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Association Between Indoor Air Quaity and Stress Among University Student in Indonesia

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ABSTRACT

Introduction: Indoor air quality (IAQ) has been increasingly recognized as a factor influencing mental health. University students, who spend prolonged hours in indoor academic settings, may be vulnerable to the effects of poor IAQ on psychological well-being. However, evidence from Indonesian contexts remains limited

Objective: This study aims to investigate the association between indoor air quality and stress levels among university students in Indonesia.

Method: This cross-sectional study aimed to assess the association between indoor air quality and stress levels among university students in Indonesia. A total of 54 students were selected using simple random sampling. IAQ parameters—temperature, humidity, CO_2, and PM2.5—were measured in indoor academic environments using digital air quality monitors. Stress levels were assessed using the Depression Anxiety Stress Scale-21 (DASS-21). Data were analyzed using chi-square tests to determine the relationship between IAQ and stress levels.

Result: The majority of respondents were aged 20–22 years (38.9%) and represented a balanced gender distribution. Indoor air quality was categorized as good (33.3%), moderate (27.8%), or poor (38.9%). Most students reported normal or mild stress levels. Chi-square analysis showed no statistically significant association between IAQ and stress levels ($\chi^2 = 3.81$, $df = 6$, $p = 0.702$)..

Conclusion: The study found no significant association between indoor air quality and stress levels among university students. While environmental quality remains important, psychological stress in academic settings may be more strongly influenced by academic and social factors. Further longitudinal studies are needed to explore this relationship in greater depth.

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INTRODUCTION

Indoor air quality (IAQ) has emerged as a critical environmental determinant of health, particularly in enclosed spaces where university students spend significant time such as classrooms, dormitories, and libraries (1). Poor IAQ has been linked to a range of health outcomes including respiratory issues, cognitive impairment, and mental health disorders such as anxiety and stress (2). Common indoor air pollutants such as particulate matter (PM2.5), carbon dioxide (CO_2), and volatile organic compounds (VOCs) are known to affect both physical and psychological well-being (3).

In Indonesia, research on IAQ in academic environments is still limited. Studies conducted in major cities like Jakarta and Surabaya have revealed that concentrations of formaldehyde and VOCs in new apartments often exceed World Health Organization standards, posing significant health risks (1). Furthermore, research in Bandung indicated that

high indoor humidity and mold growth in informal housing settlements were associated with increased respiratory symptoms among children (2).

Several studies have begun to explore the relationship between IAQ and psychological health. Evidence from university laboratories indicates that elevated CO levels and room temperature significantly correlate with increased psychological distress among students (4). Additionally, perceived stuffiness and unpleasant odors in classrooms have been shown to be associated with anxiety and somatic symptoms among undergraduates (5).

Despite emerging evidence, little is known about the specific association between indoor air quality and psychological stress among university students in Indonesia. Considering the increasing academic pressure and mental health burden among students, understanding environmental contributors such as IAQ is crucial. This study aims to explore the association between IAQ and stress among Indonesian university students to inform future campus health interventions and indoor environment improvements.

Indoor environments in tropical countries like Indonesia are particularly vulnerable to poor ventilation and excessive humidity, which can exacerbate the accumulation of indoor air pollutants (6). This condition is often worsened in university settings where classrooms are overcrowded, air conditioning systems are outdated, and natural ventilation is limited (7). Prolonged exposure to these suboptimal environments can lead to discomfort, reduced concentration, fatigue, and mental strain, potentially elevating stress levels among students (8).

Several international studies have indicated a potential psychophysiological link between air quality and stress-related biomarkers such as cortisol levels, heart rate variability, and self-reported anxiety (9). These findings are supported by controlled trials demonstrating that cleaner indoor air environments are associated with improved mood, reduced tension, and better cognitive performance (10). However, similar investigations in Southeast Asian populations—especially among university students—remain scarce, which presents a significant knowledge gap.

In Indonesia, mental health issues among university students have shown an alarming upward trend, with recent reports highlighting academic pressure, poor living environments, and lack of institutional support as key stressors (11). While mental health interventions on campuses often focus on counseling or psychological support, little attention is paid to environmental factors such as air quality that may underlie or exacerbate student stress (12). Addressing IAQ could therefore be a proactive, cost-effective strategy to improve student well-being and academic performance.

Given the existing evidence and contextual urgency, this study aims to fill a critical gap in environmental health research by examining the association between indoor air quality and perceived stress among university students in Indonesia. The results are expected to provide valuable insights for university administrators, public health policymakers, and environmental health professionals in developing targeted interventions that promote healthier learning environments.

METHODS

This study employed a quantitative analytic method with a cross-sectional design to examine the association between indoor air quality and stress levels among university students in Indonesia. The research was conducted from March to May 2024 at a selected state university in South Sulawesi Province. A total of 54 students were selected using simple random sampling from various faculties. Inclusion criteria included: (1) currently enrolled as an undergraduate student, (2) spending at least 6 hours per day in indoor campus environments (e.g., classrooms, libraries, dormitories), and (3) willing to participate by signing informed consent. Students with diagnosed psychological disorders or under psychiatric treatment were excluded.

Indoor air quality (IAQ) parameters were measured in the classroom environments where the students spent the majority of their time. IAQ variables included temperature, relative humidity, carbon dioxide (CO_2) concentration, and particulate matter (PM2.5), measured using a portable digital air quality monitor (Model: Temtop M2000). Measurements were taken during peak class hours (09:00–12:00) over five consecutive days in each location.

Stress levels among participants were assessed using the Depression Anxiety Stress Scale-21 (DASS-21), which has been validated in Indonesian (13). Participants completed the self-administered questionnaire under supervision in a quiet room to ensure focus and confidentiality.

Data were analyzed using SPSS version 25. Descriptive statistics were used to summarize respondent characteristics and IAQ parameters. Bivariate analysis using Pearson's correlation and chi-square tests were

performed to determine the association between IAQ variables and student stress levels. A significance level of $p < 0.05$ was used as the threshold for statistical significance.

RESULT

Table 1. Characteristics Respondent

Characteristics	Category	Frequency (n)	Percentage (%)
Gender	Male	27	50.0
	Female	27	50.0
Faculty	Science	14	25.9
	Engineering	13	24.1
	Health	13	24.1
	Education	14	25.9
Age Group	< 20 years	16	29.6
	20–22 years	21	38.9
	> 22 years	17	31.5

Table 1 presents the demographic characteristics of the 54 university students who participated in this study. The distribution of gender was balanced, with 27 male students (50.0%) and 27 female students (50.0%). Regarding academic background, respondents were almost evenly distributed across the four faculties involved in the study. Students from the Faculty of Science and the Faculty of Education each accounted for 14 individuals (25.9%), while students from the Faculties of Engineering and Health each comprised 13 individuals (24.1%). In terms of age, the majority of students were between 20 and 22 years old, totaling 21 participants (38.9%). This was followed by 17 students (31.5%) who were older than 22 years, and 16 students (29.6%) who were younger than 20 years. This demographic spread provides a relatively balanced representation across gender, academic disciplines, and age groups, which supports the generalizability of the findings within the sampled university population.

Table 2. Association Between Indoor Air Quality and Stress Level Among Students (n = 54)

Indoor Air Quality	Normal	Mild	Moderate	Severe	Total
Good	8	3	2	5	18
Moderate	3	4	4	4	15
Poor	6	6	5	4	21
Total	17	13	11	13	54

Chi-square (χ^2) = 3.81 Degrees of Freedom (df) = 6 p-value = 0.702

Table 2 displays the cross-tabulation between indoor air quality categories (Good, Moderate, Poor) and levels of stress among university students (Normal, Mild, Moderate, Severe). The highest number of students with normal stress levels were found in rooms with good air quality (8 students), whereas rooms with poor air quality had the most students with mild stress (6 students) and moderate stress (5 students). However, the distribution of stress levels across different air quality categories did not show a clear trend.

A Chi-square test was conducted to determine whether there was a statistically significant association between indoor air quality and student stress levels. The test yielded a Chi-square value of $\chi^2 = 3.81$ with 6 degrees of freedom and a *p*-value of 0.702. Since the *p*-value is greater than 0.05, the result indicates that there is no statistically significant association between indoor air quality and stress levels among the sampled university students.

DISCUSSION

This study aimed to explore the association between indoor air quality (IAQ) and stress levels among university students in Indonesia. Although previous literature has suggested that poor IAQ can negatively affect

psychological well-being, our findings did not reveal a statistically significant association between IAQ and student stress levels ($p = 0.702$). Several factors may explain this result. First, the measured indoor air quality across all sampled rooms may not have varied significantly enough to produce detectable effects on stress levels. Prior studies have found that substantial changes in IAQ—such as high concentrations of PM2.5, CO_2, or VOCs—are required to induce measurable psychological effects (14). In our study, most environments fell within acceptable or only slightly elevated thresholds, which may have limited their influence on stress responses.

Second, stress among university students is multifactorial and often more strongly influenced by academic pressure, financial difficulties, and social relationships than by environmental factors (15). For example, Suryani et al. (2022) identified academic workload, uncertainty about the future, and personal expectations as dominant stressors among Indonesian students (16). Environmental factors like IAQ, while important, may have only a marginal or indirect role in this complex interplay.

Nonetheless, other studies have found associations between perceived air stuffiness and increased somatic or anxiety symptoms, indicating that psychological perception of the environment may be as influential as objective IAQ measurements (416. In our case, the students may not have perceived the air quality as significantly unpleasant or stressful, thus moderating any potential psychological effect.Additionally, controlled trials in Western settings have reported that improved ventilation and air purification can enhance cognitive function and mood, especially in office environments (17). These benefits, however, may depend on longer-term exposure and chronic environmental stressors not fully captured in a cross-sectional design such as ours. Although the statistical analysis did not show significant results, this does not rule out the potential health relevance of IAQ. Longitudinal studies and mixed-method approaches could better capture the interaction between environmental conditions and mental health over time.

CONCLUSIONS

This study found no statistically significant association between indoor air quality and stress levels among university students in Indonesia. While previous research has suggested that poor IAQ may contribute to psychological distress, the findings from this study indicate that other factors, such as academic pressure or personal circumstances, may play a more dominant role in influencing student stress. Nonetheless, maintaining good indoor air quality remains important for overall health and comfort in academic environments. Future research using longitudinal or mixed-method designs is recommended to explore more nuanced relationships between environmental conditions and mental health outcomes among students.

CONFLICTS OF INTEREST

All Author Declare No. conflict of interest

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