EFFECTS OF AIR TEMPERATURE MODIFIED BY VULNERABILTIY FACTORS

The report "Effects of Air Temperature Modified by Vulnerability Factors" was prepared as a milestone by researchers in the EU Project EXHAUSTION*. This report summarises the evidence on the interactive effects of high air temperature and various vulnerability factors, including the environmental, socio-economic, and individual behavioral factors on heart- and lung-related deaths and diseases (cardiopulmonary mortality and morbidity) across Europe. The study was conducted at the city, small-area (e.g., municipalities), and individual level. The findings show a greater vulnerability to heat for people living in urban areas with dense population, high air pollution levels, low coverage of green spaces, as well as areas with low Gross Domestic Product. Moreover, people with chronic pre-existing diseases and the elderly were found to be at greater risk. The findings highlight the urgent need to improve the urban environment as well as the health status and living conditions in European cities to contrast the impacts of heat and future climate change. This report alerts stakeholders and policymakers that targeted climate change adaptation measures need to be considered to protect vulnerable population and thereby increase European resilience to climate change.

[*for more information on the project, visit the project website and the preceding report]

Policy Implications:

- Better air quality regulation and increased green spaces in densely populated areas would decrease heat-related hospital admissions and deaths.
- Health promotion and improvements in the population's socio-economic status might help decrease future heat-related health impacts.
- Identifying vulnerable groups and defining specifically targeted prevention and response actions in adaptation plans is crucial.
- Health policies ought to be more explicit in accounting for climate change impacts and enhance adaptation and mitigation policies.
- Designing targeted adaptation measures like heat health action plans incorporating air quality measures is essential.

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- Following the new WHO Air Quality Guidelines, more ambitious air pollution mitigation measures having clear health benefits need to be urgently implemented to enhance resilience and sustainable development in alignment with climate change policies.

Findings

A. European Cities

Across the 204 European cities, population density and the proportion of the population aged 65 and older were found to be important factors enhancing the heat-health risk. Increased population density was associated with an increased risk of heat-related mortality, especially from respiratory diseases [RD]. In general, a significant increase in all heat-related mortality outcomes was observed for an increase in the share of the population aged 65 years and older. In particular, the risk of heat-related RD mortality increased from 1.70 (95% Confidence Interval [CI]: 1.09 - 2.66) in cities with low* to 3.21 (95%CI: 1.99 - 5.18) in cities with a high* proportion of the population aged 65 and above. **The results show a greater vulnerability to heat for people living in densely populated areas and the elderly.**

The overall heat effect modification for cardiopulmonary mortality [CPD] across European cities is presented in Figure 1.

[*low proportion = 12%; high proportion = 22%]

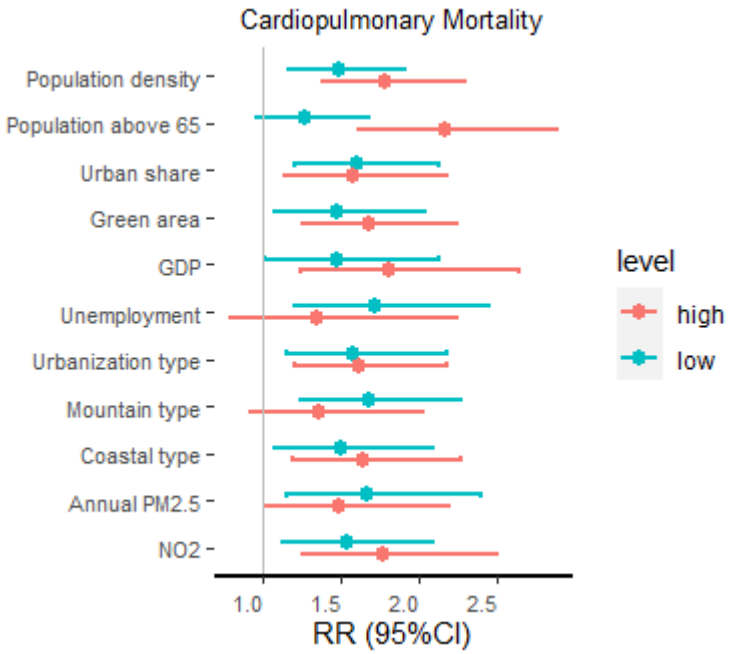

Figure 1: Overall heat effects on cardiopulmonary mortality across European cities modified by vulnerability factors

Estimates are presented as Relative Risks (RR) for mortality per an increase in temperature from the 75th to the 99th percentile (and 95% CIs) for low and high levels of the effect modifier (5th and 95th percentiles of the modifier's distribution, respectively): results from single predictors' models.

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B. Small-area level

We separately assessed the heat vulnerability factors at the small-area level (NUTS3) in Northern and Southern Europe‡. In Northern Europe, heat effects on total and cause-specific mortality were stronger in areas with higher population density, a higher degree of urbanization, higher levels of air pollution (particulate matter with diameters ≤2.5 µm), and a lower percentage of green spaces. For instance, heat-related relative risks for CPD mortality were 1.15 (95%CI: 1.11 - 1.19) and 1.26 (95%CI: 1.21 – 1.30), respectively, at low* and high* levels of population density. Besides, areas with more than 50% of people living in the mountain areas showed lower heat effects on total mortality. In Southern Europe, areas with lower* employment rates, lower* Gross Domestic Product [GDP] per capita, and higher* levels of air pollution (particulate matter with diameters ≤10 µm) were found to have stronger heat effects on total mortality. For example, heat-related relative risks for total mortality were 1.26 (95%CI: 1.20 - 1.33) and 1.17 (95%CI: 1.12 - 1.24) in areas with low* and high* employment rates, respectively. In addition, we estimated stronger heat effects on mortality in coastal areas compared to non-coastal areas. **The results show a greater vulnerability to heat for people living in urban areas with dense populations, high air pollution levels, and low coverage of green spaces, as well as areas with low GDP**.

The overall heat effect modification for cardiopulmonary mortality across small areas in Northern European cities is presented in Figure 2.

[‡Northern Europe: Norway, England and Wales, and Germany; Southern Europe: Italy and Attica region in Greece. *low level = 5th percentile of the respective variable distribution, high level = 95th percentile of the respective variable distribution]

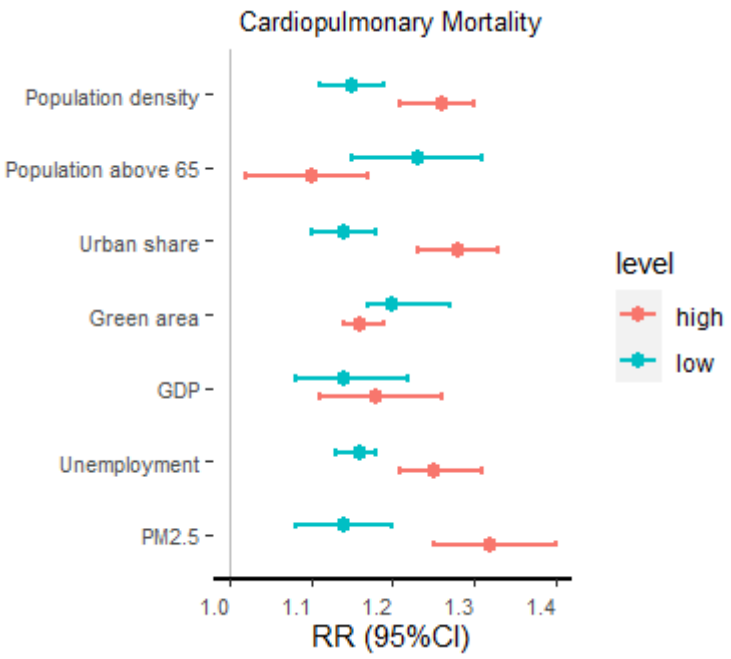

Figure 2: Overall heat effects on cardiopulmonary mortality across small areas in Northern Europe modified by vulnerability factors

Estimates are presented as Relative Risks (RR) for mortality per an increase in temperature from the 75th to the 99th percentile (and 95% CIs) for low and high levels of the effect modifier (5th and 95th percentiles of the modifier's distribution, respectively): results from single predictors' models.

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C. Individual level

We examined the heat effect modification by participant characteristics at the individual level in five European cohorts*. When pooling the results across cohorts, we observed stronger heat effects on natural-cause and CPD mortality among people with pre-existing cardiovascular disease [CVD]. For example, the relative risks for CPD mortality associated with heat were 1.20 (95%CI: 1.01 - 1.43) and 1.13 (95%CI: 0.96 - 1.33) among people with and without pre-existing CVD, respectively. In addition, the heat effect on CPD mortality was more pronounced in participants with hypertension. Concerning area-level factors and heat-related mortality, people who lived in neighborhoods with medium socio-economic status were likely to be more vulnerable to heat than those of low or high socio-economic status. In the RoLS cohort (Rome, Italy) - where we observed the most consistent associations between heat and cause-specific mortality - the heat effects on natural-cause, CPD, CVD, and RD mortality were stronger among the elderly (65+ years), females, people not born in the study area, and the unemployed or retired individuals. **The results suggest a potentially greater vulnerability to heat for people with pre-existing cardiovascular diseases or old age, and not employed.**

The overall heat effect modification by participant characteristics for cardiopulmonary mortality across cohorts is presented in Figure 3.

[*Cohort name (study area): RoLS (Rome, Italy), KORA (Augsburg, Germany), UK Biobank (United Kingdom), CONOR (Norway), and SWEDEHEART (Sweden)]

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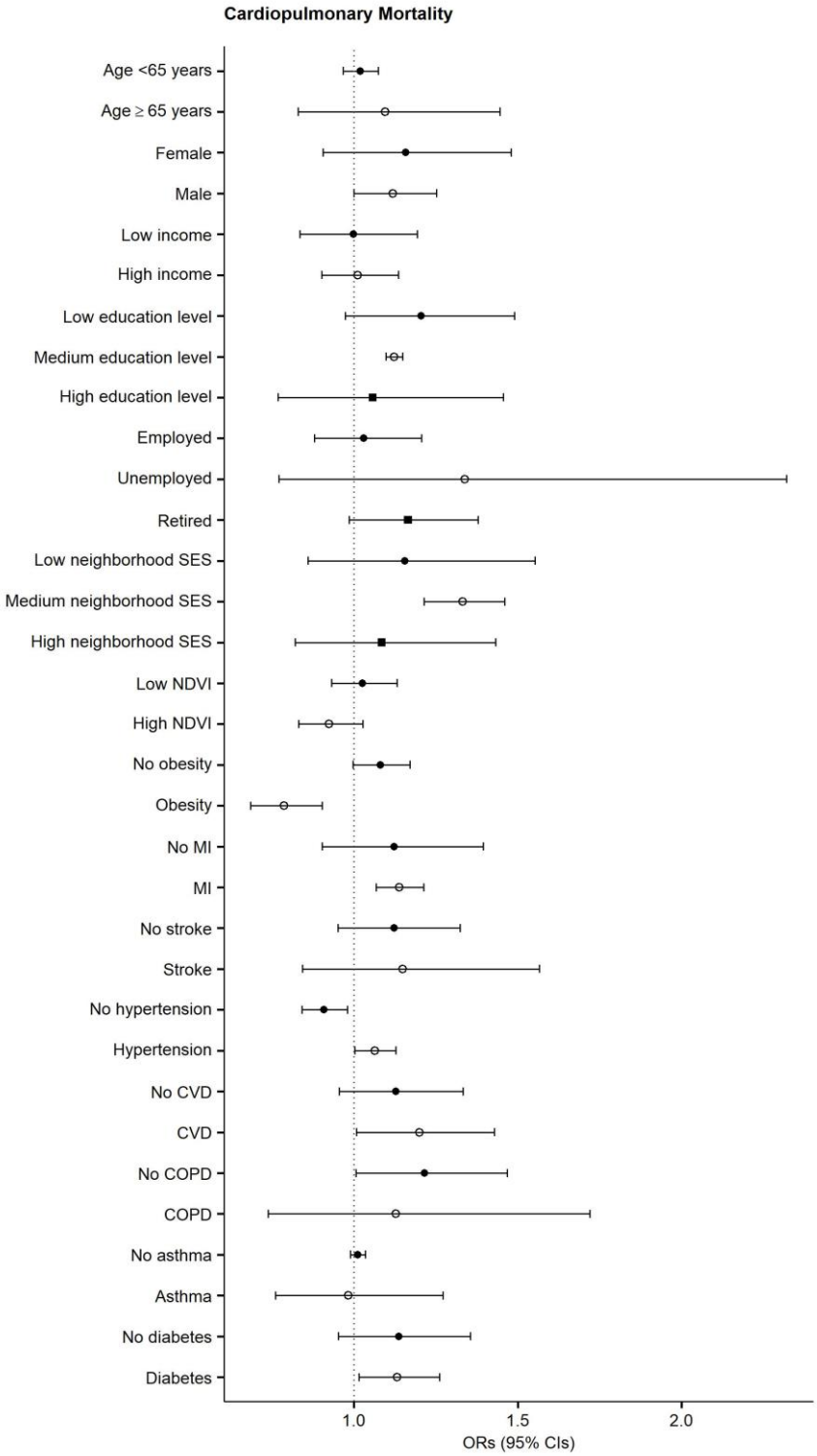

Figure 3: Overall heat effects on cardiopulmonary mortality modified by participant characteristics across cohorts.

Estimates are presented as the odds ratio (ORs) of cause-specific mortality with the corresponding 95% confidence intervals for an increase in the mean temperature from the 75th to the 99th percentile of the cohort-specific temperature distribution.

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