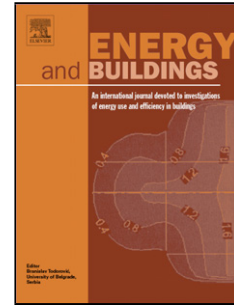


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# Clarifying thermal comfort of healthcare occupants in tropical region: A case of indoor environment in Thai hospitals

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## Abstract:

Because the thermal environment affects both physical and psychological health, the issue of maintaining comfort in hospital is vital. For assessing the hospital indoor environment, it is still doubtful whether the predicted mean vote (PMV) model and comfort criteria of ASHRAE Standard 55 are applicable to healthcare occupants. The number of studies that have examined thermal comfort in healthcare is very limited. Therefore, this research aims to clarify the thermal comfort of healthcare occupants, validate the usability of the PMV model and determine whether the comfort criteria of current hospital standards are suitable for a tropical region. A field survey was conducted in two general hospitals in Bangkok. The data sets of patients, visitors and staff were analysed separately to understand their specific requirements. This was done by comparing objective parameters according to comfort criteria of ASHRAE Standard 55 and subjective measurements of actual comfort.

The results showed that the PMV model mismatched thermal comfort for healthcare occupants in the tropics, particularly for medical staff. The preferred temperature for the thermal comfort of tropical occupants was slightly colder than neutral, although patients preferred warmer temperatures than other occupants. The acceptable temperature range for patient, visitor, and medical staff are at 21.8-27.9, 22.0-27.1, and 24.1-25.6 °C respectively, which is warmer than suggested by the Thai standard. As a result, to optimally enhance the comfort and health of occupants in a healthcare facility in tropical regions, the standard used for hospital environments must be carefully integrated and revised in accordance with the different requirements for the thermal comfort of various healthcare occupants.

## Keywords:

*Thermal comfort, Healthcare facility, Tropical region, Indoor environment*

## 1. Introduction

Thermal comfort is defined as the satisfaction of occupants with the thermal environment, which can be assessed by subjective evaluation [1]. Research on thermal comfort has been discussed for several decades because it is essential to provide an appropriate thermal environment for building occupants. The World Health Organization's guidance on thermal comfort emphasises that the thermal environment is associated not only with human comfort but also with health and productivity of occupants [2, 3]. In this regard, a healthcare facility is particularly critical due to the vulnerability of the occupants, who are at the risk for health symptoms, sick building syndrome and respiratory diseases [4, 5]. The fact that a hospital has unique functional characteristics leads to difficulty in providing a thermal environment that is suitable for different occupants. Patients with a lower metabolic rate and less clothing insulation, spending a shorter time in hospital and may require different thermal conditions compared with medical staff, who are in good health, have a higher metabolic rate and work in the hospital for more than 10 hours per day. It is necessary to identify a common range of operative and radiant temperatures in order to reconcile such different thermal requirements [6]. The most famous method for determining thermal environmental conditions is based on Fanger's predicted mean vote (PMV) model, which was developed in 1970 for a Danish laboratory experiment with European subjects [7]. The PMV model has been verified in many field studies in different contexts and resolved many arguments stemming from regional and individual differences in thermal perception. Regarding Fanger's theory, which later became the basis for ASHRAE Standard 55, thermal comfort is affected by both environmental and human factors. The environmental factors include air temperature, mean radiant temperature, air velocity and relative humidity. The factors related to individuality involve the metabolism rates of activities and clothing resistance. There have been many efforts to identify other factors that influence thermal comfort, such as age, gender, health status and adaptability to the surrounding environment [8, 9]. The more complex factors include cultural influences and the psychological characteristics of individuals [10, 11]. Furthermore, many studies distinguished between an objective assessment based on PMV calculations and a subjective assessment of thermal comfort. In the context of a healthcare facility, where occupants are more vulnerable to the thermal environment, a very limited number of studies have been done [9, 12]. Fransson et al. [13] noted that subjective sensation votes for comfort are greater than objective indicators based on a prediction. Currently, it is still being questioned whether the predicted mean vote according to ASHRAE Standard 55 is suitable for the different occupants of a hospital.

The problem concerning the thermal environment in hospitals in a tropical context has been found to be almost uncontrollable because of the high demand for healthcare services in this region [14]. Regretfully, thermal comfort in hospitals in tropical countries has been a neglected area of research so far. There are only a few previous research

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