ALMA MATER STUDIORUM
UNIVERSITÀ DI BOLOGNA
DEPARTMENT OF STATISTICAL SCIENCES
"PAOLO FORTUNATI"

MAX PLANCK INSTITUTE
FOR DEMOGRAPHIC RESEARCH

European Research Council

FRONTIERS
FUTURE EARTH, CLIMATE CHANGE AND SOCIAL CHALLENGES

POPCLIMA (GA101002973)

Temperature related deaths in Europe

Rosanna Gualdi[1], Risto Conte Keivabu[2], Raya Muttarak[1]

1 Department of Statistical Sciences "Paolo Fortunati", University of Bologna (Italy), 2 Max Planck Institute for Demographic Research, Rostock (Germany)

Health, Morbidity, and Mortality Working Group
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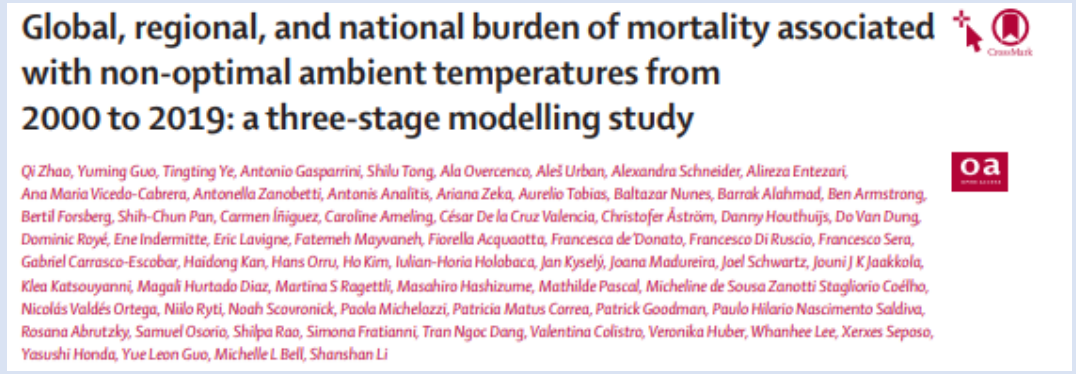
European Association of Population Studies

Literature and Background

Cold Spell



Global, regional, and national burden of mortality associated with non-optimal ambient temperatures from 2000 to 2019: a three-stage modelling study

Qi Zhao, Yuming Guo, Tingting Ye, Antonio Gasparrini, Shilu Tong, Ala Overcenco, Aleš Urban, Alexandra Schneider, Alireza Entezari, Ana Maria Vicedo-Cabrera, Antonella Zanobetti, Antonis Analitis, Ariana Zeka, Aurelio Tobias, Baltazar Nunes, Barrak Alahmad, Ben Armstrong, Bertil Forsberg, Shih-Chun Pan, Carmen Íñiguez, Caroline Ameling, César De la Cruz Valencia, Christofer Åström, Danny Houthuijs, Do Van Dung, Dominic Royé, Ene Indermitte, Eric Lavigne, Fatemeh Mayvaneh, Fiorella Acquaotta, Francesca de'Donato, Francesco Di Ruscio, Francesco Sera, Gabriel Carrasco-Escobar, Haidong Kan, Hans Orru, Ho Kim, Iulian-Horia Holobaca, Jan Kyselý, Joana Madureira, Joel Schwartz, Jouni J K Jaakkola, Klea Katsouyanni, Magali Hurtado Diaz, Martina S Ragettli, Masahiro Hashizume, Mathilde Pascal, Micheline de Sousa Zanotti Stagliorio Coêlho, Nicolás Valdés Ortega, Niilo Ryti, Noah Scovronick, Paola Michelazzi, Patricia Matus Correa, Patrick Goodman, Paulo Hilario Nascimento Saldiva, Rosana Abrutzky, Samuel Osorio, Shilpa Rao, Simona Fratianni, Tran Ngoc Dang, Valentina Colistro, Veronika Huber, Whanhee Lee, Xerxes Seposo, Yasushi Honda, Yue Leon Guo, Michelle L Bell, Shanshan Li

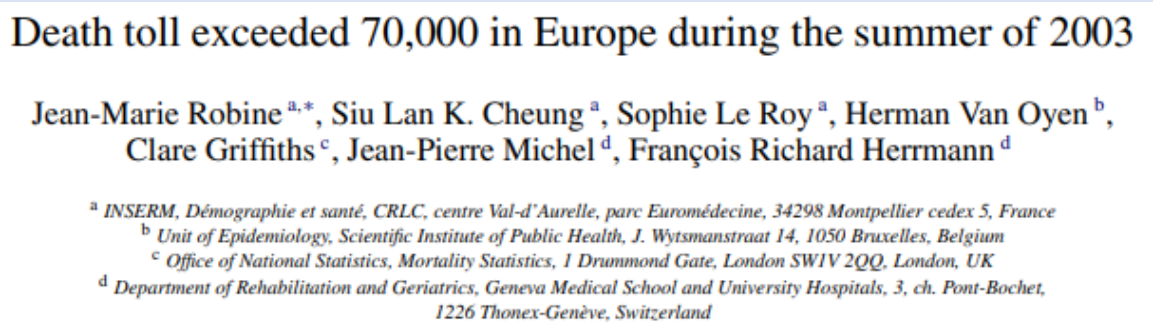
Source: (Zhao et al., 2021).

Excess mortality attributed to heat and cold: a health impact assessment study in 854 cities in Europe

Pierre Masselot, Malcolm Mistry, Jacopo Vanoli, Rochelle Schneider, Tamara Iungman, David Garcia-Leon, Juan-Carlos Ciscar, Luc Feyen, Hans Orru, Aleš Urban, Susanne Breitner, Veronika Huber, Alexandra Schneider, Evangelia Samoli, Massimo Stafoggia, Francesca de'Donato, Shilpa Rao, Ben Armstrong, Mark Nieuwenhuijsen, Ana Maria Vicedo-Cabrera, Antonio Gasparrini, on behalf of MCC Collaborative Research Network and EXHAUSTION project

Source: (Masselot et al., 2023).

Heatwaves



Death toll exceeded 70,000 in Europe during the summer of 2003

Jean-Marie Robine [a,*], Siu Lan K. Cheung [a], Sophie Le Roy [a], Herman Van Oyen [b], Clare Griffiths [c], Jean-Pierre Michel [d], François Richard Herrmann [d]

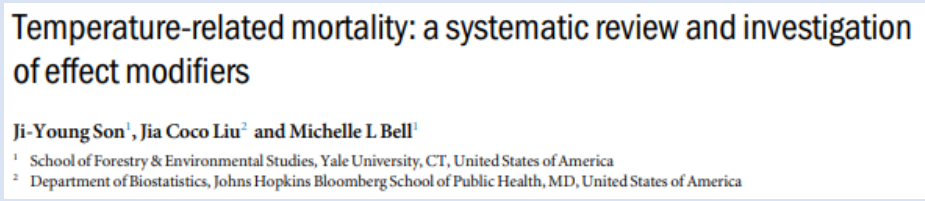
[a] INSERM, Démographie et santé, CRLC, centre Val-d'Aurelle, parc Euromédecine, 34298 Montpellier cedex 5, France
[b] Unit of Epidemiology, Scientific Institute of Public Health, J. Wytsmanstraat 14, 1050 Bruxelles, Belgium
[c] Office of National Statistics, Mortality Statistics, 1 Drummond Gate, London SW1V 2QQ, London, UK
[d] Department of Rehabilitation and Geriatrics, Geneva Medical School and University Hospitals, 3, ch. Pont-Bochet, 1226 Thonex-Genève, Switzerland

Source: (Robine et al., 2008).

July 2023: Global air and ocean temperatures reach new record highs

8th August 2023

Source: (Copernicus., 2023).



Temperature-related mortality: a systematic review and investigation of effect modifiers

Ji-Young Son[1], Jia Coco Liu[2] and Michelle L Bell[1]

[1] School of Forestry & Environmental Studies, Yale University, CT, United States of America
[2] Department of Biostatistics, Johns Hopkins Bloomberg School of Public Health, MD, United States of America

Source: (Son et al., 2023).

Research Questions

- How do extreme temperatures affect mortality of individuals aged above 65 in Europe?
- How does geographical heterogeneity in Europe affect the extreme-temperatures related-mortality in individuals aged above 65?
- ·Are there sex disparities across geographical regions in Europe?

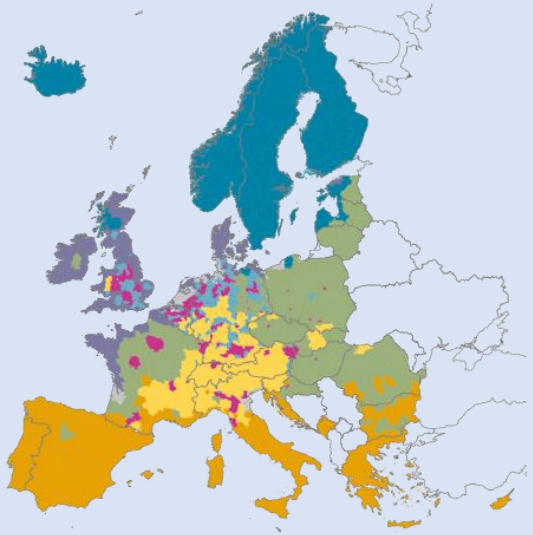
Our Contribution 🌡️

1. PERIOD OF INVESTIGATION: 2014 – 2022

2. GEOREFERENCE: 28 European countries at NUTS 3 level

3. CLASSIFICATION: 8 regions defined by European Environment Agency (EEA) developed through the RESIN project (H2020).
   - Climate Hazards (KC);
   - Geographical region type (such as urban, rural, coastal, etc.) (C);
   - Levels of Exposure of the population (E);
   - Vulnerability of the population (S);
   - Adaptive capacity of the areas (including GDP, Levels of Infrastructure) (AC).

65+



Data Sources and Variables

1. EUROSTAT

- Population Counts: Monthly population estimates by sex, 5-year age at NUTS 3 level (DEMO_R_PJANGRP3)
- Death Counts: Deaths by month, sex, 5-year age group at NUTS 3 level (DEMO_R_MWEEK3)

2. E-OBS (Copernicus Data Store)

- Meteorological Information: - Monthly average relative humidity, solar radiation, wind speed
  - Monthly average temperature categorized in percentiles:

P1: days below and equal to the 1st percentile;
1st to 5th; 5th to 10th; 10th to 25th;
Comfort: 25th to 75th;
75th to 90th; 90th to 95th; 95th to the 99th;
P99: above the 99th percentile.

3. European Environment Agency (EEA Datahub)

- European Climatic Risk Typology: - NUTS3 categories

1. Inland and Urbanized,
2. Inland Hinterlands,
3. Northern Lands,
4. Southern Lands,
5. Northwest Coasts,
6. Landlocked and Elevated,
7. Northwest Urban,
8. Lowlands and Estuaries.

Methodology: Poisson regression with Fixed Effects

$$log(Y_{nt}) = \log(E_{nt}) + \sum_j \theta_j TEMP^j_{nt} + X_{nt}\beta_{nt} + \alpha_{nw} + \delta_{yw} + e_{tn}$$

FE: month by location (NUTS 3) and month by year.

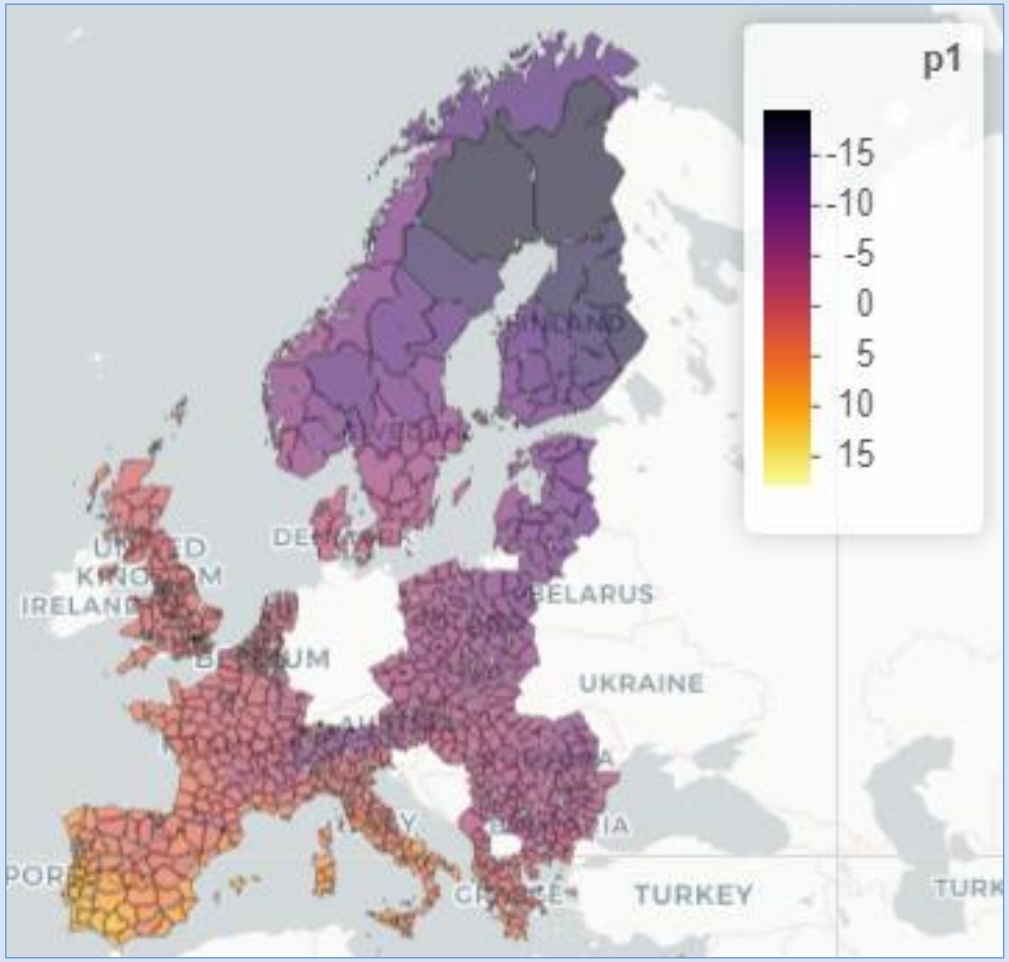
SE: NUTS3 level.

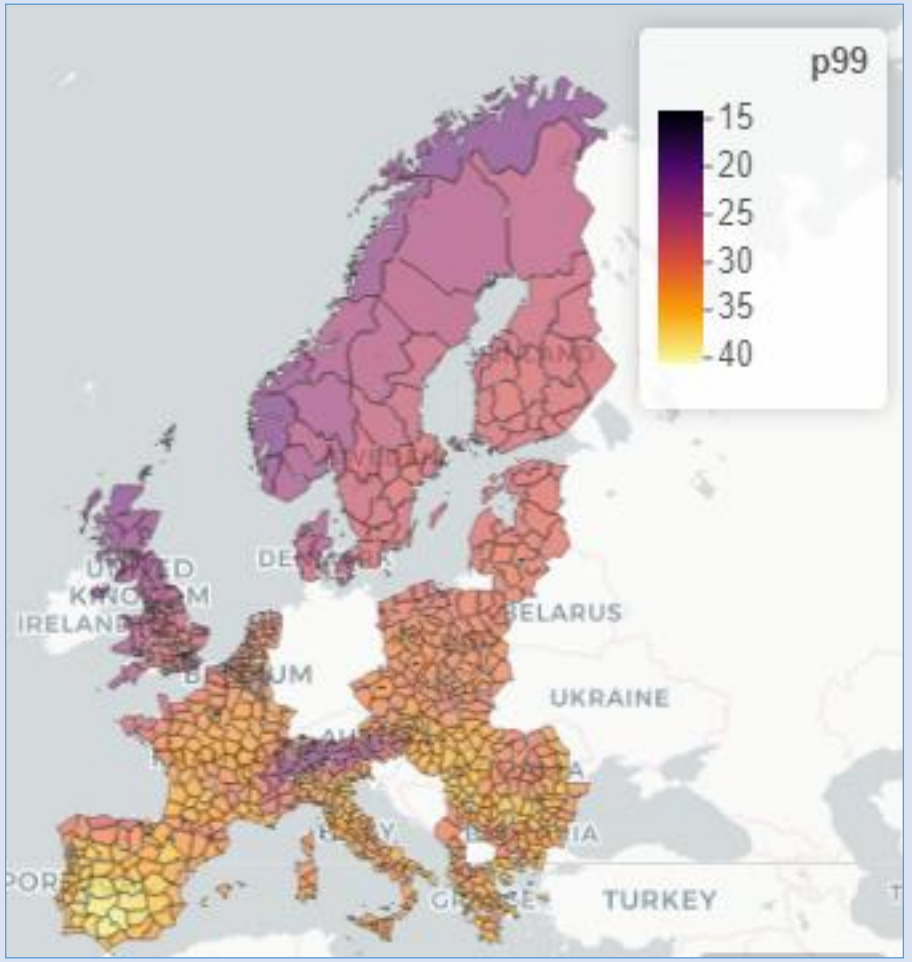
Controls: solar radiation, wind speed, relative humidity, sex, age categories.

Reference bin: 25 to 75th percentile.

temperature categorized in percentiles: days below and equal to the 1st percentile;
from the 1st to the 5th percentile;
from the 5th to the 10th percentile;
from the 10th to the 25th percentile;
from the 25th to the 75th percentile;
from the 75th to the 90th percentile;
from the 90th to the 95th percentile
from the 95th to the 99th percentile;
above the 99th percentile.

Percentile temperatures in Europe





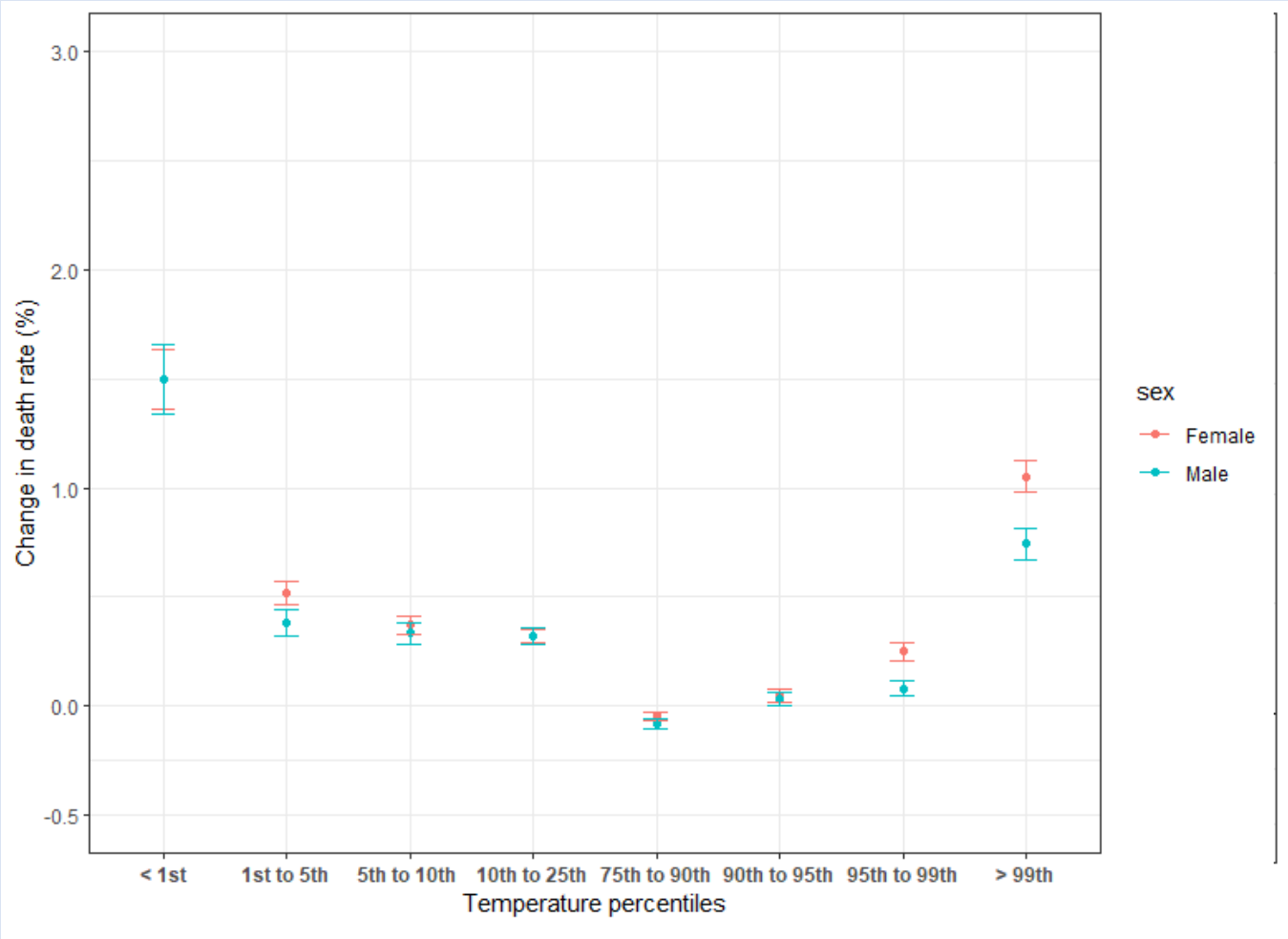
1st and 99th percentile in NUTS3 temperature distribution in 2014-2022

Extreme temperature and mortality in Europe

65+

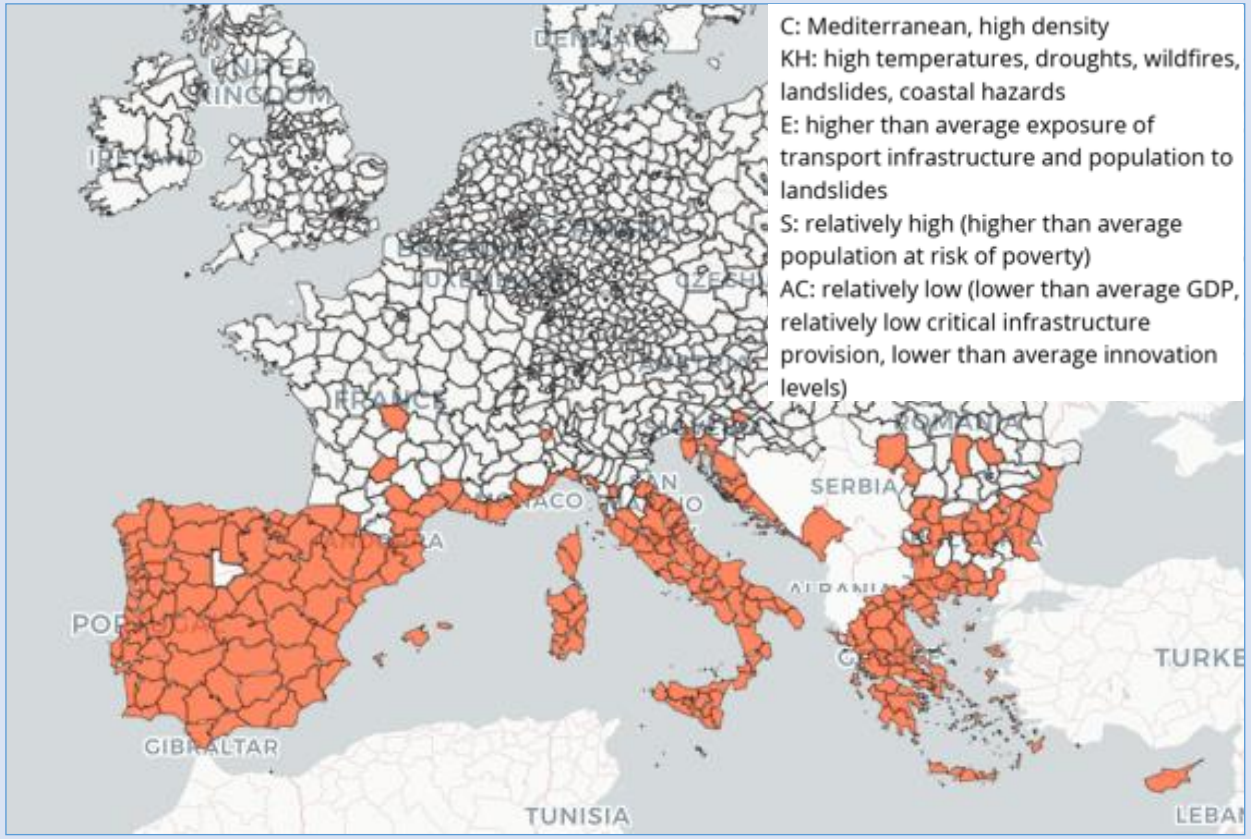
2014 - 2022

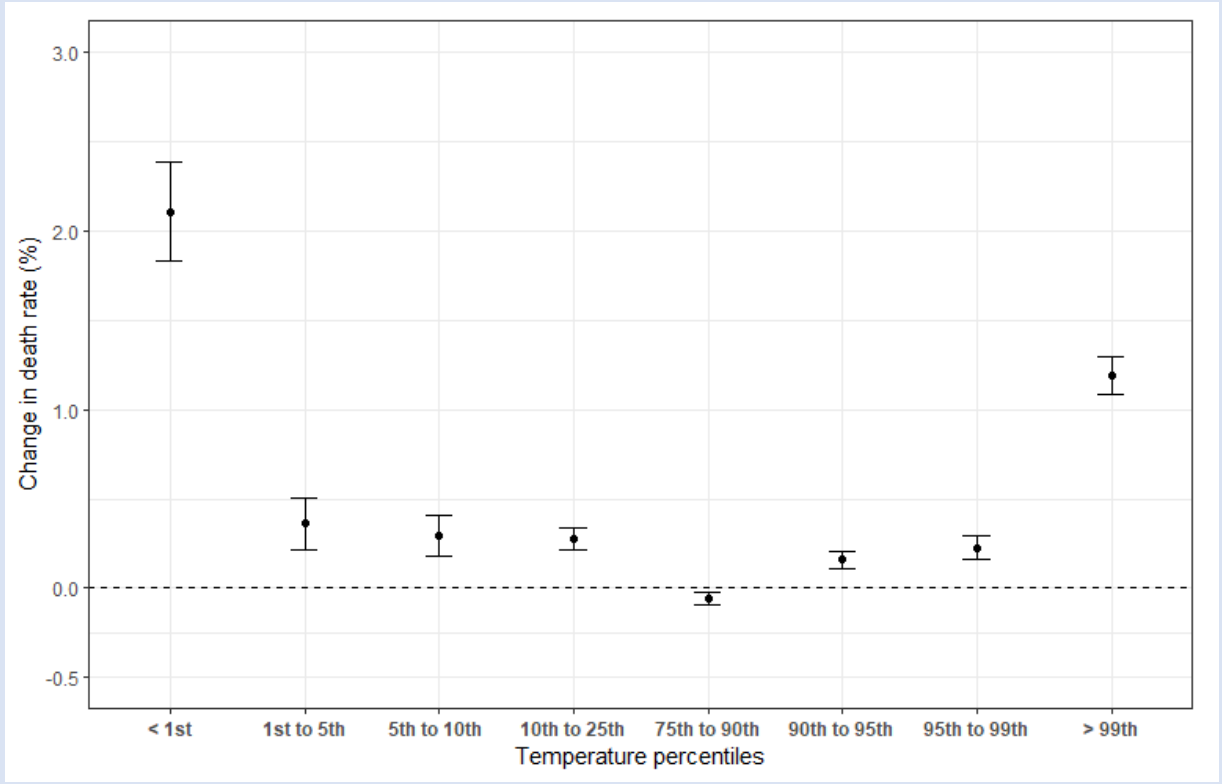
per sex



Extreme temperature-related mortality (65+) in Southern Europe 2014 - 2022

per sex



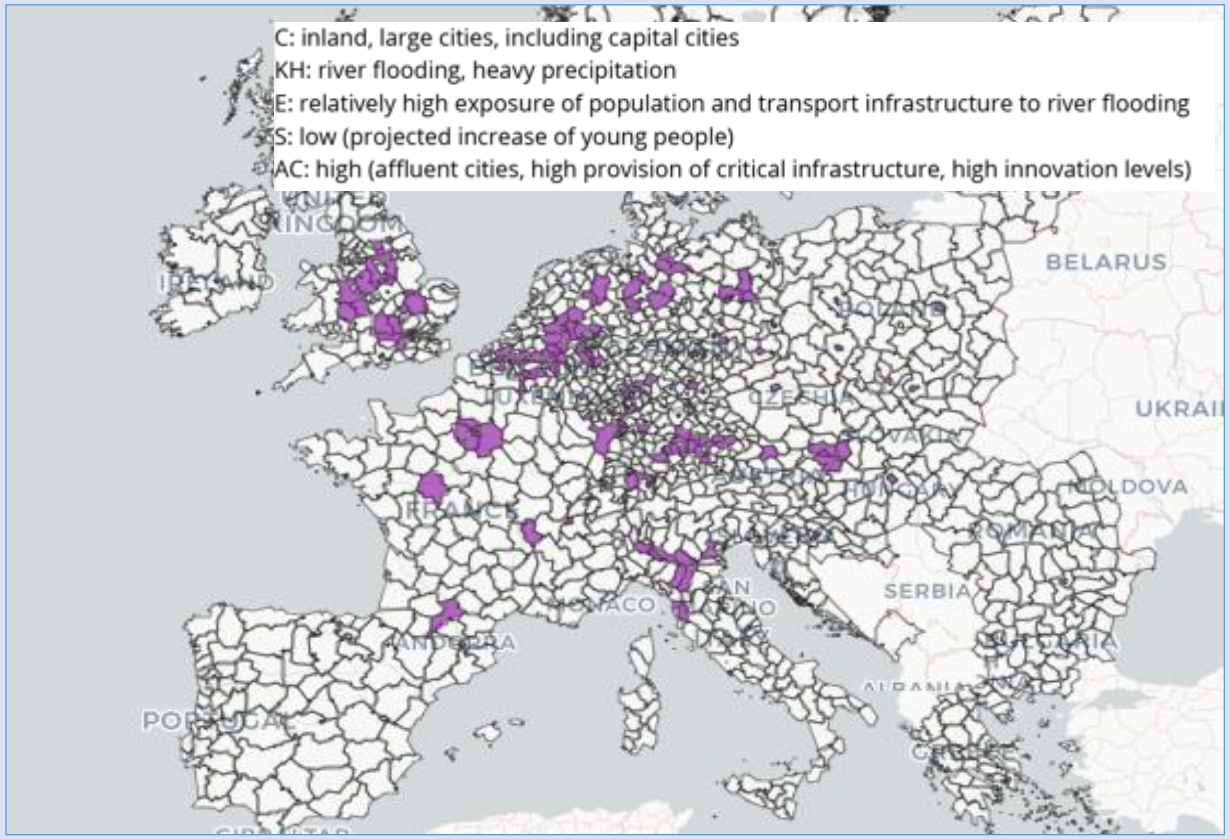


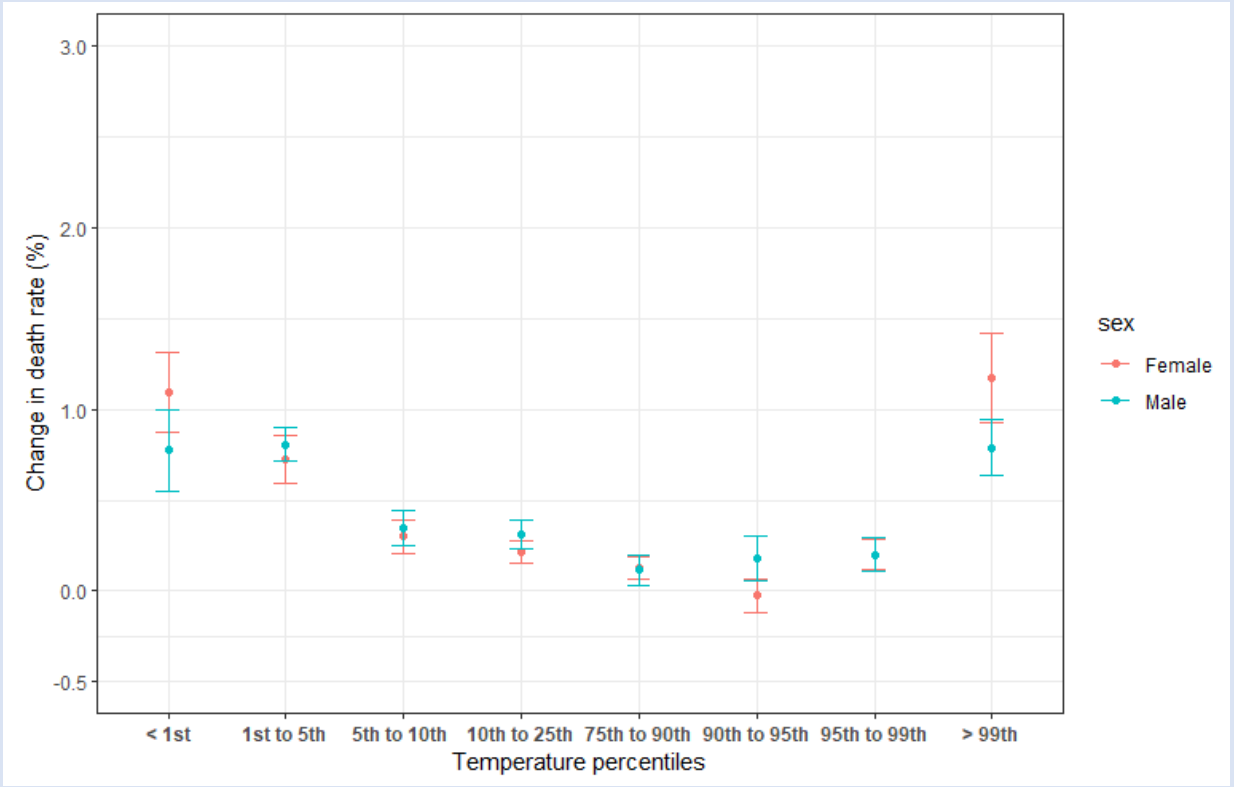
Source: Climate risk typology of NUTS3 regions in Europe

Legend: C, city type; KH, key hazard; E, exposure; S, sensitivity; AC, adaptive capacity (including GDP, gross domestic product).

Extreme temperature-related mortality (65+) in Inland Urbanized 2014 - 2022

per sex



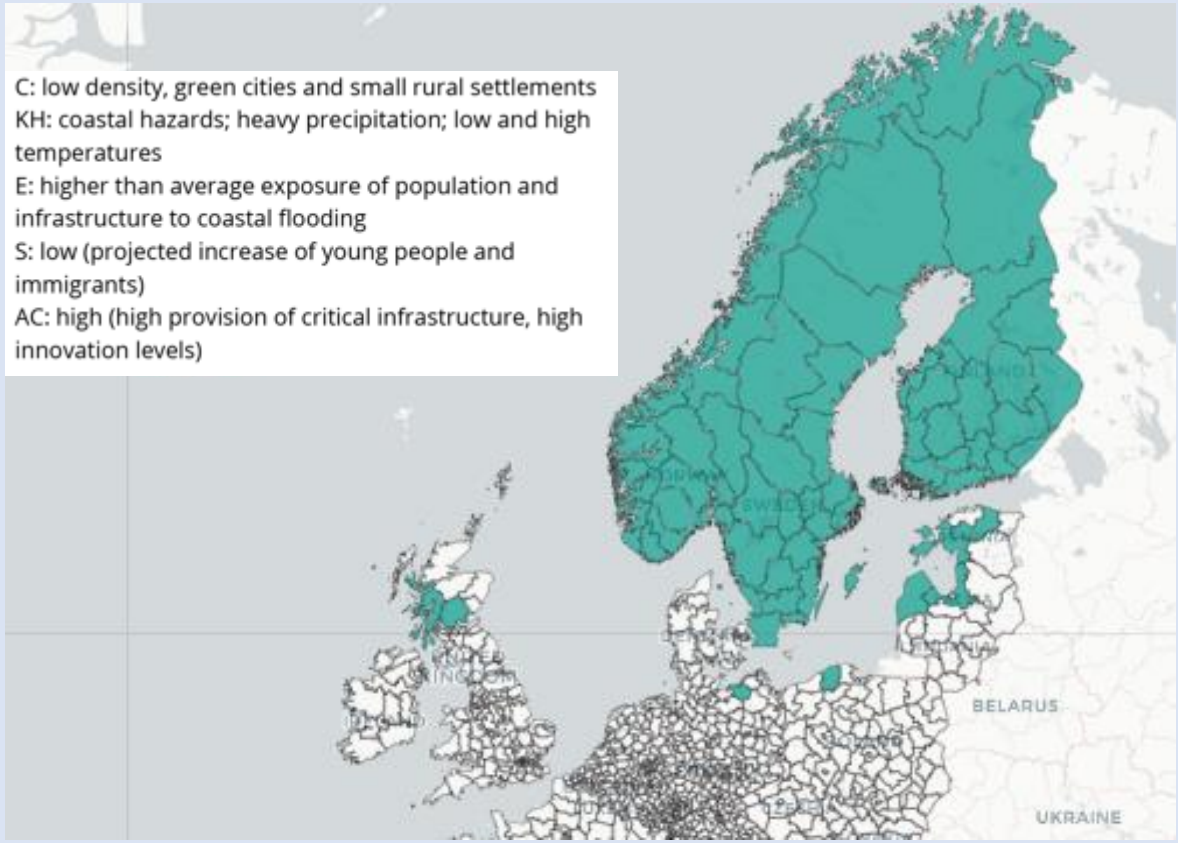


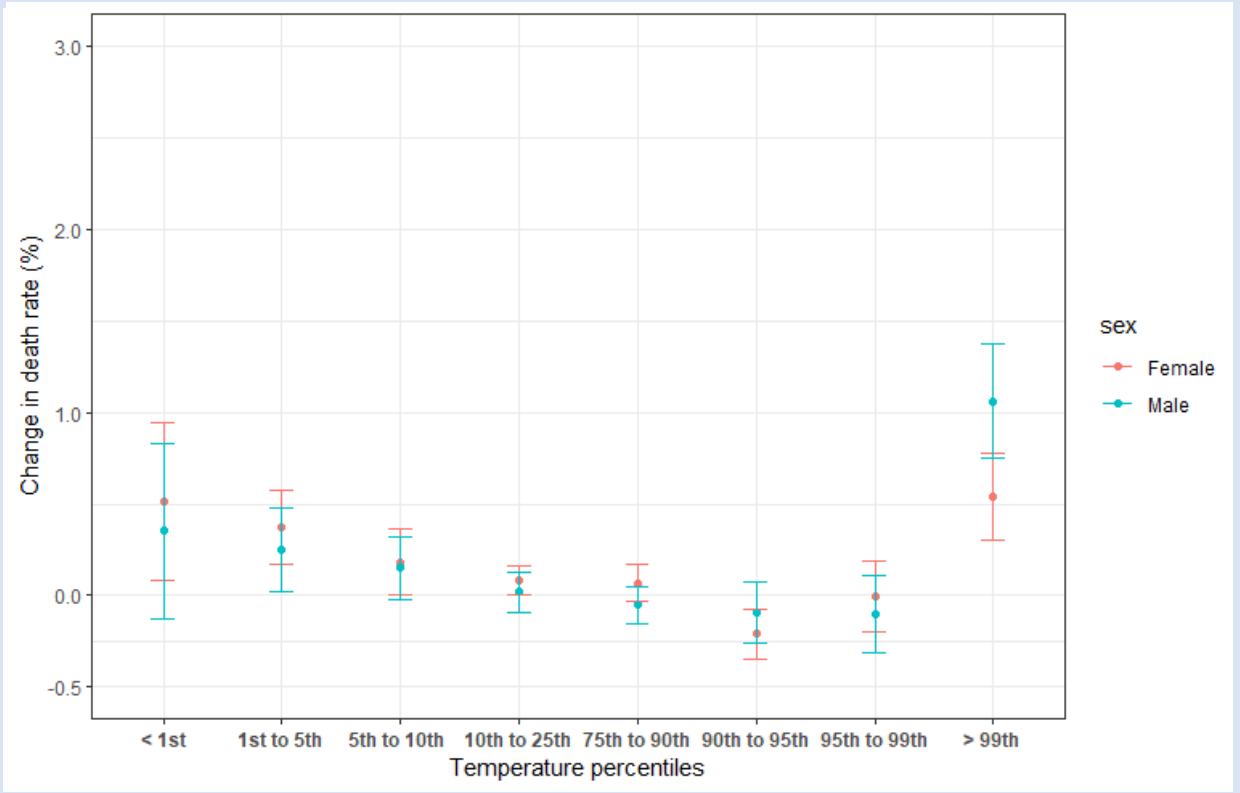
Source: Climate risk typology of NUTS3 regions in Europe

Legend: C, city type; KH, key hazard; E, exposure; S, sensitivity; AC, adaptive capacity (including GDP, gross domestic product).

Extreme temperature-related mortality (65+) in Northern Europe 2014 - 2022

per sex





Source: Climate risk typology of NUTS3 regions in Europe

Legend: C, city type; KH, key hazard; E, exposure; S, sensitivity; AC, adaptive capacity (including GDP, gross domestic product).

Limitations

- better understand which mechanisms can determine sex and geographical heterogeneity;
- not considering some control variables → (e.g.: gdp and population density);
- missing death counts for some Countries → (e.g.: Germany, Ireland, Iceland)
  → excluded Countries not in the EU

Conclusion

1) Heat and cold-related mortality in over 65s take in to account geography, clima, adaptation, vulnerability;

2) Effect of hot temperatures seems to exacerbate sex differences more than cold temperatures;

3) Support the development of adaptation and resilience strategies and plans.

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THANK YOU FOR LISTENING!

Rosanna Gualdi,
rosanna.gualdi2@unibo.it

Risto Conte Keivabu,
contekeivabu@demogr.mpg.de

Raya Muttarak
raya.muttarak@unibo.it

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UNIVERSITÀ DI BOLOGNA
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"PAOLO FORTUNATI"

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This presentation is part of POPCLIMA's Strand 2 which aims to investigate the effect of climate change on mortality.