MAPPING THE EFFECTS OF ENERGY POVERTY ON THERMAL COMFORT AND SKIN TEMPERATURE PROFILES OF RESIDENTS: A FIELD STUDY OF NATURALLY VENTILATED MULTI-STOREY SOCIAL HOUSING IN COLOMBO METROPOLITAN REGION

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Thesis/Dissertation submitted in partial fulfillment of the requirements for the degree

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DECLARATION

I declare that this is my own work and this thesis/dissertation does not incorporate without acknowledgement any material previously submitted for a degree or diploma in any other University or Institute of higher learning and to the best of my knowledge and belief it does not contain any material previously published or written by another person except where the acknowledgement is made in the text. I retain the right to use this content in whole or part in future works (such as articles or books).

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The above candidate has carried out research for the PhD/MPhil/Masters thesis/dissertation under my supervision. I confirm that the declaration made above by the student is true and correct.

Name of Supervisor	Signature	Date
1. Prof. I.G.P. Rajapaksha	…………………….	11.04.2025
2. Dr. C.S.A Siriwardana	…………………….	08/04/2025

DEDICATION

I dedicate this thesis to my family, who have always provided encouragement and unwavering support in my pursuit of academic goals with passion and determination. Thank you for your endless love and sacrifices.

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ABSTRACT

Global warming is causing unprecedented climatic extremes and a rapid rise in urban temperatures, leading to overheated indoor environments. This issue is particularly critical for residents of social housing with deprived socio-economic backgrounds, as they face an increased risk of heat-related health implications. These conditions underscore the urgent need to enhance indoor thermal comfort and living standards in urban social housing. In response, this study conducts an experimental investigation into the indoor thermal conditions of a naturally ventilated 12-storey social housing building in Colombo, Sri Lanka. The research methodology combines field surveys, in-situ measurements of thermal environmental parameters, and infrared thermography, using a representative sample of 98 residents and their household units. Findings reveal that indoor temperatures ranged from 30.4°C to 34.2°C, indicating significant indoor overheating. The mean relative humidity was elevated at 63%, while a low mean air velocity of 0.1 m/s indicated poor natural ventilation. A mean thermal sensation vote (TSV) of 2.2, along with 90.8% of residents expressing a preference for significantly cooler conditions, highlights widespread thermal discomfort. Additionally, 38.8% of households were identified as multi-dimensionally energy-poor, with a significant correlation observed between higher levels of energy poverty and increased thermal discomfort. Skin temperature analysis revealed elevated mean facial temperatures, with the forehead showing the highest at 35.5°C. This analysis further suggests a strong association between elevated facial skin temperatures and greater thermal discomfort. According to the linear regression method, the comfort temperature was 28.8°C, while the Griffiths method estimated it at 27.3°C. To cope with thermal discomfort, residents frequently used adaptive behaviours such as using fans (89.8%) and going outside (53.1%), while bathing (18.4%) and changing clothing (6.1%) were less preferred. These findings highlight the urgent need for tailored interventions to improve living standards in social housing and offer valuable insights to inform policies and strategic initiatives aimed at enhancing residents' quality of life.

Keywords: Warm-humid climate, Multi-storey social housing, Thermal comfort, Comfort temperature, Energy poverty, Infrared thermography, Skin temperature

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LIST OF ABBREVIATIONS

Abbreviation	Description
UDA	Urban Development Authority
URP	Urban Regeneration Program
SCURP	Support to Colombo Urban Regeneration Project
AIIB	Asian Infrastructure Investment Bank
UNEP	United Nations Environmental Programme
UHI	Urban Heat Island
WBGT	Wet Bulb Globe Temperature
ISO	International Organization of Standardization
PMV	Predicted Mean Vote
ASHRAE	American Society of Heating, Refrigerating and Air-Conditioning Engineers
CIBSE	Chartered Institution of Building Services Engineers
TSV	Thermal Sensation Vote
EP	Energy Poverty
LIHC	Low-Income High Cost
AFCP	After Fuel Cost Poverty
MIS	Minimum Standard Income
2M	Twice the National Median
MEPI	Multidimensional Energy Poverty Index
SA	Surface Area
TP	Thermal Preference
TA	Thermal Acceptance
TCV	Thermal Comfort Vote
FLIR	Forward Looking Infrared
PPD	Predicted Percentage of Dissatisfied
EPI	Energy Poverty Intensity
SD	Standard Deviation

LIST OF APPENDICES