

# Diversity of summertime thermal and environmental perceptions in residential public spaces:

A walking-based assessment in Hong Kong's public housing estates

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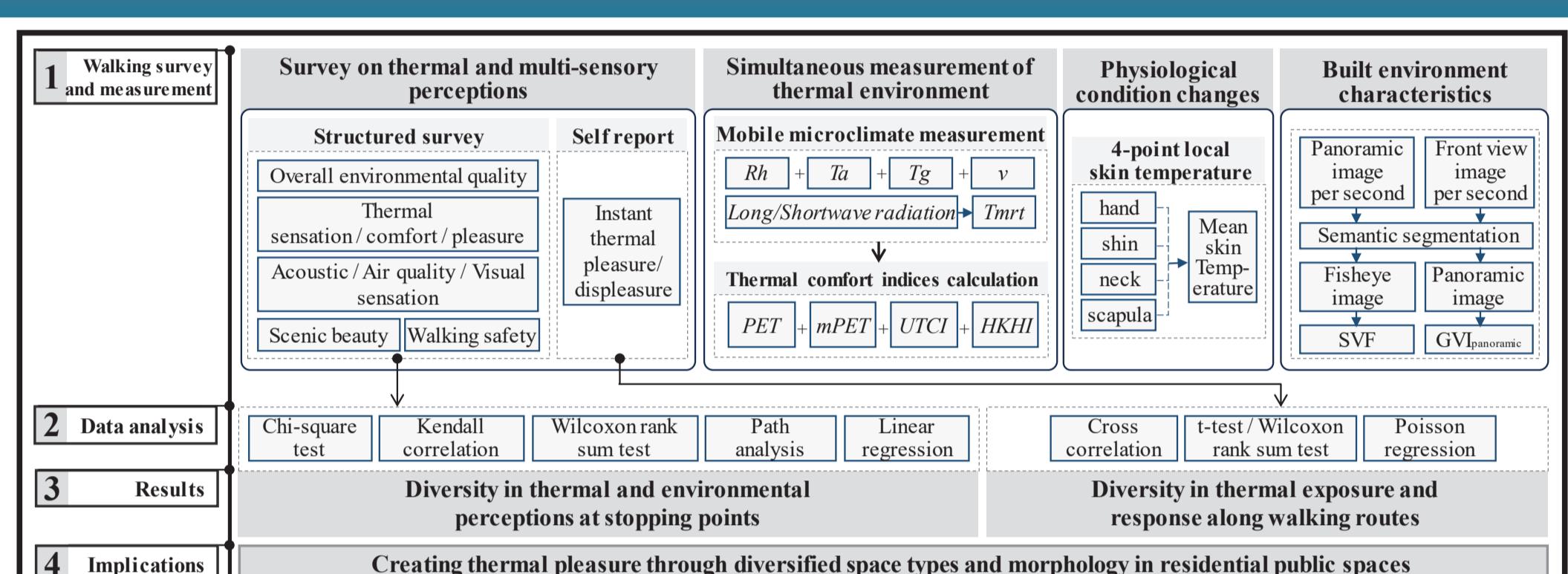
## MOTIVATION

Outdoor thermal experience constitutes the outdoor experiences, which are threatened by the rising extreme heat.

### The objectives of this work are,

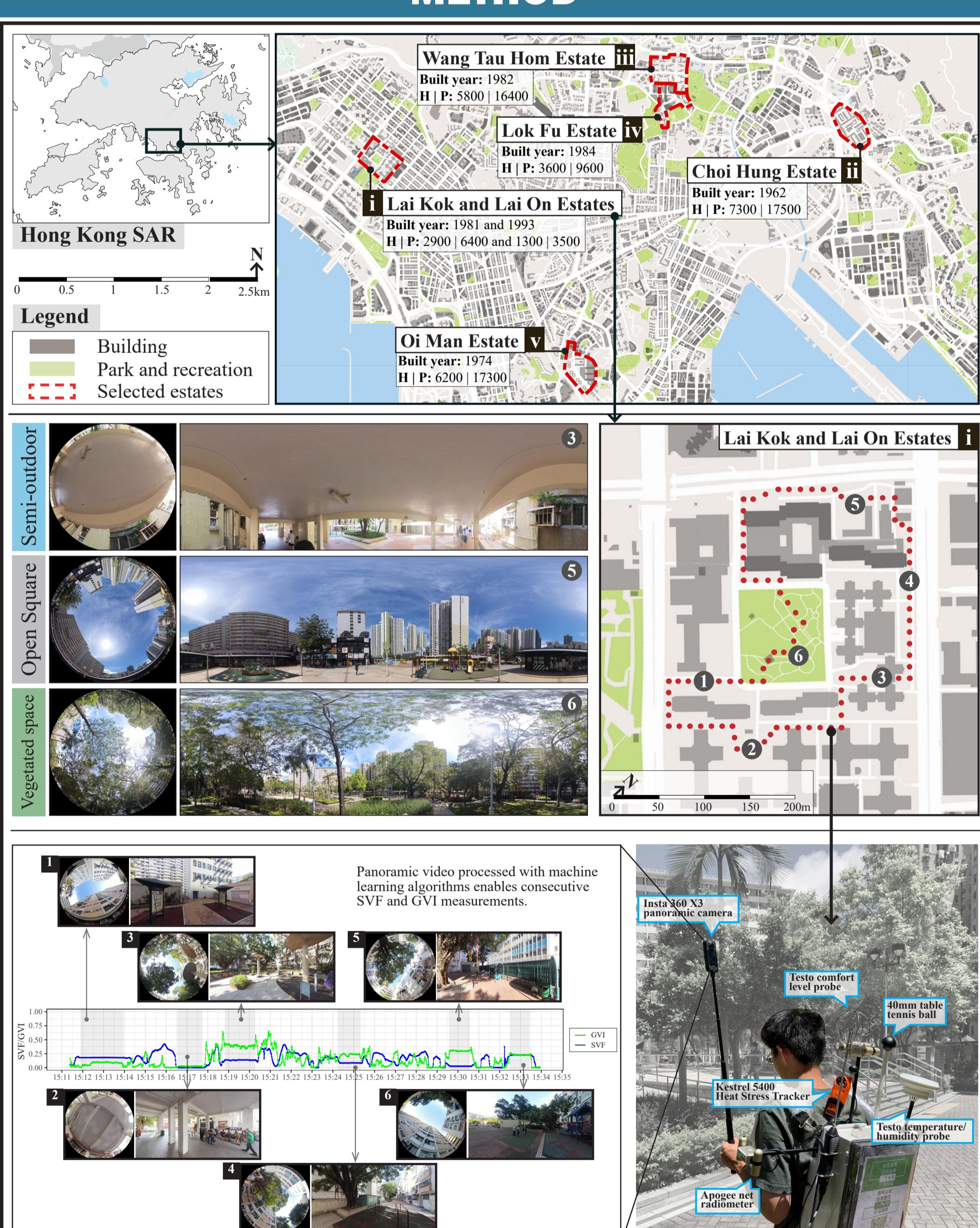
- (1) to quantify the **multivariate association and influencing pathway** among built environment, microclimate condition, and thermal and environmental perceptions during outdoor walking in summer with heat extremes,
- (2) to quantify the physio-psychological response of outdoor thermal experience to the diversity of microclimate and built environment.

## WORKFLOW



With recruited participants, this work incorporates **field survey** and **simultaneous microclimate and built environment measurements** in selected public housing estates.

## METHOD



### Mobile microclimate measurements

Ta / Rh / v / Tg (40mm table-tennis ball / 25mm metallic black globe) / Longwave and shortwave radiation

### Skin temperature measurements

ISO 4-point method at neck, scapula, hand, and shin.

### Built environment measurements

Panoramic-video-based SVF and GVI.

### Multisensory survey

Multisensory perceptions

5-pt Overall Environmental Quality / Scenic Beauty Vote / Loudness Sensation Vote / Air Quality Sensation / Visual Sensation Vote / Walking Safety Vote

Thermal perceptions

7-pt TSV / 5-pt TCV / TPIV

## ACKNOWLEDGMENTS

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## RESULTS

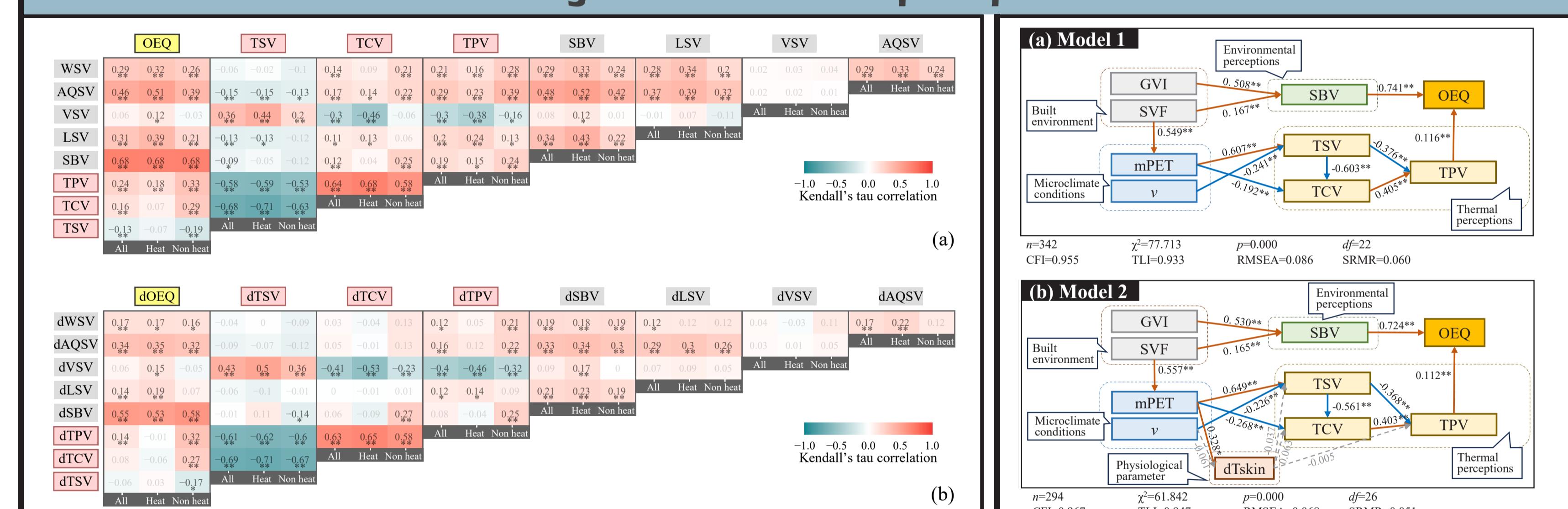
### Diversity in thermal and environmental perceptions



Percentage of thermal and environmental perception votes in different types of public spaces under extreme-heat, non-extreme-heat, and both conditions ( $n_{All}=342$ ,  $n_{Heat}=186$ ,  $n_{Non-heat}=156$ ). (Note: \* and \*\* refer to significance at 0.05 (two-tailed) and 0.01 (two-tailed) respectively.)

**Thermal and environmental perceptions are dependent on space types.**

### Multivariate associations among environment and perceptions



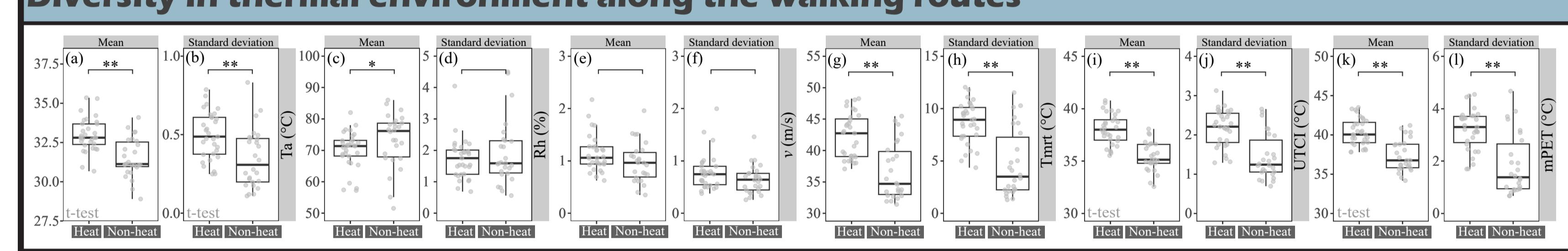
Kendall's tau correlation coefficients among thermal and environmental perceptions under extreme-heat and non-extreme-heat conditions with (a) data at all stopping points ( $n_{All}=342$ ,  $n_{Heat}=186$ ,  $n_{Non-heat}=156$ ), and (b) differences between two adjacent stops ( $n_{All}=285$ ,  $n_{Heat}=155$ ,  $n_{Non-heat}=130$ ).

**Noncorrelated between OEQ and thermal perceptions under heat**

Pathway models (a) among built environment characteristics, microclimate conditions, and thermal and multisensory perceptions, (b) with physiological parameter included.

### Significance of scenic beauty

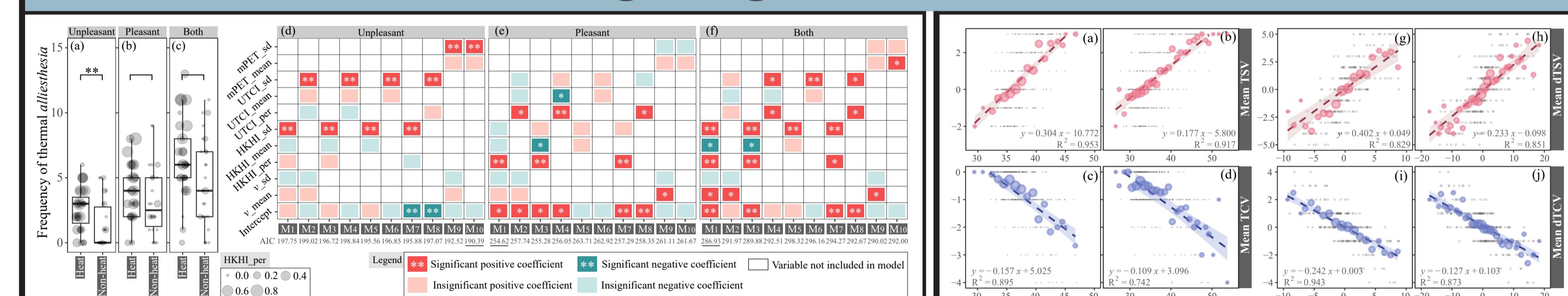
### Diversity in thermal environment along the walking routes



Means and SDs of microclimate variables along walking routes under extreme heat and non-extreme heat conditions.

**Significant stronger variations in microclimate variables under heat**

### Evidence of thermal alliesthesia along walking under heat

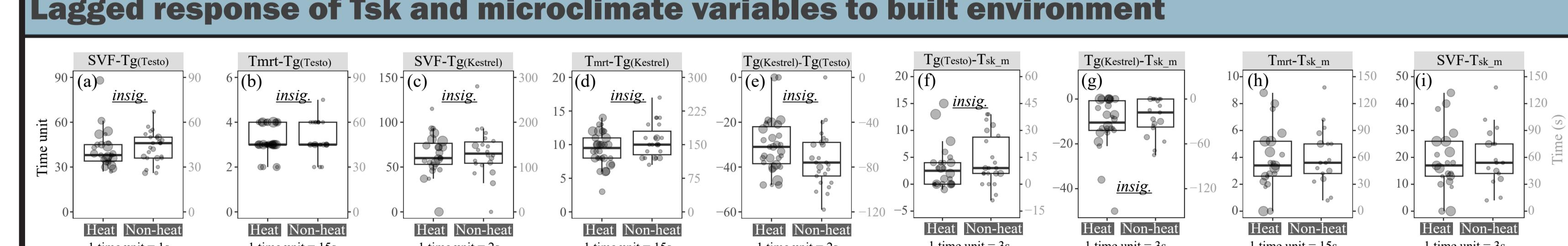


**Microclimate variation associated with more alliesthesia**

Linear regression models between binned UTCI, PET and (a-d) mean thermal perception votes, (g-j) mean difference of thermal perception votes between two adjacent stopping points.

**Neutral PET 32.77°C due to alliesthesia**

### Lagged response of Tsk and microclimate variables to built environment



Lagged response (a-e) among built environment characteristics and measured microclimate variables, (f-i) among built environment characteristics, measured variables and Tsk\_m, along the walking routes under heat stress and non-heat stress conditions. (Note: insig. refers to insignificant difference between groups.)

**Lagged response of skin temperature to sky view factor quantified as 58.89s**

## KEY TAKEAWAY

Thermal and environmental perceptions surveyed along 57 guided walking tours in summer.

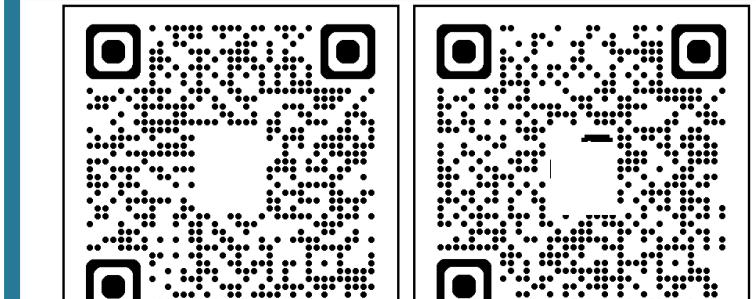
**Scenic beauty** contributes greater than **thermal pleasure** to **overall environmental quality**.

One-level enhancement in thermal pleasure along walking requires  $4.29^{\circ}\text{C}$  UTCI reduction.

**Stronger microclimate variations** lead to more frequent **thermal alliesthesia**.

A mean **lagged response** of **58.89 s** between **mean skin temperature** and **sky view factor**.

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