

Reducing the Surface Temperature but Not the Stress: A Multi-Site Micrometeorological Assessment of Heat Stress Mitigation in Tropical Schools

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Cool Coatings, Thermal Comfort, WBGT, MRT, Urban Climate, Sensor Networks



BACKGROUND

- Heat Stress Critical in Tropical Cities.
- Schoolchildren are especially vulnerable to heat stress, impairing learning. Schools: high exposure, low control.
- Cool paints widely deployed.
- Evidence focuses on surface cooling.

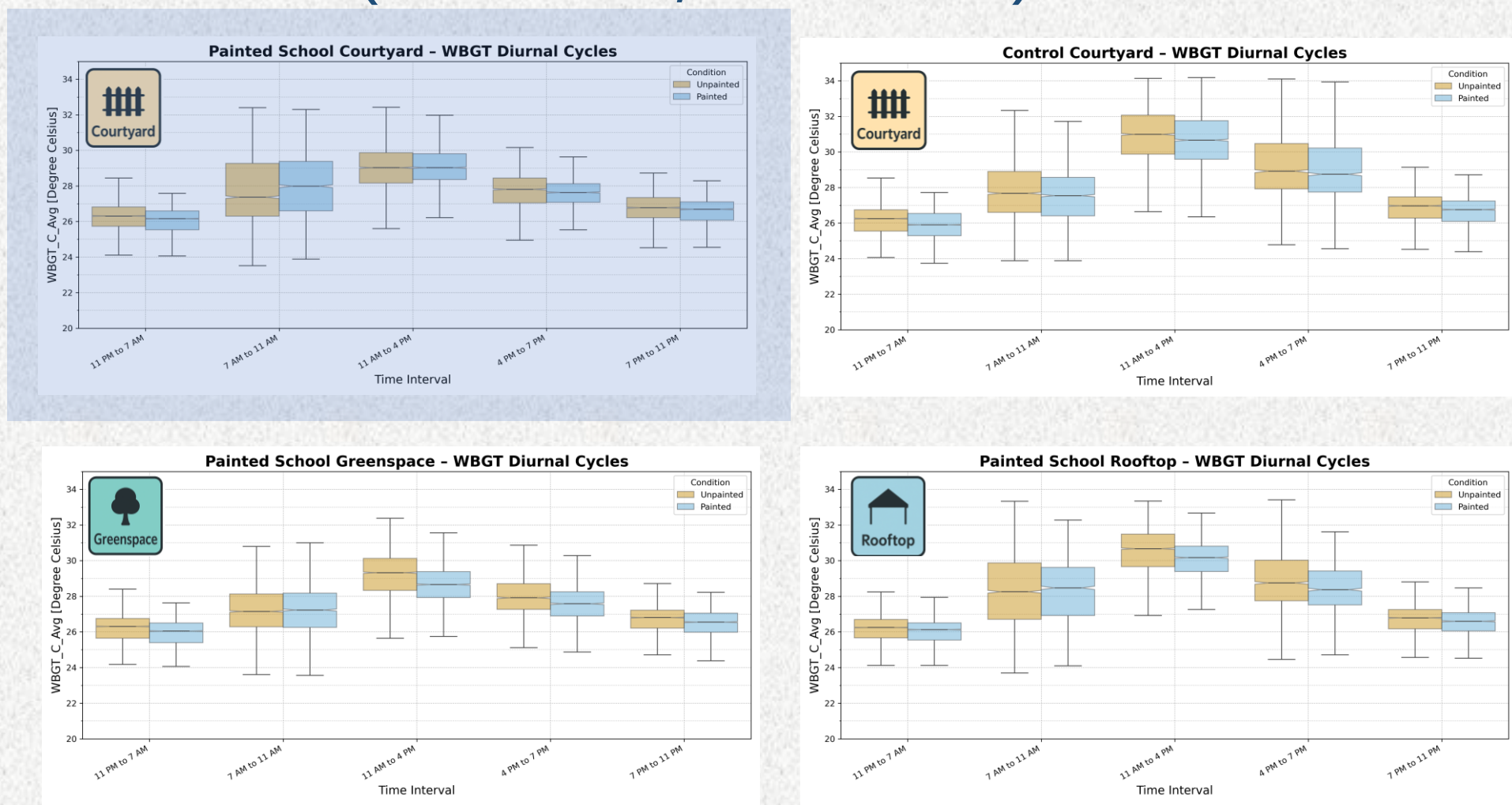
RESEARCH GAP

- Lab-based or non-representative studies.
- Focus on air temperature (T_{air}) / surface temp only.
- Mean Radiant Temperature (MRT), Wet Bulb Globe Temperature (WBGT), rarely assessed.
- Real-world tropical data lacking.
- Unknown: Do cool paints reduce heat stress where people are?

FINDINGS

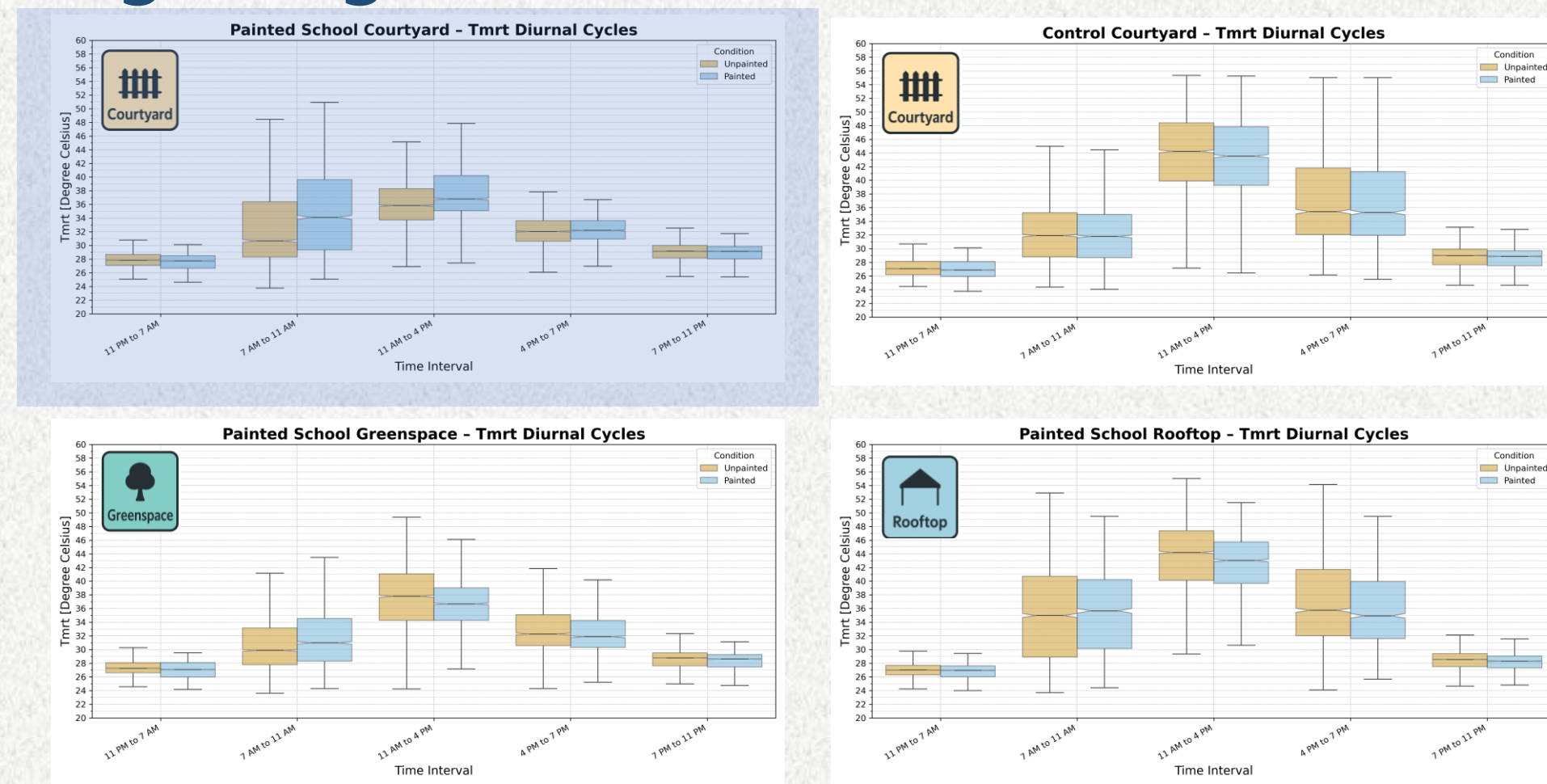
- Surface cooling observed but in painted courtyards Air temperature change minimal (-0.40°C vs. controls) WBGT increased outdoors ($+0.62^{\circ}\text{C}$, 7–11am).

Cool Painted

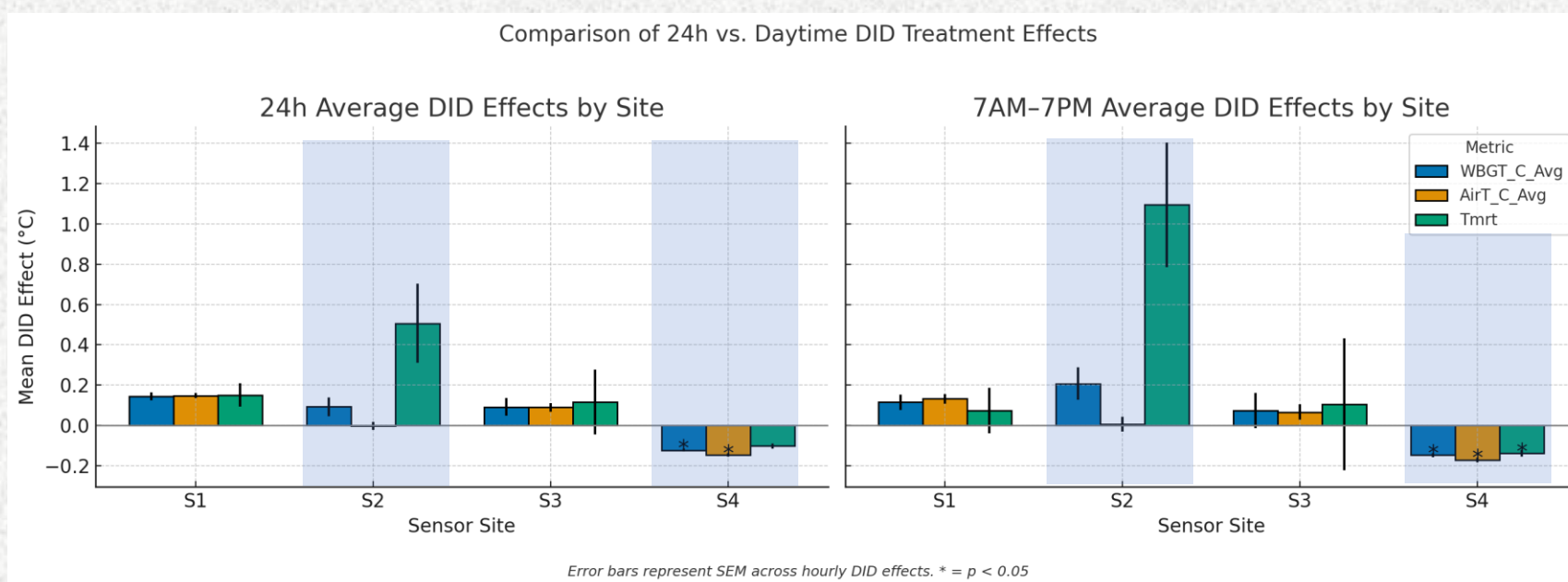


- T_{mrt} increased ($+3.0^{\circ}\text{C}$ morning, $+0.9^{\circ}\text{C}$ midday).
- Indoor cooling marginal (-0.38°C air; -0.35°C WBGT).

Cool Painted



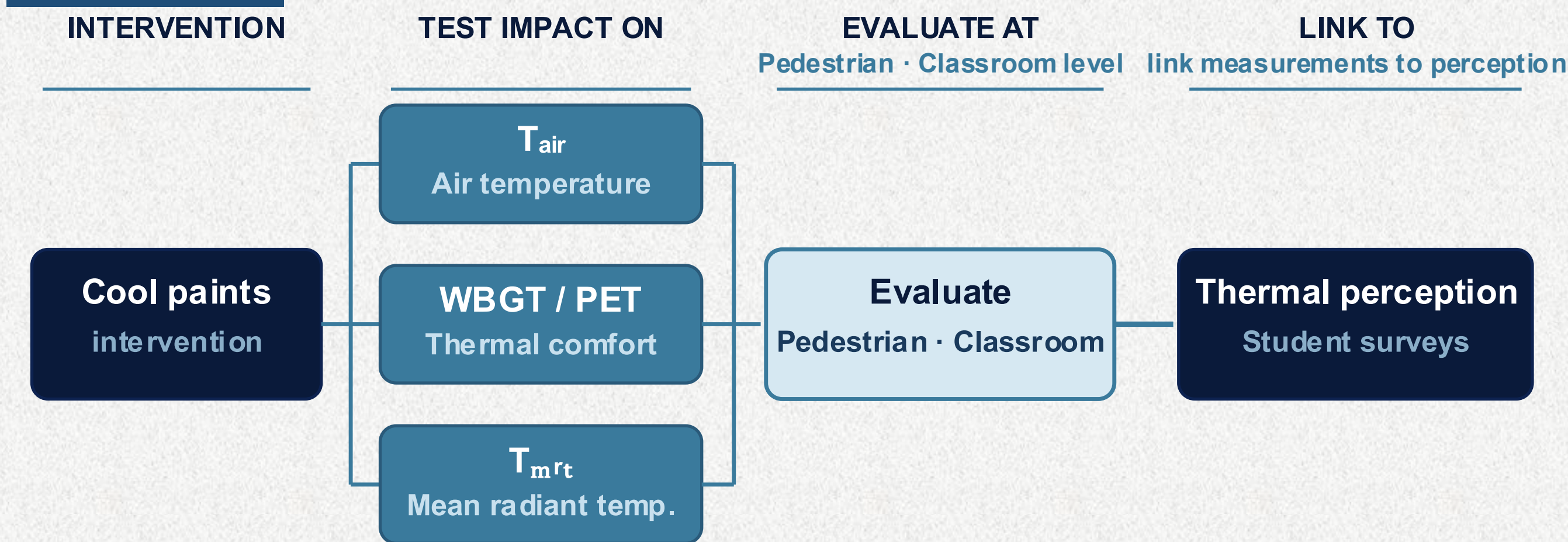
- DiD analysis supports these findings.



CONCLUSIONS

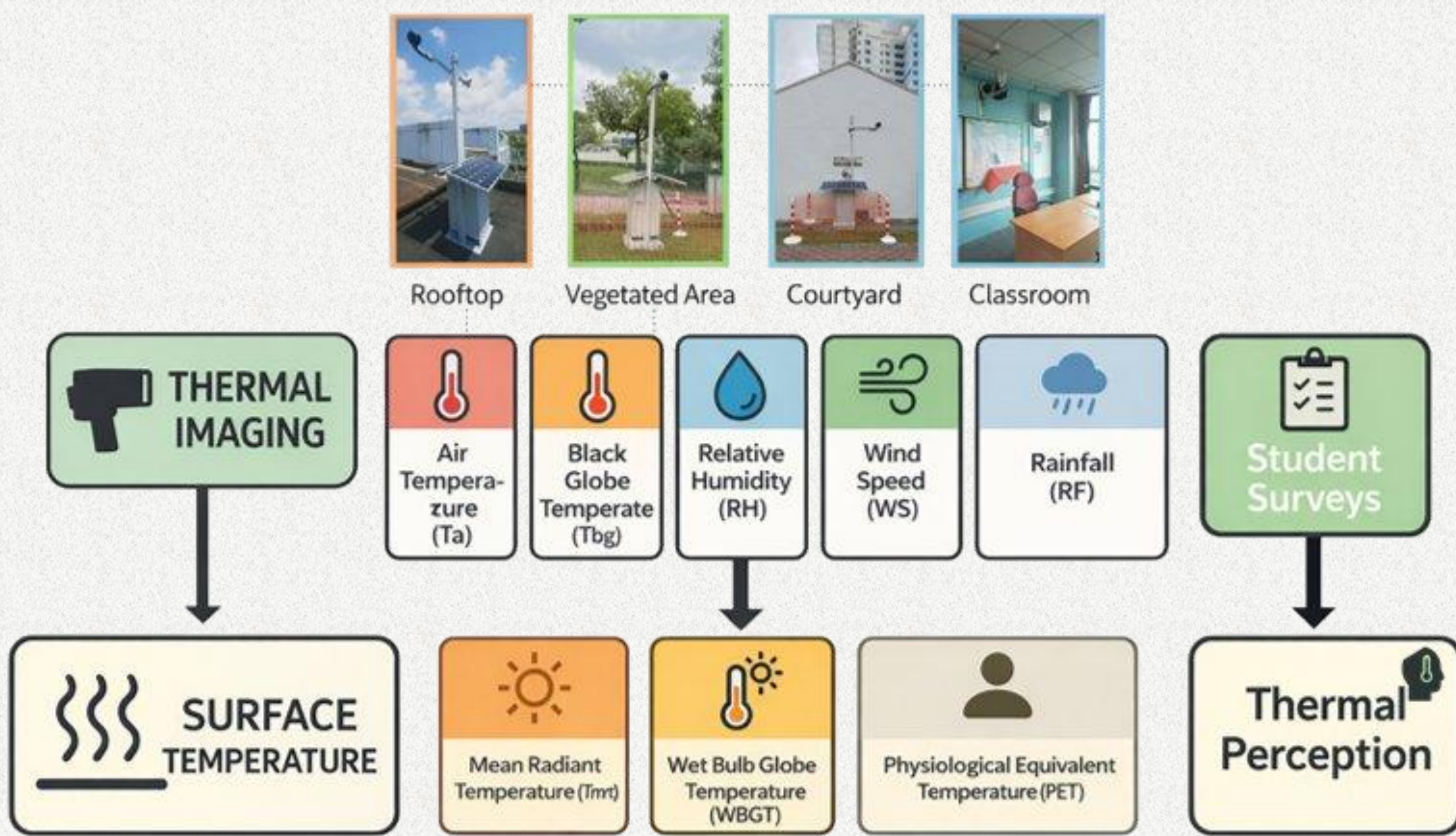
- Cool paints reduce surface temperatures but do not improve WBGT or PET in naturally ventilated environments.
- They can increase T_{mrt} revealing risks.
- No perceived comfort improvement.
- Facade-only application in naturally ventilated environments is ineffective for thermal comfort.

AIM



METHODS

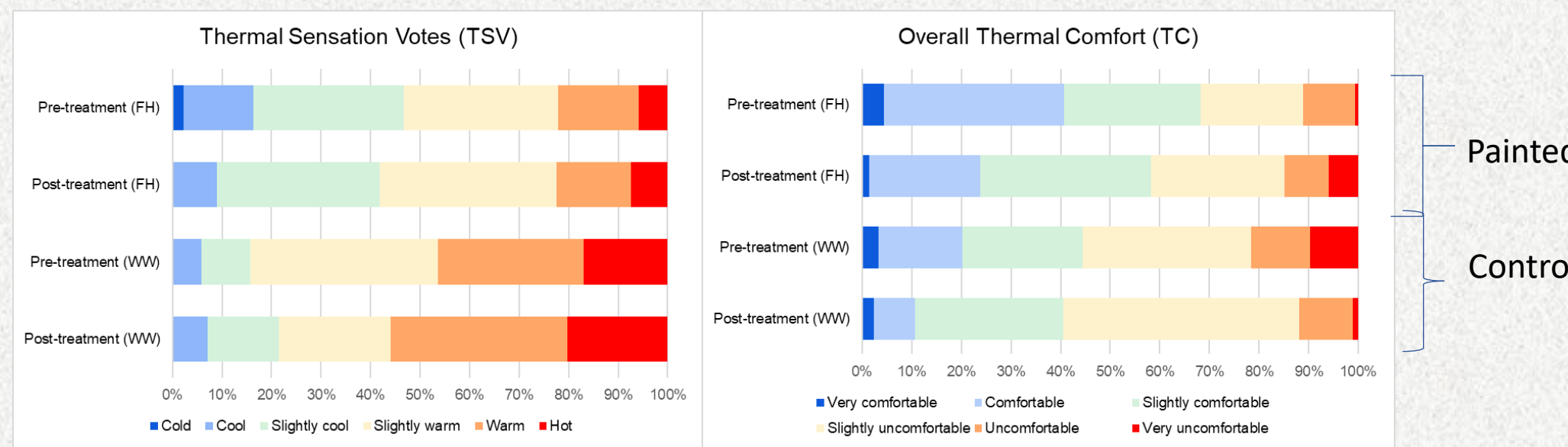
- 4 schools (3 painted, 1 control).
- 15 sensor stations (roof / wall / greenspace / classroom).
- ~7–8 months (pre/post/parallel comparison).
- Real-world, multi-method approach.



KEY DISCUSSION POINTS

- Surface cooling $\neq$ human cooling:** cool paints lower surface temps but can increase T_{mrt} via reflected radiation.
- Reflection = redistribution, not removal.
- Evaluate using human metrics (WBGT, PET, T_{mrt}), not surface temperature alone.
- Cooler walls can mean hotter people.**

- No improvement in perceived student comfort.



FUTURE APPLICATIONS

- Apply thermal forensics to evaluate urban interventions**
- Verify real human benefits, not just surface cooling using WBGT / MRT / PET (not $T_{surface}$ or T_{air} alone).
- Detect unintended impacts (increased T_{mrt}) before scaling.
- Adhere to measurement standards (WMO).
- Walls on pedestrian level are not recommended for cool paints.

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