

The Correlation Between Occupational Conditions and the Incidence of Acute Respiratory Infections Among Outpatient Workers: A Cross-Sectional Study

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ABSTRACT

Background: Substandard workplace environmental conditions may increase the risk of Acute Respiratory Infections (ARIs) among healthcare workers. Environmental factors such as temperature, humidity, and ventilation can influence the growth and transmission of respiratory pathogens. This study aimed to analyze the association between environmental conditions and ARI incidence among outpatient healthcare workers in 2025.

Methods: A cross-sectional study was conducted using environmental monitoring data on temperature, humidity, and ventilation, along with ARI incidence data obtained from medical records between August and September 2025. Total sampling was applied, involving 85 outpatient healthcare workers. Data were analyzed using univariate and bivariate analyses with the chi-square test.

Results: Among the participants, 60 workers (70.6%) experienced ARIs. Inappropriate environmental conditions were identified for temperature among 43 workers (50.6%), humidity among 58 workers (69.7%), and ventilation among 66 workers (77.6%). Bivariate analysis showed a significant association between humidity and ARI incidence ($p < 0.001$), with inappropriate humidity increasing the risk of ARIs sixfold (OR=6.00; 95% CI: 2.16–16.64). No significant associations were found between temperature ($p = 0.082$) or ventilation ($p = 0.814$) and ARI incidence.

Conclusion: Humidity was significantly associated with ARI incidence among outpatient healthcare workers. Inappropriate humidity may promote the growth and survival of respiratory pathogens, thereby increasing the risk of infection. In contrast, temperature and ventilation were not significantly associated with ARIs, possibly due to limited environmental variation and the use of air-conditioning systems.

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INTRODUCTION

Sudden onset of cough, rhinorrhea, dyspnea, and pharyngitis are respiratory manifestations attributable to Acute Respiratory Infections (ARIs) [1]. This disease can be transmitted from droplets containing viruses or bacteria that are inhaled by healthy people [2]. Based on WHO data (2020), ARIs cause 4 million deaths per year, with 98% of these deaths caused by lower respiratory tract infections [3]. According to data from the 2023 Indonesian Health Survey, there were 877,531 cases of ARIs in Indonesia, with DKI Jakarta ranking 6th among contributors [4]. According to data from the DKI Jakarta Health Office, there were 638,291 cases of ARIs during January-June 2023 [4]. Based on previous research [5] in East Jakarta, ARIs are most common among adults (42.33%).

Among workers, ARIs are a reasonably common problem. Previous research found that 30% of furniture industry workers experienced ARIs [6]. At the Canadian Acute Care Hospital, about 50% of workers reported ARIs each flu season, with 2,222 episodes of ARIs reported among 2,728 participants [7]. Similar research at Soroka and Rabin Medical Centers showed an increase in ARIs cases among healthcare workers, from 472 cases in 2016/2017 to 1,402 cases in 2018/2019 [8]. This situation affects service standards because 28.3% of medical staff are forced to be absent due to respiratory problems, further adding to hospitals' financial pressure, while the rest continue to work despite symptoms, thereby increasing the risk of transmission [9].

This study is grounded in John Gordon's Epidemiologic Triad Theory, which states that disease occurrence results from the interaction between three main components: agent, host, and environment. Within this framework, environmental factors are recognized as key determinants of pathogen survival and transmission dynamics. Temperature, humidity, and ventilation are environmental determinants that affect the incidence of acute respiratory infections (ARIs) [10]. A previous study found that temperature (p-value = 0.0001) and air humidity (p-value = 0.0031) were associated with the incidence of ARIs in Medan City from 2013 to 2022 [11]. Research conducted across several hospitals revealed a correlation between temperature and an increase in airborne microorganisms, as measured by the number of aerobic colonies (p-value = 0.01) [12]. Another study found that high temperatures and relative humidity of 40-60% reduce the transmission of ARIs [13]. Ventilation also plays an important role, as higher air exchange rates (13 ACH) can reduce pathogen counts compared with lower rates (3 ACH) [14].

The 2024 Performance Report of the Occupational Safety and Health and Environmental Health Installation at RSPI Sulianti Saroso indicates that Acute Respiratory Infection (ARIs) is the predominant medical condition affecting workers at RSPI Sulianti Saroso, accounting for 76% of all disease diagnoses among healthcare personnel. This finding aligns with research

[15] indicating that ARI cases predominantly occur among adults (the working-age population) [16].

The 2024 Final LAKIP data showed that RSPI did not meet the 100% target for the National Quality Indicator for Outpatient Waiting Time, recording only 92.31%, indicating that patients wait longer in the waiting room [15]. One of the most common confined spaces that can increase the risk of airborne infection between individuals is the hospital waiting room [16]. An extended duration of stay in healthcare facilities is associated with increased HAIs [17].

Although previous studies have examined the relationship between environmental factors and respiratory infections, evidence focusing on indoor environmental conditions among healthcare workers remains limited, particularly in infectious disease hospitals. Most existing studies have focused on community populations or patients rather than on healthcare personnel, who are continuously exposed to occupational risks. Therefore, this study aims to investigate the association between indoor environmental factors, including temperature, humidity, and ventilation, and the incidence of acute respiratory infections (ARIs) among outpatient healthcare workers at RSPI Sulianti Saroso in 2025, providing evidence to support occupational health and infection prevention strategies.

METHODS

This quantitative study used a cross-sectional observational analytical design to assess the correlation between physical environmental factors, such as temperature, humidity, and ventilation, and the incidence of acute respiratory infections among outpatient workers at Sulianti Saroso Hospital. This study was conducted from early August to early September 2025. Data on ARI cases were obtained from workers' medical records, while environmental data were obtained from monthly monitoring. All medical records of RSPI workers constituted the population data in this study. The research sample was determined using inclusion and exclusion criteria. The inclusion criteria were complete medical records of workers employed in the outpatient service rooms at Sulianti Saroso Hospital. The exclusion criteria were workers who wore masks in the service rooms where observations were conducted while they were working (Figure 1).

The scale used for the ARIs incidence variable and environmental factors was nominal. The nominal scale for categorizing ARIs is divided into 2 categories, with number 1 indicating an ARI diagnosis and number 2 indicating a non-ARI diagnosis. The temperature, humidity, and ventilation categories are also assigned numeric values: 1 indicates compliance with applicable laws and regulations, and 2 indicates noncompliance. The ARIs' incidence category was

determined based on the medical diagnoses in the medical records, and environmental factor data were obtained from monitoring conducted by occupational health and safety officers. The environmental factor category was adjusted in accordance with the Minister of Health Regulations No. 2 of 2023, No. 40 of 2022, and No. 7 of 2019, which govern environmental health in health facilities. Univariate analysis was performed on participant characteristics, including age, gender, length of service, and ISPA incidence, as well as environmental factors, including temperature, humidity, and ventilation in outpatient service rooms. A bivariate analysis using the chi-square test was conducted to assess the association between temperature, humidity, ventilation, and the incidence of ARIs among workers. The use of data in this study has been approved by the Ethics Committee of RSPI Sulianti Saroso in 2025, and the researcher maintains data anonymization and confidentiality. (Approval Letter Number: PP.07.01/D.XXXIX.14/66/2025).

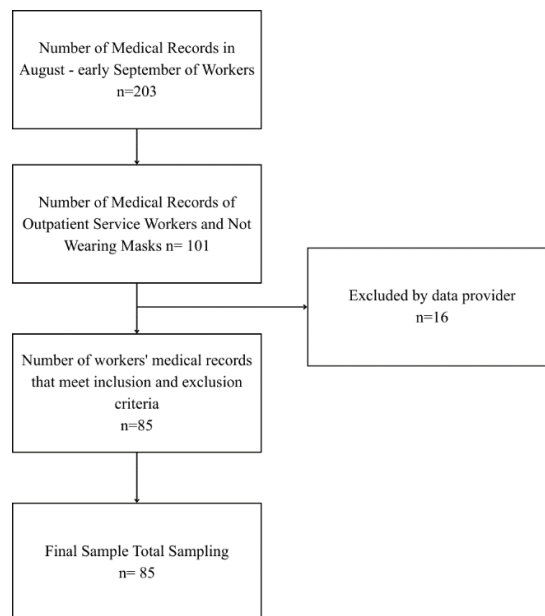


Figure 1. Flowchart of Research Sample Selection

RESULTS

Table 1 shows that most respondents were pre-elderly workers aged 45–59 years (50.6%), while 49.4% were aged 19–44 years. Female workers constituted the majority of the sample (67.1%), compared with males (32.9%). Regarding length of service, most respondents had worked for more than five years (89.4%), whereas only 10.6% had worked for 1–5 years. These findings indicate that the study population was predominantly female, pre-elderly, and experienced healthcare workers.

Table 1. Characteristics of the research sample

Characteristic	Number (N=85)	Proportion (%)
Age		
Adult (19-44 years)	42	49,4
Pre-elderly (45-59 years)	43	50,6
Sex		
Male	28	32,9
Female	57	67,1
Length of Service		
1-5 years	9	10,6
> 5 years	76	89,4
Total	85	100%

The number of ARI cases found in the outpatient service worker sample reached 60 people (70.6%) out of 85 respondents, followed by diagnoses that did not include ARIs in 25 people (29.4%) (Table 2).

Table 2. Overview of ARIs Incidence

Diagnosis	Number (N = 85)	Proportion (%)
ARIs	60	70.6
Non-ARIs	25	29.4
Total	85	100.0

Table 3 shows that 43 people (50.6%) worked at temperatures that did not comply (category: Not Compliant) with the applicable Ministry of Health regulations (Minister of Health Regulation No. 2 of 2023, Minister of Health Regulation No. 40 of 2022, and Minister of Health Regulation No. 7 of 2019), while 42 people (49.4%) worked at temperatures that did comply (category: Compliant). Inappropriate humidity conditions were also experienced by 58 workers (68.2%), and 66 workers (77.6%) worked in workplaces that did not comply with the Minister of Health Regulation in the ventilation factor.

Table 4 shows that humidity was significantly associated with the incidence of ARIs among outpatient healthcare workers ($p < 0.001$). Workers exposed to non-compliant humidity levels had six times higher odds of developing ARIs compared with those exposed to compliant humidity conditions (OR=6.00; 95% CI: 2.16–16.64). In contrast, temperature ($p = 0.082$) and ventilation ($p = 0.814$) were not significantly associated with ARI incidence. Therefore, humidity was the only environmental factor significantly related to ARIs in this study.

Table 3. Overview of Room Environmental Conditions

Indoor Environmental Conditions	Frequency (N=85)	Percentage (%)
Temperature		
Compliant	42	49.4
Non-compliant	43	50.6
Humidity		
Compliant	27	31.8
Non-compliant	58	68.2
Ventilation		
Compliant	19	22.4
Non-compliant	66	77.6

Table 4. The correlation between temperature, humidity, and ventilation and the incidence of acute respiratory infections (ARIs)

Environmental Conditions	ARIs (+) n (%)	ARIs (-) n (%)	Total N (%)	P-value	OR (95% CI)
Temperature					
Compliant	26 (30.6)	16 (18.8)	42 (49.4)	0.082	2.3 (0.89–6.09)
Non-compliant	34 (40.0)	9 (10.6)	43 (50.6)		
Humidity					
Compliant	12 (14.1)	15 (17.6)	27 (31.8)	0.000	6.00 (2.16–16.64)
Non-compliant	48 (56.5)	10 (11.8)	58 (68.2)		
Ventilation					
Compliant	13 (15.3)	6 (7.1)	19 (22.4)	0.814	1.14 (0.38–3.45)
Non-compliant	47 (55.3)	19 (22.4)	66 (77.6)		

DISCUSSION

The present study found a high prevalence of acute respiratory infections (ARIs) among outpatient healthcare workers, with 70.6% of workers diagnosed with ARIs. Among the environmental factors examined, only humidity was significantly associated with ARI incidence, while temperature and ventilation were not. These findings suggest that indoor environmental conditions, particularly humidity, may play an important role in respiratory health among healthcare workers continuously exposed to occupational hazards in healthcare settings. The findings support the Epidemiologic Triad Theory, which recognizes environmental factors as important determinants in disease occurrence and transmission.

Humidity was significantly associated with ARI incidence, with workers exposed to non-compliant humidity levels having six times higher odds of developing ARIs than those exposed to

compliant humidity conditions. This finding is consistent with previous studies reporting significant associations between humidity and respiratory infections. Putri et al. reported that humidity was significantly associated with ARI incidence ($p=0.000$). At the same time, Wolkoff highlighted that maintaining indoor relative humidity between 40–60% may reduce the risk of respiratory infections and improve respiratory comfort [10,18]. Inappropriate humidity can facilitate the growth of pathogenic microorganisms, including bacteria and fungi, while excessively low humidity may impair mucociliary clearance and weaken respiratory tract defenses [18,19]. Furthermore, increased humidity has been shown to promote fungal growth and increase bacterial proliferation in indoor environments, thereby creating conditions that favor the transmission of respiratory pathogens [20–22].

In contrast, temperature was not significantly associated with ARI incidence in this study. Similar findings have been reported by Ahmed et al., Coşkun et al., and Annisa & Achmadi, who found no significant relationship between temperature and respiratory infections [23–25]. One possible explanation is that the temperature variation observed in outpatient rooms was relatively narrow and remained within a moderate range, thereby limiting its effect on respiratory health outcomes. Previous research has shown that the impact of temperature on respiratory diseases becomes more pronounced under extreme conditions, whereas moderate indoor temperatures may not substantially alter pathogen survival or transmission [26,27]. Moreover, the relationship between temperature and respiratory infections is multifactorial and may be influenced by pathogen characteristics, population density, and other environmental factors [24,28].

Similarly, ventilation was not significantly associated with ARI incidence. Although most rooms did not meet the recommended ventilation standards, the widespread use of air-conditioning and mechanical ventilation systems may have reduced airborne pathogen concentrations and mitigated the potential adverse effects of inadequate ventilation [29]. Previous studies have also reported inconsistent findings regarding the relationship between ventilation and respiratory infections, with several studies finding no significant association [28–30]. In healthcare facilities, ventilation effectiveness depends not only on air exchange rates but also on filtration systems, airflow patterns, occupancy levels, and maintenance quality. Consequently, ventilation alone may not fully account for variations in ARI incidence among workers, particularly when other environmental factors, such as humidity, exert a stronger influence [28,29].

The findings highlight the importance of workplace environmental control in occupational health and infection prevention programs. Maintaining optimal humidity levels may help reduce occupational exposure to airborne pathogens among healthcare workers. From an occupational health perspective, regular environmental monitoring, preventive maintenance of air-

conditioning systems, and compliance with environmental health standards should be integrated into hospital infection prevention and control strategies. Such measures may help create safer working environments, reduce respiratory disease burden among healthcare personnel, and improve healthcare service continuity.

Limitations Study

Several limitations should be considered when interpreting these findings. First, the cross-sectional design precludes causal inference regarding the relationship between environmental conditions and ARI incidence. Second, the study was conducted in a single infectious disease hospital, which may limit the generalizability of the findings to other healthcare settings. Third, potential confounding factors such as smoking status, vaccination history, underlying medical conditions, mask-use compliance, and direct exposure to infected patients were not assessed. Finally, environmental measurements were obtained from routine monitoring records rather than repeated individual-level assessments. Despite these limitations, this study provides valuable evidence regarding the role of indoor environmental conditions, particularly humidity, in influencing respiratory health among healthcare workers.

CONCLUSION

This study demonstrated that humidity was the only indoor environmental factor significantly associated with the incidence of acute respiratory infection (ARI) among outpatient healthcare workers. In contrast, temperature and ventilation showed no significant associations. Workers exposed to non-compliant humidity conditions were at substantially higher risk of developing ARIs, highlighting the critical role of humidity in maintaining respiratory health within healthcare settings. These findings emphasize the importance of environmental control as part of occupational health and infection prevention strategies. Regular monitoring of indoor environmental conditions, particularly humidity, should be integrated into hospital workplace health programs to minimize occupational exposure to airborne pathogens and reduce the burden of respiratory infections among healthcare workers. Future studies employing longitudinal designs and incorporating additional individual and occupational risk factors are needed to further clarify the mechanisms linking indoor environmental conditions to ARI incidence.

DECLARATIONS

Ethics approval

This study has been approved by the Health Research Ethics Committee of RSPI Sulianti Saroso (Approval Letter Number: PP.07.01/D.XXXIX.14/66/2025).

Conflict of interest

The authors of this study declare no conflict of interest.

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