Damià Barceló, PhD, Jay Gan, PhD, Philip Hopke, PhD, Wei Ouyang, PhD, and Elena Paoletti, PhD

Co-Editors-in-Chief

Science of the Total Environment

May 3, 2024

Dear Dr. Barceló, Dr. Gan, Dr. Hopke, Dr. Ouyang, Dr. Paoletti, and the *Science of the Total Environment* editorial board:

On behalf of my co-authors, Stefano Schiavon and Duncan Callaway, I would like to submit the attached manuscript entitled “**Building and occupant characteristics as predictors of temperature-related health hazards in American homes**” for consideration as a Research Paper in *Science of the Total Environment*. This manuscript has not been published previously (in whole or in part) nor is it currently under consideration for publication in any other journal. All authors know and approve of its submission.

This manuscript applies machine learning methods to predict temperature-related illness in American households using the Residential Energy Consumption Survey (RECS), which is conducted every 3-5 years by the U.S. Energy Information Administration (EIA). Our study is a novel application of this existing data set, which uniquely couples detailed descriptors of the occupants and the building. This allows us to explore the complex interaction between vulnerability, largely described by demographic variables like race, age, and income, and exposure, described by building variables like construction type, insulation level, and heating, ventilation, and air-conditioning (HVAC) system type. Existing models to predict temperature-related health hazards often exclude building characteristics because this data is generally not accessible at scale. While our study cannot identify causal relationships between the input variables and temperature-related health hazards, the results can help public health agencies strategize limited resources to identify and intervene in at-risk households.

As part of our data analysis, we also estimate the prevalence of heat and cold-related illness in the U.S. in both 2015 and 2020. We find that this issue affects approximately 2 million households annually and the problem is widespread across all states. Heat-related illness is not a problem limited hot climates nor is cold-related illness limited to cold climates.

Our machine learning results demonstrate that with climate, demographic, and buildings variables, we can predict at-risk households with up to 85% accuracy. Inclusion of building variables gives approximately a 13% improvement in model accuracy. This result is statistically significant and has a strong effect size. In general, model precision is low, around 5%, meaning that we identify many false positives. However, it is worth considering that temperature-related health hazards are often underreported. When evaluating variable contributions, we find that energy insecurity as it relates to the inability to afford HVAC system operation and maintenance was the strongest predictor temperature-related illness followed by infiltration.

This research is well-aligned with the aims and scope of *Science of the Total Environment* in that we investigate the relationship between people and their home environment in contributing to the risk of temperature-related health hazards. This manuscript builds upon research previously published in this journal[[1]](#footnote-1) on the role of housing characteristics in mediating indoor heat exposure. Our results provide municipalities a pathway towards better data collection to identify at-risk households and better public health programming aimed at preventing in-home extreme temperature health hazards.

We would like to suggest three possible reviewers:

1. Holly Samuelson, Associate Professor, Harvard University, [hsamuelson@gsd.harvard.edu](mailto:hsamuelson@gsd.harvard.edu)
2. Clayton Miller, Associate Professor, National University of Singapore, [clayton@nus.edu.sg](mailto:clayton@nus.edu.sg)
3. David Hondula, Associate Professor, Arizona State University, [david.hondula@asu.edu](mailto:david.hondula@asu.edu)

Thank you for your consideration.

Sincerely,

Arfa Aijazi

PhD Candidate, University of California, Berkeley

1. Samuelson, Holly, Amir Baniassadi, Anne Lin, Pablo Izaga González, Thomas Brawley, and Tushar Narula. “Housing as a Critical Determinant of Heat Vulnerability and Health.” *Science of The Total Environment* 720 (June 2020): 137296. <https://doi.org/10.1016/j.scitotenv.2020.137296>. [↑](#footnote-ref-1)