Passive and low-energy strategies can improve thermal comfort and resilience during sleep

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# Summary

Sleep is a pillar of human health and wellbeing. In the U.S. and other developed countries, there is a high reliance on heating ventilation and air conditioning systems (HVAC) to control the interior thermal environment in the bedroom. However, these systems are problematic for several reasons: they are energy intensive, less accessible due to energy poverty, and their suitability is further compounded by climate change. Passive and low-energy strategies, such as personal comfort systems, may address these challenges, but their effectiveness has not been extensively studied for sleeping. We show that many passive and low-energy strategies are highly effective in supplementing or replacing HVAC systems during sleep. Using passive strategies in combination with low-energy strategies that elevate air movement like ceiling or pedestal fans can enhance the cooling effect by 3 times. We applied our experimentally-measured heating and cooling effect to two historical case studies: the 2015 Pakistan heat wave and the 2021 Texas power crisis. Passive and low-energy strategies can reduce the sleep time heat or cold exposure by as much as 90%. The low-energy strategies we tested consume one to two orders of magnitude less energy than HVAC systems, and the passive strategies require no energy input. Our results demonstrate that these strategies can also help reduce peak load surges in extreme temperature events. This reduces the need for utility loadshedding, which can put individuals at risk of heat or cold exposure. Our results may serve as a starting point for evidence-based public health guidelines on how individuals can sleep better during heat waves and cold snaps without HVAC.