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Environmental and Housing-Related Risk Factors of Acute Respiratory Infection among Boarding House Students: A Case–Control Study in Minahasa Regency, Indonesia.

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ABSTRACT

Acute Respiratory Infection (ARI) remains a major global health problem that affects all age groups, including young adults. University students living in boarding houses are potentially at higher risk due to crowded housing, poor ventilation, and unhealthy living behaviors. This study aimed to analyze the risk factors associated with ARI among boarding house students in Tataaran Patar, Minahasa Regency, North Sulawesi. A case–control study was conducted from May to September 2025, involving 68 respondents (34 ARI cases and 34 controls). Data were collected using structured questionnaires and analyzed using chi-square tests, with Odds Ratios (ORs) calculated to estimate the strength of associations. The results showed that room size (p=0.027, OR=3,040), presence of a kitchen inside the room (p=0.026, OR=3,125), and occupancy density (p=0.003, OR=4,866) were significantly associated with ARI incidence. In contrast, ventilation conditions (p=0.808, OR=0,888) and smoking behavior (p=0.808, OR=0,888) were not significantly associated with ARI. These findings indicate that room size, indoor kitchen facilities, and occupancy density are factors significantly associated with ARI among boarding house students in Tataaran Patar. Further studies using multivariate analysis are recommended to identify independent risk factors.

INTRODUCTION

Acute Respiratory Infection (ARI) remains a major public health concern worldwide, affecting all age groups including young adults. It encompasses a wide spectrum of illnesses, ranging from mild conditions such as the common cold to more severe diseases like pneumonia (WHO, 2023). In Indonesia, the prevalence of acute respiratory infection (ARI) is exceedingly high, positioning it among the top ten most prevalent diseases (Nur, 2021). ARI constitutes a significant proportion of patient consultations within healthcare facilities, accounting for approximately 40% to 60% of all visits to puskesmas and 15% to 30% of all outpatient and inpatient encounters in hospitals. It is estimated that the incidence of ARI episodes in Indonesia occurs between three to six times per month. This data indicates that the morbidity rate associated with ARI remains considerably elevated (Helfrida et al., 2021). Among university students, frequent episodes of ARI may interfere with academic performance, attendance, and

social engagement, thereby impacting both individual achievement and campus life (Wahyudi et al. 2025).

Students living in boarding houses are particularly vulnerable to ARI due to environmental and behavioral factors. Boarding houses are often characterized by crowded living arrangements, suboptimal ventilation, and varying standards of hygiene, which collectively create favorable conditions for the transmission of respiratory pathogens (Yang et al., 2021). In addition, lifestyle behaviors such as indoor smoking, cooking in poorly ventilated rooms, and limited attention to personal and environmental cleanliness may further increase susceptibility to respiratory infections.

Tataaran Patar, a district adjacent to higher education centers in Manado, North Sulawesi, hosts a substantial population of students residing in boarding houses of diverse physical and environmental quality. Variations in room size, occupancy density, and access to health services are likely to influence the incidence of ARI among these students. Understanding the context-specific risk factors in this setting is crucial for designing targeted and effective preventive strategies (Adriansyah et al., 2021).

Previous studies have identified environmental conditions, personal hygiene behaviors, nutritional status, and comorbidities as important determinants of ARI (Setawan, 2023; Sari & Putra, 2019). However, limited research has focused specifically on boarding house students, who represent a distinct group with unique social and behavioral characteristics. This study aims to analyze the risk factors associated with ARI among boarding house students in Tataaran Patar. The findings are expected to provide evidence for public health interventions, inform policy development regarding student housing standards, and contribute to reducing the burden of ARI in young adult populations.

METHODS

This study employed an analytical observational design with a case-control approach to examine risk factors associated with Acute Respiratory Infection (ARI) among boarding house students in Tataaran Patar, Minahasa Regency, North Sulawesi. In this design, cases and controls were defined based on ARI status, with cases representing students who experienced ARI and controls representing those without ARI. Exposure histories related to housing conditions and behavioral factors were assessed retrospectively to identify factors associated with ARI occurrence.

The target population consisted of all active university students residing in boarding houses in Tataaran Patar. A purposive sampling technique was applied to recruit respondents. Inclusion criteria were: (1) being an active university student, (2) residing in a boarding house in Tataaran Patar for at least six months, and (3) willingness to participate and provide informed responses through the questionnaire. Exclusion criteria included respondents who declined participation or provided incomplete data. Each case was matched with one control from the same boarding house and length of stay, resulting in a 1:1 matched case–control design. A total of 68 respondents were included in the study, comprising 34 cases and 34 controls. Primary data were collected through structured questionnaires administered via direct interviews with respondents. The questionnaire had been pretested for validity and

reliability prior to field use. Secondary data were obtained from the local public health center (Puskesmas Koya) to identify potential cases of ARI among students.

The dependent variable was ARI incidence, defined as the presence of at least one respiratory symptom (such as cough, cold, sore throat, fever, or shortness of breath) within two weeks prior to data collection, measured dichotomously. Independent variables included environmental and behavioral factors: room size, ventilation quality, occupancy density, smoking behavior, and presence of a kitchen inside the bedroom. Data processing involved data editing, coding, entry, and cleaning prior to analysis. Descriptive statistics were used to summarize the characteristics of respondents and study variables. Bivariate analysis was conducted to assess the association between each independent variable and ARI incidence. Statistical significance was tested using the chi-square test, and Odds Ratios (ORs) with 95% confidence intervals were calculated to estimate the strength of associations. All statistical analyses were performed using a statistical software package, with a significance level set at $p < 0.05$.

RESULTS

Table 1, summarizes data from 68 respondents. The majority of respondents were 20 years old (30.88%), followed by those aged 19 and 21 years (17.64% each). Only a small proportion of respondents were aged 25 years (1.57%) and 26 years (1.47%). In terms of sex, the majority of respondents were female (79.41%), while male respondents accounted for 20.59%. This indicates that most of the study participants were young adults aged 19–21 years and predominantly female.

Tabel 1. Frequency Distribution of Respondents by Age, and Sex

Variable	n	%
Age		
18	3	4.41
19	12	17.64
20	21	30.88
21	12	17.64
22	11	16.17
23	4	5.88
24	3	4.41
25	1	1.57
26	1	1.47
Sex		
Male	14	20.59
Female	54	79.41

Source: Primary Data, 2025

Based on the Chi-square test results in Table 2, a *p-value* of 0.808 (> 0.05) was obtained, meaning that there was no significant relationship between ventilation and the incidence of ARI among students living in boarding houses in Tataaran Patar. The Odds Ratio (OR) was 0.888 with a 95% confidence interval of 0.342–2.308, indicating that students residing in boarding

houses with good ventilation had slightly lower odds of experiencing ARI compared to those living in poorly ventilated rooms. However, because the confidence interval includes the value of 1, this association was not statistically significant.

Tabel 2. Chi-square Test Ventilation against ARI

Ventilation	ARI				OR (95% CI)	*p-Value*
	Yes		No			
	n	(%)	n	(%)		
Good	15	44.1	18	52.9	0,888 (0,342 – 2,308)	*0.808*
Poor	19	55.9	16	47.1		
Total	34	100	34	100		

Source: Primary Data, 2025

Tabel 3. Chi-square Test Results Room Size Against ARI

Room Size	ARI				OR (95% CI)	*p-Value*
	Yes		No			
	n	(%)	n	(%)		
Spacious (≥ 8 m^2)	15	44.1	24	70.6	3.040 (1.117-8.274)	*0.027*
Cramped (< 8 m^2)	19	55.9	10	29.4		
Total	34	100	34	100		

Source: Primary Data, 2025

The results of the Chi-square test results in Table 2, a *p-value* of 0.027 (< 0.05) was obtained. This indicates a significant relationship between room size and the incidence of ARI. Students living in small rooms (< 8 m^2) experienced ARI more often than those living in large rooms (≥ 8 m^2). The Odds Ratio (OR) was 3.040 with a 95% confidence interval of 1.117–8.274, indicating that students living in cramped rooms (< 8 m^2) had approximately three times higher odds of experiencing ARI compared to those living in more spacious rooms (≥ 8 m^2). This finding was statistically significant, as indicated by the 95% confidence interval that excludes the null value of 1.

Tabel 4. Chi-square Test Results Smoking Behavior Against ARI

Smoking Behavior	ARI				OR (95% CI)	*p-Value*
	Yes		No			
	n	(%)	n	(%)		
Yes	18	52.9	19	55.9	0,888 (0,342 – 2,308)	*0.808*
No	16	47.1	15	44.1		
Total	34	100	34	100		

Source: Primary Data, 2025

The results of the Chi-square test results in Table 4, a p-value of 0.808 (> 0.05) was obtained, which means that there is no significant relationship between smoking behavior and the incidence of ARI among boarding house students at the study site. The Odds Ratio (OR) was 0.888 with a 95% confidence interval of 0.342–2.308, indicating that students who did not

smoke had slightly lower odds of experiencing ARI compared to those who smoked. However, this association was not statistically significant, as the 95% confidence interval included the null value of 1.

Tabel 5. Chi-square Test Results Kitchen Inside Room Against ARI

Kitchen Inside Room	ARI				OR (95% CI)	*p-Value*
	Yes		No			
	n	(%)	n	(%)		
Yes	25	73.5	16	47.1	3,125 (1,130-8,639)	*0.026*
No	9	26.5	18	52.9		
Total	34	100	34	100		

Source: Primary Data, 2025

Based on the chi-square test results in Table 5, a p-value of 0.026 (< 0.05) was obtained. This proves that there is a significant relationship between the presence of a kitchen in the room and the incidence of ARI. Students who have a kitchen in their room are at greater risk of developing ARI than those who do not. Based on the Chi-square test results in Table 5, a p-value of 0.026 (< 0.05) was obtained, indicating a statistically significant association between the presence of a kitchen inside the room and the incidence of ARI. The Odds Ratio (OR) was 3.125 with a 95% confidence interval of 1.130–8.639, indicating that students who had a kitchen inside their room had more than three times higher odds of experiencing ARI compared to those who did not. This association was statistically significant, as indicated by the 95% confidence interval that excludes the null value of 1.

Tabel 6. Chi-square Test Results Occupancy Density Against ARI

Occupancy Density	ARI				OR (95% CI)	*p-Value*
	Yes		No			
	n	(%)	n	(%)		
Dense	27	79.4	15	44.1	4,866 (1,672-14,273)	*0.003*
Not Dense	7	20.6	19	55.9		
Total	34	100	34	100		

Source: Primary Data, 2025

Based on the chi-square test results in Table 6, a p-value of 0.003 (< 0.05) was obtained. This means that there is a significant relationship between housing density and the incidence of ARI. The more densely populated a room is, the higher the risk of ARI. Based on the Chi-square test results in Table 6, a p-value of 0.003 (< 0.05) was obtained, indicating a statistically significant association between occupancy density and the incidence of ARI among boarding house students. The Odds Ratio (OR) was 4.866 with a 95% confidence interval of 1.672–14.273, indicating that students residing in densely occupied rooms had nearly five times higher odds of experiencing ARI compared to those living in rooms with lower occupancy density. This association was statistically significant, as indicated by the 95% confidence interval that excludes the null value of 1.

DISCUSSION

The results showed that of the five variables analyzed, three variables were found to be associated with the incidence of ARI among students living in boarding houses in Tataaran Patar, namely room size, the presence of a kitchen in the room, and housing density, while ventilation and smoking behavior were not significantly associated.

This study found no relationship between ventilation and the incidence of ARI (p = 0.808 ; OR = 0.888). This result differs from the theory that good ventilation can reduce the risk of ARI by improving air circulation and reducing the concentration of pollutants in the room (WHO, 2010). its effect may be attenuated in settings where other environmental risks are more prominent. In this study context, small room size and high occupancy density likely limited the effectiveness of ventilation in improving indoor air quality. Moreover, university students may spend considerable time outside their rooms for academic and social activities, thereby reducing cumulative exposure to indoor ventilation conditions. Similar findings have been reported in student housing studies where ventilation alone did not significantly reduce ARI risk in overcrowded living environments (Zhu et al.,2020).

Room size demonstrated a moderate to strong association with ARI incidence (p = 0.027; OR = 3.040). Students residing in rooms smaller than 8 m^2 had approximately three times higher odds of experiencing ARI compared to those living in larger rooms. This magnitude of risk suggests that room size is an important environmental determinant of ARI, as limited space can facilitate the accumulation of airborne pathogens and reduce effective air circulation, particularly in shared living environments (Ariyanti, 2021). These findings are consistent with Sulistyorini (2018), who reported that inadequate room size significantly increases the risk of respiratory tract infections.

Smoking behavior was not significantly associated with ARI incidence (p = 0.808; OR = 0.888). Although cigarette smoke is known to contain irritants and toxic substances that damage the respiratory tract, the Odds Ratio in this study indicates a weak and non-significant association. While tobacco smoke is a well-established irritant that impairs mucociliary clearance and local immune defenses of the respiratory tract (U.S. Surgeon General, 2014), its impact in this study population may have been mitigated by behavioral patterns such as smoking outside the room. This may be attributed to the relatively similar distribution of smokers between case and control groups, as well as behavioral factors such as smoking predominantly outside the room (Brown, 2022). Similar findings were reported by Wahyuni (2019), who noted that the effect of smoking on ARI risk among students became less apparent when environmental housing factors were taken into account.

The presence of a kitchen inside the room showed a moderate association with ARI incidence (p = 0.026; OR = 3.125). Indoor cooking activities generate fine particulate matter ($PM_{2.5}$), carbon monoxide, and nitrogen dioxide, all of which are known to cause airway inflammation and increase susceptibility to respiratory infections (Radbel et all.,2024). Students who had a kitchen inside their room had more than three times higher odds of developing ARI compared to those without indoor kitchens. This finding indicates a meaningful elevation in risk, likely due to exposure to indoor air pollution generated from cooking activities. Combustion processes produce particulate matter and other pollutants that can

irritate the respiratory tract and increase susceptibility to infection (WHO, 2021). This result aligns with the findings of Rumagit et al. (2020), who reported that indoor kitchen related pollution significantly increases ARI risk, particularly in small and poorly ventilated living spaces.

Occupancy density exhibited the strongest association with ARI incidence among all variables analyzed ($p = 0.003$; OR = 4.866). Students living in densely occupied rooms had nearly five times higher odds of experiencing ARI compared to those in less crowded conditions, indicating a strong risk factor. High occupancy density facilitates close interpersonal contact and increases the likelihood of droplet and airborne transmission of respiratory pathogens. This finding supports previous research by Cui et al., (2017) and is consistent with WHO (2018) guidelines, which identify overcrowding as a major driver of respiratory infectious disease transmission.

This study has several limitations that should be considered when interpreting the findings. First, although a matched case–control design was applied based on boarding house, age, and length of stay, the analysis relied on bivariate Odds Ratios without multivariate or conditional logistic regression, which may have limited the ability to control for residual confounding. As a result, the reported Odds Ratios reflect crude associations rather than fully adjusted estimates. Second, the relatively small sample size may have contributed to wide confidence intervals for some variables, indicating limited precision in the estimation of risk magnitude. Third, exposure information was collected retrospectively using self-reported questionnaires, which may be subject to recall bias. Despite these limitations, the observed direction and magnitude of the Odds Ratios provide meaningful insights into environmental risk factors for ARI among boarding house students.

Overall, the magnitude of Odds Ratios observed in this study suggests that environmental housing factors particularly occupancy density and room size pose moderate to strong risks for ARI among boarding house students, whereas behavioral factors such as smoking showed weak or negligible associations. These findings underscore the importance of improving housing standards and reducing overcrowding as key preventive strategies for ARI in student populations.

CONCLUSION

This study demonstrated that room size, indoor cooking facilities, and occupancy density are significant risk factors for Acute Respiratory Infection (ARI) among boarding house students in Tataaran Patar. In contrast, ventilation and smoking behavior were not significantly associated with ARI incidence. These findings highlight the critical role of housing conditions in shaping students' respiratory health.

Improving student housing standards is essential to reduce ARI risk. Boarding house owners should provide adequately sized rooms, limit occupancy, and establish shared kitchens with proper ventilation. Students are encouraged to avoid cooking in bedrooms and maintain room hygiene. Policymakers and health authorities should enforce housing health regulations and promote awareness of ARI prevention in student communities. Further research with larger samples and additional environmental and behavioral variables is recommended to strengthen the evidence base.

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