Diaz Lozano Patiño E, Vakalis D, Touchie M, Tzekova E, Siegel JA. 2018. Thermal comfort in multi-unit social housing buildings. *Building and Environment*, **144**, 230-237.
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Abstract

Thermal comfort influences occupant health and perceptions of the indoor environment. It is particularly important for vulnerable populations, such as those who inhabit social housing, because they may be more sensitive and prone to illness when exposed to high or low temperatures. In this study, we evaluated hygrothermal conditions inside 70 social housing units in Toronto across seven buildings for a year. We found that all the buildings had a high prevalence of discomfort due to high heat in the summer, with some units spending most of the time above 28 °C. This was indicative that there is insufficient cooling in the units. Further, we found that some units were over-heated during the winter season. Additionally, by analyzing carbon dioxide concentrations, we found that there was no evidence that the units were under-ventilated. Our results were compared to occupant surveys administered in the beginning of the study, and we found that there were discrepancies between the monitoring results and what occupants reported. In particular, there were several reports of underheating in the winter prior to the monitoring period while the monitored data did not show evidence of underheating, but this may be partially due to a mild winter in the monitored year. Older buildings may not be fit to withstand extreme heat events that some cities are experiencing and may be placing some of their occupants at risk for heat stresses. Planned energy retrofits are an opportunity to address thermal comfort concerns.

Main findings

1. High indoor air temperatures were common in the monitored buildings during the summertime. This is of concern during extreme heat events such as heat waves, where occupants can be placed at increased risk of developing heat related illnesses.
2. Thermal comfort modelling showed year-round discomfort due to heat and almost no discomfort due to cold which contrasts the results from a previous survey where discomfort due to cold was prevalent.
3. There is no evidence of underventilation in the units. The CO_2 data shows that most units have indoor CO_2 concentrations below the recommended concentration by ASRHAE/ANSI Standard 62.1.
4. There was no relationship between increased discomfort and floor height, which suggests that the stack effect does not influence thermal comfort in these buildings.
5. Other similar buildings located in cold climate regions should consider installing occupied controlled thermostats in the units as well as passive or active cooling measures to avoid discomfort due to heat.

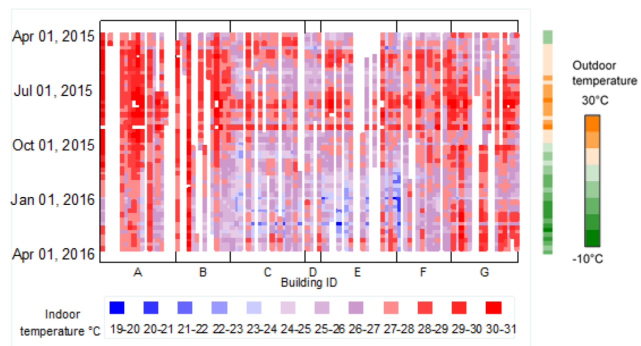

Figure 1 Heat map of weekly average indoor and outdoor air temperatures for the period April 1, 2015 to April 1, 2016. Note that the outdoor temperature for the first 2 weeks of April 2015 was estimated using data from Toronto Pearson International Airport, since the weather stations were not deployed on site until the week of April 19, 2015. The airport data was adjusted based on the weekly averages for the 2015 year.

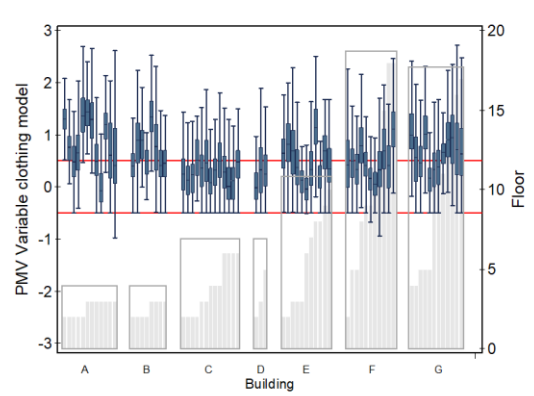

Figure 5 Box plot of the Predicted Mean Vote calculated using the ANSI/ASHRAE Analytical Comfort Zone Method for July 2015. Red lines indicate ±0.5, which represents the comfort range. Grey bars indicate floor for each suite, grey boxes represent the height in floors of the building.

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