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ASSOCIATION BETWEEN VENTILATION AREA AND THERMAL COMFORT IN BOARDING SCHOOL DORMITORY ROOMS

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ABSTRACT

Association between Ventilation Area and Thermal Comfort in Boarding School Dormitory Rooms. *Ventilation plays a crucial role in creating thermal comfort, particularly in high-density residential environments such as Islamic boarding schools. Ventilation that does not meet established standards can lead to increased indoor temperature, excessive humidity, and poor air quality, thereby affecting occupants' comfort and health. According to the standards of the Ministry of Health, the ideal ventilation area should be at least 10% of the floor area. This study aimed to analyze the relationship between ventilation area and thermal comfort in dormitory rooms of an Islamic boarding school. This study employed an analytic quantitative design with a cross-sectional approach. The sample consisted of 19 dormitory rooms and 262 female students from an Islamic boarding school in Banjar Regency, South Kalimantan. Data were collected through physical measurements (temperature, humidity, and air velocity) and a questionnaire assessing perceived thermal comfort. The measurement results showed that 94.7% of the dormitory rooms did not meet the ventilation area standard (≤10% of floor area). Among these rooms, 96.2% of occupants reported experiencing thermal discomfort. Meanwhile, in rooms that met the ventilation standard, all occupants (100%) also reported thermal discomfort. The chi-square test indicated a significant relationship between ventilation area and thermal comfort ($p = 0.000$; $\alpha = 0.05$). These findings indicate that ventilation plays a role in thermal comfort, although other contributing factors should also be considered. Proper ventilation planning in accordance with established standards remains important as part of efforts to create a healthy residential environment in Islamic boarding schools.*

INTRODUCTION

Ventilation is an essential element in creating thermal comfort in residential environments, particularly in tropical climates such as Indonesia[1–2]. According to SNI 03-6572-2001, thermal comfort is influenced by air temperature, relative humidity, air velocity, as well as occupants' activity levels and clothing. Thermal discomfort can reduce concentration and productivity and may even affect health, especially in high-density environments such as Islamic boarding schools.

Data from the Ministry of Religious Affairs in 2023 indicate that there are more than 38 Islamic boarding schools in Banjar Regency, South Kalimantan. Most of these institutions provide dormitory housing with a high number of occupants per room. Under such conditions, ventilation plays a critical role in maintaining air circulation, reducing temperature and humidity, and improving indoor air quality. Regulation of the Minister of Health No. 1077 of 2011 stipulates that the minimum ventilation area should be at least 10% of the building's floor area. However, field observations indicate that many dormitory rooms in Islamic boarding schools do not meet this standard, thereby increasing the risk of thermal discomfort and potential health problems.

Cross ventilation is considered the most effective method for distributing air evenly within indoor spaces. Inadequate ventilation can result in high indoor temperatures, stuffy conditions, and increased concentrations of indoor pollutants[(1–5)]. An adequate ventilation area has been shown to contribute significantly to thermal comfort in classroom settings[(6–12)]. Meanwhile, natural ventilation plays an important role in regulating temperature and humidity in residential buildings[(2–5)].

Although several studies have examined the relationship between ventilation and thermal comfort in various building types, research focusing specifically on Islamic boarding school environments remains limited. This is noteworthy because the residential characteristics of boarding schools differ from those of private housing or classrooms, particularly in terms of high occupancy density and limited personal space. These conditions highlight the need to evaluate ventilation design in boarding school environments, especially in relation to compliance with environmental health standards.

This study was conducted at Pondok Pesantren Darul Hijrah Puteri in Banjar Regency, South Kalimantan, which comprises 68 dormitory rooms and accommodates more than 1,000 female students. Preliminary measurements indicated that most rooms have ventilation areas below the required standard. Such conditions may lead to thermal discomfort, potentially affecting students' well-being and learning productivity.

This study aims to determine the relationship between ventilation area and thermal comfort in dormitory rooms of an Islamic boarding school. The findings are expected to provide input for standard-compliant ventilation planning and to support the creation of a healthy, comfortable dormitory environment conducive to students' learning activities.

MATERIALS AND RESEARCH METHODS

This study was an analytic quantitative study with a cross-sectional approach aimed at determining the relationship between ventilation area and thermal comfort in dormitory rooms of an Islamic boarding school. The study was conducted at Pondok Pesantren Darul Hijrah Puteri, Banjar Regency, South Kalimantan, which has 68 dormitory rooms and accommodates more than 1,000 female students.

The study population included all dormitory rooms and their occupants. Room samples were selected using simple random sampling, while respondents were selected through proportional random sampling from each selected room. The total sample consisted of 19 rooms and 262 female students. The number of rooms was determined using the Slovin formula with a margin of error of 20%.

Data collection was carried out from 6 to 13 May 2025 through direct observation, physical measurements, and questionnaire distribution. Ventilation area was measured using a measuring tape and compared with the room floor area. Thermal comfort parameters comprised both objective and subjective data. Objective data included air temperature, relative humidity, and air velocity, measured using a thermohygrometer and an anemometer. Subjective data were obtained from occupants' perceptions of temperature, humidity, air circulation, clothing, activity, and room layout.

Data were analyzed using univariate analysis to describe the characteristics of each variable and bivariate analysis to examine the relationship between ventilation area and thermal comfort using the Chi-square test with a significance level of 0.05. This study received ethical approval from the Health Research Ethics Committee of Poltekkes Kemenkes Banjarmasin (No. 00172163721111220250222000 73).

RESEARCH RESULTS AND DISCUSSION

This study evaluated the relationship between ventilation area and thermal comfort at Pondok Pesantren Darul Hijrah Puteri, Banjar Regency. Data were collected from 19 dormitory rooms with a total of 262 respondents. The results are presented in the following four subsections:

Characteristics of Dormitory Room Ventilation Area

Based on direct measurements, most dormitory rooms did not meet the minimum standard for natural ventilation area, namely ≥10% of the floor area, as stipulated in Regulation of the Minister of Health No. 1077/MENKES/PER/V/2011. Of the 19 rooms examined, only 3 rooms (15.8%) had ventilation areas that met the standard, while the remaining 16 rooms (84.2%) were below the required threshold.

Tabel 1. Persentase Kamar Berdasarkan Luas Ventilasi

No.	Ventilation Area Criteria	Number of Rooms	Percentage (%)
1.	Meets the standard (≥10%)	3	15,8
2.	Does not meet the standard (<10%)	16	84,2
	Total	19	100

This condition indicates that most dormitory rooms were not designed with an optimal natural air circulation system, thereby potentially creating an uncomfortable thermal environment.

Subjective Thermal Comfort Conditions

Respondents were asked to assess the thermal comfort of their dormitory rooms based on subjective aspects, including temperature, humidity, air circulation, and comfort during daily activities. The questionnaire results showed that the majority of female students (65.3%) reported feeling thermally uncomfortable with the conditions of their rooms.

Table 2. Respondents' Perceptions of Thermal Comfort

No.	Comfort Category	Number of Respondents	Percentage (%)
1.	Comfortable	91	34,7
2.	Uncomfortable	171	65,3
	Total	262	100

Most respondents complained of stuffy air, high daytime temperatures, and uneven air circulation, particularly in rooms located on upper floors and in rooms with small ventilation openings.

Relationship between Ventilation Area and Thermal Comfort

The Chi-square test was used to examine the relationship between ventilation area and thermal comfort. The analysis results indicated a significant relationship between the two variables (p-value = 0.000 < α = 0.05).

Table 3. Relationship between Ventilation Area and Thermal Comfort

No.	Ventilation Area	Comfortable	Uncomfortable	Total
1.	Meets the standard (≥10%)	3 (100%)	0 (0%)	3
2.	Does not meet the standard (<10%)	88 (33,6%)	174 (66,4%)	262
	Total	91	171	262

Chi-Square Test Result: p = 0.000

Rooms with ventilation areas that met the established standards tended to be occupied by residents who reported thermal comfort. In contrast, rooms that did not meet the minimum ventilation area requirements showed a predominance of negative responses regarding temperature comfort and air circulation[13–14].

The findings of this study indicate that ventilation plays a crucial role in creating thermal comfort in dormitory rooms within Islamic boarding schools. Natural ventilation functions as a medium for air exchange between indoor and outdoor environments. When the ventilation area is too small, trapped hot air cannot be effectively discharged, resulting in stuffy and uncomfortable indoor conditions[15–17]. Ventilation area has a significant influence on indoor air temperature and humidity[2–5], while cross ventilation can enhance air circulation by up to 70% compared to single-sided ventilation[18–20]. Adequate air supply within dormitory rooms directly affects occupants' thermal comfort, particularly in spaces with limited ventilation[21–22].

In the context of Islamic boarding schools, dormitory rooms are typically occupied by 10 to 20 female students, and dense activities combined with occupants' metabolic heat contribute to increased indoor temperatures[23–26]. When ventilation is insufficient, the accumulation of carbon dioxide and heat becomes unavoidable. This condition affects not only comfort but also concentration and physical well-being. Activities carried out in dormitory rooms, such as studying, discussions, and religious practices, require adequate thermal comfort to be performed optimally. Prolonged thermal discomfort may reduce productivity and increase the risk of health problems[27–35].

Field measurements showed that temperatures in several rooms reached 31–32°C with relative humidity levels exceeding 70%, which are far above the comfort standards recommended by SNI 6390:2011, which specifies an indoor temperature range of 24–27°C and relative humidity of 40–60%. One contributing factor to these conditions is building design that does not adequately support cross ventilation, such as multi-storey buildings with narrow spacing between structures, as well as ventilation openings in the form of small windows or ineffective air vents. In addition, densely arranged rooms filled with personal belongings further obstruct air movement.

Inadequate ventilation not only reduces comfort but may also adversely affect health. Warm and humid air provides an ideal environment for the growth of microorganisms, including fungi and bacteria. Complaints such as difficulty sleeping, headaches, and sensations of stuffiness were reported by several respondents, underscoring the importance of implementing ventilation standards in high-density residential environments.

The results of this study are consistent with previous research. Sulastri (2021) reported that insufficient ventilation in Islamic boarding schools in Central Java adversely affected students' sleep quality due to high indoor temperatures. The strength of the present study lies in its quantitative approach and the use of direct measurements of ventilation area, accompanied by statistical analysis, thereby providing findings that can serve as a valid technical reference[36].

As a recommendation, Islamic boarding schools are advised to evaluate their building ventilation designs. The implementation of cross ventilation, the use of louvers or high-level vents near the upper walls, and the addition of mechanical ventilation such as exhaust fans in rooms that are difficult to modify structurally may serve as practical solutions. Furthermore, education should be provided to administrators and students to avoid blocking ventilation openings or placing objects in front of air inlets, in order to maintain optimal air circulation.

CONCLUSIONS AND RECOMMENDATIONS

This study demonstrates a significant relationship between ventilation area and thermal comfort in dormitory rooms at Pondok Pesantren Darul Hijrah Puteri, Banjar Regency. The majority of rooms did not meet the minimum ventilation standard (≥10% of the floor area), resulting in thermal discomfort characterized by high temperatures, excessive humidity, and poor air circulation. In contrast, rooms with ventilation areas that complied with the standard tended to provide better thermal comfort for their occupants.

It is recommended that the management of Islamic boarding schools improve ventilation design by implementing cross ventilation and providing adequate air openings. Education for administrators and students is also essential to ensure that air circulation pathways remain unobstructed and function optimally. Future studies should consider additional variables such as occupant density, types of ventilation, and indoor air quality. Evaluation of simple interventions, such as room rearrangement or the addition of mechanical ventilation, may also represent important steps toward improving comfort and environmental health in residential settings.

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