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Thermal Comfort and Childcare, Kerala, India

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Abstract: This research investigates what thermal comfort means to children living in institutionalized care in Kerala by evaluating their adaptive behavior. While there are research on thermal comfort and children, there are no available data on children from vulnerable backgrounds or living in care system. Field study methods like comfort surveys, environmental measurements and semi-structured interviews were adopted. One Boys Home and one Girls Home were selected and collected total 90 responses. Some children despite mentioning the environment was hot/warm also related to it as slightly comfortable, this major finding establishes the wider tolerance range to the environment. Lack of thermal memory and no access to thermal controls resulted the children having higher thermal acceptability rate. There was disparity in responses between genders. Girls had strong preference and expectations from their environment while boys were more acceptable and tolerant of their environment even during the heat waves recorded during study.
Keywords: Thermal comfort, Adaptive behavior, Thermal acceptability, Tolerance, Children.

1. Introduction

India has major proportion of orphaned children in the world, with population of 22 million, states a survey by Orphan Outreach Program (2020) conducted post-Covid. In India, one in ten children will grow up an orphan (Srivastava & Bharti, 2022). The Annual Report by Ministry of Women and Children Development (2017), shows that only 370,227 Children in Need of Care and Protection (CNCP) live in institutionalised care and 7422 numbers of Children in Conflict with Law (CCL), the remaining continue to live on streets or unauthorized shelters. The purpose of this research is to understand thermal comfort for children institutionalised in Kerala, India by evaluating their adaptive behavior. Children in any context are particularly vulnerable to major health outcomes because of climate change due to their potential exposure and sensitivity to their environment. (K.L Ebi, J.A Paulson, 2007). While children living in a normal household have the resources to restore comfort, the children living in Child Care Institutions (CCI) are more exposed to the conditions without reinforcement. ASHRAE standard 55 defines the concept of thermal comfort as “a condition of mind which expressed satisfaction with the thermal environment”. The ASHRAE standards aims to meet the thermal needs of about 80% of the occupants in a building as it is not practical to satisfy 100% of the occupants.

2. Literature

Ormandy & Ezratty (2012) explain the factor of thermal comfort as Environmental like Temperature, Ventilation and Humidity, and Individual like age, gender, health conditions, clothing level and metabolic rate. Thermal Memory is a reference of recent thermal experiences one stores in mind by correlating the comfort temperature to mean outdoor temperature (Schweiker et al., 2020). Thermal Expectation results in psychological adaptation when a person prepares oneself for an indoor thermal condition (Schweiker et al, 2020). ‘Thermotolerance’ is described as an organism’s capability to withstand and survive high temperature without having a prior opportunity for acclimatization (Park & Yun, 2013).

Adaptive Behaviour can be defined as "If a change occurs such as to produce discomfort, people react in ways that tend to restore their comfort" (Nicol & Humphreys, 1998). With the scope of adaptive opportunity in hot-humid environments, the comfort range was wider accounting for user's adaptive behaviour (Nicol and Humphreys, 1998). There are scenarios when adaptive actions are restricted due to climate, health, culture, clothing style, gender, conflicting requirement and having no freedom to operate thermal controls (Nicol & Humphreys,1998). In hot-humid climate naturally ventilated spaces, occupants have wider range of acceptability and tolerance to their environmental than specified by ASHRAE and ISO standards (Rajasekar & Ramachandraiah, 2010).

Wargocki & Wyon (2007) states that "children are less resilient to adverse environmental conditions compared to adults, therefore, unacceptable environmental conditions affect them more significantly". Children feel comfortable for temperature range of 15.3–33.7 °C for 80% acceptability. This range exceeds the specified range by Indian and international standards for adult population which show that children's heat tolerance is quite high (Jindal, 2018). Liu et al. (2017) states that acceptable temperature range (ATR) of children between 10-15 years is much wider than the adaptive predicted mean vote model. There exists significant gap in knowledge on thermal comfort of Children living in Childcare institutes. Singh et al. (2018) report that children from lower social background feel reluctant to express their desire or opinion about their comfort due to the lack of available opportunities. The children don't feel empowered enough to take charge to dictate their comfort or even take control to manage their own comfort (Montazami et al., 2017). Naqshbandi et al. (2012) explain how institutionalisation of orphans impacts the psychological take on defining comfort. Lack of emotional attachment to the space due to forced institutionalisation due to abandonment or loss of parent could be the reason.

3. Methodology

The research proposes a thermal comfort field study. 15 Children each from 2 Childcare Institutions (one girl's home and one boy's home) were chosen for the study and 90 sets of data responses are collected. 3 methods of data collection was implemented. Semi structured interviews and thermal comfort survey were carried out with the participants. Environmental measurements using a data logger was used to record dry bulb temperature and relative humidity at 10 minute interval in 3 spaces – outdoors, main hall and sleeping area. The research was largely based on the Qualitative data collected during interviews. Quantitative data helped correlate the environmental conditions to thermal sensations of the participants using Thermal comfort survey. The survey investigates the thermal experience based on the ASHRAE and BEDFORD 7-point scales, of Thermal Sensation Vote, Thermal Preference, Overall comfort, Thermal acceptability and Satisfaction. Every participant was coded and anonymised for to protect identity and ethical reasons. The Data was collected in April and May (summers) and was one of the worst-case summers in the past years with prolonged heat waves.

3.1 Ethics

The research involves interaction with children below the age of 18 who are from a vulnerable background, (Children in need of care and protection), therefore a separate ethical approval was taken. The Ethical approval for this research was granted on 13th July 2023 by the Ethics administrator, School of architecture, The University of Sheffield. The consent for the interviews were taken first from the primary caregiver at the institute. All children selected for the interview were 12 years and above and consent was taken individually from them as well following good practice. Since the interaction with the child was one-on-one, a third party

(childcare social worker) was present to moderate the interview to ensure safeguarding. An information sheet with details about the research was given to the caregivers and every student in both English and Malayalam (native language). Identity and personal information of no participants were recorder or asked during the entire data collection process. All data collected were anonymised and stored in the University drive for safety.

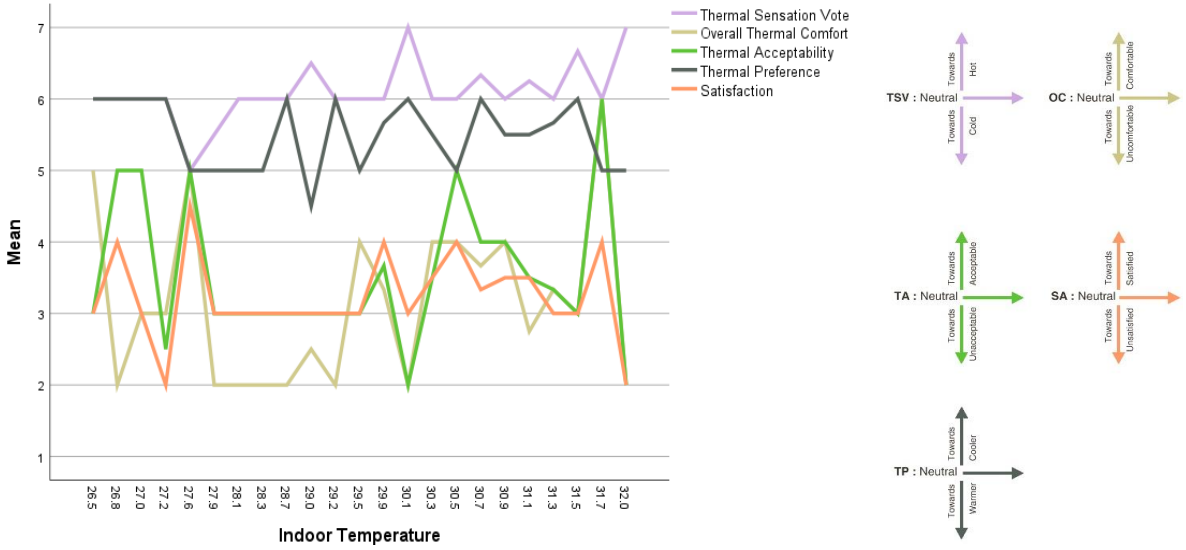
4. Analysis

Kerala is the southernmost state in the Indian subcontinent. It falls under 'Am' Koppen climate classification and has a tropical monsoon climate. The average air temperature range is 20 – 35 °C (68–95 °F). The major wind is the sea breeze (from the Arabian Sea) from the west. Summers are hot, dry and have a higher wind velocity. During data collection (April-May 2023), there was a prevailing heat wave that affected more than 10 regions in Kerala, temperature exceeded 40°C frequently (report : Mathrubhumi News dated 18th April 2023).

4.1 Quantitative Analysis

On analysing the results from the Thermal comfort survey, 60% of the participants said it was 'warm'. The participants said they were feeling hot most of the time in the building. With respect to seasons, they said they feel hot and sweat in summer, and pleasant in winters/monsoon. TSV based on gender, girls said it was 'Hot' more than boys did. 75% of the girls found the environment 'Uncomfortable'. While a large portion of the boys said either they were 'Slightly Uncomfortable' (55%) or 'Slightly comfortable' (30%). 68% overall participants found the environment uncomfortable/slightly uncomfortable and 20% comfortable. The overall comparison showed that even though the participants mentioned that they were feeling hot or warm in their TSV, the satisfaction, acceptability and overall thermal comfort always varied between feelings slightly accepting to slightly unaccepting. They did not feel strongly against the environment even though they knew they were feeling hot.

Figure 1 - Overall thermal experience comparison

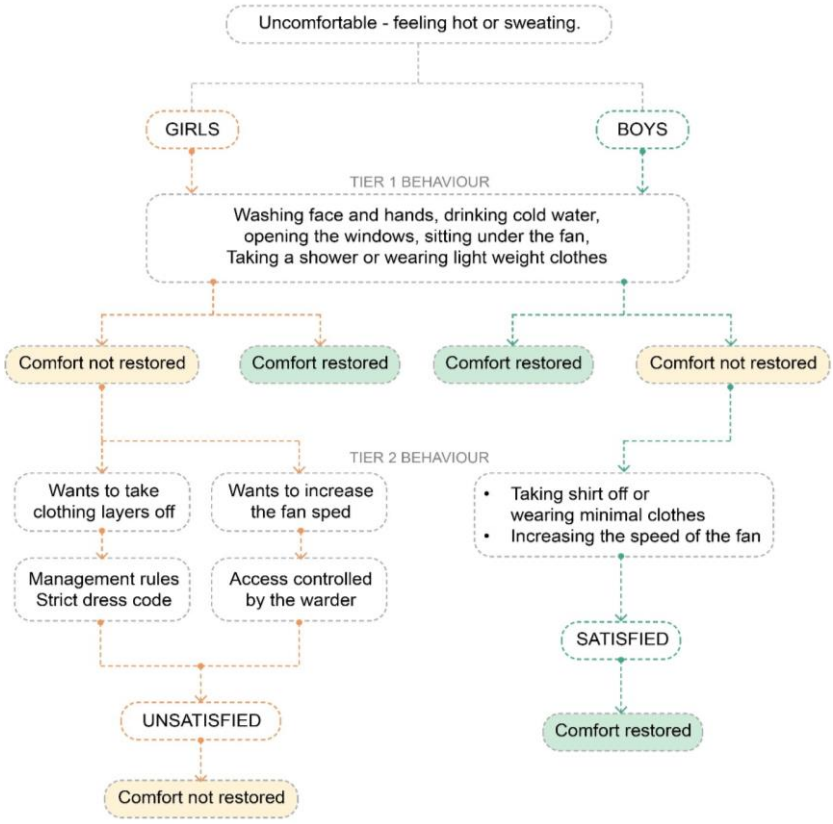


4.2 Qualitative Analysis

The interviews were transcribed and processed in Atlas.ti software using predefined codes. During the interviews, 25 out of 30 children mentioned they keep windows opened during the night, described how they adjust their clothing and drink lots of cold water. 26 children

mentioned the use of fans or increasing the fan speed. Some responses were unique to the time of survey, like closing window to block sun was a common response in the afternoon surveys. Showering was a popular adaptive behaviour and the children even altered their routine to schedule showering based on which part of the day, they wanted to feel most comfortable. The management had restricted showering frequencies to maximum of 1-2 which made the child plan their showers. The children preferred sleeping on the floor on a hot and humid night rather than on the lower bunk bed where you get very less cooling from fan. The children were restricted to go out during the peak sun hours to avoid any sunburns.

Figure 2 - Comfort restoration flow chart



During the interview, the children were asked to recollect one of the unpleasant thermal memory they had during their stay in the building. The responses were largely from 3 events. 9 children reportet health challenges like skin allergies, dehydration, and sunburns. 13 participants mentioned power cuts where they had to sleep without the fans. In the Girls Home, they would keep all the windows open, use their books and papers to fan themselves to sleep. In the Boys home, they rearranged the dorm to make space in the floor for everyone to sleep, (tiled floor was cooler to sleep on) they had wet towels on, slept shirtless and even fanned themselves using books to sleep.

Some restrictions in sleeping environment were addressed that did not allow restoring comfort for children. The Girls were not allowed to wear shorts or sleeveless shirts in the home which forced them to be in a state of dissatisfaction. Few girls reported, the lack of access to control their sleeping environment for choosing the fan's speed led to uncomfortable sleeping incidents. The warden would keep a few fans on minimum speed if any child (or children) were feeling unwell or had flu (due to lack of sick room/isolation facilities). This forced the rest of the children sleeping nearby to be dissatisfied all night.

When asked about thermal preference, a larger number of the participants mentioned they are okay with the warm climate until they start sweating. Boys were okay with sweating in moderate levels while girls described their onset to discomfort begins with sweating. 90% of the girls specifically said that they wanted to plant more trees around the building. This was to increase shading and develop a cooler microclimate around their building. The reference can also suggest that the idea of being closer to nature created a sense of calm and further gave a cooling effect. Adding more standing fans in the dormitories was a popular suggestion. This will allow children sleeping in the lower bunk get access to cool air from the fans and ensure a better-quality sleep.

5. Discussion and Conclusion

The gap in freedom given to the children in both the homes regarding controlling their environment, reflected on the pattern of their response for TSV and Overall comfort and did not relate with one another. The Girls home had a restrictive environment, they did not have access to control their environment with respect to choosing the Fans speeds (or because of sleeping in lower bunks). The freedom to control their environment or choose to wear what they want was absent. These responses collected during the interviews show that they knew why they were feeling uncomfortable, and this understanding of their helplessness made them have a stronger opinion than the boys.

While the boys had the freedom to have wider adaptive behaviours and flexibility their comfort range was also wider which explains why they felt comfortable even in hotter climates. Since the girls had a restrictive environments, their preference and expectations were more pronounced, they had a clear idea on what changes could bring them more comfort. Malik & Bardhan (2020) suggested that thermal adaptability in resource-constrained low-income housed are influenced also by socio-cultural, economical and contextual factors. Their results show that the mean neutral temperature is 28.3° C with a wider comfort band of 24.6° - 32.2° C, which confirmed the higher thermal adaptability of the occupants. In this study, the temperature range recorded was from 26 - 32° C. This temperature range recorded during study (26-32° C) is within the Acceptable Temperature Range (ATR) of children.

It was observed that these children don't feel empower to take control of their environment due to lack of freedom. This thought aligns with what Montazami et al. (2017), states about children from lower socio-economic background refraining from taking control of their environment. Humphreys (1977), suggested amongst children there were not much wider gaps in thermal preference based on gender, which is largely the case in this research. However, there is a wider gap in responses when it came to their thermal comfort and thermal acceptability. It is likely that this gap is due to the variation in freedom to control their environment due to the difference in sensitivity towards their environment seen in both genders. It could also be possible like Karjalainen (2012) said, about females have lower tolerance to small thermal deviations and will need more individual control over their environment and adaptive opportunity than male.

For future research, the author recommended the study to broaden to understand variation in Thermal comfort for children from different age groups. The study could be further expanded to collect data from more than 2 homes per gender, to understand if gender actually plays a role in defining ones acceptability and tolerance towards their environment. Since the research largely dependent on the qualitative data through interviews the authenticity of the information regardless of the chosen participant type can be considered

reliable. The information collected were mostly based on memories and adaptive behavior children narrated in their stories from day to day life and based on the daily facts.

To conclude, the overall comfort range was wider despite their thermal sensation vote being uniformly warm/hot. The clothes worn by the participants did determine their comfort levels. Thermal comfort was defined by the freedom the participants had to access and control their environment (like fans, windows and clothing). Overall thermal comfort data differed for the girls and boys. A larger number of girls felt uncomfortable while the boys felt between slightly uncomfortable to slightly comfortable. Thermal expectation and preference varied highly based on the gender. Humidity was the major concern children pointed out in terms of their comfort. Sweating or feeling moist marked the onset to their discomfort. Thermal comfort for children was largely related to comfort and quality of sleeping. The temperature range recorder during the entire study was within the Acceptable temperature Range (ATR) of children.

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