns with the study by Asyiroh et al. (2021), which found that a history of comorbidity was more prevalent among children with respiratory infections (65% in cases vs. 7.5% in controls). The consistency of these findings reinforces that comorbidity is a significant host factor increasing individual susceptibility to ARI.

Table 5. The Association Between Room Ventilation and the Incidence of ARI

Room Ventilation	Incidence of ARI		P- Value	PR (95% CI)
	ARI n (%)	Non-ARI n (%)		
Underweight/Overweight	39 (70.9)	8 (14.5)	<0.001	14.320 (5.544 – 36.989)
Normal	16 (29.1)	47 (85.5)		
Total	55 (100)	55 (100)		

The Chi-Square test results show a p-value of < 0.001 ($p < 0.05$), indicating a significant association between room ventilation and the incidence of Acute Respiratory Infection (ARI). The Odds Ratio (OR) of 14.320 (95% CI: 5.544–36.989) reveals that students living in rooms with inadequate ventilation have approximately 14 times greater odds of contracting ARI compared to those residing in well-ventilated rooms.

Descriptively, the proportion of ARI cases was significantly higher among students occupying poorly ventilated rooms (70.9%) compared to those in adequately ventilated spaces (29.1%). This finding demonstrates that room ventilation quality is a crucial environmental factor in the occurrence of ARI within the Islamic boarding school setting. Poor ventilation increases airborne pathogen concentration and accelerates ARI transmission (Stadnytskyi et al., 2021). These results align with research by Rafaditya et al. (2022), which found that ARI incidence was higher among respondents living in homes with substandard ventilation—32 individuals (59.3%) with inadequate ventilation experienced ARI, compared to 22 (40.7%)

who did not. Room ventilation is a highly influential environmental factor on the incidence of ARI. Inadequate physical building components, such as damp floors and substandard wall structures, further compromise residential hygiene and increase susceptibility to airborne infections (Gultom, Nurmaini, & Siregar, 2022). Ventilation that does not meet standards leads to suboptimal air exchange, increases humidity, and allows for the accumulation of pathogenic microorganisms indoors. This finding aligns with the study by Lara et al. (2015), which states that inadequate ventilation significantly contributes to increased ARI incidence. This finding is strongly supported by recent longitudinal analyses in dormitory cohorts, which demonstrate that higher outdoor air ventilation rates directly reduce the transmission of respiratory viruses among residents (Gold et al., 2025). This consistency reinforces that room ventilation quality is a primary determinant of ARI occurrence, particularly in high-density communal living environments.

Table 6. The Association Between Occupancy Density and the Incidence of ARI

Occupancy Density	Incidence of ARI		P- Value	PR (95% CI)
	ARI n (%)	Non-ARI n (%)		
Dense	42 (76.4)	36 (65.5)	0.208	1.705 (0.740 – 3.927)
Non-Dense	13 (23.6)	19 (34.5)		
Total	55 (100)	55 (100)		

The Chi-Square test yields a p-value of 0.208 ($p > 0.05$), indicating that there is no statistically significant association between occupancy density and the incidence of Acute Respiratory Infection (ARI). The Odds Ratio (OR) of 1.705 (95% CI: 0.740–3.927) suggests that occupancy density is not a significant risk factor for ARI among the students.

Descriptively, the proportion of ARI cases is higher among students living in dense accommodations (76.4%), yet the proportion of students without ARI in dense housing is also substantial (65.5%). This indicates that while high density may increase the likelihood of interpersonal contact, this factor alone did not demonstrate a statistically significant influence in this study. This outcome is likely moderated by other, more dominant factors, such as room ventilation quality and environmental hygiene (Mirino, Dary, & Rifatolistia, 2022). Occupancy density in this study did not show a significant association with the incidence of ARI. This result aligns with the research by Nurwijayanti, Sandya, & Radono (2024), which states that occupancy density is not a primary factor in ARI occurrence, but is rather influenced by other environmental factors such as ventilation and exposure to pollutants. This finding is consistent with the study by Ismiati & Wijayanti (2021), which reported that ARI incidence was more common among respondents living in accommodations with non-compliant occupancy density 50% in the ARI group versus 30.13% in the non-ARI group. This similarity confirms that occupancy density remains a potential risk factor, even though it was not statistically significant in this particular investigation (Ismiati & Wijayanti, 2021). In shared student quarters, high-density environments inevitably increase close-contact exposure, facilitating rapid localized outbreaks of respiratory pathogens (Segaloff et al., 2021).

Table 7. The Association Between Environmental Cleanliness and the Incidence of ARI

Environmental Cleanliness	Incidence of ARI		P- Value	PR (95% CI)
	ARI n (%)	Non-ARI n (%)		
Less Clean	42 (76.4)	36 (65.5)	0.208	1.705 (0.740 – 3.927)
Clean	13 (23.6)	19 (34.5)		
Total	55 (100)	55 (100)		

The Chi-Square test yields a p-value of 0.030 ($p < 0.05$), indicating a statistically significant association between environmental cleanliness and the incidence of Acute Respiratory Infection (ARI). The Odds Ratio (OR) of 2.391 (95% CI: 1.079–5.295) reveals that students residing in a less clean environment have approximately 2.4 times greater odds of contracting ARI compared to those living in a clean environment.

Descriptively, the proportion of ARI cases is higher among students living in less clean environments (72.7%) compared to those in clean environments (27.3%). This finding underscores that environmental hygiene plays an important role in influencing ARI incidence within the pesantren setting. A less clean environment increases exposure to dust, pathogenic microorganisms, and air pollutants,

thereby facilitating respiratory tract disorders (Violita, Howay, & Mamoribo, 2021). Furthermore, elevated concentrations of indoor bacterial and fungal aerosols serve as strong, direct predictors for lower respiratory tract infections in closed spaces (Fakunle, Jafta, Smit, & Naidoo, 2022). This result aligns with research by Rahmat et al. (2025), which reported a significant association between environmental sanitation and ARI incidence, concluding that poor environmental hygiene increases the risk of exposure to infectious agents. Poor physical layout and inadequate natural lighting inside dormitories can foster damp environments that encourage the survival and spread of pulmonary pathogens (Faizal, Pangesti, & Po, 2021). Within the Epidemiologic Triad framework, environmental cleanliness is a key component of the "environment" factor, which plays a major role in the occurrence of infectious diseases. The communal living model of Islamic boarding schools makes environmental cleanliness a crucial element in efforts to prevent and control ARI among students.

Table 8. Results of Multiple Logistic Regression Analysis of Factors Associated with ARI Incidence

Variable	B	Sig.	Exp (B)	95% CI for Exp (B)
Age	2.169	0.001	8.752	2.451 – 31.245
Room Ventilation	4.642	0.000	103.737	7.851 – 1370.656
Occupancy Density	0.651	0.340	1.918	0.503 – 7.313
Comorbidity	1.292	0.323	3.641	0.280 – 47.331
Environmental Cleanliness	-2.090	0.113	0.124	0.009 – 1.638

Based on the results of multivariate analysis using multiple logistic regression, room ventilation emerged as the most dominant factor associated with the incidence of ARI among students at Ma'had Ibnul Mubarak Islamic Boarding School. This is indicated by a p-value of < 0.001 and the highest Odds Ratio (OR) of 103.737 (95% CI: 7.851–1370.656). This result shows that students residing in rooms with non-compliant ventilation have approximately 103 times greater risk of contracting ARI compared to those in rooms with adequate ventilation, after controlling for the variables of age, occupancy density, comorbidity, and environmental cleanliness. This wide confidence interval explicitly indicates potential sample size limitations within specific exposure subcategories or inherent model instability due to the very strong effect size of the environmental variable.

In addition to room ventilation, age also remained a statistically significant factor in the multivariate analysis ($p = 0.001$). The analysis showed that students in the early adolescence group have approximately 8.7 times greater odds of experiencing ARI compared to the late adolescence group even after controlling for environmental conditions, comorbidities, and occupancy density. This persistent significance underscores that host susceptibility factors independently contribute to the incidence of ARI within the shared dormitory environment (Asyiroh et al., 2021).

The dominance of room ventilation underscores the critical importance of air circulation quality as a primary determinant of ARI incidence. Suboptimal ventilation impedes proper air exchange, leading to increased humidity and the potential accumulation of pathogenic microorganisms indoors. This condition heightens the risk of respiratory disease transmission, particularly in the communal living environment of an Islamic boarding school. This finding aligns with Lara et al. (2015), who stated that ventilation that fails to meet health standards increases humidity and supports the growth of bacteria causing ARI. Within the epidemiologic triad concept, room ventilation is a key component of the "environment" factor that plays a significant role in the occurrence of infectious diseases. Therefore, improving ventilation systems constitutes a crucial strategy in ARI prevention efforts within the pesantren environment.

4. Conclusion

This study successfully answers the research purpose by demonstrating that specific host and environmental factors are significantly associated with the incidence of Acute Respiratory Infections (ARI) among students (santri) at Ma'had Ibnul Mubarak Islamic Boarding School. The summarized findings reveal that younger age, the presence of comorbidities, inadequate room ventilation, and poor environmental cleanliness serve as the primary risk determinants. Among these variables, room ventilation is identified as the most dominant factor influencing the transmission of respiratory conditions, whereas nutritional status and occupancy density show no significant relationship. In terms of research development, future studies should consider longitudinal designs to comprehensively explore the interactions between indoor microclimate fluctuations and respiratory pathogen survival. Additionally,

integrating continuous air quality monitoring technologies presents a promising prospect for expanding the technical scope of further studies in congregate living setups. For practical application, these insights offer an evidence-based foundation for boarding school administrations to execute targeted structural modifications in dormitory ventilation to effectively control the incidence of ARI.

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6. References

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