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THERMAL COMFORT ANALYSIS IN OLDER ADULT HOUSING (CASE STUDY: LAWANG DISTRICT, MALANG)

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ABSTRACT

Thermal comfort is crucial in building design because it can affect the occupants' health, productivity, and well-being. For older adults, thermal comfort becomes critical, as aging can decrease their physiological ability to adapt to the environment temperature changes. Using field measurement and questionnaire survey, this research assessed the thermal comfort of older adult occupants in a naturally ventilated housing in Lawang District, Malang, Indonesia. Adaptive Comfort Model (ACM) was used to analyze thermal sensation (TSV), thermal acceptability (TA), and thermal preference (TP), with utilizing a psychometric chart. The result of the study indicates that climate-responsive and naturally ventilated housing can sustain acceptable thermal condition for older adult occupants, highlighting the importance of adaptive design strategies to enhance comfort and support healthy aging in tropical highland environment.

Keywords: Older adult; building comfort; thermal comfort; adaptive comfort model

INTRODUCTION

Climate has a big impact on many parts of life, including architecture. Because of the different climates in different countries, buildings have been built in different ways, depending on their surroundings (Alhindawi and Jimenez-Bescos, 2022; Ospino, Robles and Tovar, 2024). These architectural responses often manifest through the development of building strategies that correspond to local climatic conditions, aiming to achieve comfort and support daily activities within built environments (Syaifuddin Zuhri, Imam Ghozali, and Heru Subiyantoro, 2024).

In an architectural context, adapting building in regulated thermal comfort is the most essential aspect in building design. Environmental conditions, climate, cultural background, human psychology, gender, age, physiological conditions, and health, are all factors that affect thermal comfort (Laouadi, Sirati and Jandaghian, 2025). Buildings with optimal thermal comfort can improve cognitive function, physical performance, health, well-being, and satisfaction with activities within the building (Xie *et al.*, 2020; Zhou *et al.*, 2023; Laouadi, Sirati and Jandaghian, 2025). On the other hand, poor thermal comfort can make sleep worse, make it harder to exercise, disrupt physical activity, and raise health risks.

However, while thermal comfort is always a primary consideration in design, thermal requirements are typically designed universally based on the average age characteristics of healthy adults. Nevertheless, each group of building users has different physiological and behavioral characteristics when responding to environmental thermal conditions. One group that is highly sensitive to thermal conditions is the elderly.

People with age 65 years old or older are considered older adults. (Lee *et al.*, 2018) grouped elderly into 3 age ranges: young-old (65-74 years old), middle-old (75-84 years old) and old-old (85 years or older). As people age, they experience increased difficulty in regulating their body temperature, heightened sensitivity, reduced sweating and vasodilation, and impaired temperature regulation due to medication (Xia *et al.*, 2023; Fastl *et al.*, 2024). They are also more vulnerable to infections which may increase under climate stresses like heat, pests, or floods, and other environmental hazards (Gamble *et al.*, 2016). As a result, they are more likely to be harmed by extreme heat or cold, which has a big effect on how comfortable they feel and how they feel about the temperature inside a building.

About 63 million people, or about 1 in 5 Indonesians, will be older adults (60 and up) by 2045. This change means that Indonesia is moving from a "demographic bonus" period (when there were a lot of people of working age) to an aging society, where the number of people who need help goes up. Older adults will become a significant policy focus in healthcare, pensions, social protection, and housing. Therefore, it is time for Indonesian homes to consider designing housing that prioritizes the thermal comfort of older adults. According to (Zhou *et al.*, 2025), considering thermal comfort in elderly spaces is crucial because it can contribute to their health, comfortable aging, and daily activity performance.

Numerous studies have examined the thermal comfort of older adults in residential buildings, such as (Nie *et al.*, 2019; Molina *et al.*, 2021) which examined thermal comfort in dwellings in Peru and Tibet. They found that passive heating and the composition of the room layout can influence occupant thermal comfort. Meanwhile, (Laouadi, Sirati and Jandaghian, 2025) developed a predictive model of thermal comfort for older adults in residential areas across various climate zones.

However, most of these studies focus on the thermal comfort of older adults in residences under extreme climate conditions, particularly in cold regions. In Indonesia, there are still a few to none studies that discuss thermal comfort in elderly homes in tropical climates with humid conditions. This study focuses on thermal comfort in older people residence situated in a tropical highland climate, which is in Lawang district. This house is examined as a case study to explore the influence of architectural design and local climate conditions on thermal comfort and their daily living experiences. As an explanatory pilot study, it aims to understand how architectural design and local climatic conditions shape thermal comfort and daily adaptive behaviors among older occupants.

Based on this background, this study aims to analyze thermal comfort in older adults housing based on climate conditions in Lawang District, Malang Regency, Indonesia. To achieve this objective, this study uses a psychrometric chart with the Adaptive Comfort Model (ACM) analysis to evaluate the thermal conditions impacting the activities and behavior of older people. This pilot study offers preliminary insights into how building characteristics and highland climatic conditions influence thermal comfort perceptions among older adults. The early findings may guide future research on thermal performance in tropical residential environments and inform considerations for creating older people-supportive housing that is responsive to the environment.

Building Comfort Aspects

Studies have shown that older adults are less able to adapt to temperature changes, making them more sensitive to heat and cold, which can cause negative effects to their health and well-being (Zhou *et al.*, 2024, 2025). To make sure that older people are comfortable enough inside the building, it is important to apply design strategies that respond to the local climate. It helps to maintain stable indoor environments, enhance comfort for building's occupants, and encourage healthy aging (Hailu, Gelan and Girma, 2021).

Creating a comfortable building environment involves various aspects, such as physical, environmental, and psychological factors. It is related to climate aspects and has become a major concern in sustainable and human-centered building design. Climate influences several architectural design elements (Givoni, 1998), including sun exposure, solar heat gain, conduction and convection of ambient heat, natural ventilation and passive cooling design. Thus, thermal comfort in buildings is directly related to these climate influences, which have a significant impact on the quality of the indoor environment.

There are two commonly used models to examine thermal comfort on psychrometric chart: Predicted Mean Vote (PMV) and the Adaptive Comfort Model (ACM). The PMV model was developed by (Fanger, 1970), it employs a physiological approach based on the heat balance between the human body and its surrounding environment. The PMV model is used in air-conditioned rooms or spaces with mechanical, thermal control systems, where indoor condition can be maintained at stable levels. On the contrary, the ACM model uses an empirical (adaptive) approach based on field observation of occupant behavior and

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thermal perception in relation to local climate conditions. The ACM model is more suitable for naturally ventilated buildings without any mechanical cooling systems. According to this model, thermal comfort depends on the occupant's ability to adapt to their environment condition (de Dear and Brager, 2002). The ACM model assumes that occupants can gain thermal comfort by changing their clothing, opening the windows, or changing activity levels. Therefore, the comfortable indoor temperature can be varied depend on the outdoor temperature.

The thermal comfort level of indoor air condition is evaluated through the psychometric chart, which also presents predicted thermal comfort zones. It also helps to study thermodynamic air processes, design appropriate air-conditioning systems, and evaluate building energy efficiency. This analysis is very important, especially for older adults. Keeping indoor thermal condition steady can enhance comfort, reduce health problems caused by thermal stress, support overall well-being, and promote healthy aging.

METHODS

This study used a case study of housing inhabited by older adults in Lawang, Malang. Lawang has a tropical climate with high precipitation, especially during the rainy season (October to March). According to the Köppen climate classification, Lawang is categorised under the tropical monsoon climate. This area is geographically located in the highland region with the land elevation of the house is higher than the average land elevation in Indonesia. The research object was located in Jl. Pandowo, Lawang, Malang, Jawa Timur, Indonesia (Figure 1). This house was chosen in consideration of its suitability for the demographic of users, who are older adults.

The research object is a two-story housing, facing the west side (Figure 2). The house consists of a terrace, living room, family room, two bedrooms, dining room, kitchen, and bathroom on the first floor. While on the second floor, the house contains two bedrooms and a balcony (Figure 3). This house applied natural ventilation, without a fan or air conditioner (AC). The house was made of plastered brick walls and clay tile roofs. The occupants of this housing consist of two older adults, one male (85) and one female (75). The research involves two older respondents and is positioned as a pilot case study. To enhance internal validity, data were triangulated by taking questionnaires and measuring the temperature within seven days a week and four times a day.

Figure 1. The map of the investigated house
(Source: Google Maps, 2021).

Data collections were conducted in December 2021, during the rainy season and conducted in two parts. The first part was conducted by collecting data on climate conditions, including temperature, humidity, and air speed at the site. Climate data were gained from application software records, specifically 'info BMKG' and 'weather' applications on electronic devices. These applications provided weather data from Karangploso, Malang. Each room in the house was measured for temperature, relative humidity, and air velocity at four designated time intervals: 08.00, 12.00, 16.00, and 20.00 WIB. All rooms in the house were measured, excluding the balcony and terrace areas, as they were outdoor spaces. Almost all of the rooms have at least one window, which comes in various sizes.

Figure 2. The house facade faces the west side
(Source: Author, 2021).

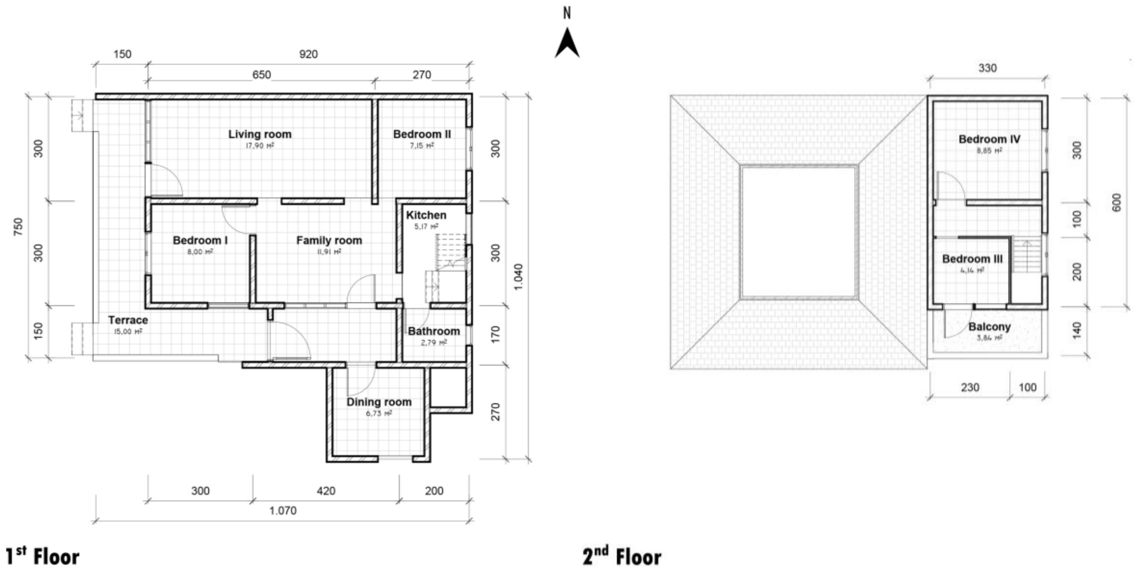

Figure 3. Plans of the house
(Source: Author, 2021).

Table 1. Likert Scale of Thermal Comfort Questionnaire

`	Thermal Sensation (TSV)	Thermal Acceptability (TA)	Thermal Preference (TP)
3	Hot	-	-
2	Warm	-	-
1	Slightly warm	Acceptable	Want warmer
0	Neutral	Unacceptable	No change
-1	Slightly cool	-	Want cooler
-2	Cool	-	-
-3	Cold	-	-

(Source: (Forcada *et al.*, 2021; Feng *et al.*, 2024))

The second part involved collecting data on housing conditions. Data collected through site measurement, observation, and questionnaires with the occupants. Site conditions were collected from measuring dimensions and describing the house situation. Observations were conducted within the house from 08.00 to 20.00 WIB. Observations aimed to examine the shifting of occupants' activities and house situation. Researchers distributed the questionnaires over one week to evaluate how occupants perceived the thermal comfort. The questionnaire incorporated Likert-scale items, followed the ASHRAE 7-point scale, which consists of thermal sensation (TSV), thermal acceptability (TA), and thermal preference (TP) (Table 1).

Both climate data and housing conditions data were identified and classified. Climate data were analyzed using psychrometric charts for the entire house. Psychrometric charts were used based on the standard of ASHRAE 55-2023. In this study, thermal measurement of the psychrometric charts involves indoor temperature, mean outdoor temperature, and air speed. Then, analyses were conducted with the ACM (Adaptive Comfort Model) index, as responses of the housing condition that has no air conditioner (AC) or fan. The acceptable indoor temperature should be based on the satisfaction of 90% of the occupants, which in ACM is shown by equation T_{comf} (de Dear and Brager, 2002).

The comfort temperature Tcomf is equal to:

$$Tcomf = 0.31 \times \overline{Tout} + 17.8$$

The comfort temperature T1 is equal to:

$$T1 = Tcomf - 2.5$$

The comfort temperature T_u is equal to:

$$Tu = Tcomf + 2.5$$

Symbols:

$Tcomf$: comfort temperature, i.e. a temperature by which a defined percentage of occupants is in neutral thermal state[℃]

$\overline{Tout}$: Mean month outdoor air temperature [℃], in this research a week period was used instead a month

$T1$: lower limit of comfort band [°C]

Tu : upper limit of comfort band [°C]

RESULT AND DISCUSSION

Outdoor temperature measured for a week, December 5th to 11th, 2021. Each day, the temperature was measured at 08:00, 12:00, 16:00, and 20:00 (Figure 4). Then the mean temperature were calculated each time. The mean outdoor temperature for 08:00 is 24,08 °C, 12:00 is 26.58 °C, 16:00 is 25,78 °C, and 20:00 is 24,48 °C. These numbers are in between the range of average temperature on inland (26 °C) and higher mountain area (23 °C) in Indonesia (Brosur Informasi Iklim BMKG, n. d.).

Adaptive Thermal Comfort

To evaluate the indoor thermal comfort conditions, the adaptive thermal comfort assessment was also conducted at four different times of the day (08:00, 12:00, 16:00, and 20:00) using the ASHRAE Standard 55-2023 adaptive model psychrometric chart.

The adaptive model psychrometric chart at 08.00, 12.00, 16.00, 20.00 is shown in Fig. 5a, 5b, 5c, and 5d. The adaptive comfort chart illustrates the relationship between the prevailing mean outdoor temperature (X-axis) and the operative temperature (Y-axis). The dark green area represents a 90% acceptability range of comfort zones, while the light green area represents an 80% acceptability range of comfort zones as defined by ASHRAE Standard 55. The red circles which fall in the dark green area mean that current temperature meets the 90% comfort standard and is comfortable for occupants. As well as if the circle falls in the light green area, mean that current temperature meets the 80% comfort standard and is also comfortable for occupants.

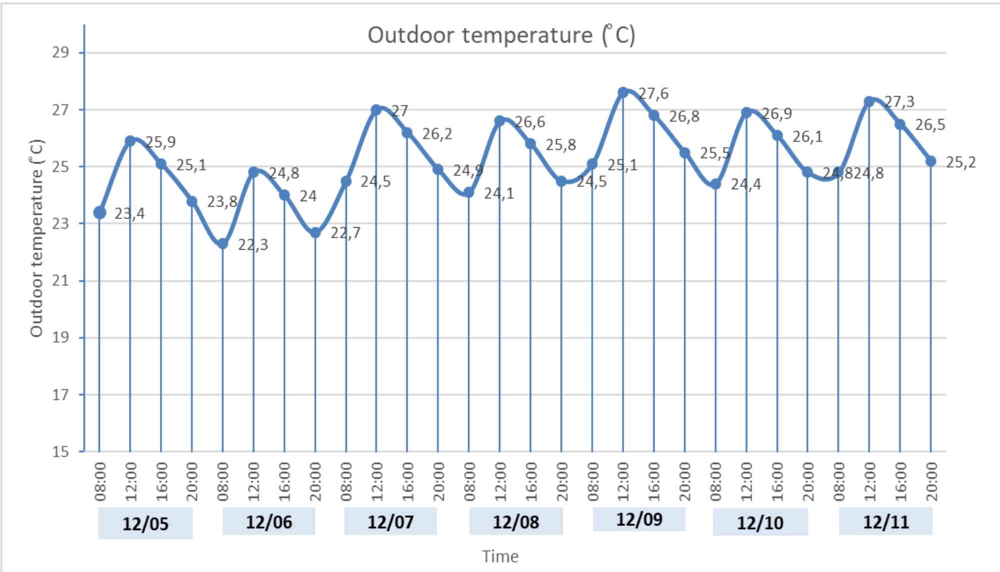

Figure 4. Outdoor temperature (T_{out}) observed December 5th - 11th, 2021
(Source: Author, 2021)

Table 2. Mean Outdoor Temperature for a week

Time	Mean outdoor temperature (°C)
08:00	24,08
12:00	26,58
16:00	25,78
20:00	24,48

(Source: Author, 2021)

According to ACM of ASHRAE Standard 55, this approach is used for naturally ventilated spaces. It assumes that occupants can adapt to their thermal environment with metabolic rates between 1.0 and 1.3 met (light activity) and clothing insulation levels between 0.5 and 1.0 clo. This allows occupants to adjust to different indoor and outdoor temperatures depending on season or situation. Meanwhile, the wind speed observed from 0.1 to 0.33 m/s, which is classified under the 0.3 m/s category in ACM among the four wind speed categories (0.3, 0.6, 0.9, and 1.2 m/s).

At 08:00, the observed operative temperature was 24.88°C, with a mean outdoor temperature of 24.08°C and a wind speed of 0.3 m/s, as shown in Fig. 5a. The 80% acceptability limit range between 21.8°C and 28.8°C is considered comfortable, while the 90% acceptability limit range between 22.8°C and 27.8°C is also considered comfortable. The observed operating temperature of 24.88°C is within 80% to 90% acceptability limits. This means that most people will feel comfortable or thermally neutral in these settings.

At 12:00, the observed operative temperature was 26.31°C, with a mean outdoor temperature of 26.58°C and a wind speed of 0.3 m/s, as shown in Fig. 5b. The 80% acceptability limit range between 22.5°C and 29.5°C is considered comfortable, while the 90% acceptability limit range between 23.5°C and 28.5°C is also considered comfortable. The observed operating temperature of 26.31°C is within the 80% to 90% acceptability limits, indicating that most occupants would feel thermally comfortable but slightly warmer than in the morning.

At 16:00, the observed operative temperature was 25.86°C, with a mean outdoor temperature of 25.78°C and a wind speed of 0.3 m/s, as shown in Fig. 5c. The 80% acceptability limit range between 22.3°C and 29.3°C is considered comfortable, while the 90% acceptability limit range between 23.3°C and 28.3°C is also considered comfortable. The observed operating temperature of 25.86°C is within 80% to 90% acceptability limits. This means that most occupants would feel neutral or thermally comfortable under these conditions, slightly cooler than in the afternoon.

Table 3. Result of the Mean Temperature of Each Room in a Week

Room	**Mean Temperature in a Week (°C)**			
	8:00	**12:00**	**16:00**	**20:00**
Living room	26.23	27.83	27.39	26.56
Family room	25.63	27.00	26.54	25.67
Bedroom I	23.96	25.39	24.94	24.14
Bedroom II	25.16	26.59	26.17	25.34
Dining room	25.37	26.76	26.33	25.57
Kitchen	24.10	25.43	25.14	24.27
Bathroom	23.90	25.21	24.79	24.01
Bedroom III (2F)	24.51	25.99	25.37	24.57
Bedroom IV (2F)	25.09	26.59	26.07	25.23
Average Room Temperature Each Time	**24.88**	**26.31**	**25.86**	**25.04**

(Source: Author, 2021)

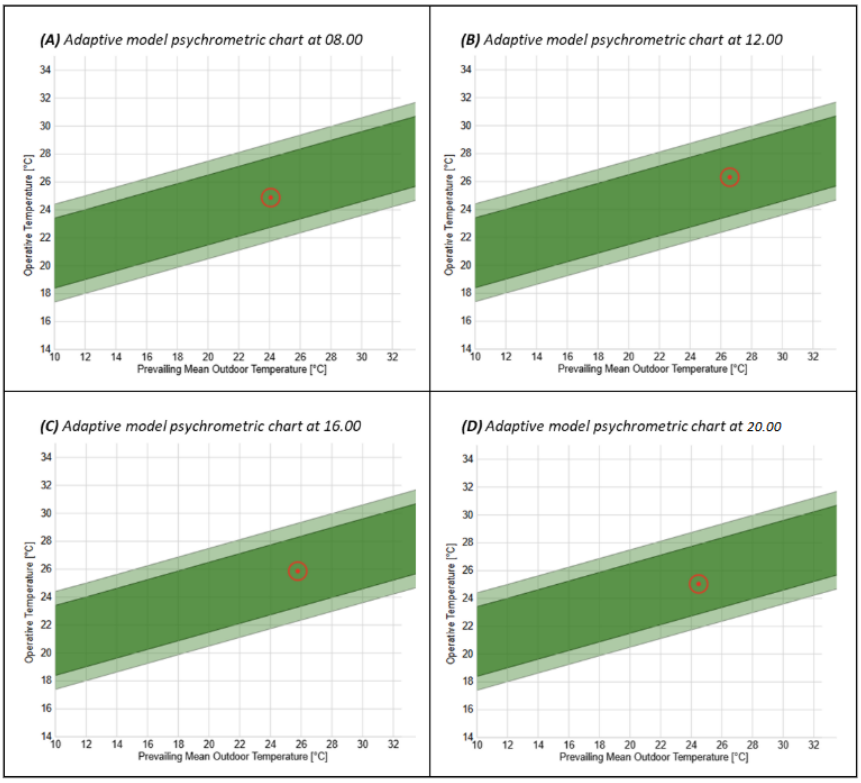

Figure 5. Adaptive model psychrometric chart at 08.00, 12.00, 16.00, 20.00
(Source: Author, 2021)

At 20:00, the observed operative temperature was 25.04°C, with a mean outdoor temperature of 24.48°C and a wind speed of 0.3 m/s, as shown in Fig. 5b. The 80% acceptability limit range between 21.9°C and 28.9°C is considered comfortable, while the 90% acceptability limit range between 22.9°C and 27.9°C is also considered comfortable. The observed operating temperature of 25.04°C is within the 80% to 90% acceptability limits, indicating that most occupants would feel thermally neutral or comfortable under these conditions.

Thermal Sensation (TSV) Analysis and Indoor Temperature

The results of the TSV questionnaire, using a 7-point Likert scale (according to Table 1), were processed based on gender and room type into the scatter plot diagrams (Fig 6.). This aims to determine the sensation trends felt by each occupant in each room at different temperatures. Overall, it was found that there was a strong linear relationship between TSV and indoor air temperature. The results of the regression calculation showed an equation TSV = 0.9494T – 24.098, with determination coefficient (R2) = 0.7606. It means that approximately 76% of the variation of the occupants' thermal sensation can be explained by changes in indoor temperature. Then to obtain the overall neutral temperature of the house, it was determined that the neutral TSV on the Likert scale was 0, then by using the results of the regression equation, the neutral temperature is 25.39 °C.

$$Tn = \frac{0 - (-24.098)}{0.9494} = 25.38\ ℃$$

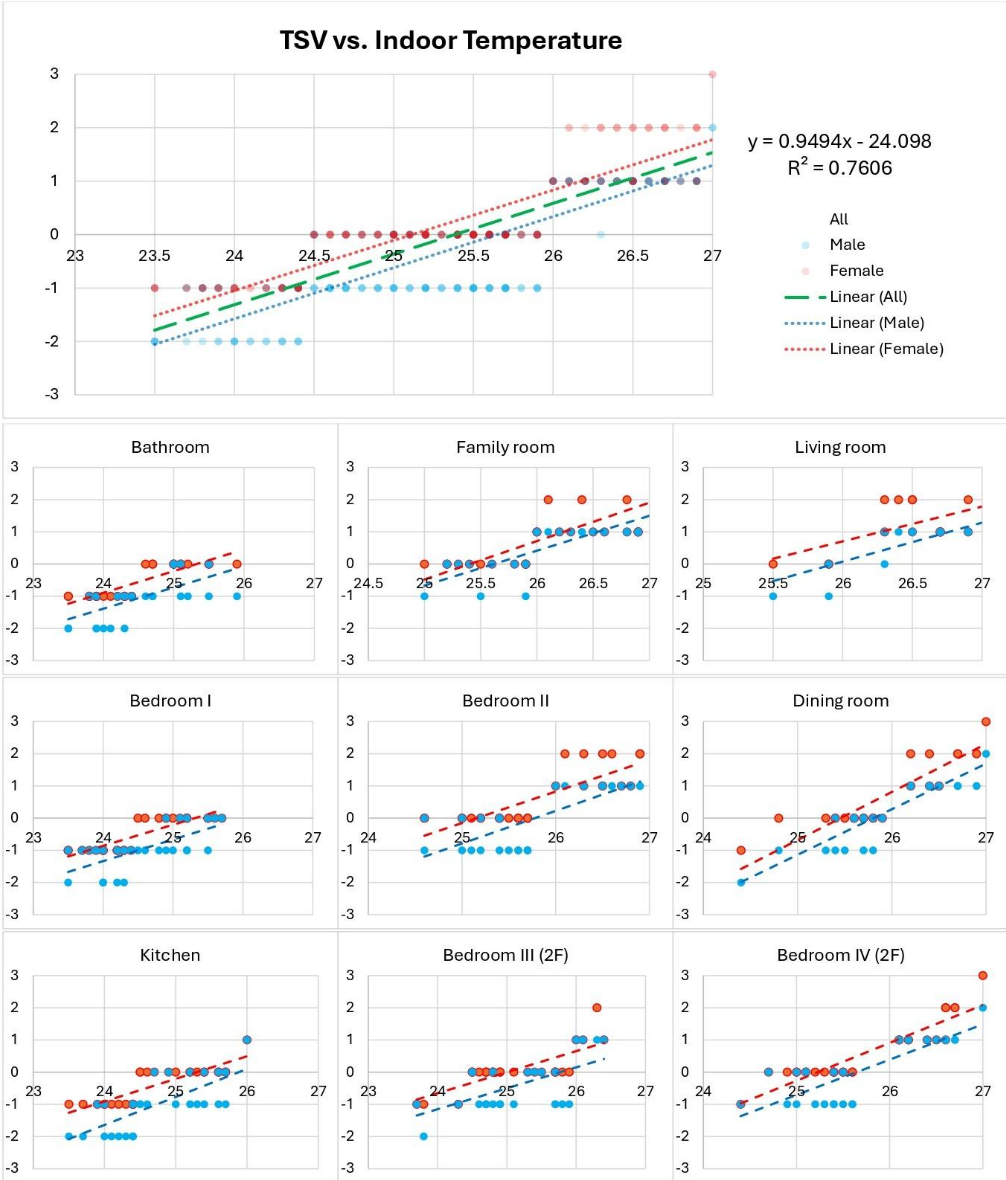

Figure 6. Thermal Sensation Vote Analysis
(Source: Author, 2021)

Next, discussing the TSV trend, which shows a positive pattern, where occupants feel cooler at lower temperature, and warmer as the temperature rises. Both occupants show a similar linear trend in their TSV, even though the female occupants' regression line lies slightly above the male occupant's. This indicates that women tend to feel warmer at the same temperature. Meanwhile, in this case, the male occupant reported a cooler sensation than the female at the same temperature. Differences in age, activity level, and personal thermal history can contribute to differences in sensations among older adults.

Many factors affect how humans feel warmth differently, such as gender differences, physiological variances, and age. (Karjalainen, 2012) indicated that females are 1.74 times more likely to experience thermal discomfort, while (Lan *et al.*, 2008) found that female prefer slighthly warmer environments due to consistenly lower skin temperatures. (Wu *et al.*, 2023) also confirmed that older adults show slower and less obvious thermal changes compared to younger age group. The differences in how people perceive the temperatures arise from physiological differences, such as metabolism and thermoregulation. (Xiong *et al.*, 2022) mentioned that perimenopausal women have higher warmth perception and thermal dissatisfaction, emphasizing the complex relationship among age, gender, and thermal comfort.

Thermal Acceptability (TA)

Average TA (Fig. 7) across all spaces ranged from 44% to 97%, with all bedrooms achieving the highest acceptability (around 90% and above). The drastic result seen on the living room's TA was under 50%, followed by the balcony with 75%. The results found that thermal conditions were acceptable for most of the intimate or most private spaces. On the other side, space that is more public gets a lower thermal acceptability rate.

The actual conditions on site contribute to the room's TA. In terms of spatial organization, the living room is located at the front of the house. The West-facing side has openings in the form of windows and ventilation (Fig. 8). This room has more windows and is larger in size than the other rooms. Despite this, the living room's mean temperature is the highest among all the rooms in the house (Table 3).

Comparing the living room which has the lowest TA rate with bedroom III that has the highest TA rate, they both have windows that face outside the house, except the bedroom III windows stay open and the room faces South (Fig. 9). The observation suggests that lower TA rate happened because all the ventilations in the living room were closed most of the time. Bad air circulation made the room temperature rise and reduced the TA rate. The room orientation also plays on the temperature of the room. The living room that faces west has a higher temperature than bedroom III that faces South. This confirms that opening orientation influences thermal comfort in wet tropical climates (Adianti and A, 2019).

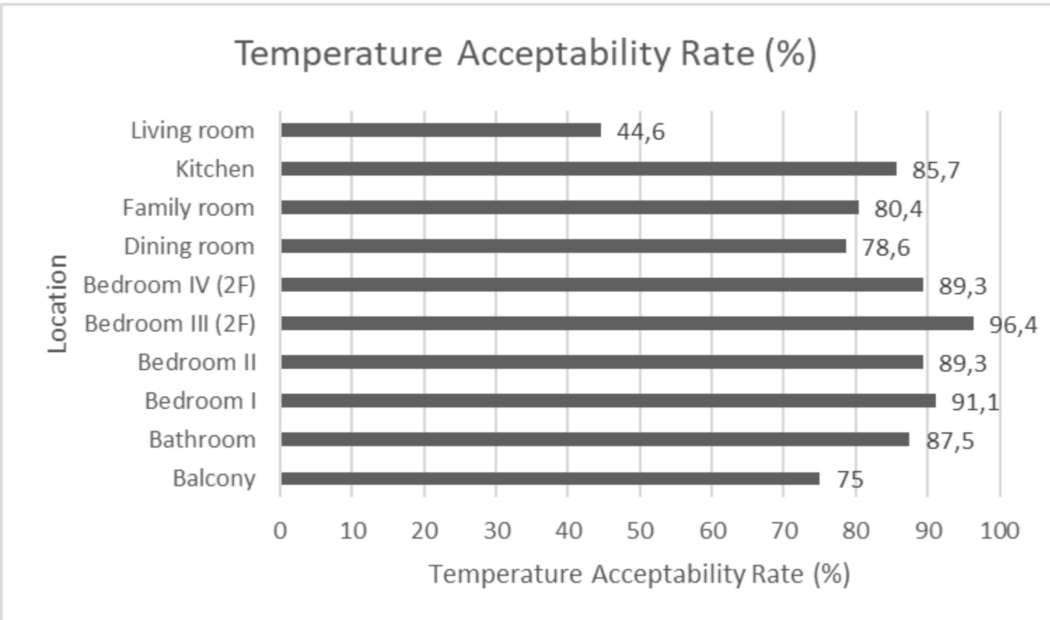

Figure 7. Thermal Acceptability Rate
(Source: Author, 2021)

Figure 8. Ventilation placement in the living room
(Source: Author, 2021)

Figure 9. Ventilation placement in the bedroom III on the second floor
(Source: Author, 2021)

Thermal Preference (TP)

The questionnaire results of TP (Fig. 10) indicated that the female occupant (75) tends not to change the thermal settings (TP = 0, n = 136) for the overall rooms in the house. During midday and afternoon, the female occupants expressed a bigger preference in cooler conditions (TP = -1). Most of the time, the real thermal condition suits to the female occupant's preference. Meanwhile, the male occupant (85) preferred warmer conditions for almost all of the rooms (TP = 1, n = 119). During midday and afternoon, the male occupants also expressed a bigger preference in cooler conditions (TP = -1), yet in the morning and night, male occupants preferred the warmer conditions (TP = 1).

These contrast patterns between male and female occupant reflect physiological and metabolic differences related to age and gender. It indicated that older female has lower metabolic rates and higher humidity sensitivity than older males. These findings were consistent with previous studies. (Jung *et al.*, 2023) stated that there are significant differences in thermoregulation between young people and older people. Older people tend to feel cold easily because they lack of sensitivity in feeling hot and have high risk in perceived extreme surge of temperatures. (Pandolf, 1997) also declared that older male has lower tendency to feel overheated compared to younger male. Conversely, older females and younger females have no significant differences in perceiving thermal conditions because they have more stable thermal perceptions. As someone gets older, physically it has changed: decreasing cardiac output, losing control in sweating, decreasing muscle and metabolism rates, decreasing sensitivity of thermal, and increasing fat body percentages.

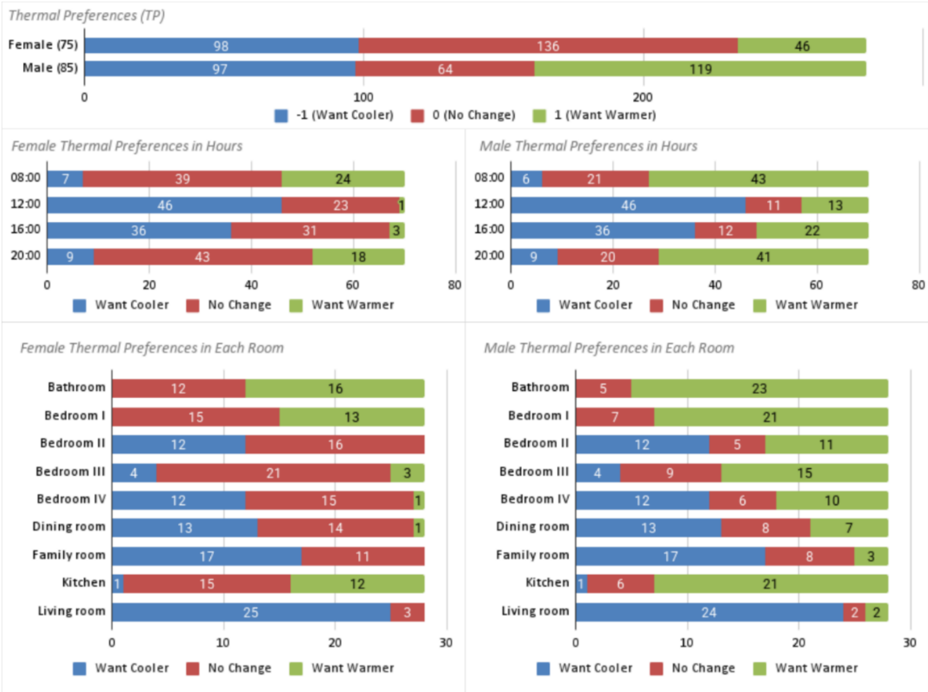

Figure 10. Distribution of Thermal Preferences
(Source: Author, 2021)

On the other hand, according to the specific room, significantly in the living room, both male and female occupants preferred the cooler conditions. It could be influenced by the ventilation of the room. This finding was relevant to the result of thermal acceptability in the previous segment.

Implications for Older Adult Thermal Comfort

The integration of objective models (adaptive model) and subjective thermal responses (TSV, TA, and TP) shows a strong correlation between occupant-perceived comfort and the thermal neutral zone predicted by the adaptive framework. When the indoor operative temperature was maintained around 25–26°C—coinciding with the center of the adaptive comfort band—both elderly occupants reported neutral sensations (TSV ≈ 4), high acceptability levels (TA > 85%), and no desire for temperature change (TP = 0). This consistency reveals that residence with natural ventilation maintains comfort effectively within the limits of the adaptive comfort model as suggested in *ANSI/ASHRAE Addendum d to ANSI/ASHRAE Standard 55-2017*2017). de Dear and) in adaptive comfort theory also confirmed this concept.

Minor inconsistencies were observed during early morning and evening periods when indoor temperatures dropped to around 24°C. In these situations, the TSV result of occupants directed at “slightly cool”, but the responses of TA remained acceptable at 75%. This finding is aligned with previous studies indicating that occupants in residences with natural ventilation tend to tolerate a wider thermal range through physiological adaptation and behavior adjustments, such as wearing adaptive clothing and changes activity levels (Toe and Kubota, 2013).

Furthermore, the slight variation between individuals indicated the female occupant tended to perceived warmth earlier than the male occupants, highlighting age and gender-related differences in thermal sensitivity. The thermal comfort experienced by older adults inside residence with natural ventilation is the combination result of some efforts between the physical environment, the adaptive behavior, and the psychological expectation. Adaptive comfort model and subjective comfort index have been proven to be dependable evaluation tools for tropical house design (Rupp, Vásquez and Lamberts, 2015; Sudarsanam and Kannamma, 2025).

CONCLUSION

This pilot study offers preliminary insights into how older adults perceive and adapt to thermal conditions in a naturally ventilated home within a tropical highland climate. The results indicate a connection between how occupants perceive their comfort and the thermal conditions predicted by the adaptive framework. The result shows that even though the building is on the higher elevation of the land than Indonesia's average land elevation, the spatial organization, orientation of openings, and air circulation patterns are still giving significant impact to the level of thermal comfort in a room. The study emphasizes the importance of integrating adaptive thermal comfort principles with spatial design strategies to enhance the well-being of older adult occupants. In addition, variation in site conditions, such as topography, microclimate, and building exposure, can potentially shape different perceptions of thermal comfort among older adults. Future studies should explain how these site-related factors influence the adaptive thermal comfort responses of older adults.

This study also shows how important it is to understand how the condition of buildings, the climate, perceived comfort, and how older adults adjust to their thermal environment affect their well-being and thermal comfort in their homes. Therefore, in designing homes for older adults, it is important not only to focus on technical standards, but also behavioral adaptation, activities, and occupants' comfort perception. The solution involves designing climate-adaptive homes which do not ignore the characteristics, identity, activities, and conditions of people within the residence.

While the findings are limited by the small number of respondents, the study highlights how environmental factors, architectural features, and adaptive behaviors interact in daily thermal experiences of older adults. These observations point to potential design considerations such as optimizing natural ventilation paths, improving shading strategies, and managing heat gain that may support comfort in similar homes. Future studies should explain this approach to a broader range of residential settings, climatic regions, and participant groups. It also needs to investigate how behavioral, environmental, and social factors collectively shape older adults' adaptive responses to thermal condition in their homes.

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