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INSTITUTE OF ATMOSPHERIC PHYSICS CAS

CZU Faculty of Environmental Sciences

Do heat prevention plans reduce heat-related mortality in Europe?

Aleš Urban, Veronika Huber
Salomé Henry, Nuria Pilar Plaza,
Pierre Masselot, Antonio Gasparrini
PROCLIAS TG 3.1 + MCC

PROCLIAS

LONDON SCHOOL of HYGIENE &TROPICAL MEDICINE

MCC Collaborative Research Network
An international research program on the associations between environmental stressors, climate, and health

cost EUROPEAN COOPERATION IN SCIENCE & TECHNOLOGY

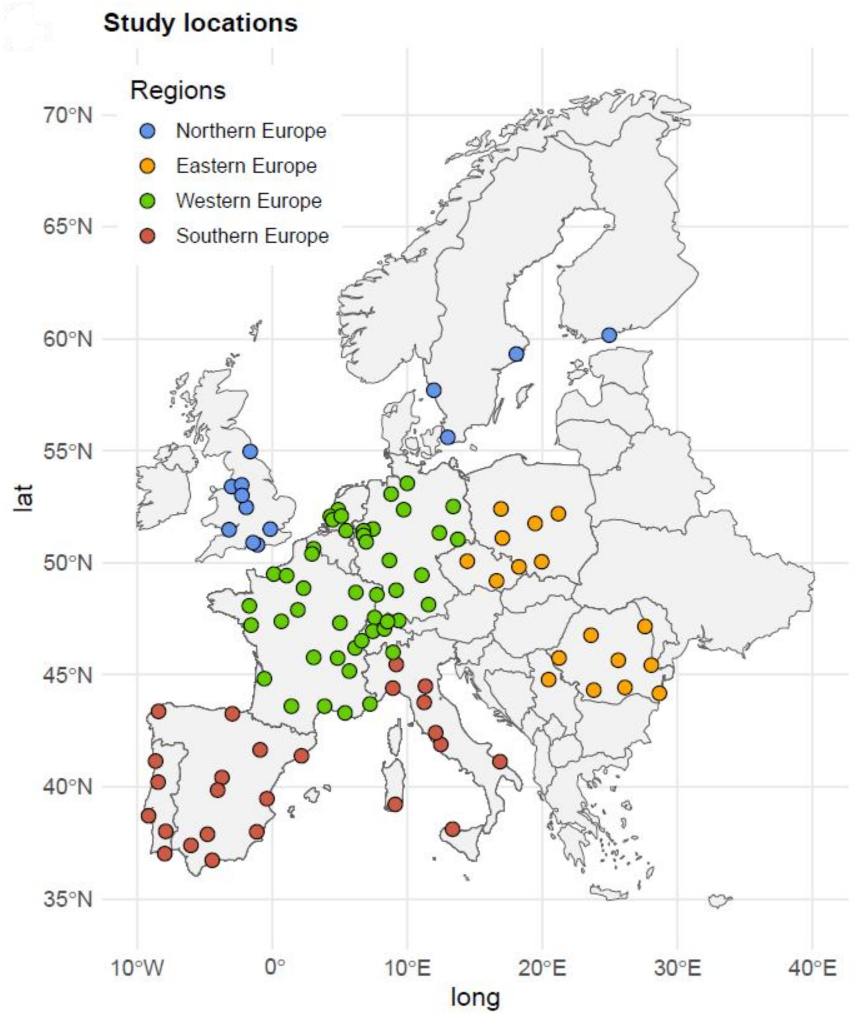
Funded by the Horizon 2020 Framework Programme of the European Union

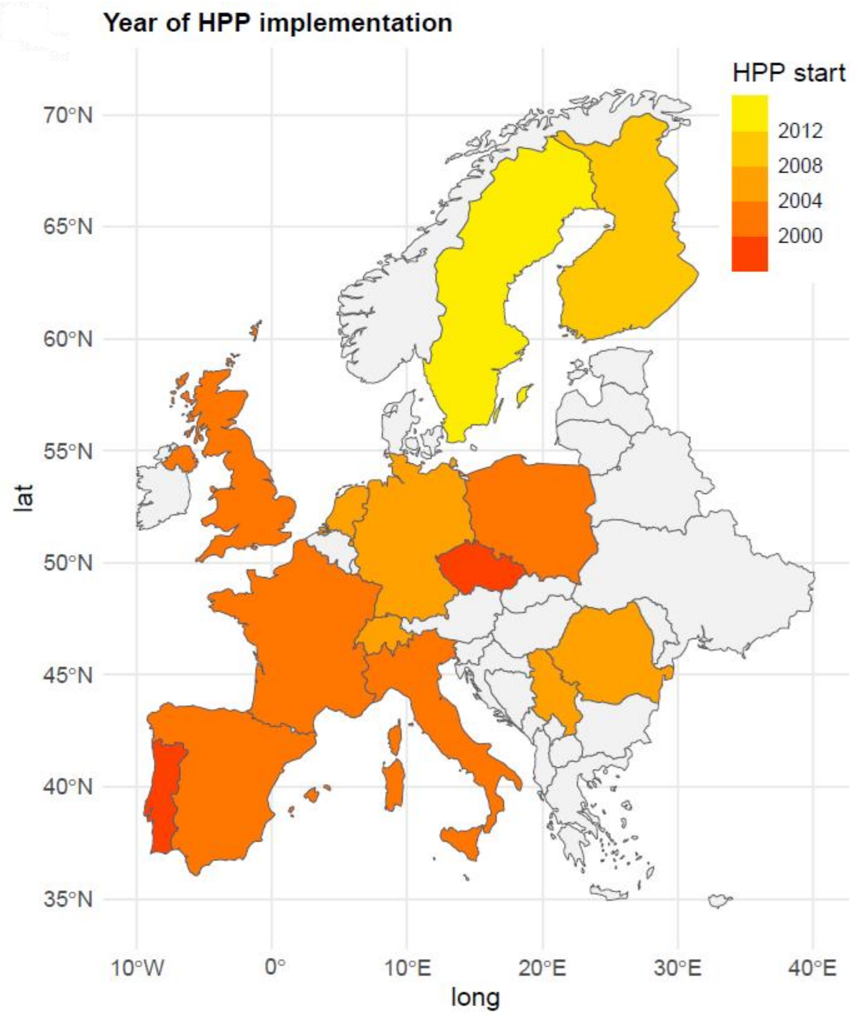
CrossEU

HPP = Heat Prevention Plan

Health, Weather and HPPs: 102 cities, 14 EU countries

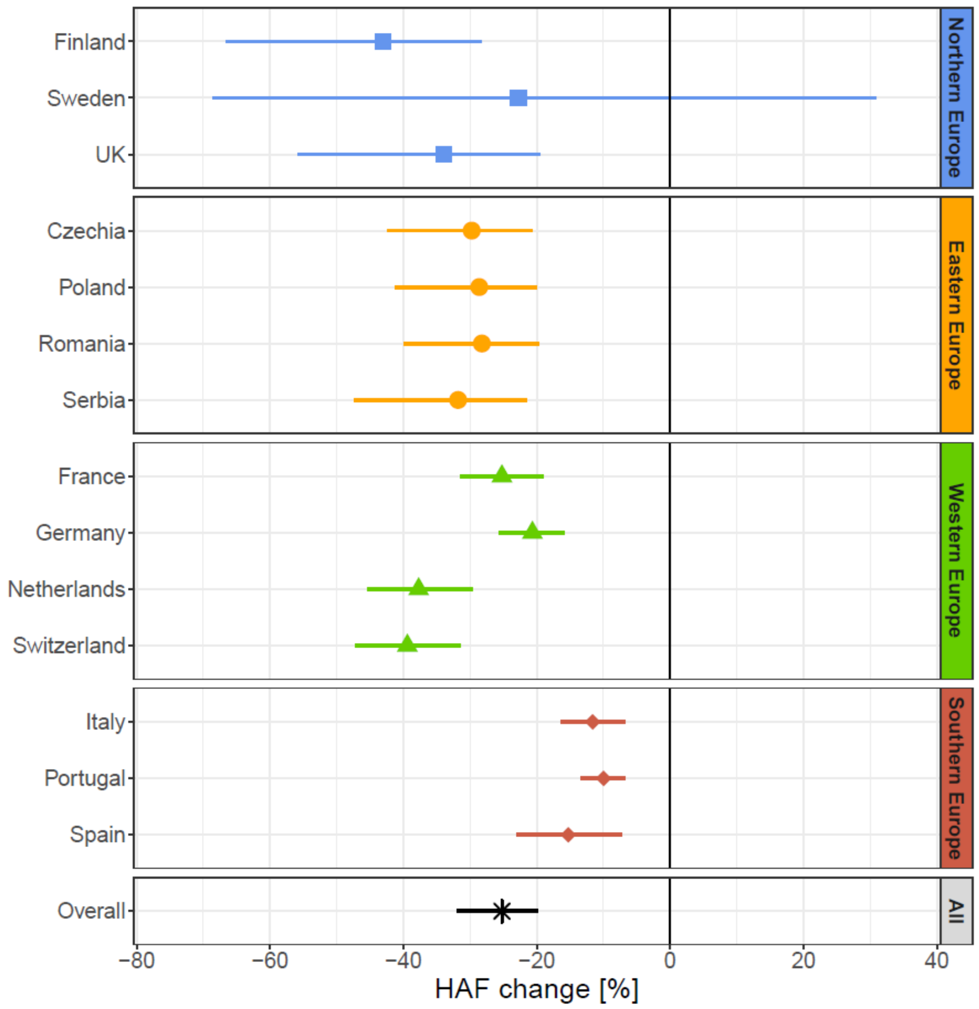
Study period: 1990–2019





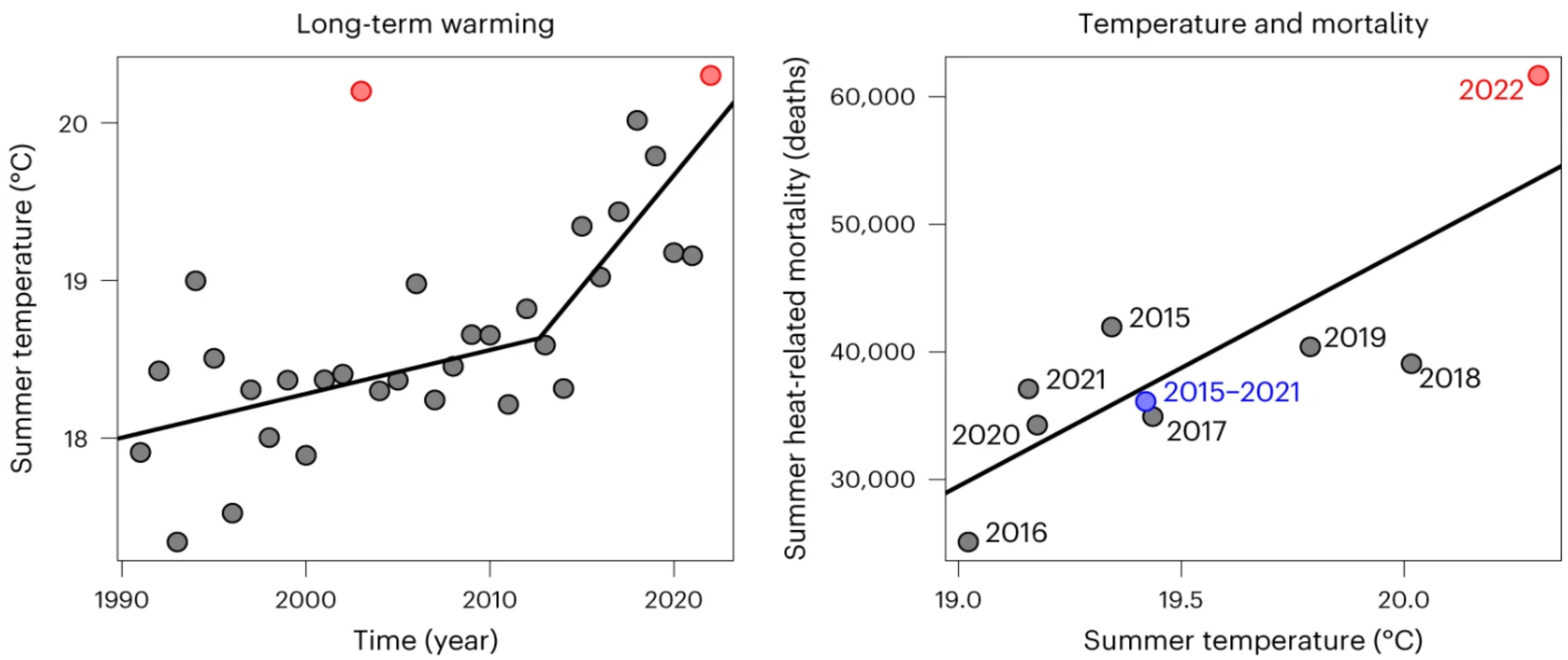
Results

- **HPP implementation was associated with a 25.2% reduction in excess deaths** attributable to extreme heat.
- Correspond to **14,551 total deaths avoided across all study locations**.
- No significant differences in HPP effectiveness were observed by European region or HPP class.
- Further research on the effectiveness of specific adaptation measures is needed.



25% heat-related death reduction attributable to HPPs

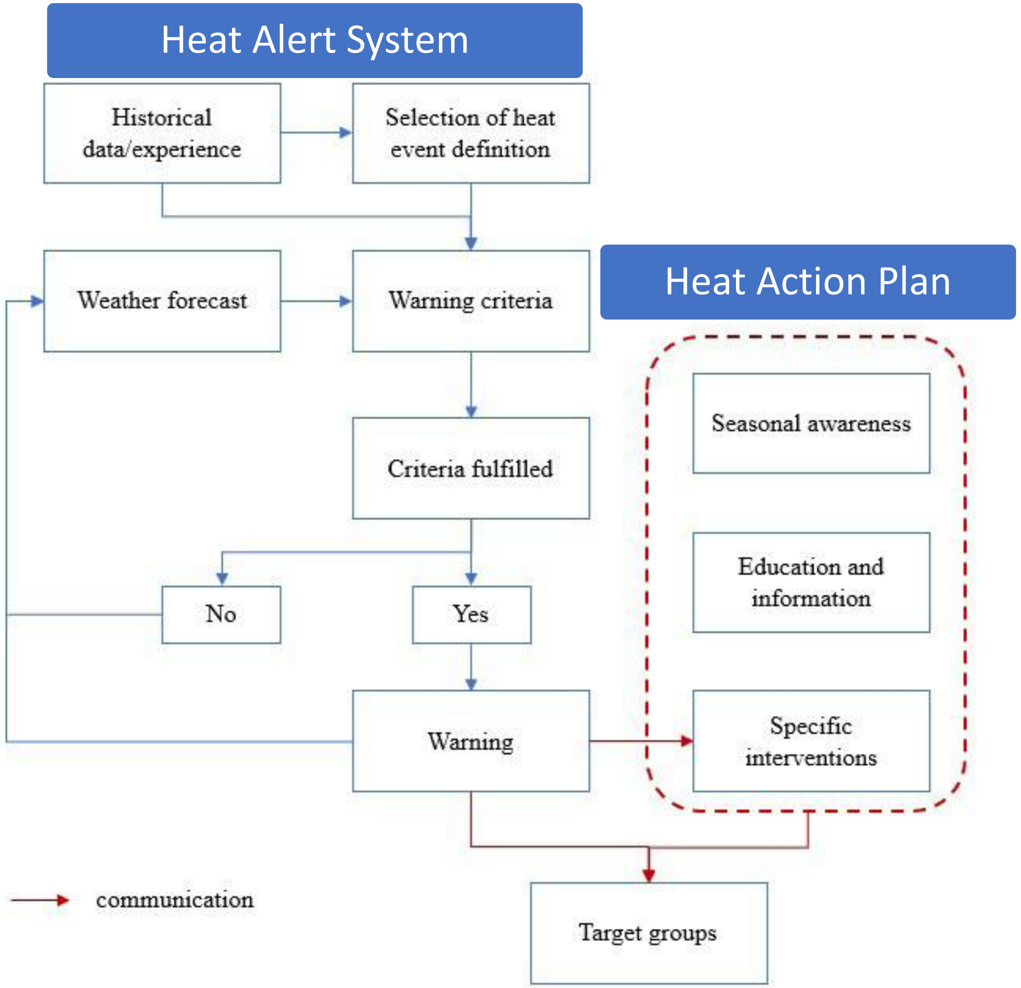
Motivation

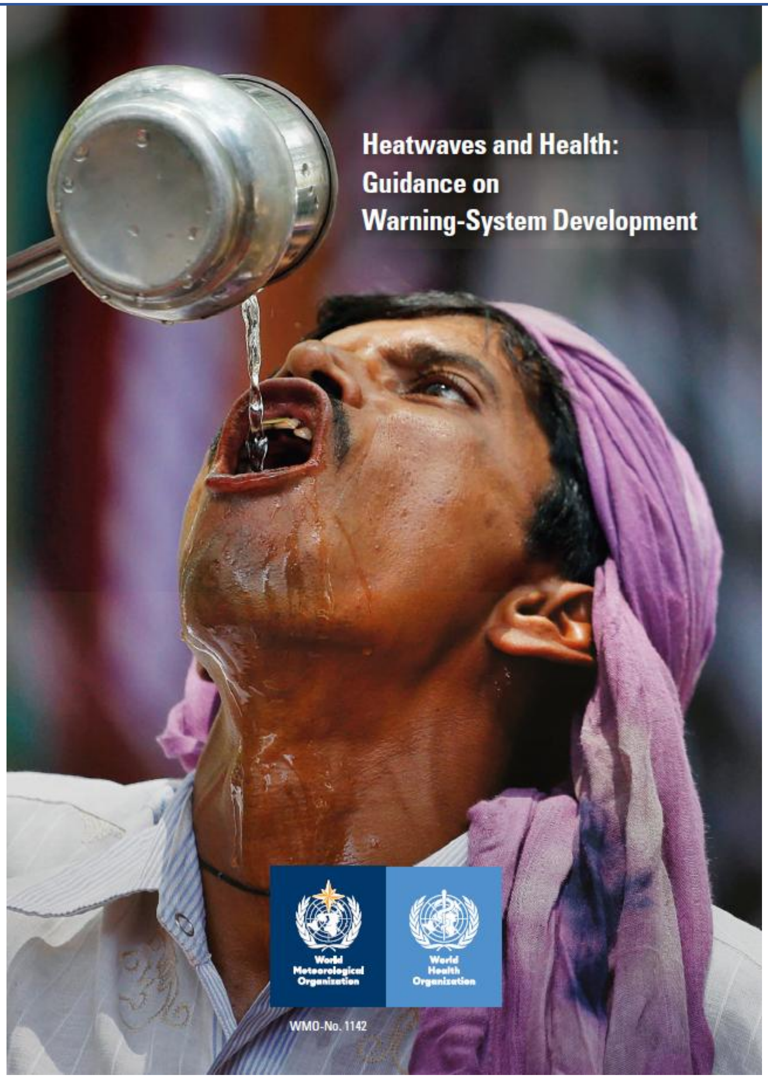


- How can we avoid the increasing impact of heat on human health in Europe?

Ballester et al. (2023) Nature Medicine

Heat prevention plans (HPPs)





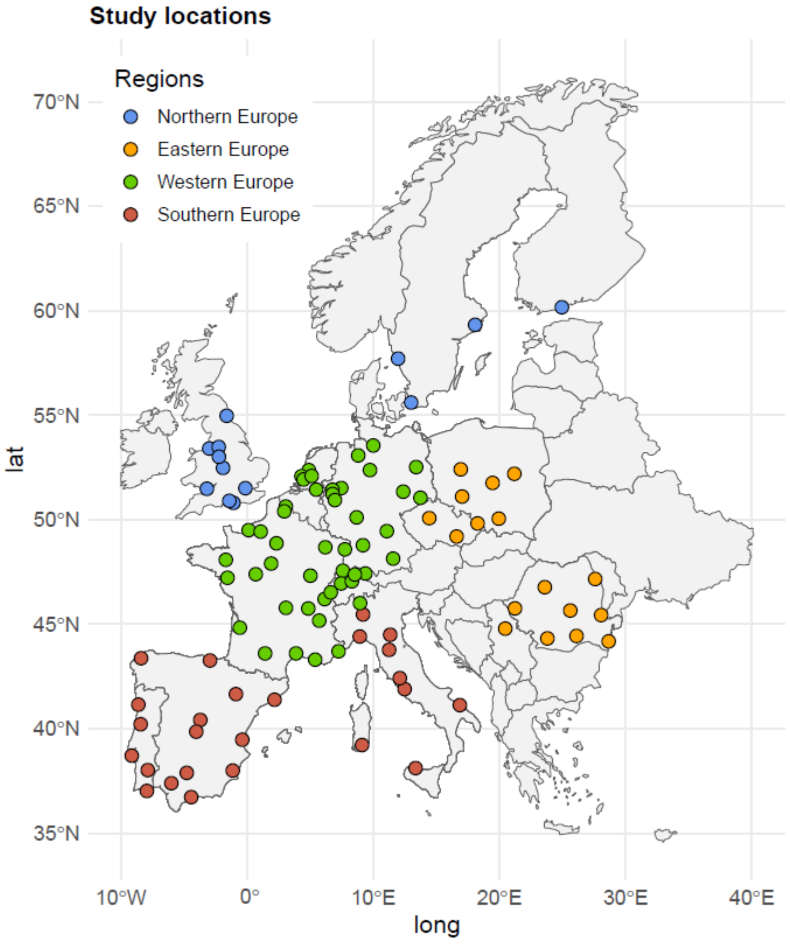
McGregor et al. (2015) WMO & WHO

Previous evidence

- Toloo et al (2013) Env. Health:
  - *„heat warning systems are effective in reducing mortality"*
  - *„more research is urgently required into the cost-effectiveness of heat warning systems"*
- Dwyer et al. (2022) Int. J. Biometeorology:
  - *„examined the reviews that identified the methodological challenges"*
  - *„evaluations of heat plans globally should employ robust methodologies"*
- **Limitations** of previous studies:
  - **Often limited to single cities/countries, selected heat events**, etc.
  - **Insufficient consideration of temporal and geographical variation** in mortality risks due to the underlying changes in vulnerability.

Health and Weather Data

- Daily mortality and temperature data from 102 cities in 14 EU countries



Data collected via:

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HPP classification

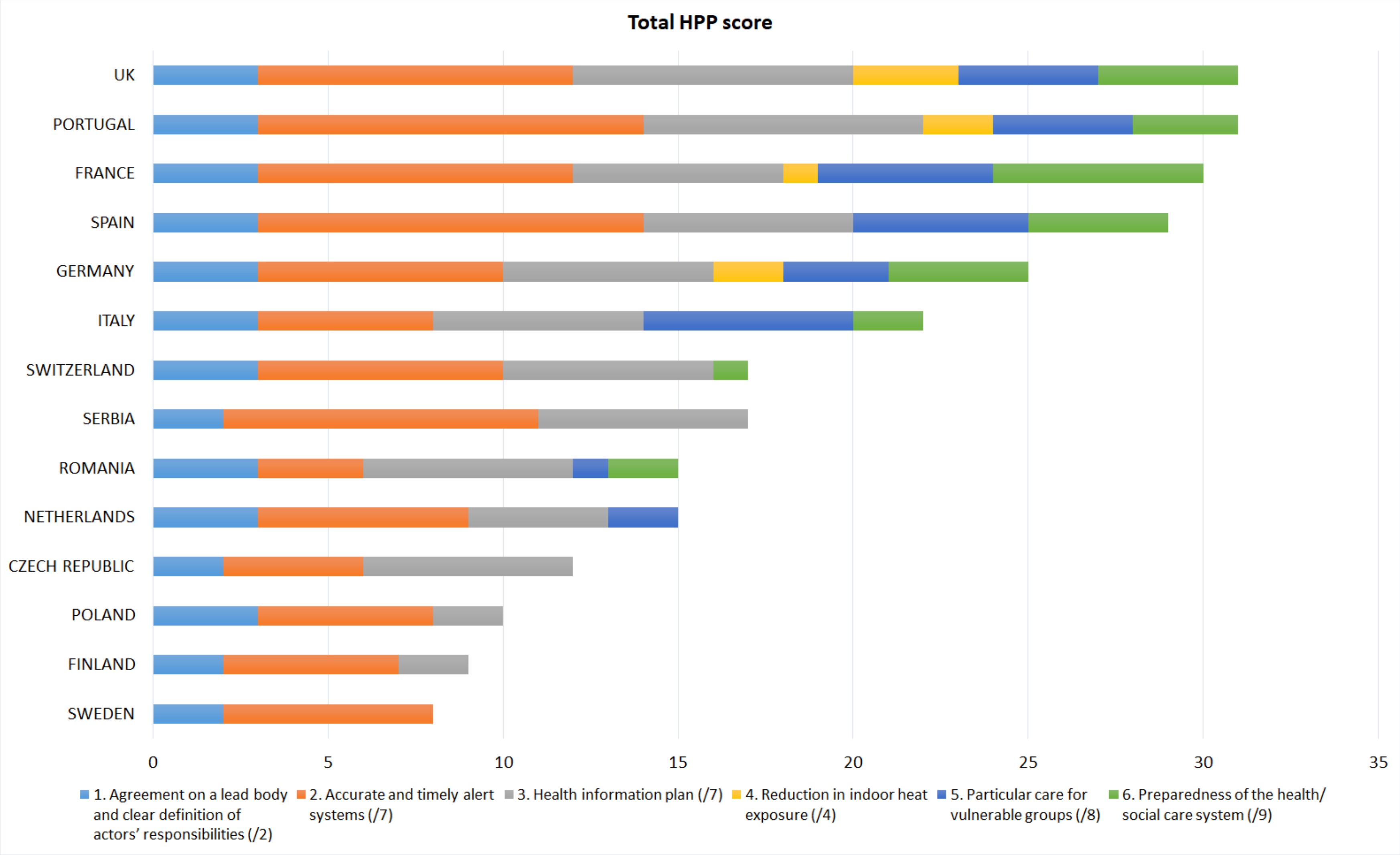
- We classified nationwide HPPs based on WHO's Lead Criteria:*

Lead	Maximum points
Agreement on a lead body	2
Accurate and timely alert systems	7
Health information plan	7
Reduction in indoor heat exposure	4
Particular care for vulnerable groups	8
Preparedness of the health/social care system	9
Real-time surveillance and evaluation	2

$\sum=35$

*Data were collected during the COST Action PROCLIAS

HPP classification



Data

- Mortality data from 102 cities in 14 EU countries + **implementation year, level of HPPs**

COUNTRY	N LOCATIONS	1990	1991	1992	1993	1994	1995	1996	1997	1998	1999	2000	2001	2002	2003	2004	2005	2006	2007	2008	2009	2010	2011	2012	2013	2014	2015	2016	2017	2018	2019	
Finland	1 metropolitan area					0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	1	1	1	1	1	1	1	1	1	North
Sweden	3 cities	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	1	1	1	1	1	1	1	
UK	9 cities	0	0	0	0	0	0	0	0	0	0	0	0	0	0	3	3	3	3	3	3	3	3	3	3	3	3	3	3	3	3	
Czechia	3 cities					0	0	0	0	0	0	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	East
Romania	8 cities					0	0	0	0	0	0	0	0	0	0	0	0	2	2	2	2	2	2	2	2	2	2	2	2	2	2	
Poland	5 cities		0	0	0	0	0	0	0	0	0	0	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	
Serbia	1 city						0	0	0	0	0	0	0	0	0	0	0	0	2	2	2	2	2	2	2	2	2	2	2	2	2	
France	20 cities											0	0	0	0	3	3	3	3	3	3	3	3	3	3	3	3	3	3	3	3	West
Germany	14 cities				0	0	0	0	0	0	0	0	0	0	0	0	3	3	3	3	3	3	3	3	3	3	3	3	3	3	3	
Netherlands	5 cities						0	0	0	0	0	0	0	0	0	0	0	0	2	2	2	2	2	2	2	2	2	2	2	2	2	
Switzerland	8 cities						0	0	0	0	0	0	0	0	0	0	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	
Italy	10 cities	0	0	0	0	0	0	0	0	0	0	0	0	0	0	3	3	3	3	3	3	3	3	3	3	3	3	3	3	3	3	South
Portugal	5 districts	0	0	0	0	0	0	0	0	0	3	3	3	3	3	3	3	3	3	3	3	3	3	3	3	3	3	3	3	3	3	
Spain	11 cities	0	0	0	0	0	0	0	0	0	0	0	0	0	0	3	3	3	3	3	3	3	3	3	3	3	3	3	3	3	3	

HPP class	Definition
HPP = ?	No data
HPP class 0	No/basic weather forecast before HPP implementation
HPP class 1	HPP score ≤ 10
HPP class 2	10 > HPP score ≤ 20
HPP class 3	HPP score > 20

Methods – details

Two-stage metaregression study design:

- **1st stage:** time series on city level.
  Divided to 3-year subperiods (slide 10) with HPP implementation (NO vs YES)
    - Distributed lag non-linear models (DLNM; *dlnm* R package) – adjusted for time trends and seasonality in mortality data
    - DLNM: ERF for each subperiod in each location, May-September
    - Reduced *coefficients* of the exposure response function exported to the second stage.

Methods – details

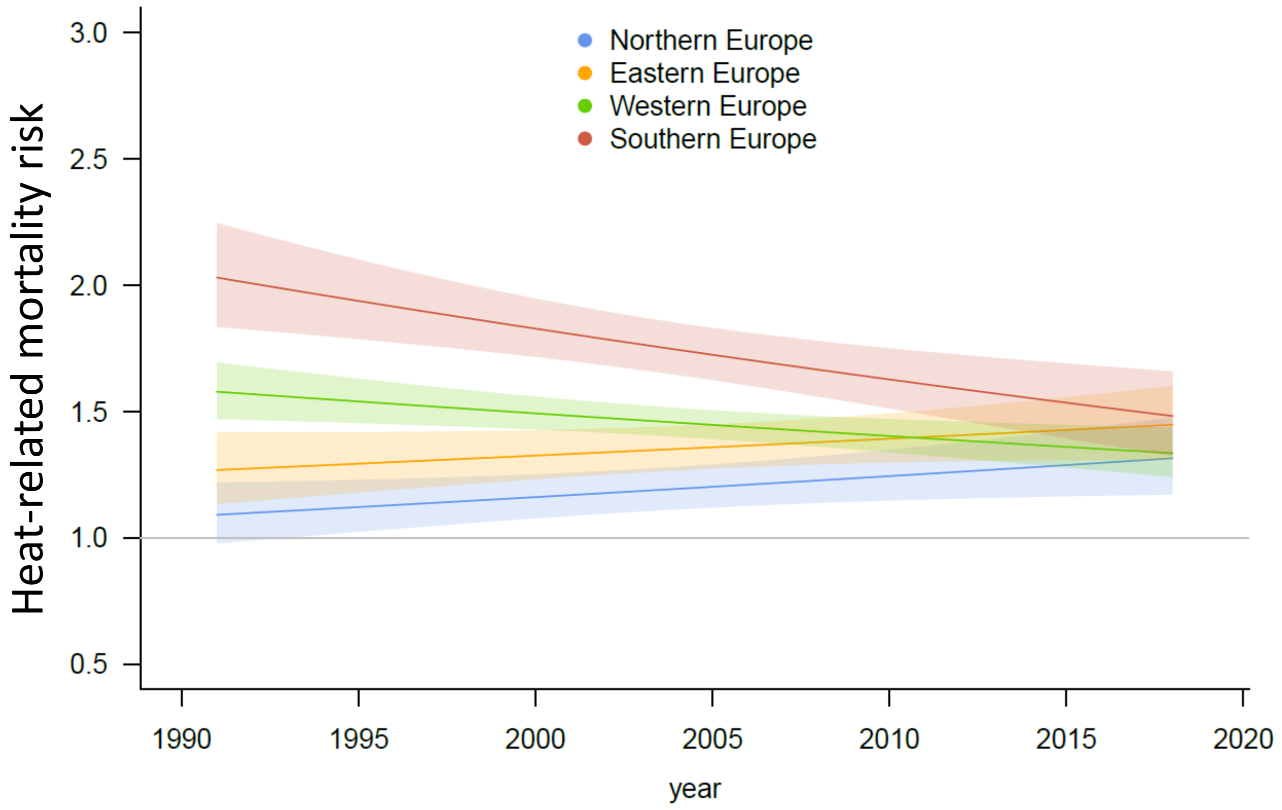
Two-stage metaregression study design:

- **2nd stage:** metaregression model (mixmeta R package):
  - model <- mixmeta (coef ~ Region*year + HPPstart), … , random=~year | cityname)
    - *coef* and *vcov* = first stage *coefficients* for each city in each subperiod
    - *Region* = 4 European Regions (slide 7)
    - *Year* = linear trend in heat-mortality (general heat-vulnerability)
    - *HPPstart* = NO – before HPP / YES – after HPP
    - *random* = random effect to capture heterogeneity in data across cities
  - => **Pooled effect for all locations based on Region and HPP implementation, adjusted for the long-term trend in heat-vulnerability** (slide 13)

Main output:
Comparison of **counterfactual** (w/o HPP) vs **factual** scenario (w/ HPP)
counterfactual = what would have been the heat-attributable risk without HPP? (slide 14)

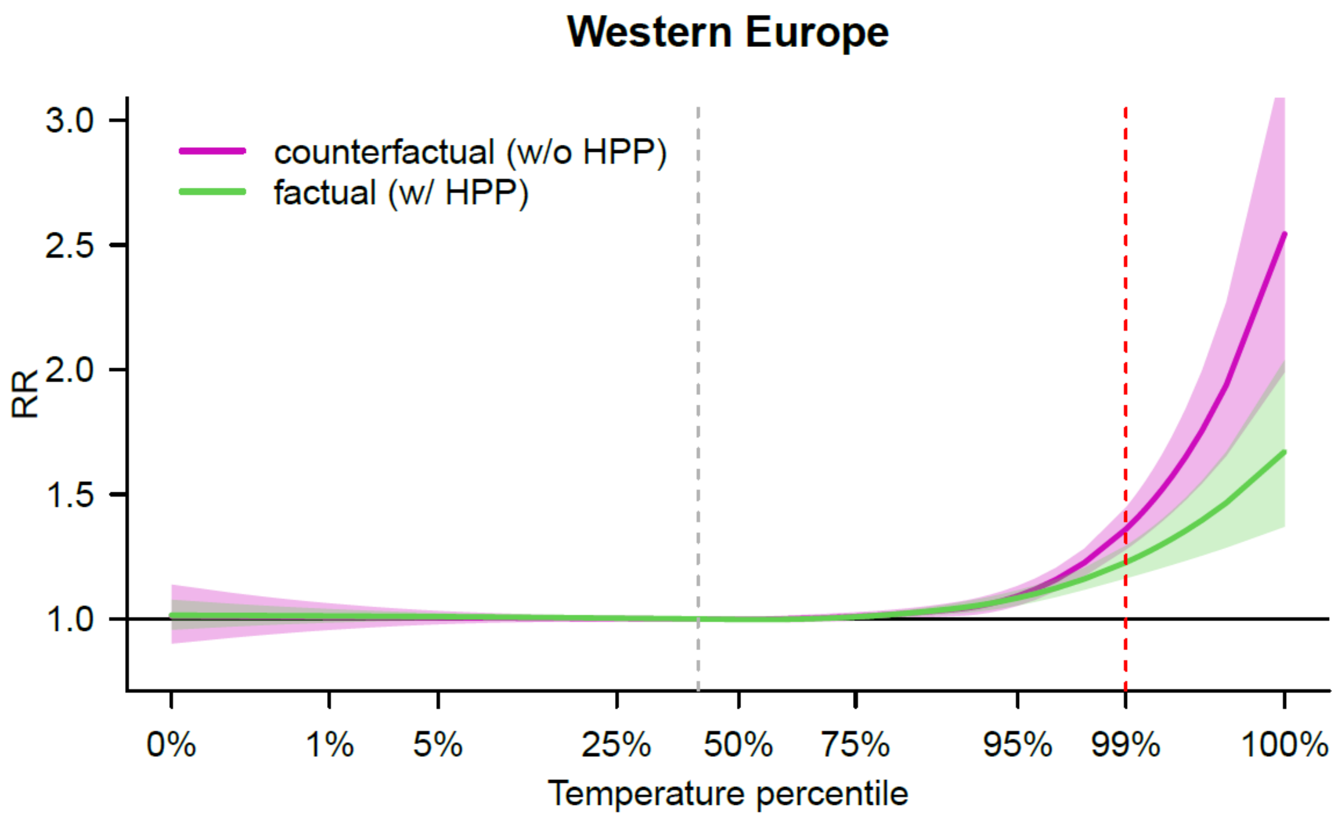
Methods

- The effect of HPP implementation adjusted for **the long-term trend in heat-related mortality risk (vulnerability) in the four main EU regions**.



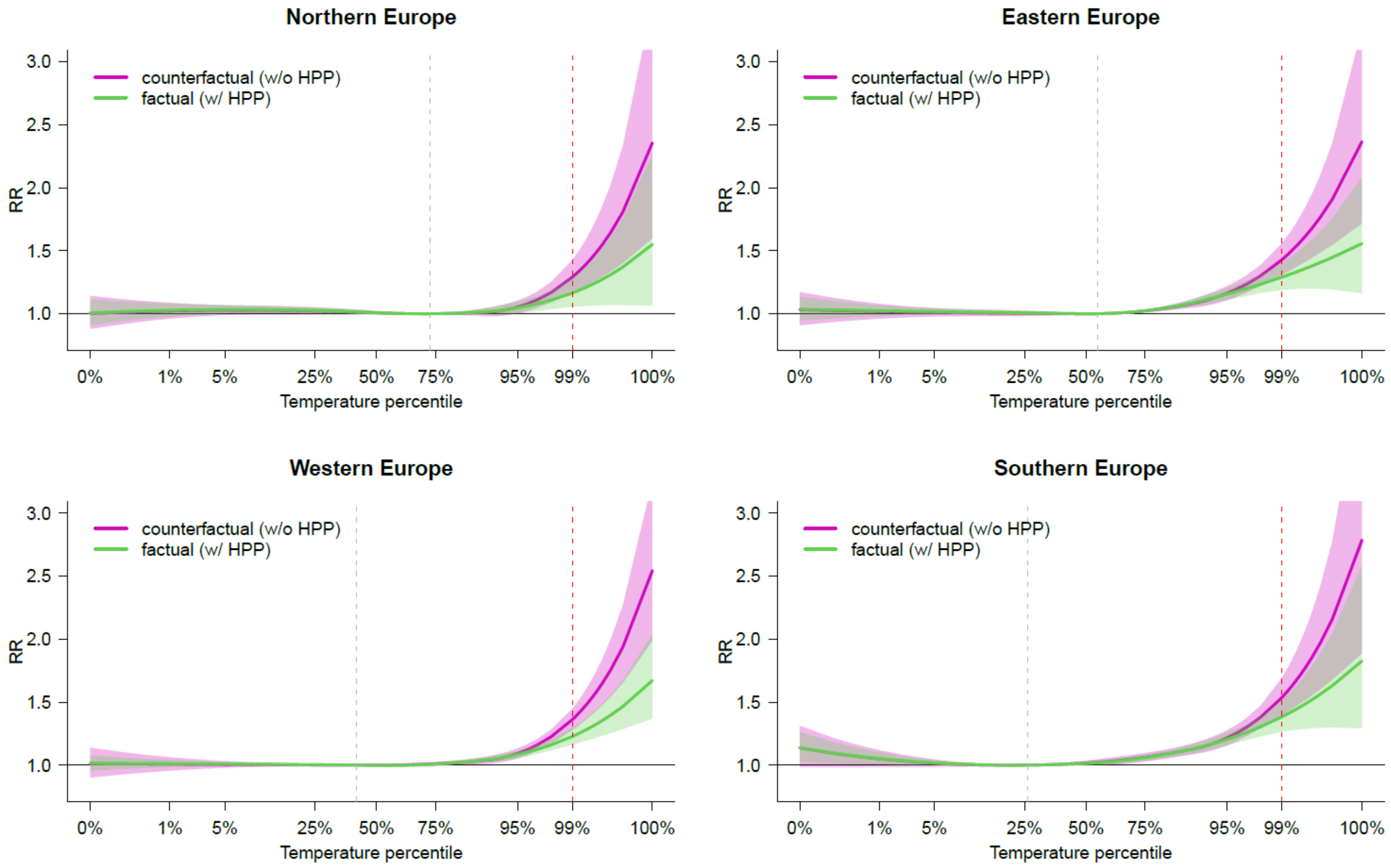
Results

- Reduction of the heat-related mortality risk after HPP implementation in Western Europe – **!!! adjusted for the long-term trend in heat vulnerability** (slide 13)



Results

- Reduction of the heat-related mortality risk after HPP implementation in the four main EU regions.



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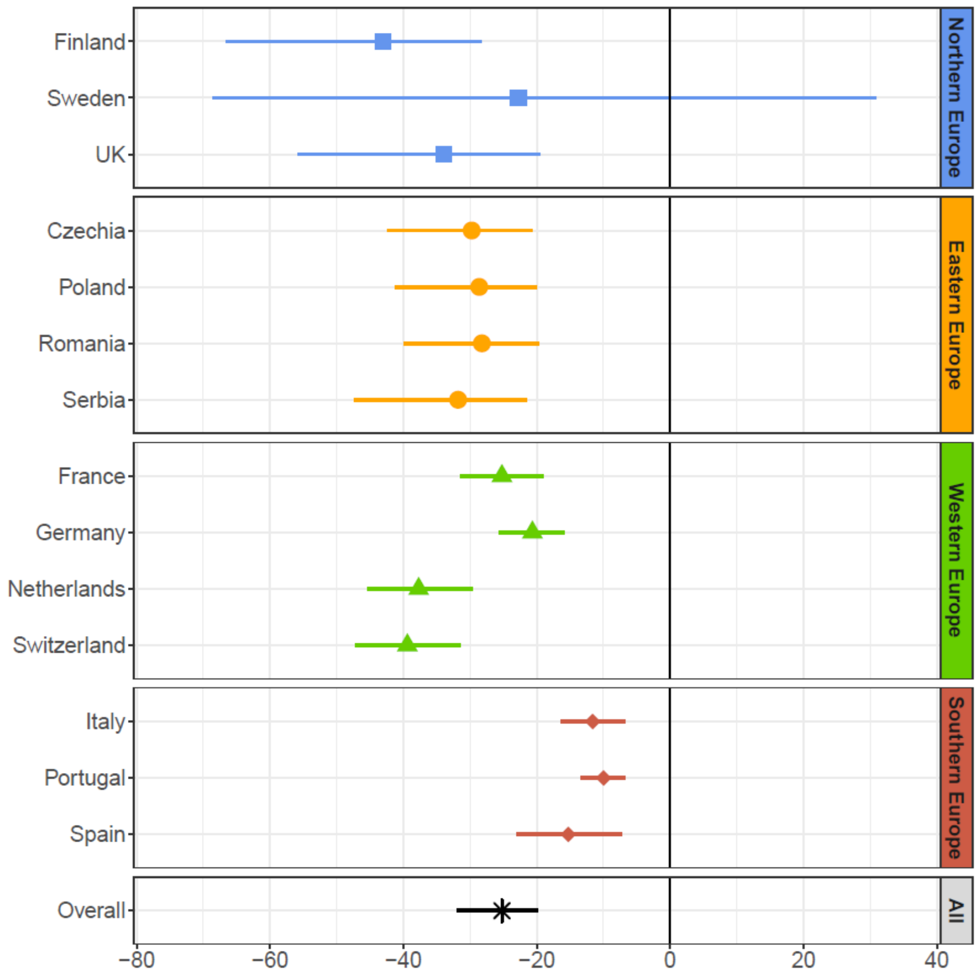

% change in heat-attributable mortality fraction associated with HPP implementation

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Thank you!

urbana@fzp.czu.cz
@urbales

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