The impact of extreme heat and cold on energy poverty in Australia

Ang Li
NHMRC Centre of Research Excellence in Healthy Housing
Centre for Health Policy
Melbourne School of Population and Global Health
The University of Melbourne

January 2024

FUNDED BY
FUEL POVERTY RESEARCH NETWORK
ENERGY POVERTY IN EARLY CAREER

Rationale

Climate change is shifting the distribution of temperature, leading to higher average temperatures, more intense and frequent heatwaves globally and, in the short-term, more extreme cold snaps. There is a growing recognition that climate change will affect the global experience of energy poverty (Churchill, Smyth, & Trinh, 2022; Feeny, Trinh, & Zhu, 2021; Sherriff, 2014; Sherriff, Brown, & Butler, 2019). Regions that previously experienced low levels of energy poverty, with infrastructure and housing well adapted for their historical climates, face the new problem of summer energy poverty due to excessive heat (Castaño-Rosa, Taylor, Pelsmakers, Gullman, & Sukaden, 2022). Consequently, groups may develop vulnerabilities that require different types of adaptive capacities (Li, Toll, & Bentley, 2023). This project explores how climatic changes will affect energy poverty, ascertains who is vulnerable, and identifies potential points of intervention to ameliorate climate change-related energy poverty.

Key research questions

The project aimed to examine the effect of the intensity, duration, and frequency of extreme heat and cold on risk of energy hardship, and to stratify this impact by social vulnerability and adaptive capacity.

1. What is the relationship between energy poverty and extreme temperature in terms of extremes of both heat and cold?
2. What individual, housing, and neighbourhood characteristics are a source of vulnerability or adaptive capacity?

Research activity

Quantitative analysis was conducted on matched longitudinal datasets. For the indicators of energy poverty and social vulnerability, data from the Household, Income, and Labour Dynamics survey was obtained that includes objective and subjective measures of energy poverty and the economic, social, and demographic features of individuals between 2005 to 2021. For the observations of extreme heat and cold, time series for daily maximum and minimum temperatures was obtained from the Bureau of Meteorology's Australian Climate Observations Reference Network – Surface Air Temperature (ACORN-SAT) that combine 112 site-based surface observations across Australia. These datasets were matched at the local government area level.

Methodologies: Quantitative modelling, fractional polynomials regressions, stratification, projection, population based longitudinal data, and climate data.

Findings

This study examined the impact of the intensity, duration, and frequency of extreme heat and cold on the risk of experiencing energy poverty over a decade across Australia. The study also explored vulnerabilities and adaptive capacities at the individual, housing, and neighbourhood level when exposed to extreme temperatures that either protect people from or heighten their risk of energy poverty. The models developed on the relationship between extreme temperatures and energy poverty were used to predict levels of energy poverty under 1) an extreme high greenhouse gas emission scenario in the absence of concerted mitigation efforts and 2) a moderate emission scenario with intermediate emission reductions.

Results suggest that there is a complex relationship between temperature and energy poverty, with both extreme heat and extreme cold leading to a higher risk of energy poverty. Extreme heat can result in an increase in the risk of spending a higher proportion of a household's income on energy; more people spending above 10% of their income on energy; experiencing high energy costs and falling below the poverty line; and falling into arrears on utility bills. Similarly, a decrease in minimum temperatures was associated with a higher level of energy poverty.

Results are consistent using different measures of energy poverty including 1) the proportion of household income spent on energy, 2) an indicator if the proportion of household income spent on energy was above 10%, 3) a low income high cost (LIHC) indicator that defines households as experiencing energy poverty if their equivalised energy costs are above the national median level and their equivalised household income after housing and energy costs falls below poverty line; and 4) an indicator of if the household reported being unable to pay utility bills on time because of a shortage of money.

The effect of the average annual maximum temperatures on the risk of spending >10% of household income on energy is accelerating, with one degree higher in the average annual maximum temperatures associated with an increased risk of spending >10% of household income on energy by 0.10% when the temperature is at 30°C and by 0.67% when the temperature is at 40°C.

On the other hand, the effect of the average annual minimum temperatures on the risk of spending >10% of household income on energy increases as it becomes colder, with one degree lower in the average annual minimum temperature associated with an increased risk of spending more than 10% of household income on energy by 0.35% when it is 15°C and by 0.24% when it is 5°C.

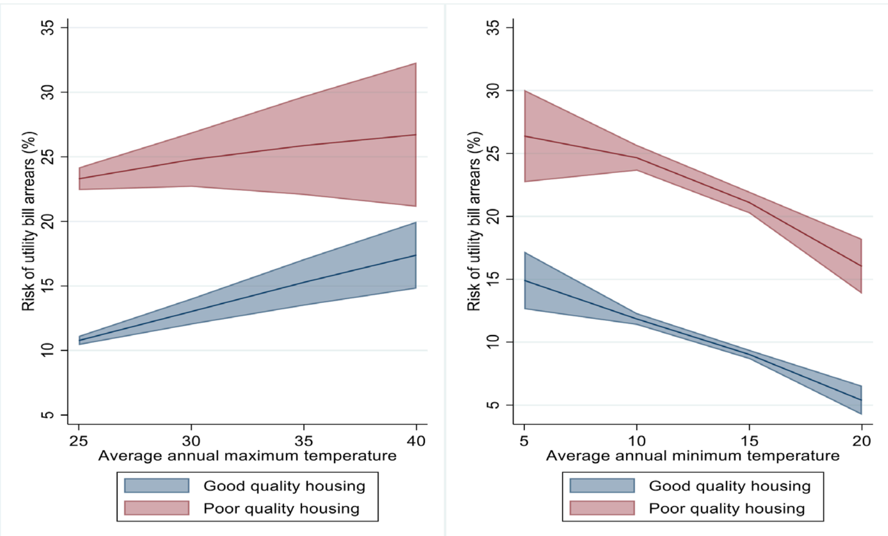

Figure 1. Effects of extreme temperature on energy poverty by housing quality

Results for changes in the yearly absolute maximum and minimum temperatures revealed a similar relationship between temperature and energy hardship. For the average duration of heatwaves and coldwaves, longer average heatwaves were found to be associated with more energy poverty while the results for the duration of coldwaves were insignificant. Total number of heatwave and coldwave days were both associated with higher energy poverty.

The results also suggest that the impact of extreme heat and cold on energy poverty varied according to the vulnerability and adaptive capacity at the individual, housing, and neighbourhood level. At the individual level, middle-aged people (people in their 30s and 40s), women, lone parents with children, group or multi-family households, and rental tenants (private and social renters combined) were more susceptible to the financial burden of extreme temperatures. The relative vulnerability of these groups can be attributed to a number of overlapping factors: strained financial burdens related to life stage (e.g., child rearing for middle-aged people and lone parents, and renters with high rental costs proportionate to income), relative economic disadvantages (e.g., female headed households, lone parents with children, and low income renters), or poor housing conditions (e.g. poorer housing quality and energy efficiency of rental properties).

However, these vulnerabilities can be offset by energy efficient housing. People who reside in good quality housing were found to be substantially less impacted by the exposure to extreme heat and cold. The average difference in the risk of utility bill arrears between good and poor housing is up to 12.7% (95%CI: 11.8, 13.6) when contending with heat, and up to 12.7% (95%CI: 11.8, 13.6) when contending with cold. Figure 1 shows the difference in the risk of utility bill arrears between good and poor-quality housing as the average annual maximum and minimum temperatures change.

While social vulnerability to the energy poverty impacts of climate change is uneven, housing and housing conditions are important adaptive capacities for temperature extremes and energy hardship. Strategies that improve the quality of housing stock in both owner occupying and rental sectors will anticipate climatic changes and help populations avoid slipping into energy poverty while maintaining healthy temperatures in their homes.

At the neighbourhood level, area vulnerability and resources were statistically significantly associated with energy hardship, as areas with lower coverage of greenspace and residential renewable energy installations experienced higher risks of energy poverty.

Under the Intergovernmental Panel on Climate Change' high emissions global warming scenario (known as RCP 8.5), the risk of energy poverty is projected to increase by 1.08%-1.98% attributable to the hotter average maximum temperature and decrease by 1.63%-2.84% attributable to the warmer average minimum temperature in long run. Given a population of more than 26 million in Australia in 2023, a 1% increase in the risk of energy poverty could translate to additional 260,000 population falling under energy poverty and being unable to pay utility bills on time.

Contrary to some predictions, energy hardship is not projected to vanish with the rise in the average global temperatures. Results suggest that despite reduced risks of energy poverty during warmer winters, the risk of energy poverty is also increasing at an increasing rate resulting from more intense extreme heat. The impact of extreme heat and cold was unevenly distributed at the individual level. However, individual vulnerabilities can be offset with resources at the housing and neighbourhood level, which suggest that these could be domains that could be targeted to increase adaptive capacity in response to climate change. Institutional arrangements around housing and rental standards should be considered. These could be to raise standards for energy efficiency or allow tenants the right to adapt properly. Interventions that increase green energy can also provide adaptive capacity that reduces susceptibility to temperature extremes.

Recommendations

1. Rental reforms that increase energy efficiency standards and allow renters to engage in modifications of their housing to make them more climate resistant could help overcome the energy poverty inequality between owner occupiers and private rental tenants.
2. Improved energy efficiency housing standards for new homes are needed to limit the risk of energy hardship.
3. Individual vulnerability can be offset by housing level interventions. Policy and programs around income support for alleviation of energy poverty and health services should be supplemented with housing level interventions that mitigate energy poverty.
4. Areas that have previously had to contend only with cold are now at risk from extreme heat-related energy poverty and should be subject to adaptation planning for this new challenge.

Outputs

1. The impact of extreme heat and cold on fuel poverty. Symposium on Housing for health in a rapidly changing climate. 35th Annual Conference of the International Society for Environmental Epidemiology in Kaohsiung, Taiwan. September 2023.
2. Climate Change and Energy Hardship: The impact of extreme heat and cold on fuel poverty. European Network for Housing Research (ENHR) Annual Conference. Lodz, Poland. June 2023.
3. Full draft of "The Impact of Extreme Heat and Cold on Energy Poverty" has been submitted for review in a high quality journal.

Acknowledgements

The research was conducted with funding support from the Fuel Poverty Research Network (Engaging in Energy Poverty in Early Career Grant) and the Australian National Health and Medical Research Council Centre of Research Excellence in Healthy Housing (grant number 1196456). I thank the participants at the European Network Housing Research conference (Poland, 2023) for their comments on earlier drafts.

References

Castaño-Rosa, R., Taylor, J., Pelsmakers, S., Gullman, M., & Sukaden, H. (2022). Energy Poverty in Finland: Reality and Challenges in the Face of Climate Change. In Energy Poverty Alleviation: New Approaches and Contexts (pp. 185-208): Springer.

Churchill, S. A., Smyth, R., & Trinh, T.-A. (2022). Energy poverty, temperature and climate change. Energy Economics, 114, 106306.

Feeny, S., Trinh, T.-A., & Zhu, A. (2021). Temperature shocks and energy poverty: Findings from Vietnam. Energy Economics, 99, 105310.

Li, A., Toll, M., & Bentley, R. (2023). Mapping social vulnerability indicators to understand the health impacts of climate change: a scoping review. The Lancet Planetary Health, 7(11), e925-e937.

Sherriff, G. (2014). Drivers of and barriers to urban energy in the UK: a Delphi survey. Local Environment, 19(5), 497-519. doi:10.1080/13549839.2013.836164

Sherriff, G., Brown, P., & Butler, D. (2019). Future Directions for Fuel Poverty Research: A Delphi Study

Cover photo: Tiff Ng Pexels.com

About the Funder

The Fuel Poverty Research Network (FPRN) was established in 2016 by researchers who were all concerned with different aspects of the interaction between people, homes and energy. The charity supports researchers and facilitates dialogue between researchers, policy and practice. FPRN's grant programme, Engaging in Energy Poverty in Early Career (EPEC), supports early career researchers (ECRs), postgraduate students (PGRs), and early career practitioners (ECPs) based in any country to contribute to efforts to tackle fuel and energy poverty through original research and publication.