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ELEVATING HEALTHCARE CLIMATE ADAPTATION

Empirical evidence of the influence of heatwaves on non-communicable diseases

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Literature review

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Empirical Evidence of the Effects of Climate Change on NCDs: A Literature Review

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Abstract: Recent years have seen a surge in research on climate change and its health impacts, highlighting the growing urgency of this issue. As climate change intensifies extreme weather events (EWEs), non-communicable diseases (NCDs) may also be exacerbated. This systematic review of 152 papers examines the effects of EWEs on NCDs. Heatwaves are associated with increased mortality from stroke, ischaemic heart disease, and respiratory conditions, though findings on morbidity are mixed. Wildfires could worsen respiratory diseases through air pollution and contribute to mental health issues, including anxiety and depression. Recurrent floods indicate long-term psychological impacts. Droughts, while harder to quantify, could lead to heat-related illnesses and mental stress due to economic hardship. Also, studies suggest that storms increase cardiovascular and respiratory risks, while also contributing to mental health problems. Vulnerable groups, particularly older adults and socioeconomically disadvantaged populations are disproportionately affected due to pre-existing conditions and limited healthcare access. Future research should focus on refining research designs and methodologies to better capture the impacts of specific EWEs on NCDs. Improved measurement and the use of direct climate change indicators, rather than proxies, could also enhance the precision of findings.

Keywords: climate change; extreme weather event; natural disaster; non-communicable disease; health

JEL Classification: I15; Q54; Q56; I18

1 Introduction

Earth's climate has been gradually yet persistently changing due to various geological and atmospheric processes. Over the past 65 million years, alternating warm and

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- **Research Question:** Global effects of climate change on NCDs ?
- **Studies:** Web of Science, PubMed, Scopus (n = 2994)
- **Method:** PRISMA (n = 152)
- **Literature on heat:** Mortality, morbidity (n = 37)

Findings summary:

- YoY studies increasing
- Heatwaves most studied (EWE)
- Heterogenous definitions
- Developing and hot countries
- Local regions
- PAN Europe less studied (except Spain, France)
- Mountainous and colder regions less studied
- Significant increase in morbidity (respiratory, cardiovascular)
- Inconclusive results for mental -health
- Confounded EWEs, NCDs (heat ➡ wildfire ➡ smoke ➡ respiratory)

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Findings: Mortality

Table 2: Impact of heat on mortality.

Outcome	Direction	Significance	Reference
Mortality			
All-cause	Increase	Significant	+++ Fouillet et al. (2006); +++ Monteiro et al. (2013); ++ Baccini et al. (2008); ++ Conti et al. (2007)[b]; ++ Hertel et al. (2009); ++ Royé et al. (2020); ++ Stafoggia et al. (2006); + Analitis et al. (2014); + Bi et al. (2022); + Chen et al. (2015); + D'Ippoliti et al. (2010)[a]; + Huynen et al. (2001); + Huang, Kan, and Kovats (2010); + Kovats, Hajat, and Wilkinson (2004); + Lin et al. (2013); + Revich and Shaposhnikov (2008); + Schulte, Röösli, and Ragettli (2021); + Sun et al. (2014); + Barnett et al. (2012); Cheng et al. (2024); Cvetinov, Zorica Podraščanin, and Tatjana (2019); Ma et al. (2015); Sheridan and Lin (2014); Yang et al. (2013); Zeng et al. (2014)
Cardiovascular	Increase	Significant	++ Baccini et al. (2008); ++ Chen et al. (2015); ++ Fouillet et al. (2006); ++ Miron et al. (2015); ++ Royé et al. (2020); ++ Schulte, Röösli, and Ragettli (2021); ++ Yang et al. (2013); + Analitis et al. (2014); + Bi et al. (2022); + D'Ippoliti et al. (2010); + Huang, Kan, and Kovats (2010); + Lin et al. (2013); + Sun et al. (2014); Arisco et al. (2023); Cheng et al. (2024); Huynen et al. (2001); Khatana, Werner, and Groeneveld (2022); Ma et al. (2015); Sheridan and Lin (2014)
		Insignificant	Hertel et al. (2009)

Heat leads to a **significant increase** in

- **All-cause mortality**

Fouillet et al. (2006): Heatwave in **France** August 1st – 20th **2003**: cumulative excess mortality of 14729 deaths or **55%**

Chen et al. (2015): Heatwaves in **Nanjing** between **2007-2013**: increase in total mortality of **24.6%**

- **Cardiovascular mortality**

Fouillet et al. (2006): **3004** excess deaths because of circulatory system diseases

Chen et al. (2015): Increase in cardiovascular mortality of **46.9 %**

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Findings: Mortality (continued)

Table 2: (continued)

Outcome	Direction	Significance	Reference
Cerebrovascular	Increase	Significant	++ D'Ippoliti et al. (2010)[a]; + Revich and Shaposhnikov (2008); Ma et al. (2015)
		Insignificant	Analitis et al. (2014)
Neoplasm	Increase	Significant	Fouillet et al. (2006); Huynen et al. (2001)
		Insignificant	Hertel et al. (2009)
Respiratory	Increase	Significant	+++ Baccini et al. (2008); +++ Fouillet et al. (2006); +++ Hertel et al. (2009); +++ Revich and Shaposhnikov (2008); ++ Analitis et al. (2014); ++ Chen et al. (2015); ++ D'Ippoliti et al. (2010)[a]; ++ Royé et al. (2020); ++ Yang et al. (2013); + Bi et al. (2022); + Cheng et al. (2024); + Huang, Kan, and Kovats (2010); + Huynen et al. (2001); + Miron et al. (2015); + Sun et al. (2014); Ma et al. (2015); Sheridan and Lin (2014)
		Insignificant	Arisco et al. (2023)
		Inconclusive	Lin et al. (2013)
– *COPD*	Increase	Significant	++ Chen et al. (2015); Zanobetti et al. (2012)
		Insignificant	Huang, Kan, and Kovats (2010)
– *ARI*		Insignificant	Huang, Kan, and Kovats (2010)

Heat leads to a **significant increase** in

- **Cerebrovascular mortality**
- **Neoplasm mortality**
- **Respiratory mortality**

Fouillet et al. (2006): **1365** excess deaths due to respiratory system diseases

Chen et al. (2015): **32%** increase in respiratory mortality

However, some studies report inconclusive or insignificant results for these outcomes

Huang et al. (2010): **2003** heatwave in nine urban districts of **Shanghai** (6.3 million residents): **no significant increase** in acute respiratory infection mortality

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Findings Morbidity

Table 3: Impact of heat on morbidity (hospitalizations, emergency department visits).

Outcome	Direction	Significance	Reference
Morbidity			
All-cause	Increase	Significant	+++ Turner, Connell, and Tong (2013); Gronlund et al. (2014); Knowlton et al. (2008); Ma et al. (2011)
	Decrease	Significant	Schulte, Röösli, and Ragettli (2021)
		Insignificant	Kovats, Hajat, and Wilkinson (2004); Schneider, Thieken, and Walz (2023)
		Inconclusive	Guirguis et al. (2018); Rocklöv and Forsberg (2009)
Cardiovascular	Increase	Significant	++ Turner, Connell, and Tong (2013); + Mastrangelo et al. (2007)[b]; + Schneider, Thieken, and Walz (2023); Knowlton et al. (2008); Ma et al. (2011); Monteiro et al. (2013); Son, Bell, and Lee (2014)
	Decrease	Significant	– Schulte, Röösli, and Ragettli (2021)
		Insignificant	Giang et al. (2014); Gronlund et al. (2014)[a]; Guirguis et al. (2018); Kovats, Hajat, and Wilkinson (2004); Lim, Hong, and Kim (2012); Michelozzi et al. (2009); Ponjoan et al. (2017); Sheridan and Lin (2014)
		Inconclusive	Rocklöv and Forsberg (2009)
Respiratory	Increase	Significant	+++ Turner, Connell, and Tong (2013); ++ Michelozzi et al. (2009); ++ Monteiro et al. (2013); + Lim, Hong, and Kim (2012); + Mastrangelo et al. (2007)[b]; Anderson et al. (2013); Gronlund et al. (2014)[a]; Knowlton et al. (2008); Kovats, Hajat, and Wilkinson (2004); Ma et al. (2011); Sheridan and Lin (2014); Son, Bell, and Lee (2014)
		Insignificant	Schneider, Thieken, and Walz (2023)
		Inconclusive	Guirguis et al. (2018); Rocklöv and Forsberg (2009)

Heat leads to a **significant increase** in

- **All-cause morbidity**
  Turner, Connell and Tong (2013): ambulance attendances in **Brisbane** between **2000-2007**:
  Temperature effect: **50.6%** , Heatwave effect: **18.8%**

- **Cardiovascular morbidity**
  Heatwave effect: **29.5%**

- **Respiratory morbidity**
  Temperature effect: 101.1%
  Heatwave effect: **48.7%**

Studies report inconclusive or insignificant results or even a decrease in these outcomes

Kovats, et.al. (2004): Daily emergency hospital admissions in **greater London** between **1994-2000**: **no clear evidence** of a relation between total emergency hospital admissions and high ambient temperatures

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Findings: Morbidity (continued)

Outcome	Direction	Significance	Reference
Cerebrovascular	Decrease	Significant	Knowlton et al. (2008)
		Insignificant	Michelozzi et al. (2009); Monteiro et al. (2013)
Renal disease	Increase	Significant	+ Gronlund et al. (2014)[a]; + Hopp, Dominici, and Bobb (2018)[a]; + Knowlton et al. (2008); Guirguis et al. (2018); Kovats, Hajat, and Wilkinson (2004)
Mental health	Increase	Significant	Bundo et al. (2021)
		Insignificant	Guirguis et al. (2018)
Heat-related disease[s]	Increase	Significant	+++ Guirguis et al. (2018); +++ Hopp, Dominici, and Bobb (2018)[a]; +++ Knowlton et al. (2008)

Heat leads to a **significant increase** in

- **Renal disease morbidity**
- **Heat-related disease morbidity**

Inconclusive results for

- **Cerebrovascular morbidity**
- **Mental health outcomes**

Bundo et al. (2021): Mental health hospitalization data from **1973 - 2017** in **Bern**: Hospitalization risk increases linearly by **4%** for every 10°C increase in mean daily temperature

Guirguis et al. (2018): Hospitalization data from **1999-2013** for three unique climate regions in **San Diego**: **No significant relationship** between mental health and temperatures for any region

Results for increases in morbidity not as clear as for mortality

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Recommendations

- Estimate comparison from heterogenous definitions
- Developed regions (Europe)
- Focus on mountainous and colder regions
- Granular health data (PAN EU)
- Appropriate research design
  - Confounded EWEs, NCDs (heat ➡ wildfire ➡ smoke ➡ respiratory)
- Health forecast

THANK YOU

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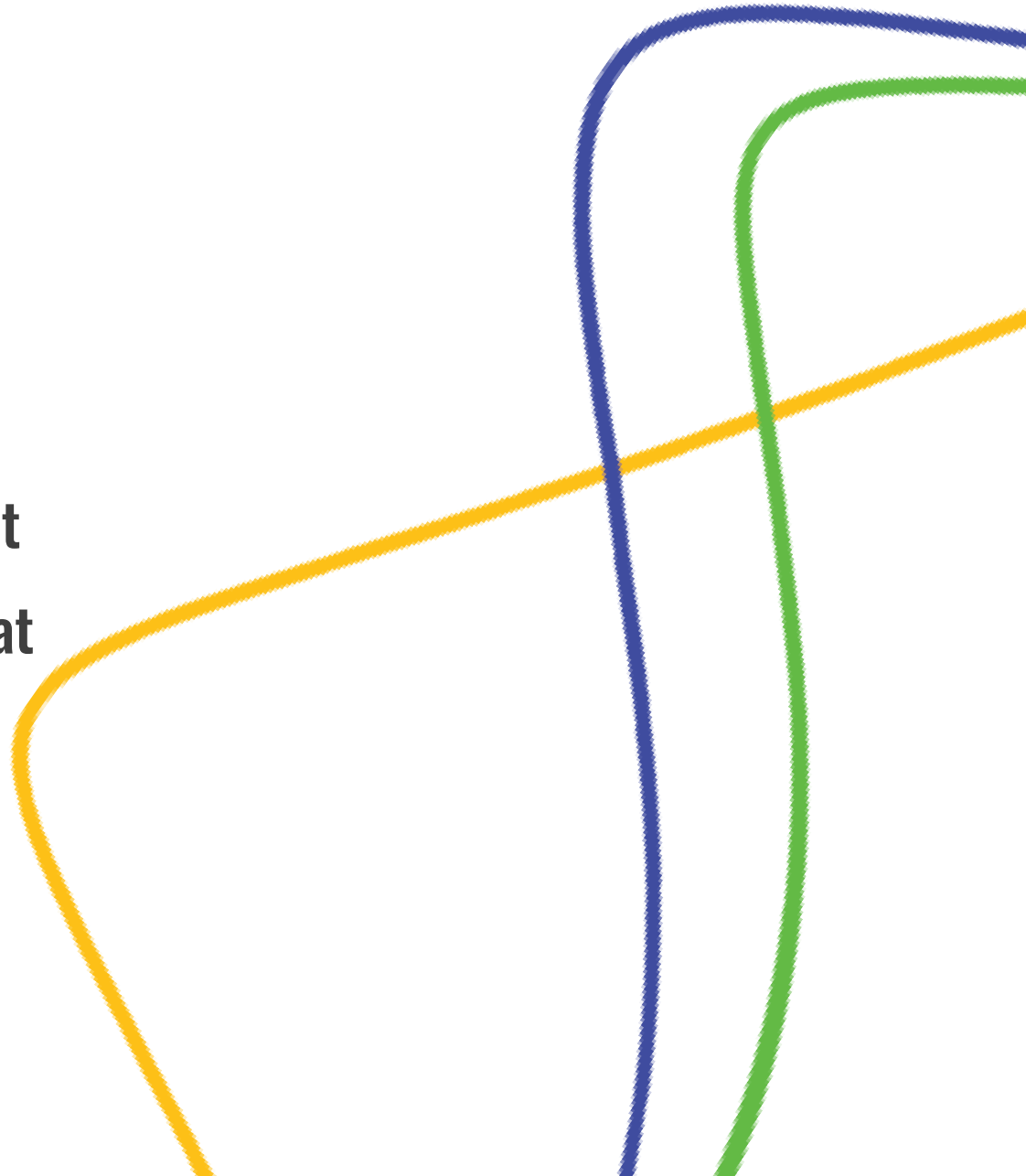
Agenda

- Literature review
- Findings on mortality of NCDs due to heat
- Findings on morbidity of NCDs due to heat



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