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Invited Perspective: Beating the Heat

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Heat exposure is a leading environmental risk factor, responsible for an estimated 300,000–500,000 deaths annually.[1,2] Despite a rapid increase in our understanding of heat-related mortality and morbidity over the past two decades,[3,4] many studies have been based on administrative data, which are often limited in their details on specific causes of death/illness, on potential confounding factors and effect modifiers, and on the context of the event itself. As the world continues to warm[5] and heat risks multiply,[6] there is a need to diversify scientific approaches used to study heat to *a*) better identify who is most at risk, *b*) elucidate the biological mechanisms underlying observed health effects, and *c*) develop evidence-based policies to protect against high outdoor temperatures.

The study by Meade et al.[7] in this issue of *Environmental Health Perspectives* reports the results of a randomized crossover trial of 16 older adults with the aim of providing evidence to inform existing Canadian guidance on safe indoor temperatures. Their investigations directly address a policy-relevant question—how cool indoor environments should be—through innovative and rigorous physiological investigation, with their results supporting a 26°C upper temperature limit for residential buildings. As the authors note, some noteworthy limitations exist around potential generalizability to other geographies, climates, and populations, as well as the prohibitive cost and expertise required to conduct such intensive, laboratory-based studies on larger sample sizes.

Two natural questions, then, follow: *a*) how to generate similarly useful information in other locations, including those that are resource-constrained, and *b*) how to determine if laboratory-based results can be applied to these and other settings. One option may be to leverage existing studies that collect similar information for other purposes. For example, cookstove intervention studies often monitor temperature exposures while also collecting biospecimens and cardiorespiratory data.[8] However, studies employing the technologies used by Meade et al. to evaluate physiological temperature (e.g., ingestible monitors, rectal thermocouple-based monitors, skin-based thermistors) are rare and may not be feasible in the field from the perspective of either acceptability or practicality.

Future work to identify easier, less invasive proxies to estimate core temperature and other clinically meaningful metrics would be valuable. These proxies may include lower-cost, local meteorological stations or wearable monitors; if shown to be useful for evaluating core temperature, they might be easier to deploy at broader scales and during routine daily activities compared with the intensive work undertaken by Meade et al. Comparison of measurement types is warranted to understand the trade-offs between ease of deployment and measurement accuracy and precision. Furthermore, evaluations of the type performed by Meade et al., across more diverse populations and climatic settings, could help provide a framework for establishing context-specific indoor thermal tolerance limits. Replication in additional geographies could provide evidence of whether such indoor temperature guidance should be the same or different across diverse settings. Novel combinations of environmental sensing, backed by a better understanding of heat response physiology, could thus provide evidence-backed guidance on indoor environmental standards and enable mechanisms to alert populations at risk for heat stress in near real time.

Researchers will surely conduct studies along these lines in the coming years. In the meantime, while we await local data, should the Ottawa-based recommendations be adopted elsewhere? On the one hand, Ottawa is a relatively cool, temperate climate, suggesting that the study's target indoor temperature of 26°C would likely be protective in most places, given that the temperature at which heat risk begins seems to be linked to a city's prevailing climate.[9,10] On the other hand, implementing (potentially) conservative indoor temperature mandates may have ancillary consequences, such as effects on household energy burdens, emissions from air conditioning, or stress on the power grid. As with any policy, especially ones that can affect large swaths of the population, balancing these types of considerations is essential.

The article by Meade et al. not only challenges us to find creative ways to produce translational science related to heat exposure but also implicitly reminds us that some of the most important questions relevant to climate adaptation policies cannot be answered in the laboratory. Although most people around the world are affected by hot temperatures to some extent,[2] vulnerability is highly heterogeneous and differs by many factors, including income, occupation, health status, and age, to name just a few.[11–13] The focus of Meade et al. on a relatively homogenous group of healthy individuals $\geq$65 years of age is not an unreasonable population on which to base policy, because older adults are certainly among the vulnerable.[11] But other choices, such as including people who may be even more at risk (e.g., the very young, those with certain illnesses, the very old), would also be reasonable. In other words, studies like the one by Meade et al. can provide needed information on how to protect against heat but cannot decide who to protect; that is in many ways a much more difficult question to answer.

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