

Health Impacts of air pollution & climate change in cities

23^d April, 2024, Brussels

Healthy cities, healthy people: Pathways for
clean air in the EU's urban environments

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Chair of European Respiratory Society (ERS)

Environment and Health Committee



Talk Outline

- Air pollution and health
- Climate change and health
- How climate change and air pollution show in our cities
- Joint effects of air pollution and heat in cities (EU Exhaustion project results)
- Wildfires, air pollution and health
- Challenges presented for respiratory patients in cities
- Conclusions



Greece fires in maps and satellite images show extent of damage



Catastrophic floods in Italy force thousands of people to evacuate



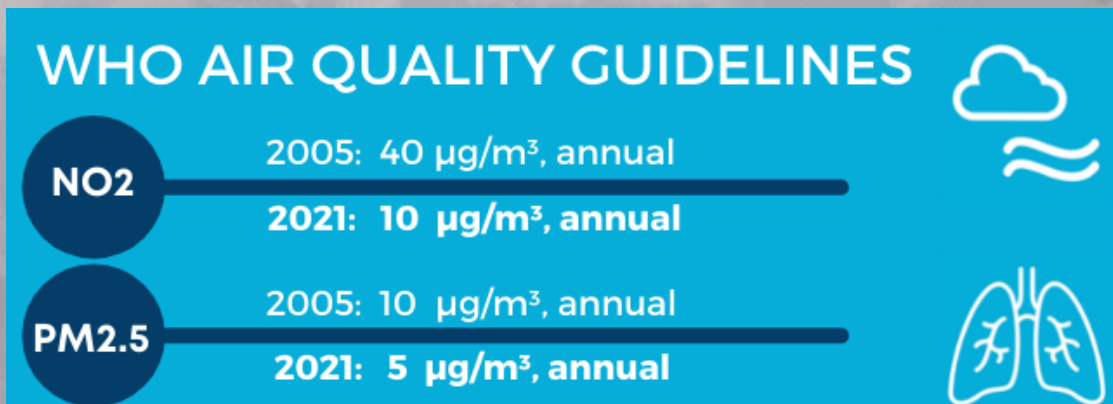
A tall, grey industrial smokestack is positioned on the right side of the frame. It is emitting a thick, white plume of smoke that drifts to the left across the sky. The sky is a uniform, overcast grey. The smoke plume is dense and billowing, with some smaller wisps trailing behind it.

Air Pollution and Health



Air pollution got lot worse:
'Air pollution more harmful, and harmful at even lower levels than previously known - substantial lowering of the guidelines compared to 2005 WHO AGQ'

1. All (97%) Europeans exposed
2. PM_{2.5} caused 432,000 premature deaths in Europe in 2021, of which 253,000 were > 5 µg/m³ (likely underestimated)



Air Pollution and Lung

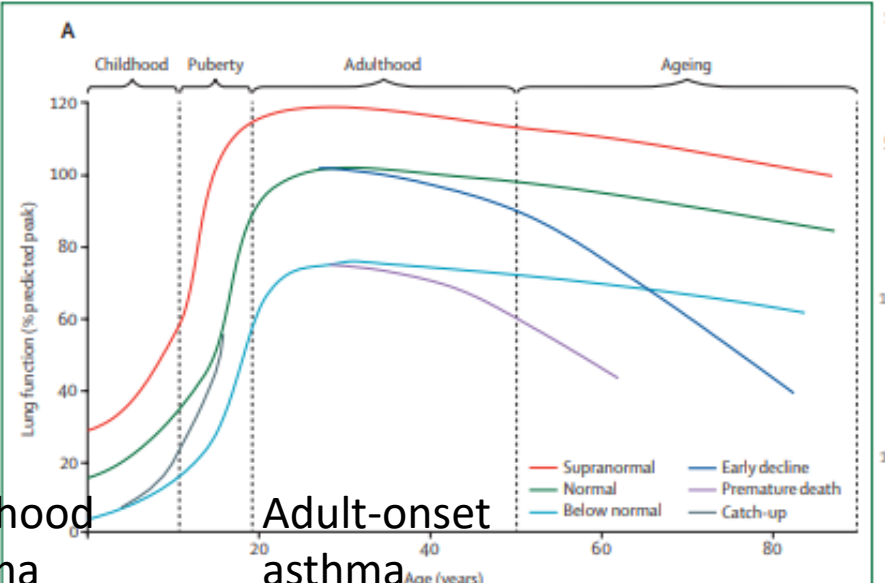


Mayor of London Sadiq Khan with Rosamund Adoo-Kissi-Debrah (Stefan Rousseau/PA) (PA Wire)



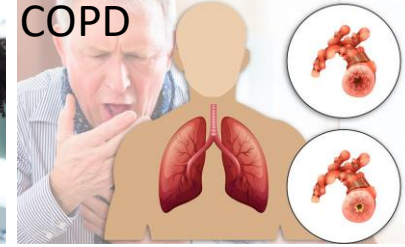
“ I believe in a world where everyone can breathe air that is free from toxic pollution, regardless of where they live, their economic status or their ethnic background ”

Rosamund Adoo-Kissi-Debrah
2022 ELF Awardee



Childhood asthma

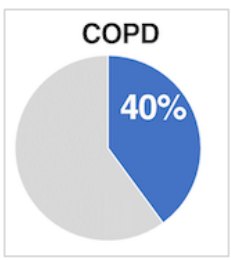
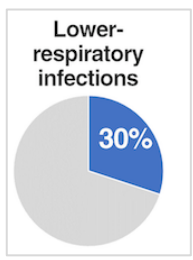
Adult-onset asthma



16% asthma cases in children *

Ella Adoo-Kissi-Debrah: Air pollution a factor in girl's death, inquest finds

© 16 December 2020



GBD - Mortality specific-causes, 'fraction attributable' to air pollution
<https://www.stateofglobalair.org/>



Ella Kissi-Debrah - 9 year old girl suffered fatal asthma attack triggered by air pollution, London, February 2013

Children's lung capacity improved in cleaner air



Photo: Getty Images

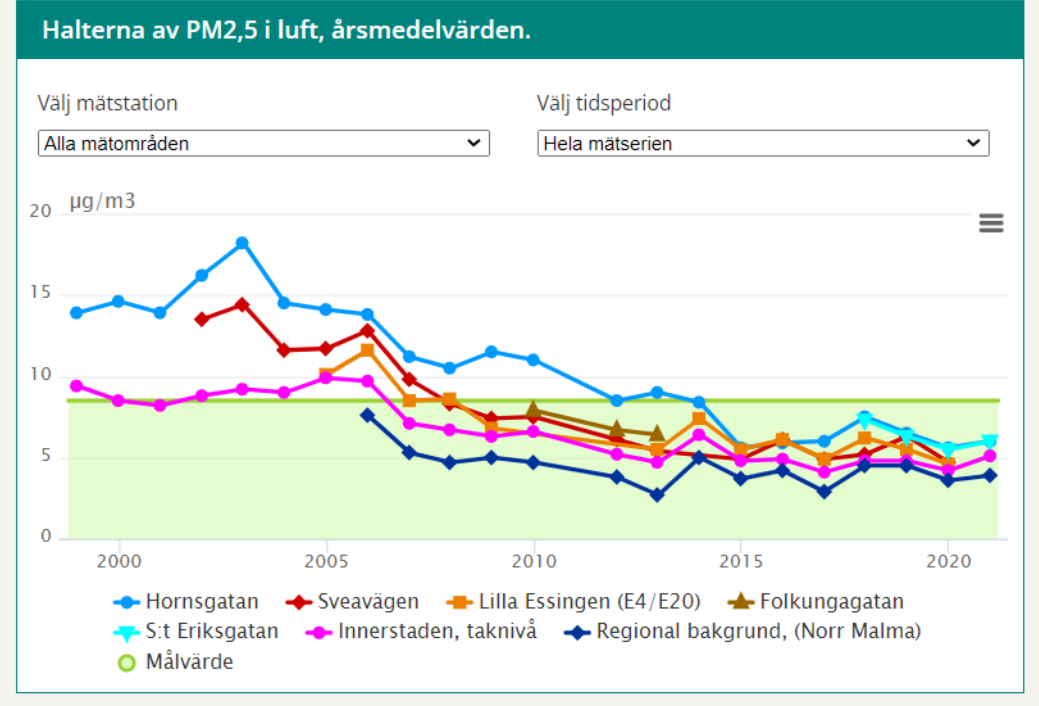
Cutting air pollution improves children's lung development, study shows

Conclusions from long-term survey in Sweden come days after 10th anniversary of Ella Kissi-Debrah's death in London



The researchers said the results sent 'a strong message to policymakers and city planners'. Photograph: Fabrizio Bensch/Reuters

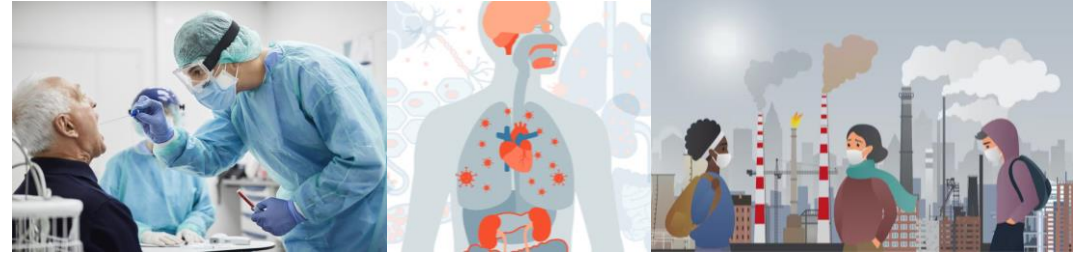
Even in Sweden: better air – bigger lungs



Associations of improved air quality with lung function growth from childhood to adulthood: the BAMSE study

Zhebin Yu¹, Simon Kebede Merid², Tom Bellander^{1,3}, Anna Bergström^{1,3}, Kristina Eneroth⁴, Antonios Georgelis^{1,3}, Jenny Hallberg^{2,5}, Inger Kull^{2,5}, Petter Ljungman^{1,6}, Susanna Klevebro^{2,5}, Massimo Stafoggia^{1,7}, Gang Wang^{1,2}, Göran Pershagen^{1,3}, Olena Gruzieva^{1,3} and Erik Melén^{1,3,5}

Air Pollution and COVID-19



Ambient air pollution exposure linked to long COVID among young adults: a nested survey in a population-based cohort in Sweden

Zhebin Yu,^a Sandra Ekström,^{a,b} Tom Bellander,^{a,b} Petter Ljungman,^{a,c} Göran Pershagen,^{a,b} Kristina Eneroth,^{a,d} Inger Kull,^{e,f} Anna Bergström,^{a,b} Antonios Georgelis,^{a,b} Massimo Stafoggia,^{a,g} Olena Gruzjeva,^{a,b,h} and Erik Melén,^{e,f,h,*} the BAMSE COVID-19 Study Group

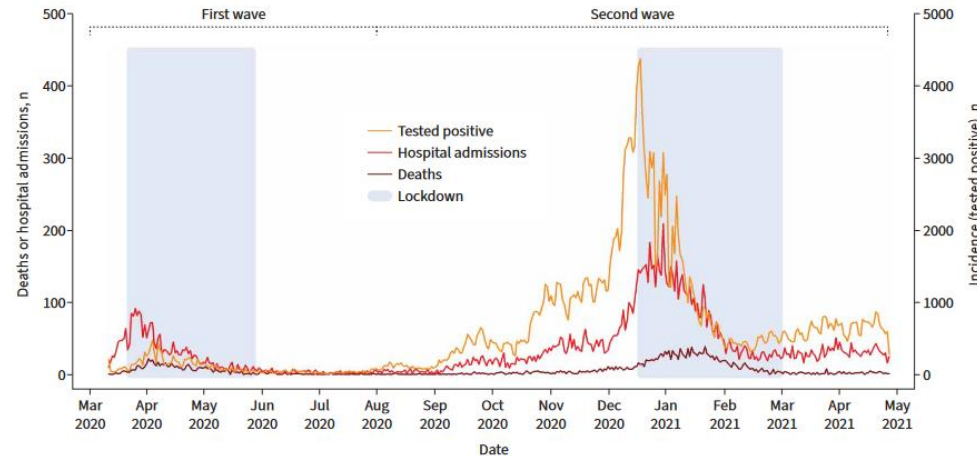
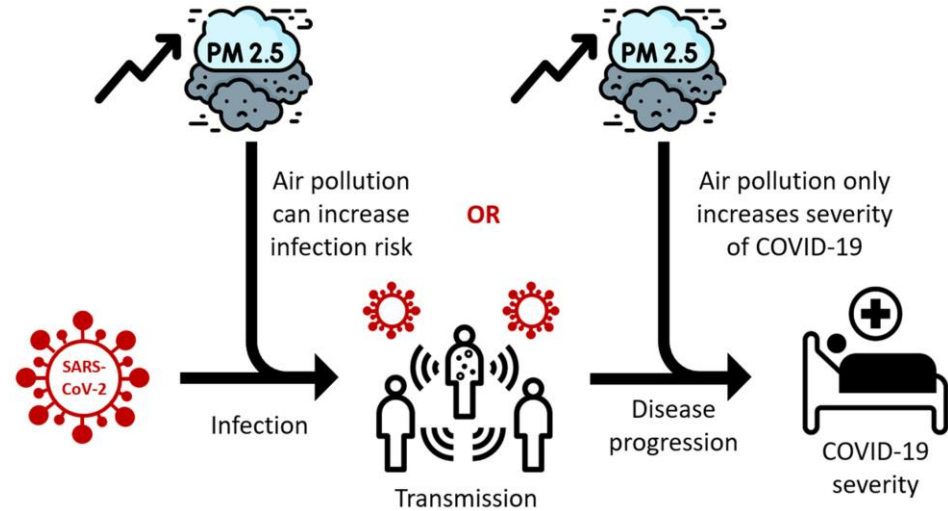


FIGURE 1 The COVID-19 pandemic in Denmark between 1 March 2020 and 26 April 2021: daily numbers of COVID-19-positive cases, hospital admissions and deaths in Denmark.

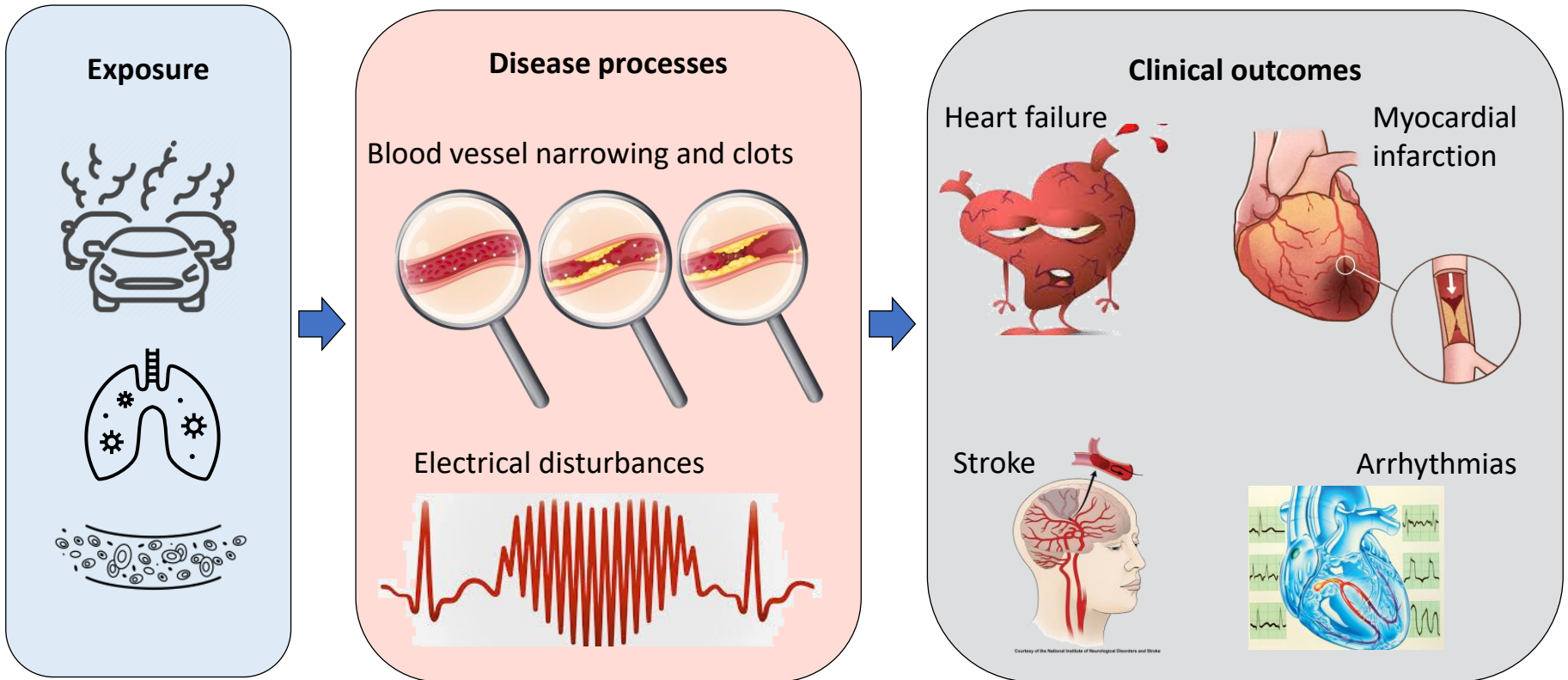


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ORIGINAL RESEARCH ARTICLE
J. ZHANG ET AL.

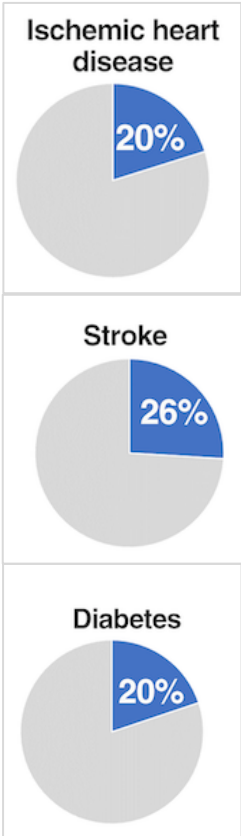
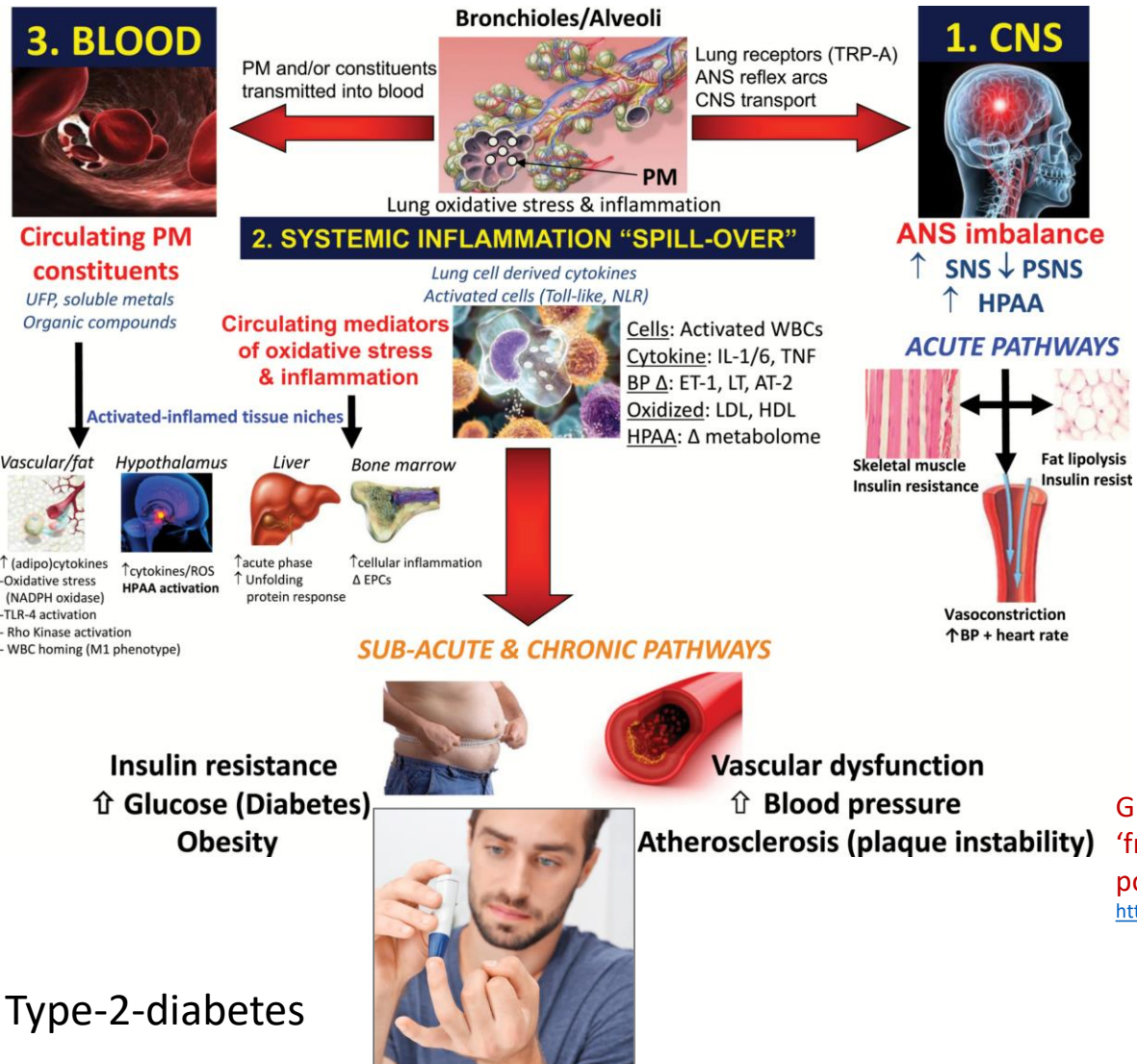
Long-term exposure to air pollution and risk of SARS-CoV-2 infection and COVID-19 hospitalisation or death: Danish nationwide cohort study

Jiawei Zhang¹, Youn-Hee Lim¹, Rina So¹, Jeanette T. Jørgensen¹, Laust H. Mortensen^{2,3}, George M. Napolitano¹, Thomas Cole-Hunter¹, Steffen Loft¹, Samir Bhatt^{2,4}, Gerard Hoek⁵, Bert Brunekreef⁵, Rudi Westendorp², Matthias Ketzel^{6,7}, Jørgen Brandt^{6,8}, Theis Lange⁹, Thea Kølsen-Fisher^{9,10} and Zorana Jovanovic Andersen¹

How does air pollution affect your heart?



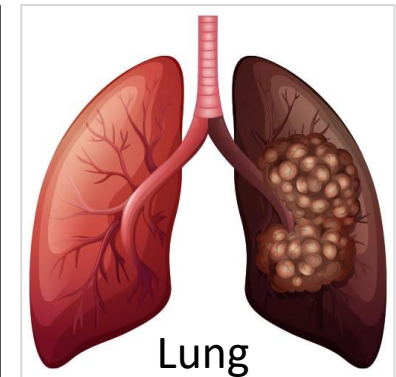
Air pollution and heart / cardio-metabolic health



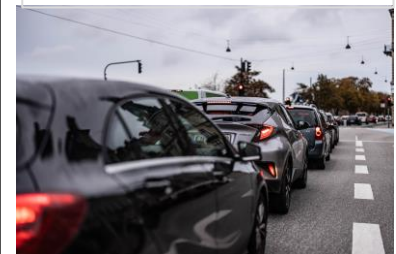
GBD - Mortality specific-causes, 'fraction attributable' to air pollution
<https://www.stateofglobalair.org/>

Type-2-diabetes

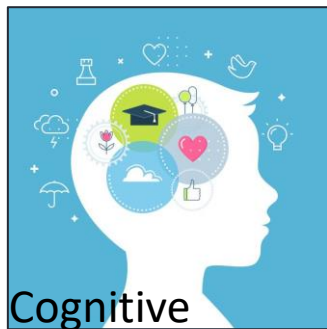
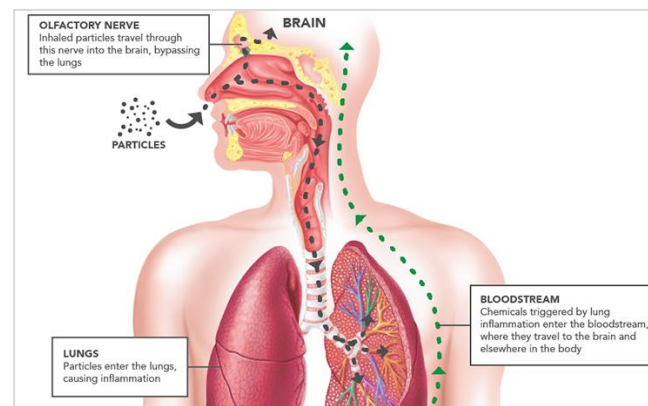
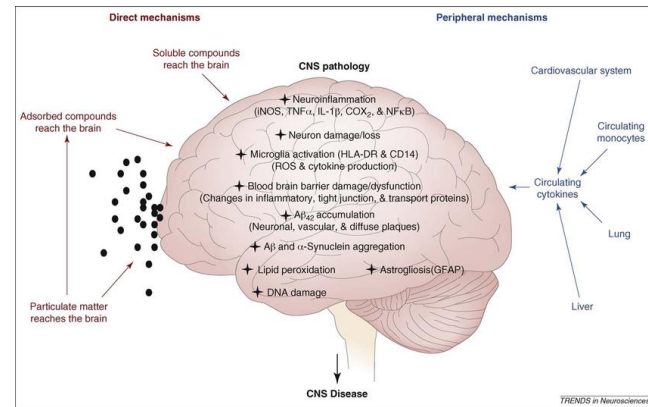
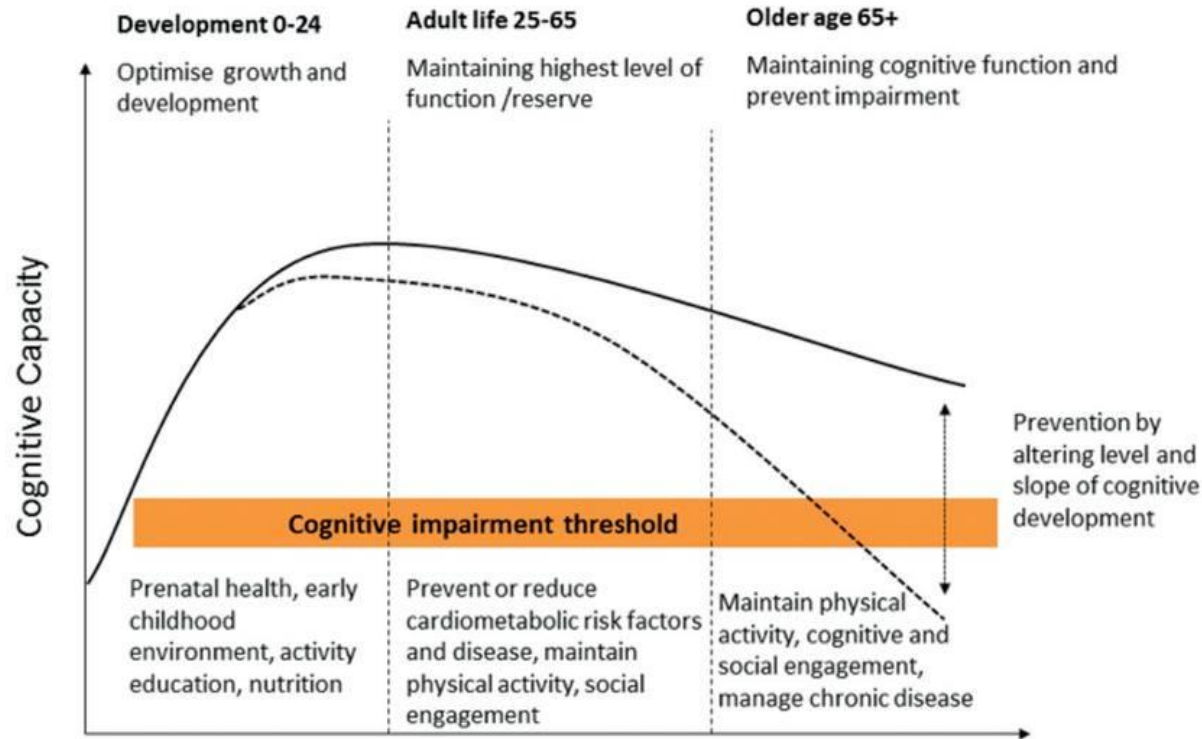
Air pollution and cancer



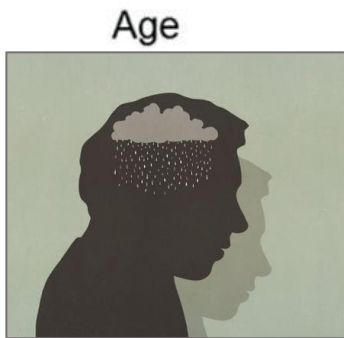
Breast, brain, colorectal, stomach, liver, bladder, kidney



Air pollution and the brain



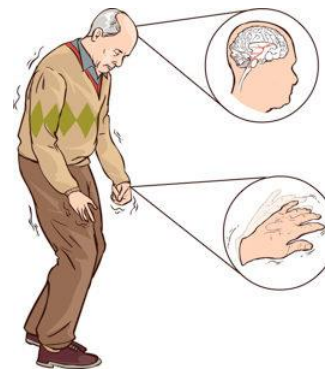
development, autism, ADHD



Depression, anxiety, suicide



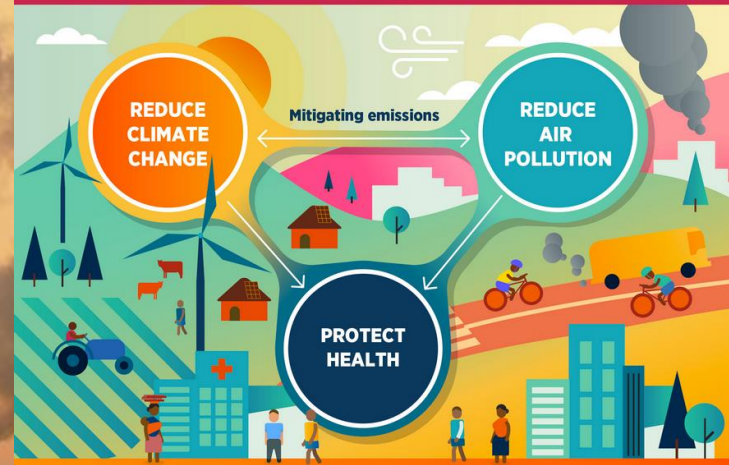
Dementia, Alzheimer's



Parkinson's disease

Climate change and air pollution inseparable issue -breaking the silos to improve research on health impacts and speed up solutions

REDUCING AIR POLLUTION AND MITIGATING CLIMATE CHANGE, TOGETHER HELP TO PROTECT OUR HEALTH



WHO Air Quality Guidelines set goals to protect millions of lives from air pollution.

CLEAN AIR FOR HEALTH

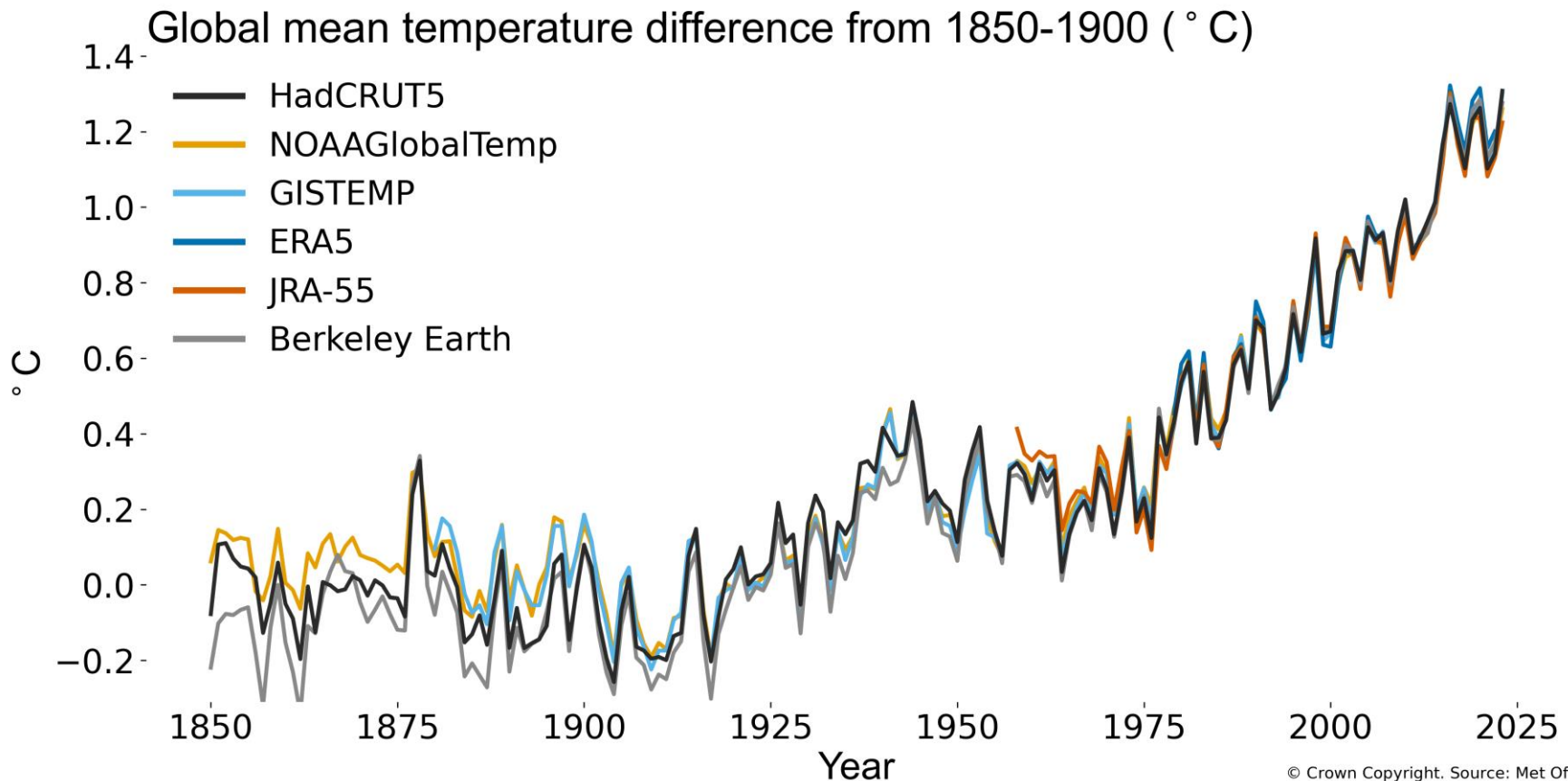
#AirPollution





Global warming – world is changing fast

‘eight warmest years on record witness upsurge in climate change impacts’



© Crown Copyright. Source: Met Office
Figure updated: 04/09/2023

'Raging' Climate Change - Unprecedented 2023

'A biblical catastrophe': death toll rises to six as Storm Daniel lashes Greece

Torrential rain blocks roads, causes power cuts and severs water supplies



Greece: residents rescued in helicopters after severe floods - video
Four days of cataclysmic rain have lashed the central Greek region of

Thousands evacuated as wildfires tear through Spanish island of Tenerife

By Claudia Rebore, Taylor Ward, Niamh Kennedy and Suggan Pickham, CNN
Published 11:43 PM EDT, Thu August 17, 2023



Residents of the town 'La Esperanza' are evacuated as the efforts to extinguish the fires continue at the island of Tenerife, Canary Islands, Spain, on August 17, 2023.

Canadian wildfire emissions hit record high as smoke reaches Europe

By Gloria Dickie
June 28, 2023 1:13 AM GMT+2 · Updated 2 months ago



[1/4] Flames reach upwards along the edge of a wildfire as seen from a Canadian Forces helicopter surveying the area near Mistissini, Quebec, Canada June 12, 2023. Cpl. Marc-Andre Leclerc/Canadian Forces/Handout via REUTERS/File Photo [Acquire Licensing Rights](#)

Devastating floods in Italy claim lives and leave thousands homeless

Twenty-one rivers burst their banks after heavy storms across country cause landslides and submerge villages



People call for help as extreme floods engulf houses and roads in Italy - video
Nine people have died and thousands have been evacuated from their homes after heavy storms wreaked havoc in the northern Italian region of Emilia-Romagna, causing severe flooding and landslides.



In pictures: Slovenia faces 'worst-ever natural disaster' after extreme flooding

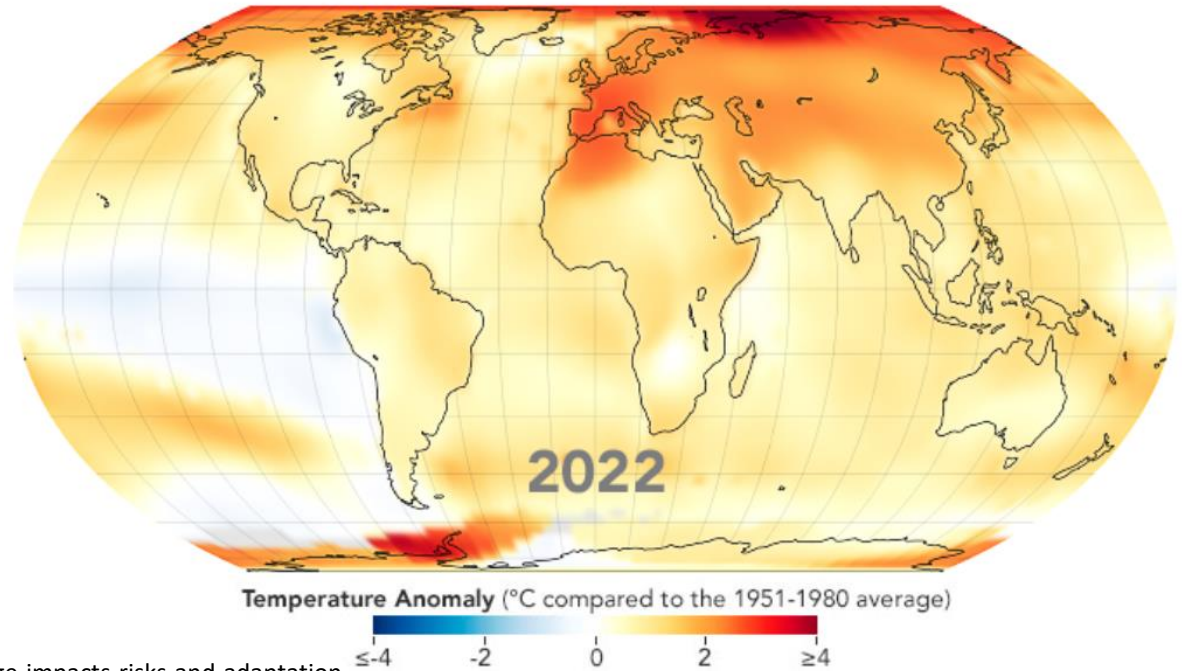


Wildfire Smoke Blankets Sky Across New York City, Prompting Air-Quality Warnings - WSJ

Visit

Global warming – Europe warming faster - prepare for more brutal heatwaves

Global mean temperature between 2013 and 2022 was 1.13-1.17°C warmer than the pre-industrial level: the warmest decade on record
European temperatures have increased faster, by 2.04 to 2.10°C, some cities more affected: southern Europe heating up fastest



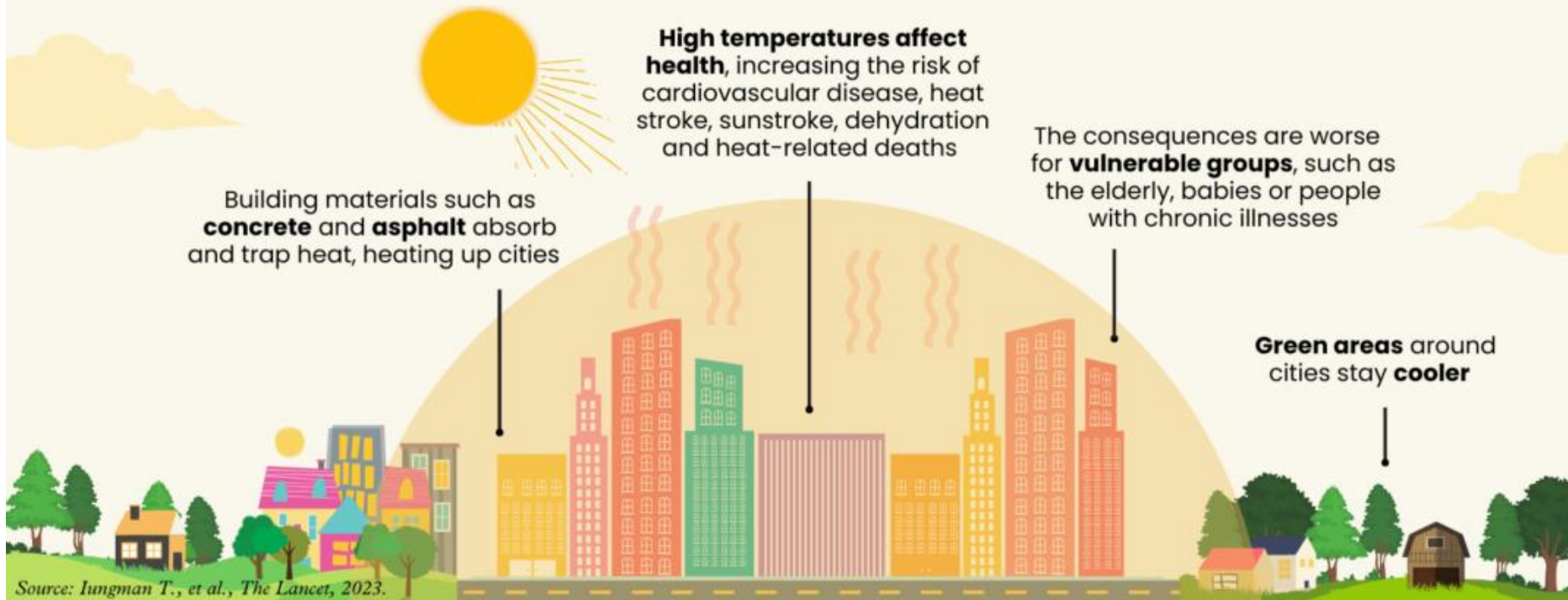
<https://www.eea.europa.eu/en/topics/in-depth/climate-change-impacts-risks-and-adaptation>



Cities- 'hot spots' of air pollution and climate change effects

The urban heat island effect

Refers to the **increase in temperature** in **urban environments** compared to surrounding areas.



'Europe saw yet another year of increasing temperatures and intensifying climate extremes — including heat stress with record temperatures, wildfires, heat waves, glacier ice loss and lack of snowfall'



 INDEPENDENT

**Europe is the fastest-warming
continent, at nearly twice the
average global rate**

April 22nd, 2024

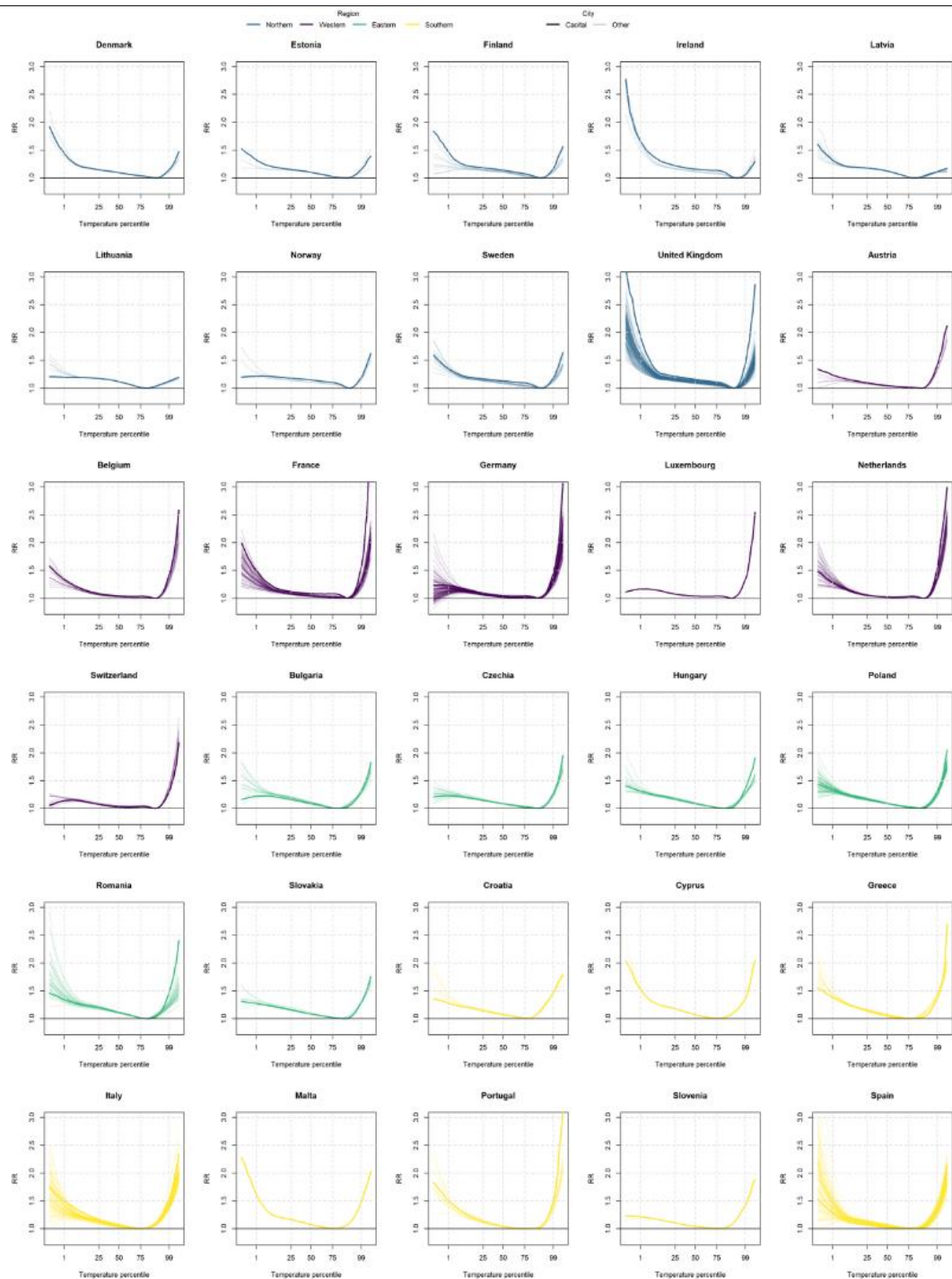
Heat vulnerability differs across Europe

We investigated the *factors explaining these differences*. May be addressed in adaptation policies

Factors increasing heat-health effects:

Area level ambient factors:

- High air pollution (PM_{2.5} and O₃)
- High population density
- Urbanized
- Lack of green space

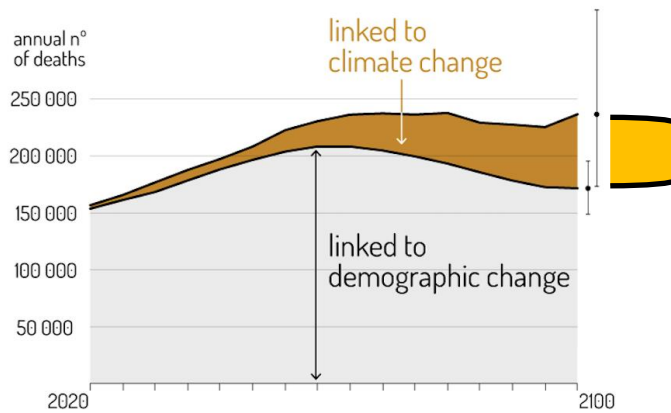


- Masselot et al. (2023). Excess mortality attributed to heat and cold: a health impact assessment study in 854 cities in Europe. *Lancet Planet Health*
- Gasparrini et al. (2022). Small-area assessment of temperature-related mortality risks in England and Wales: a case time series analysis. *Lancet Planetary Health*
- Zafeiratou et al. (2023). Assessing individual and location characteristics as modifiers of heat effects on respiratory mortality at small area scale in Europe. *Environmental Epidemiology*
- Zhang et al. (2023). Assessment of short-term heat effects on cardiovascular mortality and vulnerability factors using small area data in Europe. *Environment International*

An ageing population is a vulnerable population

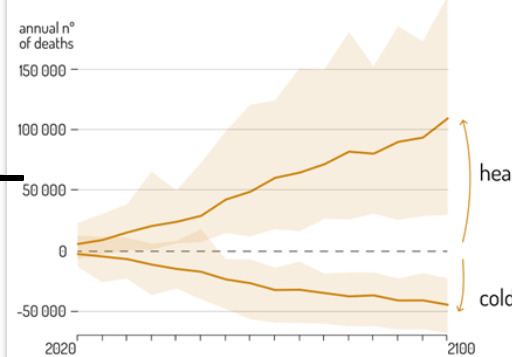
Estimated annual deaths in Europe due to temperature

Climate change will be responsible for an **increase** in temperature-related deaths per year, from **3 079** in 2020 to **64 963** in 2100.



Deaths in Europe due to climate change, by heat and cold

Climate change will cause a significant increase in heat deaths and a decrease in cold deaths, resulting in **more deaths overall**.



SSP3 scenario:

- 2010: Ten times as many cold-related deaths as heat-related deaths
- 2100: Twice as many heat-related deaths as cold-related deaths
- Today – year 2100: **>2 million excess deaths attributable to climate change (SSP370)**
- 5-10% of these deaths can be avoided by reaching WHO AQG ($5 \mu\text{g}/\text{m}^3$)


Masselot P., Gasparri A. & EXHAUSTION team (in prep.). Contrasting heat and cold-related mortality attributed to climate change in 854 European cities

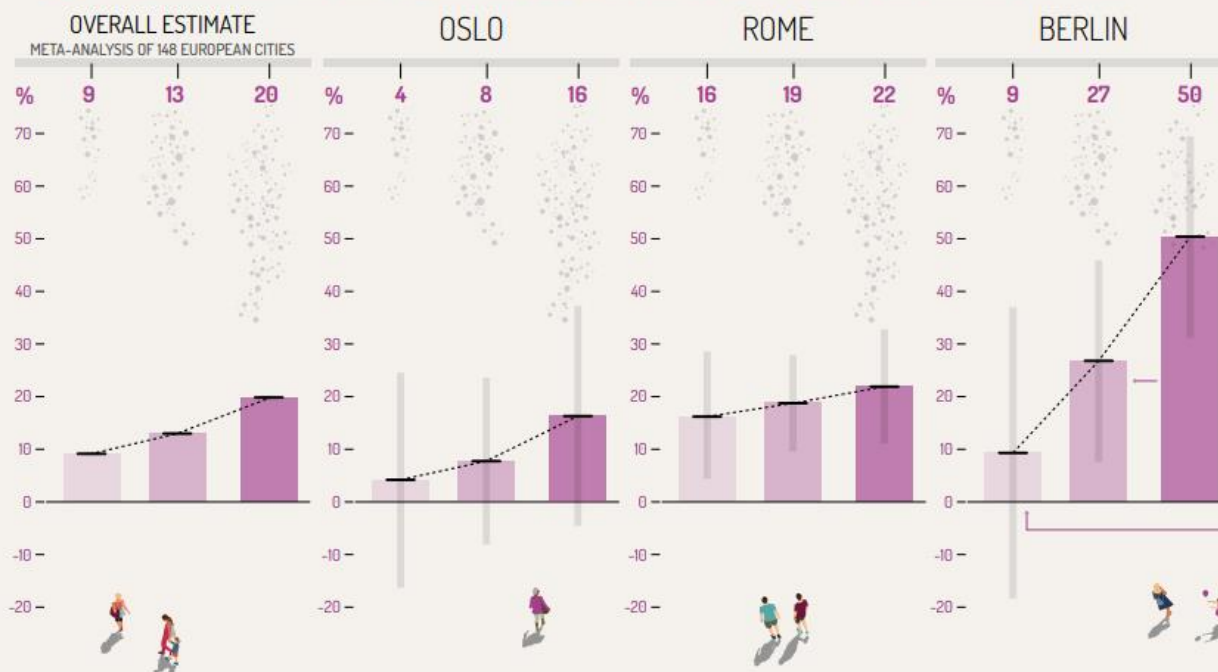
Air pollution and climate change - health

EXHAUSTION
www.exhaustion.eu

WE BREATHE CLIMATE CHANGE

More people will die of **lung** diseases in our cities when high temperatures are combined with high levels of air pollution. This is especially true for those of us who are 65 and older.

 **Change in number of deaths from lung diseases in European cities (%) in association with high temperatures, by different levels of air pollution (PM2.5)**



LEGEND

Change in n° of deaths from lung diseases when we are exposed to moderate temperatures compared to:

- High temperatures and **high** air pollution
- High temperatures and **medium** air pollution
- High temperatures and **low** air pollution

Confidence interval: the estimate lies in this interval, with very high probability

Moderate temperature level: in the study period, 75% of the days in the city have a temperature below this level (°C)

Overall estimate	Oslo	Rome	Berlin
20.2	15.3	25.7	20.2

High temperature level: in the study period, 1% of the days in the city have a temperature above this level (°C)

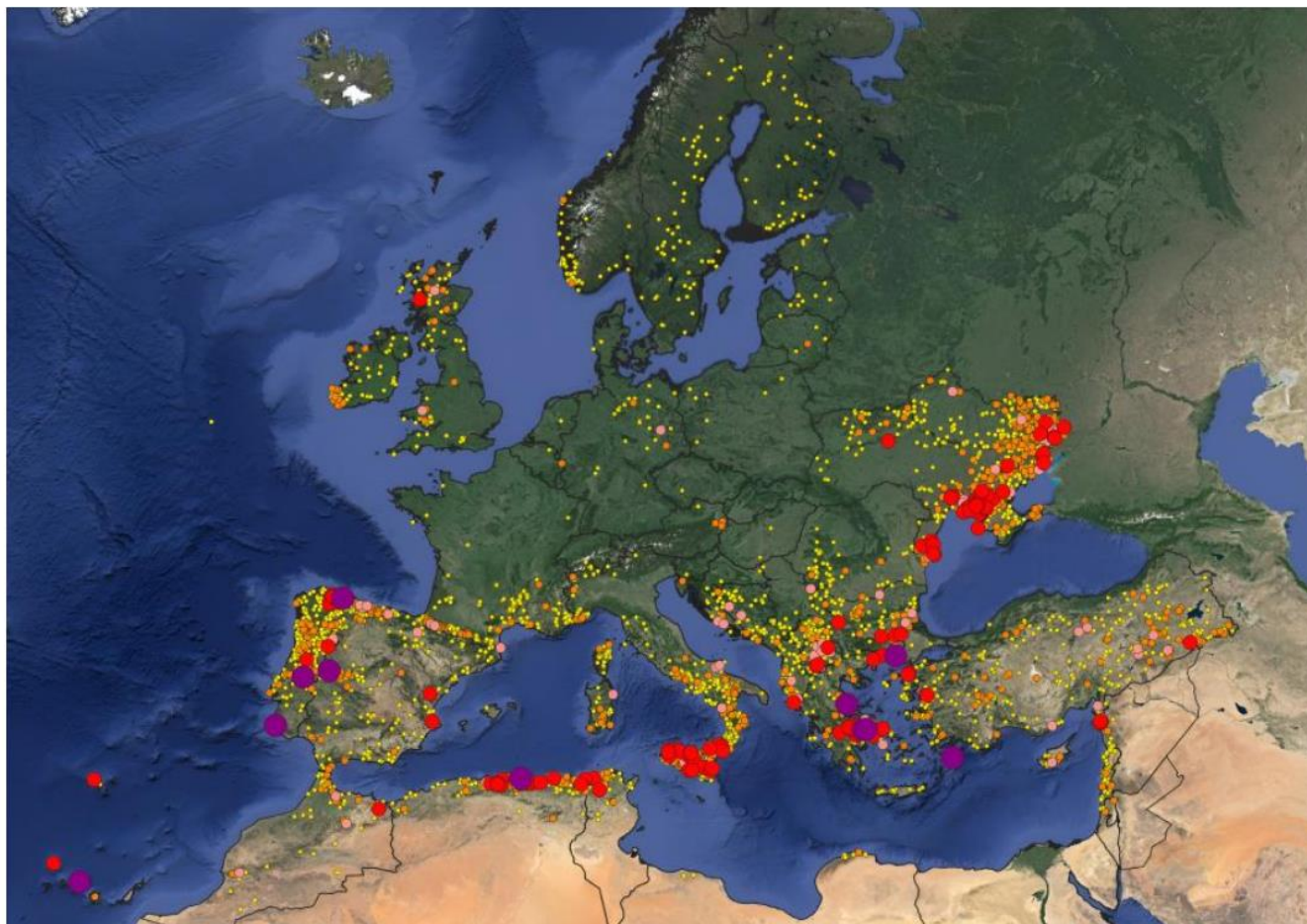
Overall estimate	Oslo	Rome	Berlin
26.4	21.7	29.6	27.1

Low, medium and high levels of air pollution (fine particles PM2.5, µg/m³)

Overall estimate	Oslo	Rome	Berlin
low 4	low 2	low 9	low 7
medium 10	medium 6	medium 15	medium 12
high 21	high 15	high 23	high 21

Wildfires: 2023 among the worst in the EU in this century

A sharp increase in burnt areas was recorded during the summer months of 2023, mostly affecting the Mediterranean region. By total burnt surface area, 2023 was the fourth worst year since 2000.



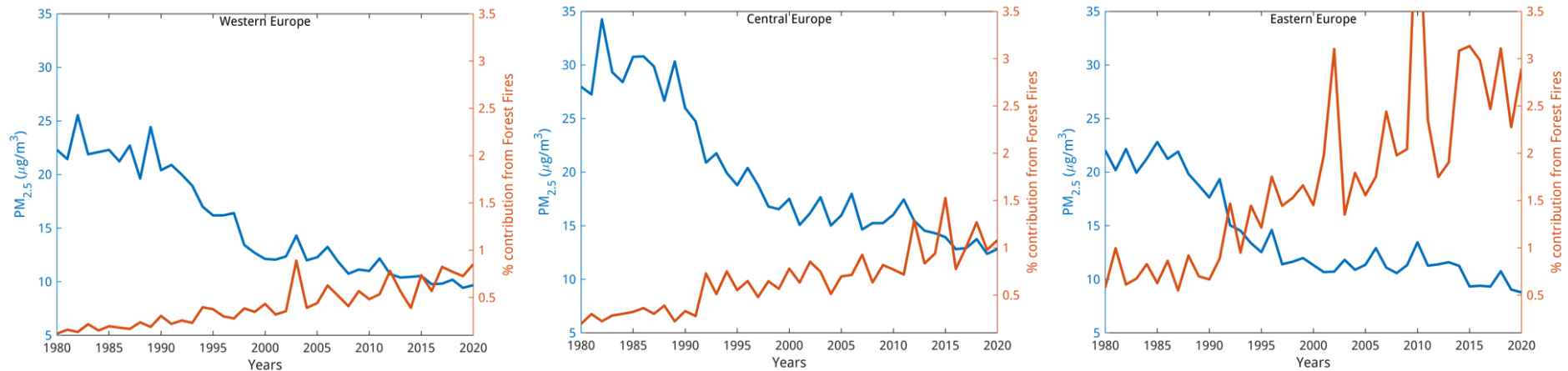
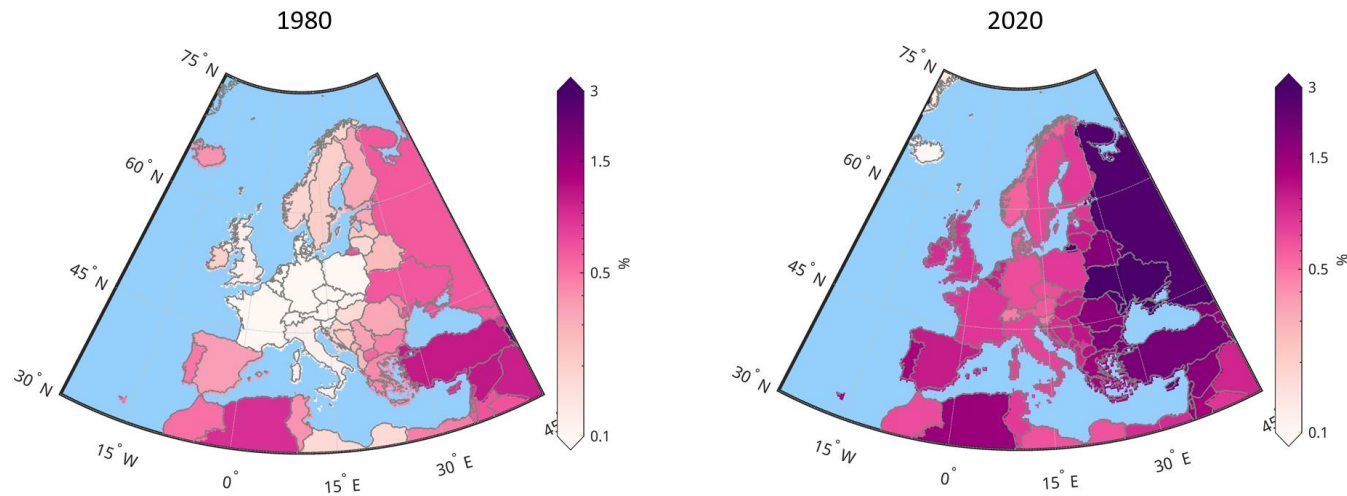
Extent of burnt areas in 2023 as reported by EFFIS. Yellow dots refer to areas up to 100 ha, orange up to 500 ha, pink up to 1000 ha, red up to 5000 ha, purple beyond 5000 ha.

© EU, 2024 - GWIS

Source: https://joint-research-centre.ec.europa.eu/jrc-news-and-updates/wildfires-2023-among-worst-eu-century-2024-04-10_en



Smoke concentrations from fires may double by the middle of the century



Population-weighted $\text{PM}_{2.5}$ concentration and % contribution from wildfires

US East Coast blanketed in veil of smoke from Canadian fires, New York City, June 8th, 2023



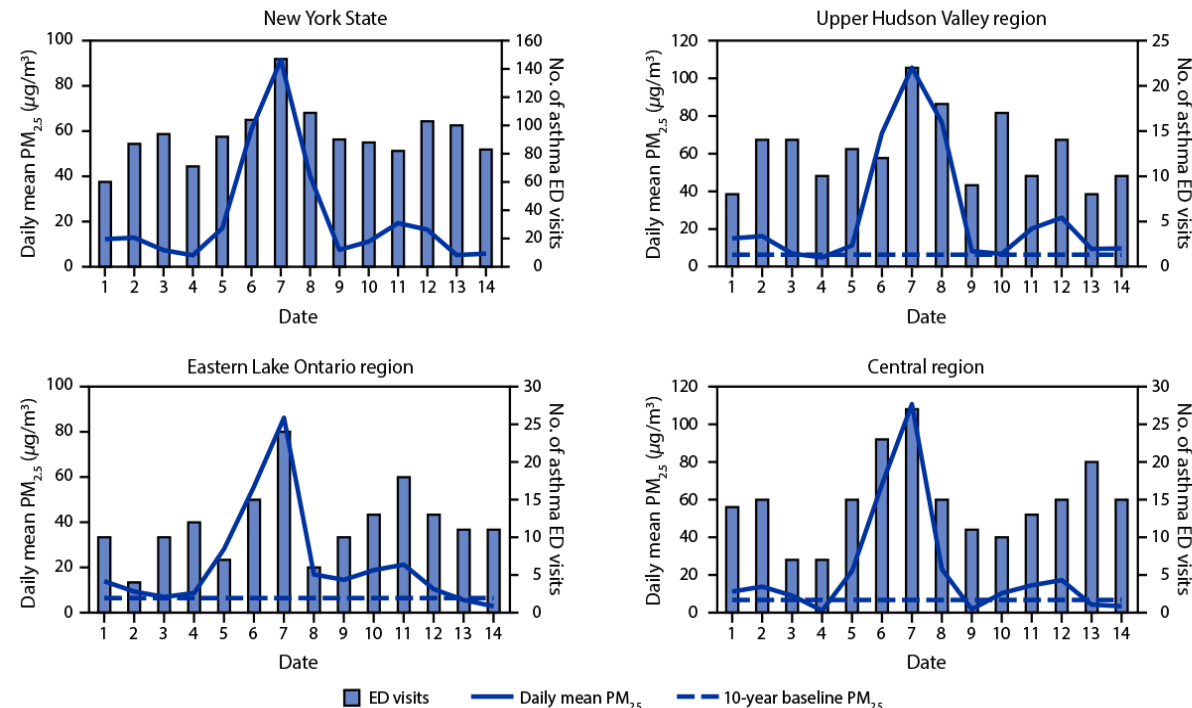
Wildfires in Canada, June 6–9, 2023 Air Pollution Episode in New York City

Emergency department (ED) visits for asthma increased during wildfire smoke exposure in New York

Asthma-associated ED visits increased over 80% on the day with the highest exposure to wildfire smoke*



FIGURE. Daily mean particulate matter with aerodynamic diameter $\leq 2.5 \mu\text{m}$ and number of asthma-associated emergency department visits statewide* and selected regions† — New York excluding New York City, June 1–14, 2023



Abbreviations: ED = emergency department; $\text{PM}_{2.5}$ = particulate matter with aerodynamic diameter $\leq 2.5 \mu\text{m}$.

<https://www.cdc.gov/mmwr/volumes/72/wr/mm7234a6.htm>

ERS statement: climate change and respiratory health

Highlighting the threats posed by climate change to respiratory health

Calling for health to be central to the development of climate change mitigation strategies and air pollution reduction policies

Urging support from the professional respiratory community to advocate for the protection of our planet and for the health of people that live and depend on it



EUROPEAN RESPIRATORY JOURNAL
EDITORIAL
A.M. VICEDO-CABRERA ET AL.

Climate change and respiratory health: a European Respiratory Society position statement

Ana Maria Vicedo-Cabrera^{1,2}, Erik Melén³, Francesco Forastiere^{4,5}, Ulrike Gehring⁶, Klea Katsouyanni^{7,8}, Arzu Yorgancioglu⁹, Charlotte Suppli Ulrik^{10,11}, Kjeld Hansen^{12,13}, Pippa Powell¹², Brian Ward¹⁴, Barbara Hoffmann¹⁵ and Zorana Jovanovic Andersen¹⁶



BREATHE
REVIEW
Z.J. ANDERSEN ET AL.

Climate change and respiratory disease: clinical guidance for healthcare professionals

Zorana Jovanovic Andersen¹, Ana Maria Vicedo-Cabrera^{2,3}, Barbara Hoffmann⁴ and Erik Melén⁵

ERS on Climate Change: Position Statement

Canada wildfires: ERS and ISEE call for immediate action to curb the health impact of climate change



14 June, 2023

<https://www.ersnet.org/news-and-features/news/canada-wildfires-ers-and-isee-demand-immediate-action-to-curb-the-health-impact-of-climate-change/>

<https://erj.ersjournals.com/content/erj/62/2/2201960.full.pdf>

<https://www.ncbi.nlm.nih.gov/pmc/articles/PMC10365076/pdf/EDU-0222-2022.pdf>

Summary of Climate Change and Lung Health

Spreading of aeroallergens (new types, longer seasons), mosquitos and ticks carrying infectious diseases moving North

More frequent and extreme weather events:

- Increasing temperatures and more frequent heat waves: high temperature / humidity/ dehydration, increase in ozone
- Wildfires: massive air pollution exposure locally, transported for 1,000s miles
- Droughts: high winds, more frequent (desert) dust and sand storms
- Thunderstorms/showers: high winds, heavy precipitation, bursts of allergen release
- Floods: moisture from rainfall increases dampness and mould indoors

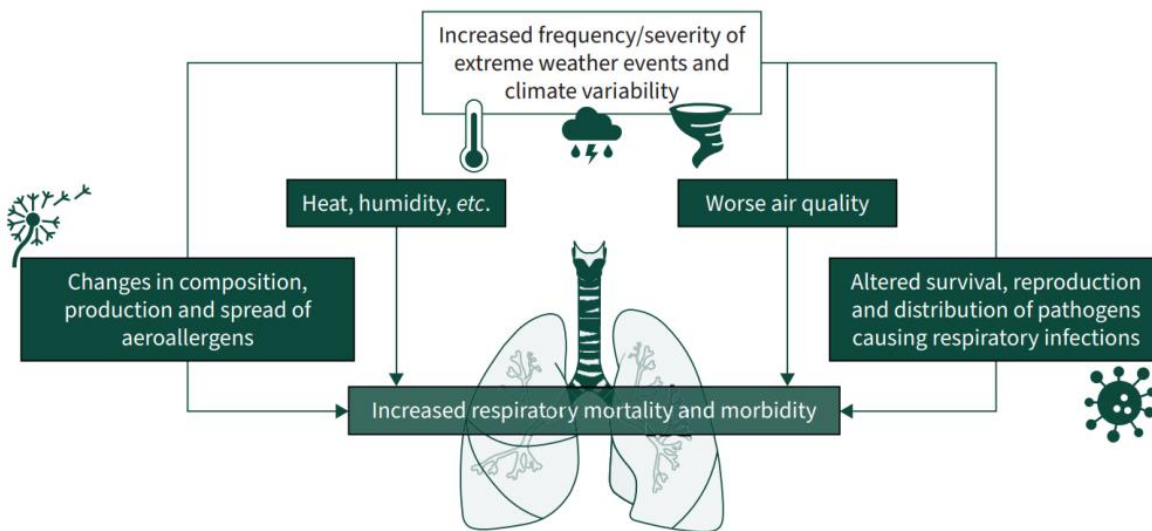


FIGURE 1 Summary scheme of the pathways linking climate change and impacts of respiratory health.



Climate change and respiratory health: a European Respiratory Society position statement

Ana Maria Vicedo-Cabrera^{1,2}, Erik Melén³, Francesco Forastiere^{4,5}, Ulrike Gehring⁶, Klea Katsouyanni^{7,8}, Arzu Yorgancioglu⁹, Charlotte Suppli Ulrik^{10,11}, Kjeld Hansen^{12,13}, Pippa Powell¹², Brian Ward¹⁴, Barbara Hoffmann¹⁵ and Zorana Jovanovic Andersen¹⁶

Conclusions:

- ERS calls on the health community and policymakers, European Parliament and governments around the world to urgently reduce emissions of greenhouse gasses and mitigate effects of climate change
- Air pollutants and greenhouse gases must be seen as a combined problem, and action must consider all emissions and health consequences
- Strict air quality standards (based on science and fully aligned with WHO 2021 Air Quality Guidelines) are major public and planetary health opportunity that would:
 - 1) mitigate climate change impacts on our health and our planet,
 - 2) prevent a substantial number of new cases of respiratory (other NCDs) diseases, and improve life of lung (NCD) patients
- Continued education of clinicians and patients crucially important to mitigate health effects on respiratory patients

Solid evidence on air pollution and climate change health effects: we know enough to act

- 2018, UN recognized air pollution as risk factor for NCDs
- WHO air pollution - 'quiet pandemic'
- 2024, COP28 – health on climate action agenda

Reduction of air pollution is a major public and planetary health opportunity, that would:

1. Prevent a substantial number of new NCD & deaths
2. Improve life of lung, heart, and other NCD patients
3. Make citizens more resilient to COVID-19 and other seasonal (influenza) epidemics
4. Help mitigate unprecedented climate change impact on our health and our planet – mitigate heat effects
5. Cities: car traffic reduction, promotion of active travel, greening (parks, shade, green roofs)

Clean air as a basic civil right - no one should get sick or die from breathing



THANK YOU

zorana.andersen@sund.ku.dk

Photos by Branislav Nenin

University of Copenhagen, Challenge - Data for Good Science

