Temperature-related mortality and climate change in Australia

Temperature-related mortality is one of the main measures used to assess the costs and benefits associated with climate change. Some assessments have found a net benefit of climate change due to reduced cold temperature deaths offsetting increases in heat-related deaths.[1–3] Antonio Gasparrini and colleagues[1] and Vicedo-Cabrera and colleagues[3] found a net benefit of climate change for Australia, a surprising outcome given that other regions that experience cooler weather were associated with a net cost of climate change. Examples of the regions that were associated with a net cost of climate change in Gasparrini and colleagues'[1] and Vicedo-Cabrera and colleagues'[3] reports include North America, Central America, central Europe, southeast Asia, South America and southern Europe. In comparison to these regions, why Australia would have a net benefit from climate change is unclear, as it is a country associated with extreme heat rather than extreme cold.

In 2018, I reported that Australian cities were adversely impacted by heat and had little cold-temperature mortality in an article published in *Climatic Change*.[4] The corresponding temperature-mortality relationship is a J-shaped curve, rather than the U-shaped curves reported by Gasparrini and colleagues.[5] This J-curve relationship implies that climate change is likely to increase the number of deaths in Australian cities in the future. A J-shaped curve has been reported before[6–10] and is more appropriate for a country known for having winters that are much milder than those in North America and central Europe.

Although Gasparrini and colleagues[1] used a statistically determined minimum mortality temperature to distinguish between heat-related and cold-related mortality, this reference temperature can be quite warm. For example, the minimum mortality temperature for Melbourne was very high and equal to the 90th percentile (ie, an average daily temperature of 22·4°C compared with the mean average daily temperature of 18·1°C reported for Australia).[1] A high minimum mortality temperature could mean that deaths during average temperatures are associated with cold-related mortality rather than being treated as deaths during moderate (usual) temperatures.

By contrast, in my article[4] I used endogenous threshold regressions and a temperature measure that accounts for acclimatisation to distinguish between heat-related and cold-related mortality. This Excess Heat Index that accounts for acclimatisation (EHI_A) is part of the Excess Heat Factor produced by the Australian Bureau of Meteorology. It is the 3-day average temperature minus the 30-day average temperature. The measure has a mean of 0°C, which is a useful reference temperature that can be compared with 3-day periods that are hotter or colder than the previous 30 days. To distinguish between heat-related and cold-related mortality, I used the thresholds determined by this estimation technique to classify the estimated mortality into the number of deaths during cold temperatures (EHI_A at $<-3{\cdot}51$°C), moderate temperatures (EHI_A at $\geq-3{\cdot}51$°C and $<1{\cdot}95$°C), hot temperatures (EHI_A at $\geq1{\cdot}95$°C and $<7{\cdot}26$°C), and extreme heat (EHI_A at $\geq7{\cdot}26$°C).

Consistent with the thresholds estimated, most temperature-related deaths in Australia were associated with high and extremely high temperature events. In some regressions a negative relationship with cold temperatures was apparent, which is plausible given that winters in Australia are quite mild. My article indicated that the risk from future temperature events in Australian capital cities will be associated with extreme heat and hot temperature events rather than cold temperature events, in contrast to the previous results.[1,3,5] I believe that further analysis is warranted to confirm whether the reference temperatures used to distinguish between heat-related and cold-related mortality are appropriate given the prevailing climate in Australia.

I declare no competing interests.

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1 Gasparrini A, Guo Y, Sera F, et al. Projections of temperature-related excess mortality under climate change scenarios. *Lancet Planet Health* 2017; **1:** e360–67.

2 Guo Y, Li S, Li Liu D, Chen D, Williams G, Tong S. Projecting future temperature-related mortality in three largest Australian cities. *Environ Pollut* 2016; **208:** 66–73.

3 Vicedo-Cabrera AM, Guo Y, Sera F, et al. Temperature-related mortality impacts under and beyond Paris Agreement climate change scenarios. *Clim Change* 2018; **150:** 391–402.

4 Longden T. Measuring temperature-related mortality using endogenously determined thresholds. *Clim Change* 2018; **150:** 343–75.

5 Gasparrini A, Guo Y, Hashizume M, et al. Mortality risk attributable to high and low ambient temperature: a multicountry observational study. *Lancet* 2015; **386:** 369–75.

6 Dang TN, Seposo XT, Duc NHC, et al. Characterizing the relationship between temperature and mortality in tropical and subtropical cities: a distributed lag non-linear model analysis in Hue, Viet Nam, 2009–2013. *Glob Health Action* 2016; **9:** 28738.

7 Lee W, Kim H, Hwang S, Zanobetti A, Schwartz JD, Chung Y. Monte Carlo simulation-based estimation for the minimum mortality temperature in temperature-mortality association study. *BMC Med Res Methodol* 2017; **17:** 137.

8 Egondi T, Kyobutungi C, Kovats S, Muindi K, Ettarh R, Rocklöv J. Time-series analysis of weather and mortality patterns in Nairobi's informal settlements. *Glob Health Action* 2012; **5:** 19065.

9 Cui Y, Yin F, Deng Y, et al. Heat or cold: which one exerts greater deleterious effects on health in a basin climate city? Impact of ambient temperature on mortality in Chengdu, China. *Int J Environ Res Public Health* 2016; **13:** 1225.

10 Sim G, Kim H, Zanobetti A, Schwartz J, Chung Y. Non-parametric Bayesian multivariate metaregression: an application in environmental epidemiology. *J R Stat Soc Ser C Appl Stat* 2018; **67:** 881–96.