PhD Open Days

Climate-Adaptive Retrofitting for Health Resilience: A Framework for Mediterranean Residential Buildings

Architecture (DArq)

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01 Why does this matter?

Mediterranean regions are warming rapidly, while residential buildings face increasing overheating risks during extreme heat events. Conventional energy-efficiency retrofits often prioritise insulation, airtightness and energy demand, but may unintentionally reduce night-time ventilation and increase indoor heat exposure. This highlights a pressing research challenge:

How can residential retrofits deliver energy efficiency while safeguarding indoor environmental quality and occupants' health resilience?

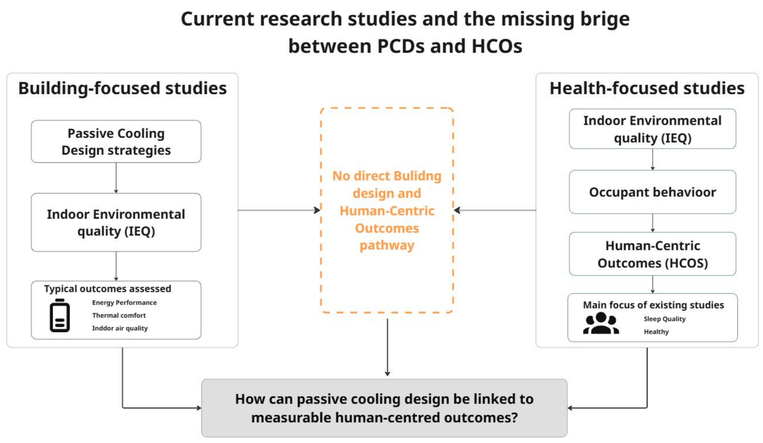


Fig. 1. Current Research Landscape and the Missing Link

02 Research Objectives

This research aims to **develop and validate a health-centred, climate-adaptive retrofit framework for Mediterranean housing by linking real-world residential performance with occupant heat resilience and retrofit decision-making. T**o achieve this aim, the research addresses three connected questions:

- **RQ1 (Theoretical):** Which architectural and thermodynamic variables most strongly influence human health resilience in Mediterranean housing?
- **RQ2 (Empirical):** What are the data-driven failure points of PCDs where IEQ no longer maintain occupant physiological homeostasis?
- **RQ3 (Optimisation):** How can multi-objective optimisation balance energy efficiency with health-risk mitigation under cost constraints?

Three contrasting Mediterranean living laboratories provide the empirical basis for measuring, explaining, and optimising residential retrofit performance.



Fig. 2 Study Sites and Residential Monitoring Design

03 Current research position

1. Review Approach and Evidence Synthesis :

Research has yet to establish an integrated evidence chain linking PCDs with IEQ, occupant exposure, and HCOs, **particularly across exposure processes, seasonal variation, and long-term effects.** A review of 79 studies found that only 9 jointly addressed passive cooling, indoor environmental quality or exposure, and health-centred outcomes. Only 6 provided empirical or modelling evidence, and none established a complete, temporally validated pathway. The resulting framework identifies occupant exposure and adaptive behaviour as potential links requiring further validation.

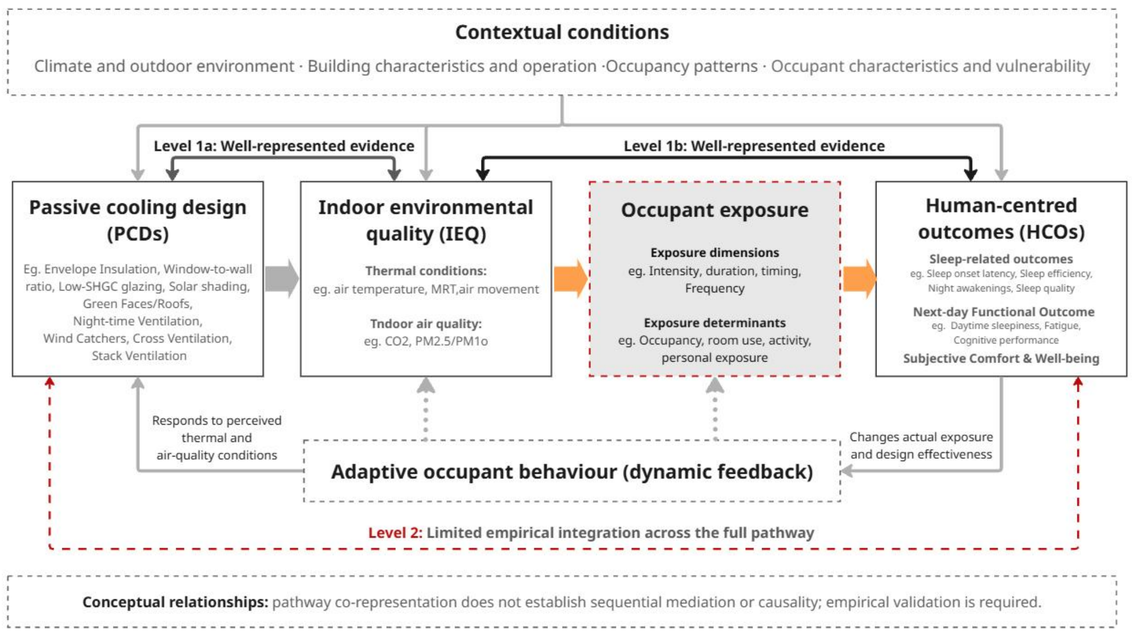


Fig. 3 Evidence-informed framework linking PCDs to HCOs

2. Data Collection and Preliminary Findings:

Preliminary analysis under the future climate scenario indicates substantial warming in both Lisbon and Madrid by 2100.

- **Lisbon:** By 2100, Lisbon's annual temperature may rise by 3–3.6°C, with strongest warming in summer under RCP8.5.
- Madrid: Under RCP8.5, Madrid's annual temperature is projected to rise by 7–8 °C by 2100 compared to 2020.

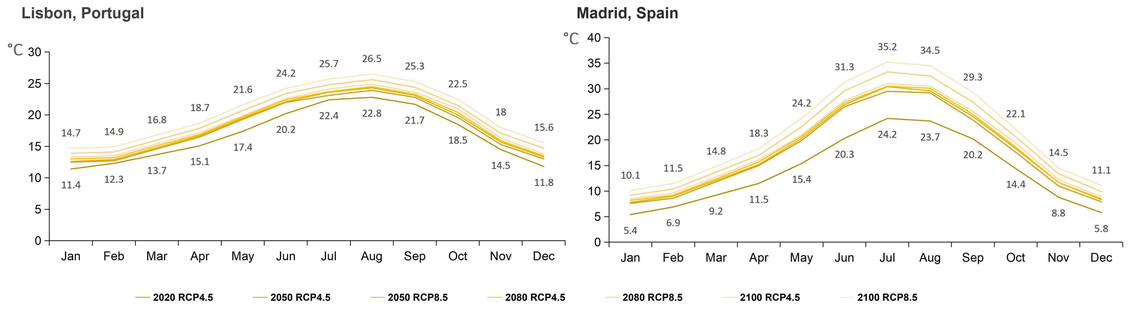
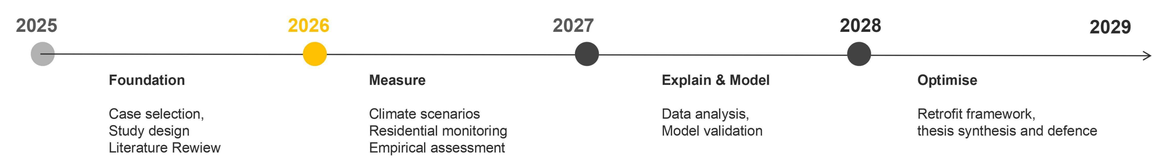


Fig. 4 Future temperature projections for Lisbon and Madrid



Acknowledgement: This work is financed by national funds through FCT under projects UID/05703/2025 (CiTUA) and UID/6438/2025 (CERIS), and received additional support from GEOTPU.LAB and FUNDEC.

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