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PERSPECTIVE

Greater understanding is need of whether warmer and shorter winters associated with climate change could reduce winter mortality

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Abstract

In temperate regions, mortality is higher during winter than summer seasons. Assuming this seasonality is associated with ambient temperature, assessments often conclude that climate change will likely reduce winter mortality. However, there has been limited evaluation of the extent to which cold temperatures are actually the proximal cause of winter mortality in temperate regions. Kinney et al. (2015 Environ Res. Lett. 10 064016) analyzed multi-decadal data from 39 cities in the US and France and concluded that cold temperatures are not a primary driver of most winter excess mortality. These analyses suggest that increases in heat-related mortality with climate change will unlikely be balanced by reductions in winter mortality, reinforcing the importance of health systems continuing to ensure adequate health protection against cold temperatures even as temperatures warm.

Perspective

Municipal to national governments are developing adaptation plans to manage the health risks of climate change. Governments want to understand which strategies, policies, and measures to prioritize to protect human health in a changing climate. One question that arises, particularly in temperate regions, is the extent to which winter season mortality could decrease with warmer and longer winters. Significant decreases in winter season mortality with warmer global mean surface temperature has implications for health systems programs and infrastructure planning. Different choices may be more appropriate if the burden of winter season mortality remains relatively constant over the coming decades.

It is well documented that more deaths occur in temperate regions in the winter, generally defined as the three coldest months of the year. Cardiovascular diseases account for the majority of deaths during the winter season in these regions (Analitis et al. 2008). Roughly 50% of the remaining deaths are due to respiratory diseases. A key question is whether these deaths are seasonal because of temperature (e.g. temperature is a proximal cause of these deaths, much as hot temperatures are a proximal cause of summer mortality) or whether deaths are seasonal for other reasons (Ebi and Mills 2013). Understanding this is important because climate change is projected to increase average ambient temperature in winter months and shorten the duration of the winter season (IPCC 2014). The assumption that mortality is seasonal because of ambient temperature often led national and international assessments of the health risks of climate change to conclude that a benefit of climate change would be lower winter mortality (e.g. Conflonieri et al. 2007). Determining the degree to which warming temperatures could alter future winter-related mortality requires understanding the role of cold temperatures in the etiology of specific health outcomes and in winter season mortality patterns, and the mechanisms whereby climate change could alter temperature-mortality relationships (Ebi and Mills 2013).

Kinney et al. (2015) directly addressed the question of the extent to which cold temperatures are associated with excess winter mortality using multi-decadal data from 36 cities in the US and three cities in France, focusing on separating the effects of cold temperatures
from the effects of the winter season. A series of analyses determined the direct effects of temperature on mortality risk, and the winter/summer mortality ratios based on seasonal mean temperatures for December, January, and February, compared with June, July, and August. Winter season excess deaths were compared to the difference in mean temperature between these two seasons, and to mean winter season temperature across the 39 cities. To examine control for season, a penalized spline function was used to test for temperature effects on mortality over time in two cities with substantial temperature differences between winter and summer (Paris and New York City), one city with a hot and humid climate (Miami), and one city with an intermediate climate (Marseille). A series of Poisson regression models were used to explore the sensitivity of the fitted temperature function with different levels of control for season; stratified analyses also were conducted.

Seasonal temperature differences across the 39 temperate cities spanned a 4-fold range, with winter temperatures ranging from −5 to over 20 °C. A similar level of winter excess mortality was observed for all cities, which the authors interpreted as suggesting ambient temperature was not a key driver of excess winter mortality. There was no statistical correlation between the magnitude of winter excess mortality and the seasonal range of temperature. Also, the variability in daily mortality within cities was not strongly influenced by winter temperature. The analyses further suggest that inadequate control for seasonality in analyses of the health impacts of cold temperatures could lead to spuriously large associations between temperature and mortality, resulting in erroneous attribution of winter mortality to temperature. Analyses of same-day temperature and mortality showed that when season is not well controlled, cold effects appear much larger. Analyses using the average of temperature over the five days preceding death showed a larger effect of temperature, but still fairly small. The authors conclude that the estimated effects of temperature in the winter season can be confounded by season if long lags are assumed.

An important implication of this research, if replicated in other studies and regions, is that contrary to suggestions in national and international climate change assessments, warmer winter temperatures will unlikely result in significantly lower mortality during winter months over coming decades as climate change continues. Further, if true, then projected changes in annual temperature-related mortality are likely to be larger than those estimated by studies combining projected increases in summer mortality with projected decreases in winter mortality to conclude the temperature-related health risks of climate change will likely be relatively small.

The results from Kinney et al (2015) are similar to results from Staddon et al (2014) and Nordio et al (2015), and with earlier studies of winter season mortality (e.g. Eurowinter Group 1997). Based on analyses of the short-term effects of ambient temperatures on daily mortality over six 7 year periods in 211 US cities, comprising over 42 million deaths, Nordio et al (2015) concluded that increased variability in temperature may be an important indicator of increased mortality risk based on cold temperatures increasing the steepness of the dose-response curve in warmer winters. Staddon et al (2014) analyzed key drivers that underlie year-to-year variations in excess winter deaths in England and Wales, concluding there was no evidence that excess winter deaths will decline as winters warm with climate change. However, in response, Hajat and Kovats (2014) argue that excess winter deaths may not be an appropriate metric for drawing conclusions about weather-related health risks associated with current or future weather patterns because many deaths occur on days with moderately cold temperatures, thereby contributing to mortality in the comparison months. Also, winter and summer temperature-related mortality might not be independent.

The results from Kinney et al (2015) differ from a recent multi-decadal analysis of ambient temperature and mortality from 384 locations in 13 countries that underscored the importance of winter mortality (Gasparini et al 2015). Using 21 day lag periods, most deaths were associated with the cold (7.29%, 95% empirical CI 7.02–7.49), with only 0.42% (0.39–0.44) of deaths associated with heat. Deaths associated with extreme cold were negligible compared with those occurring during periods of moderate cold. The cumulative exposure-response functions for winter season mortality were typically less steep at low temperatures, except for Rome, Italy; Madrid, Spain; and London, UK. London has relatively moderate winters, yet had the largest increase in winter mortality across the countries studied. As noted by Dear and Wang (2015), treating hot and cold extremes separately to determine the risks of temperature-related mortality would be helpful.

The different metrics and methods across these publications highlight that additional research is needed to better understand the sensitivity of studies of cold weather mortality to the analytical approaches, including the use of excess winter mortality to measure cold-related mortality and better understanding of the role of temperature in mortality that occurs on cold but not extreme days. Additional research is needed to understand the factors responsible for the seasonality of cardiovascular and respiratory diseases during winter months, including the extent to which temperature may be an indicator of factors that are proximal drivers of winter mortality. Evaluations of different approaches and lags to control for the impacts of influenza also are needed to strengthen analyses.

Greater understanding is needed of the independent and joint contributions of temperature and
season when analyzing winter mortality. Even if cold
temperatures are not primary drivers of most winter
mortality, health systems need to ensure adequate
health protection against the cold temperatures that
will continue to occur with climate change.

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