Effects of Air Temperature on Cardiopulmonary Mortality and Morbidity in Europe

The report "Effects of air Temperature on Cardiopulmonary Mortality and Morbidity in Europe" was prepared as a milestone of the EU Project EXHAUSTION. It summarizes the evidence on the effects of different levels and changes in ambient air temperature on cardiopulmonary (CPD) mortality and morbidity across Europe and puts a spotlight on the vulnerable and susceptible population. It can help stakeholders and policymakers to plan adaptation measures to protect the vulnerable and susceptible population and increase European resilience towards climate change and extreme weather events.

Main message

- We found increased risk of cardiopulmonary mortality and morbidity during heat exposure.
- The heat effect was stronger for respiratory mortality/morbidity than for cardiovascular causes.
- The elderly (65+ years) and females were more vulnerable to the adverse health effects of heat.
- Geographical variations in temperature effects were found by areas (e.g., by municipalities and/or counties) and across cohorts in Europe, with more prominent heat effects in the south of Europe.

About the Project

The overarching objective of EXHAUSTION is to quantify the changes in cardiopulmonary (CPD) mortality and morbidity due to extreme heat and air pollution under selected climate scenarios, while including a diverse set of adaptation mechanisms and strategies, calculate the associated costs, and identify effective strategies for minimizing adverse impacts.

This report focuses on one of the many key aspects of the project, i.e., estimating the exposure-response functions between ambient air temperature (AT) and multiple CPD endpoints and evaluating effect

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modification by area- or individual-level characteristics. Data analysis was carried out for three levels (level 1: cities; level 2: administrative small areas; level 3: individual-level data). Data for each level were: the **city-specific** time-series from 15 European countries (Czech Republic, England and Wales, Estonia, Finland, France, Germany, Greece, Ireland, Italy, Norway, Portugal, Spain, Sweden, Switzerland); the **small-area** (municipality or similar administrative units including both urban and rural settings) data from four European countries or regions (Norway, UK, Italy, and Attica in Greece); and the **individual-level** data from four European prospective cohort studies (CONOR-Norway, KORA-Germany, RoLS-Italy, SWEDEHEART-Sweden).

Findings

A. European Cities

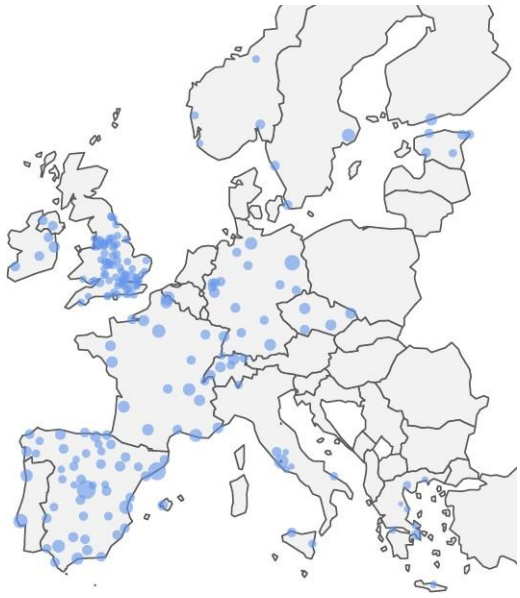

Figure 1: Map of European cities included in the study

Throughout European cities, when the daily mean temperature increased from the 75th to the 99th percentile of the city-specific temperature distribution (heat-effect), the risk for CPD mortality increased by 61% [95%CI: 35% to 93%], and the risks for cardiovascular (CVD) and respiratory (RD) mortality increased by 49%[95%CI:25% to 77%] and 110%[95%CI:61% to 175%], respectively. The largest effect for RD was seen in Portugal, where it was found to increase by 465%[271% to 759%], followed by France where it increased by 317%[202% to 477%]. Similarly, when the daily mean temperature decreased from the 25th to the 1st percentile of the city-specific temperature distribution (cold-effect), there was an overall 27% [15% to 39%] increment in the CPD mortality,

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with similar results for CPD and RD mortality. The elderly (65+ years of age) were seen to be more susceptible to the cold effect. Similarly, women were seen to be more vulnerable to the heat effect (mortality increment by 67%[95%CI:29% to 115%])than men (mortality increment by 42%[95%CI:-1% to +104%]).

B. Small area

Throughout the small areas in the five countries or regions, when the daily mean temperature during the warm season (May-September) increased from the 75th to the 99th percentile of the area-specific temperature distribution, the risk for total mortality increased by 17%[95%CI: 10% to 24%]. A north-south gradient was found, with heat effects on total mortality being stronger in Germany and the Mediterranean countries (Italy and Greece) and weaker in the north (Norway). Besides, stronger heat effects were seen among the elderly (75+ years) and females. The heat effect on morbidity was examined in Germany and Italy. For the same increment in the daily mean temperature, the risk for RD hospital admissions increased by 7%[95%CI: 7% to 8%] and 12%[95%CI: 10% to 13%] respectively, in Germany and Italy. In all five countries or regions, the heat effects on RD mortality/morbidity were stronger than those on CVD.

C. Cohort

Among the four cohorts from Italy (RoLS cohort), Germany (KORA cohort), the United Kingdom (UK Biobank cohort), and Norway (CONOR cohort), when the daily mean temperature decreased from the 25th to the 1st percentile, the risk for natural-cause, CPD, and CVD mortality was increased by 9%[95%CI: 2% to 16%], 13%[95%CI: 3% to 23%], and 19%[95%CI: 4% to 36%], respectively. With further inclusion of the fifth cohort from Sweden (SWEDEHEART cohort), for the same decrement in temperature, the risk for coronary morbidity was increased by 4%[95%CI: 1% to 8%]. We did not find evidence for cold effect modification by age or sex. Adverse heat effects on mortality were only observed in the RoLS cohort (Italy). For an increase in daily mean temperature from the 75th to the 99th percentile, the risk for RD mortality was increased by 40%[95%CI: 18% to 67%], which was slightly stronger than that on CVD.

Among the four cohorts from Italy, Germany, the UK, and Norway, when the annual standard deviation (SD) of air temperature increased from the 75th to the 99th percentile, the risk for RD mortality was increased by 18%[95%CI: 7% to 29%]. In addition, our findings suggest associations of both low and high annual mean temperature with increased risk for cerebrovascular mortality. Stronger effects of high annual mean and SD of temperature were observed among the females.

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