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Original Research

Temporal variation in the effect of heat and the role of the Italian heat prevention plan

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ABSTRACT

Objectives: The aim of the article is to evaluate the temporal change in the effect of heat on mortality in Italy in the last 12 years after the introduction of the national heat plan.

Study design: Time series analysis.

Methods: Distributed lag non-linear models were used to estimate the association between maximum apparent temperature and mortality in 23 Italian cities included in the national heat plan in four study periods (before the introduction of the heat plan and three periods after the plan was in place between 2005 and 2016). The effect (relative risks) and impact (attributable fraction [AF] and number of heat-related deaths) were estimated for mild summer temperatures (20th and 75th percentile maximum apparent temperature [Tappmax]) and extreme summer temperatures (75th and 99th percentile Tappmax) in each study period. A survey of the heat preventive measures adopted over time in the cities included in the Italian heat plan was carried out to better describe adaptation measures and response.

Results: Although heat still has an impact on mortality in Italian cities, a reduction in heat-related mortality is observed progressively over time. In terms of the impact, the heat AF related to extreme temperatures declined from 6.3% in the period 1999–2002 to 4.1% in 2013–2016. Considering the entire temperature range (20th vs 99th percentile), the total number of heat-related deaths spared over the entire study period was 1900.

Conclusions: Considering future climate change and the health burden associated to heat waves, it is important to promote adaptation measures by showing the potential effectiveness of heat prevention plans.

Introduction

Extreme temperatures are among the 10 worst reported natural disasters in terms of human lives lost globally.[1] The adverse effects of high temperatures and heat waves across Europe have been extensively documented over the past decades in several multicity studies.[2–4] Italy is one of the European countries most affected by heat waves, and every

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summer, there is a quantifiable burden of mortality and morbidity associated with the onset of heat waves.[5–7] Recent climate change scenarios have confirmed predictions of an increase in the frequency and intensity of extreme weather events in southern and central Europe,[8] and the impact of heat waves on health could have greater public health significance in the future. Italy is unique for both its climate, ranging from typical Mediterranean climates to more temperate and even continental subarctic climates in Apennine and Alpine areas, and in population characteristics both in terms of demographics and socio-economic conditions.

The temperature–mortality relationship is heterogeneous across cities[2,4,9,10] because of the different climatic conditions, individual and population characteristics and adaptation measures in place.[11] Furthermore, it may also vary over time within a same area.[12] Adaptation measures are crucial to reduce current and future adverse impacts of climate change, but to be prioritized in decision-making, they need to be evaluated. Evaluation of effectiveness of public health interventions in this field is challenging.[13,14] An indirect way of evaluating the effectiveness of heat wave response plans and warning systems has been proposed,[15,16] whereby a time series study is conducted comparing heat-related mortality before and after the introduction of the adaptation measure.[17,18]

In Europe, summer 2003 changed the perception of the health risk related to heat exposure both at individual and community levels, and has helped increase public awareness on climate change and committed the ministries of health of several countries to start up public health plans to reduce adverse effects of hot weather.[19,20]

In Italy, the Department of Civil Protection and the Ministry of Health implemented a national program for the prevention of heat health effects in 2004 that focused on the elderly and includs all regional capitals and cities with more than 200,000 inhabitants.[14] The National Coordination Center—Department of Epidemiology, Lazio Regional Health Service-ASL Roma 1—centrally manages the city-specific heat health watch warning systems (HHWWS), the national mortality surveillance system, definition of susceptible subgroups and survey of local prevention plans in place (www.salute.gov.it/caldo). Details of the Italian heat plan are described elsewhere.[14]

Briefly, preventive measures include informative campaigns for the general population, training for social and medical services, specific health interventions for at-risk subgroups, emergency protocols in health centers, social services according to the local organization services and resources and measures improving adaptive capacity such as cooling interventions.[14] During summer, as a part of the national program activities, a national helpline, managed by medical personnel and trained operators of the Ministry of Health, is activated and provides information on prevention tips for reducing health risks during heat waves, heat helplines in place in each city, and HHWWS warnings. Since summer 2015, the Ministry of Health has also made use of social media (twitter) to disseminate level 2 or 3 warnings (https://twitter.com/ministerosalute).

A first article evaluated the change in the effect of heat on mortality in the years after the 2003 heat wave, when there was a rise in population awareness and several cities introduced heat-related information campaigns and preventive measures.[17] However, the time frame was somewhat limited as many cities had just introduced the heat plan, and assumptions on the potential role of adaptation measures were partial.

In the recent years, intense heat waves have been registered throughout Italy, especially in 2012 and 2015, which together with the aging population have had a significant impact on mortality.[21]

The aim of the article is to evaluate the temporal change in the effect of heat on mortality in Italy in the last 12 years.

Methods

The study includes 23 Italian cities (Bari, Bologna, Bolzano, Brescia, Campobasso, Civitavecchia, Firenze, Frosinone, Genova, Latina, Milano, Napoli, Palermo, Perugia, Pescara, Reggio Calabria, Rieti, Roma, Torino, Trieste, Venezia, Verona, and Viterbo), characterized by different climatic conditions. Daily meteorological data and mortality for the period 1998 to 2016 were considered in the study. Weather data from the airport station closest to the each city were provided by the National Center of Meteorology and Climatology (CNMCA) of the Italian Air Force (www.meteoam.it), and the mortality data were retrieved from municipal registry offices included in the rapid national mortality surveillance system.[22]

Mortality data

Mortality was computed as the daily number of deaths occurring in each city it is a repetition. All natural deaths (International Classification of Diseases, 9th modification ICD-9: 0–799) were considered among the resident population aged 65 years and over dying in the city.

Environmental data

For each city, hourly air temperature (Temp, °C) and dew point temperature (Dew, °C) were collected, and apparent temperature (Tapp, °C), an index of thermal discomfort, was calculated as follows:

$$Tapp = -2.653 + 0.994 \times Temp + 0.0153 \times Dew^2$$

Daily maximum apparent temperature (Tappmax) was used as the exposure of interest.

The analysis was performed on four subperiods, one before the introduction of the HHWWS and the national heat plan (1999–2002) and three after its implementation moved above (2005–2008, 2009–2012, 2013–2016). This choice was made to evaluate changes in the effect of heat on mortality after the introduction of the heat prevention plan and change in the exposure. The study period was restricted to the warm season, defined from 15th of May to the 15th of September, when the national heat warning system and local plans are operational. Summer 2003 was a record-breaking summer in terms of both average summer temperatures and extreme values associated to very high effect estimates and impacts on

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