Abstracts Book

Conference on Connecting Health and Climate Change

October 11-12 in Stockholm, Sweden

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Content

CONFERENCE PROGRAM

DAY 1, Wednesday, 11 October 2023

Time/room	Main room | B1-2
08:45-09:00	Conference opening H. Orru (University of Tartu, EST), H. Sjödin (Umeå University, SWE), A. Nordström (Ministry for Foreign Affairs, SWE), K. Aunan (CICERO, NOR)
09:00-10:30	Keynote panel 1: Tracking climate change and opportunities to improve health through adaptation and mitigation Chair: K. Aunan (CICERO, NOR) Speaker/panelist: J. Fuglestvedt (CICERO, Intergovernmental Panel on Climate Change, NOR) Speaker/panelist: C. Tonne (ISGlobal, Lancet Countdown Europe, ESP) Speaker/panelist: V. Kendrovski (World Health Organization Regional Office for Europe, GER)
10:30-11:00	COFFEE BREAK
11:00-12:30	ENBEL Symposium: Stakeholders and knowledge translation, and Climate-Health Africa Network Chair: S. Kovats (UK), E. Mazzalai (ITA) • Public Health Adaptation to heat and concomitant environmental risks in Europe. Results from the ENBEL project GAP Analysis (F. de'Donato) • Vulnerability to heatwaves and other environmental co-exposures: a scoping review of prevention programs and interventions within the ENBEL project (E. Mazzalai) • Climate services for heat-health adaptation: Costs, benefits, and societal implications (S. Rao) • Implementation of adaptation in the health sector in Southern and Eastern Africa (J. Natukunda) • Advancing Climate Change & Health Agenda in Africa through networking (V. Pagiwa) • How are national infectious disease surveillance systems taking climate change into account? Gap analysis of health adaptation in Africa (S. Kovats)
12:30-13:30	LUNCH

Time/room	Main room | B1-2	Parallel room | C1	Parallel room | C2	Parallel room | C3
13:30-15:00	Oral 1: Climate change health impacts and transformation of disease patterns *Chair: H. Sjödin (SWE), J. Natukunda (UK)* • El Niño and Epidemic Malaria in Ethiopia: a new climate tool to enhance malaria surveillance and response (E. Papadopoulou) • West Nile Virus infection in Europe: a case-crossover study on the short-term effect of meteorologic parameters (G. Moirano) • European projections of West Nile virus transmission under climate change scenarios (Z. Farooq) • Temperature around conception and metabolic health in adulthood: Evidence from the UK Biobank (F. Pradella) • Delayed effect of temperature and precipitation on Lyme neuroborreliosis incidence in Europe (M. Sewe) • An extended One Health approach for analysing coastal pathogens and their drivers (M. Neumann)	Oral 2: Climate, heat, and air quality interactions on health *Chair: H. Orru (EST), C. Muthoni (KEN)* • Small-area analysis of heat effect on mortality and effect modification by air pollution in Europe (A. Schneider) • Modelling past and future air pollution levels over Europe and associated premature mortality under various emission scenarios (U. Im) • Impact of ambient air pollution on preeclampsia in 2001–2019, Rome, Italy (M. Pedersen) • The contribution of wildfires and natural aerosols to $PM_{2.5}$ exposure and human health under future climate change scenarios (S. Chowdhury) • Ancillaries of household air quality intervention on health & climate change mitigation in Ethiopia – A methodological framework (A. Kidane) • California's early transition to electric vehicles: observed health and air quality co-benefits (S. Eckel)	Oral 3: Perception, communication and partnership on climate change and health *Chair: M. Stackpole Dahl (NOR), D. O'Donnell (USA)* • Building communities of practice for transdisciplinary research in climate and health in Latin America and the Caribbean: A conceptual model (Y.P. Silva) • Defining and conceptualizing planetary health literacy – A concept mapping approach (L. Schamberger) • Knowledge, attitude, practices, and expectations on climate change and sustainable development among French healthcare professionals (V. Migeot) • Clear climate communication: ENBEL's research highlights in plain language (S. Myhre) • Innovation methods, techniques and narratives for communicating climate change public health risks to diverse audiences (C. Lawlor) • Impact beyond the Impact Factor (J. Glaser)	Oral 4: Economics and policies for a just transition *Chair: S. Rao (NOR), G. Turner (UK)* • Green dreams, local realities: The complexities of the European Union's energy transition (U. Dahal) • Pathfinder Initiative: Analysing the effects of implemented climate mitigation actions on health and greenhouse gas emissions (B. Anton) • Productivity costs of temperature changes – micro-study from Norway (L. Ma) • Assessing the health impacts associated with active transportation within four different pathways to net-zero carbon emissions in France (L. Moutet) • Linking climate change adaptation and public health: Perspectives of Norwegian policy makers (I. Budin-Ljøsne) • Relationship between universal health coverage and healthcare-related carbon emissions: a comparative analysis (I. C. de Azevedo)
15:00-15:30	COFFEE BREAK			

Time/room	Main room | B1-2	Posters room | B3	
15:30-16:00	Workshop: Climate justice and health inequalities	Poster discussion 1: Health impacts of heat stress	Poster discussion 2: Climate change health impacts and transformation of disease patterns
16:00-16:30	*Chairs: L. Mabile, E. Rial-Sebbag (University Toulouse III)*	Poster discussion 3: Perception, communication and partnership on climate change and health	Poster discussion 4: Inequities in climate change impacts and health risks
16:30-17:00	• Speaker/panelist: C. Byk (IALES, FRA) • Speaker/panelist: C. Lajaunie (INSERM, FRA) • Speaker/panelist: L. Ravez (NARILIS, BE)	Poster discussion 5: Climate resilient health systems	Poster discussion 6: Climate, heat, and air quality interactions on health
17:00-17:30		Poster viewing	
17.30-18.00	Presentation of The Lancet journals (P. Jha) & demonstration of documentary on workers' health and heat (J. Glaser)		
20:00-...	CONFERENCE DINNER AND SOCIAL PROGRAM Restaurant K-Märkt – Garnisonen, Linnégatan 87F, *doors open at 19:30*		

DAY 2, Thursday, 12 October 2023

Time/room	Main room | B1-2
09:00-10:30	Keynote panel 2: Progress in health adaptation – across scales *Chair: K. Bowen (University of Melbourne, AUS)* Speaker/panelist: H. Graczyk (International Labour Organization, CHE) Speaker/panelist: A. Kazmierczak (European Environment Agency, DEN) Speaker/panelist: I. Knutsson (Swedish National Institute of Public Health, SWE)
10:30-11:00	COFFEE BREAK
11:00-12:30	BELMONT Symposium: Transdisciplinary research to improve understanding of the climate, environment and health links *Chair: M. Chersich (ZAF), K. Aunan (NOR)* • Climate change and health risk early warning systems (J. Eggeling) • Global disparities in heat exposure (L. Ma) • Protection Resilience Efficiency and Prevention (PREP) for workers in industrial agriculture in a changing climate (K. Jakobsson) • Impact of environmental heat and a rest-shade-hydration intervention program on agro-industrial worker productivity (E. Hansson) • The CHAMNHA project: A behavior change intervention to reduce the adverse health impacts of heat on pregnant and postpartum women and neonates (M. Oguna) • Biological traits variability of schistosomiasis intermediate host snails (Bulinus and Biomphalaria) from three climatic zones of Côte d'Ivoire (N. R. Diakité) • Amplifying community voices: Sharing experiences on climate change and health (S. Myhre)
12:30-13:30	LUNCH

Time/room	Main room | B1-2	Parallel room | C1	Parallel room | C2	Parallel room | C3
13:30-15:00	Oral 5: Health impacts of heat stress *Chair: K. Aunan (NOR), S. Hajat (UK)* • Regional variation in the role of humidity on city-level heat related mortality (M. Mistry) • Ambient temperature exposure and foetal size, foetal growth, and birth outcomes in three European birth cohorts (E. Essers) • High and low temperature during pregnancy and childhood and brain structural connectivity in children (L. Granés) • The effect of heat on daily mortality in 10 cities in India (J. De Bont) • Integrating adaptation scenarios informed by SSPs in projecting temperature-related mortality burdens under climate change: a case study in Scotland (K. Wan) • Exploring the associ-ation between drought and mortality in South Africa (C. Salvador)	Oral 6: Inequities in climate change impacts and health risks *Chair: L. Mabile (FRA), G. Sandanger (NOR)* • Advancing the right to health in planetary health (K. Khanna) • Unraveling the social determinants of climate impacts on mental health: An ethnographic study in two vulnerable Bangladeshi communities (J.-M. Goudet) • Extreme urban heat increases death in drug overdose: Predictive modeling, Phoenix, USA (P. Moseley) • Modelling vulnerability to heat stress: transdisciplinary research on heat-related risks for human health in cities (I. Marginean) • Ambient temperature and cardiovascular-respiratory adverse health outcomes in Spain (H. Achebak) • Case study on a wintertime slip injury in Helsinki – Inequity perspective (R. Ruuhela)	Oral 7: Climate resilient health systems *Chair: S. Kovats (UK), J. Guo (SWE)* • Evaluating wildfire risk against hospital facility location: a perspective to inform health facility resilience globally (K. Humphrey) • Developing a Theory of Change for “net zero” healthcare at sub-national level in Europe through stakeholder engagement (O. Zotova) • Breaking down the WHOs climate change and health assessment framework to a regional level – First results of a systematic vulnerability assessment (I. Horváth) • Climate change and public health: barriers and levers for implementation of climate adaptation in Europe (Qualitative thematic analysis) (G. Turner) • Effects of ambient temperature on preterm birth, stillbirth, and low Apgar score in South Africa: A case-crossover analysis (C. Part) • Challenges and opportunities for climate change and health policies & financing in the African region (V. Pagiwa)	Oral 8: Climate hazards and population exposure *Chair: M. Jevtic (SRB), H. Orru (EST)* • High-resolution projections of ambient heat for major European cities using different heat metrics (C. Schwingshackl) • The burden of temperature-related neonatal deaths attributable to climate change in 29 Low- and Middle-income countries (A. Gasparrini) • Recent extreme heatwaves are dwarfed by projected future events (P. Aglas-Leitner) • Mortality due to extreme temperatures in South Korea by SSP scenario (H. Kim) • Projecting future temperature-mortality impacts under various population and climate change scenarios; the role of population development (E. De Schrijver) • Temperature modifies the association between air pollution and respiratory disease hospitalisation in an industrial area of South Africa (J. Wichmann)
15:00-15:30	COFFEE BREAK			

Time/room	Main room | B1-2
15:30-16:45	Health impacts of climate change: A way forward with the Climate-Health Cluster *Chair: R. Preet (SWE)* Speakers/panelists: Marc Neumann (BlueAdapt project), C. Tonne (CATALYSE project), S. Blesic (CLIMOS project), S. Luchters (HIGH Horizons project), D. Jackson (HIGH Horizons project), J. Semenza (IDAlert project), S. Sabatino (TRIGGER project)
16:45-17:00	Conference closing

Time/room	Posters room | B3	
15:30-16:00	Poster discussion session 1: Health impacts of heat stress Chair: J. Guo 1. Impacts of ambient heat exposure on acute kidney injury (S. Hajat) 2. The cost of inaction: comparative projection of heat and cold-related mortality in 854 European cities under climatic and socio-economic scenarios (P. Masselot) 3. Heat and perinatal mortality: A time-stratified case-crossover study from 16 hospitals in Benin, Malawi, Tanzania and Uganda (J. De Bont) 4. Mortality burden due to heat during summer of 2022 in Switzerland: The contribution of human-induced climate change (A. M. Vicedo Cabrera) 5. Health risks of temperature variability on hospital admissions in Cape Town, South Africa (J. Wichmann) 6. UTCI trends in south-eastern Asia and its correlation with ENSO (J. Eggeling) 7. Is the ICD-10 code T67 “heatstroke and sunstroke” a reliable indicator for heat morbidity? (K. Brugger) 8. Association between short-term increases in ambient temperature and hospital admissions in Copenhagen, Denmark (M. Bergmann) 9. Calculating Wet Bulb Globe Temperature within non-urban environments in the Community Land Model 5 (J. Buzan) 10. Australian heatwave related mortality attributed to climate change (N. Osborne) 11. Municipality assessment of temperature-related mortality risks in Norway (L. Vázquez Fernández) 12. Opportunities and barriers for occupational heat stress prevention implementation among sugarcane workers – An Interpretative Phenomenological Analysis (F. Pacheco-Zenteno)	Poster discussion 2: Climate change health impacts and transformation of disease patterns Chair: H. Sjödin 1. Early warnings for Malaria incidence using climate variables in Mozambique (C. J. Armando) 2. Impact of climate change on prevalent diseases: vulnerability and fragility in health (D. D. Juanola) 3. Estimation of the carbon footprint of tuberculosis diagnosis and treatment in India (M. Martins) 4. How do extreme heat events alter the efficacy of human entero-viruses found in the intertidal zone (J. Kevill) 5. Association of daily temperature with suicide mortality: a comparison with other causes of death and characterization of attenuation across 5 decades (R. Slama) 6. Heat stress and preterm birth – Results of the Mid German climate preterm birth study (Y. Heimann) 7. Climate change and health effects during pregnancy, delivery and postnatal period: a scoping review (A. Sturm) 8. Increased late preterm birth risk and altered uterine blood flow upon exposure to heat stress (E. Schleußner) 9. Short-term effects of extreme temperatures on cause-specific mortality in Italy. Results from the BIGEPI project (C. Di Blasi)

Time/room	Posters room | B3	
16:00-16:30	Poster discussion 3: Perception, communication and partnership on climate change and health Chair: M. Stackpole Dahl 1. Education on climate change and health – the ENBEL library (T. Veber) 2. Mapping evidence and gaps for links between air pollution and children's health (F. Beyer) 3. Heat Stress: a primer for maternal and perinatal health (C. Brimicombe) 4. Risk assessment and mapping of heat-related impacts on public health in an urban area (R. Bojariu) 5. Transdisciplinary research and action in climate and health in Latin America and the Caribbean: A network analysis (Y. P. Silva) 6. Communicating climate change through visual metaphors: costs and benefits (B. Scalingi) 7. Awareness, perception, commitment and expectations in terms of initial training on climate change among French health students (V. Migeot) 8. Human health impacts of climate change: a global scoping review (J. Limaheluw) 9. Climate change and respiratory health: A European Respiratory Society position statement (Z. Andersen) 10. Climate change and health: a call for papers on implementation research in low- or middle-income countries (M. Chersich)	Poster discussion 4: Inequities in climate change impacts and health risks Chair: G. Sandanger 1. Countrywide analysis of heat- and cold-related mortality trends in the Czech Republic: growing inequalities under recent climate warming (T. Janoš) 2. Exploring climate-related health risks and behaviors among vulnerable populations in Israel: The cases of Jewish and Bedouin Negev desert residents (M. Negev) 3. Insights into holistic approaches of climate change and social inequalities in health: A scoping review (L. Mabile) 4. Quantifying intra-urban socioeconomic and environmental vulnerability to extreme heat events in middle-income African countries (T. Govindasamy) 5. What role does the inequity of climate change impacts play in the revival of the global health policy framework? (K. Mansoor) 6. The effects of diurnal temperature range on mortality and emergency presentations in Victoria, Australia: A multi-strata study (N. Osborne) 7. Climatic impacts on mortality variability in pre-industrial Sweden (T. T. Chen) 8. Climate change: An overlooked threat multiplier for drowning (R. Sindall) 9. Manual labour in an increasingly hot climate: Workplace regulations influence physiological workload and heat stress in industrial sugarcane workers (B. Skinner) 10. Occupational injuries and heat in the Italian agricultural sector (C. Di Blasi) 11. Impacts of land cover changes on heat stress and human health (K. Aunan)

Time/room	Posters room | B3	
16:30-17:00	Poster discussion 5: Climate resilient health systems Chair: S. Hajat 1. Healthcare seeking behaviour for children under 5 with febrile illness in Malawi and Rwanda: the impact of drought (K. Khanna) 2. Planetary health education in medical schools in Germany: Perspectives of medical students participating in the cross-sectional PlanetMedEd Survey (S. B. Jabakhanji) 3. Fostering climate literacy in health professions to tackle future climate challenge (K. Brugger) 4. Barriers and motivational factors for implementing climate change mitigation measures in Austrian healthcare facilities (F. Durstmüller) 5. Sustainable solutions in climate action – The role of medical doctors (M. Jevtic) 6. How governance structures support the transformation towards climate resilient and sustainable net zero health systems (E. Weimann) 7. Measuring the effects of climate change on social determinants of health: Two assessment and documentation tools (P. Saberi) 8. Barriers and opportunities for transdisciplinary research and action in climate and health in Latin America and the Caribbean (Y. P. Silva) 9. Sustainable cooling strategies for mitigating heat stress and thermal strain in Bangladeshi ready-made garment factories (J. Smallcombe)	Poster discussion 6: Climate, heat, and air quality interactions on health Chair: H. Orru 1. Effects of regional meteorological and air conditions on community-acquired pneumonia patients with pre-existing COPD and asthma (A.-C. Link) 2. Spatiotemporal variations of the short-term association between ambient particulate matter and suicide in Finland: a nationwide epidemiological study (Y. Kim) 3. Urban heat and pollution island in global cities (S. Chowdhury) 4. Local approach to estimating the attributable burden of disease: A case study for air pollution and mortality (A. Pauwels) 5. Environmental and social inequities in continental France: An analysis of exposure to heat, air pollution and lack of vegetation (L. Adelaide) 6. Interventions to safeguard maternal and newborn health from extreme heat and air pollution: a mapping of the literature (F. Conway, R. Barrett) 7. Longitudinal associations between daylight exposure during winter months and self-reported mental health (A. Raza) 8. Solar-radiation management scheme by using aluminum oxide poses a severe risk to global mental health (G. Ghirga) 9. Copernicus Health Hub: Access by the health community to the environmental data from Copernicus Program (J. Letertre) 10. An approach to track clean air health benefits of climate action (G. Thurston) 11. Microplastics drive a pro-inflammatory response in immune cells (B. Liu)

ORAL PRESENTATIONS

ENBEL Symposium: Stakeholders and knowledge translation, and Climate-Health Africa Network

Public health adaptation to heat and concomitant environmental risks in Europe. Results from the ENBEL project GAP Analysis

Francesca de'Donato[1], Elena Mazzalai[1], Manuela De Sario[1], Grace Turner[2], Julian Natukunda[2], Zuzana Nordeng[3], Kristin Aunan[4], Sari Kovats[2]

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Keywords: heat waves, adaptation, air pollution, public health, vulnerability

Introduction: Climate change is increasing the frequency and intensity of extreme events like heatwaves, wildfires and droughts and Europe is among the most affected areas globally. Within the ENBEL project, a GAP analysis was carried out to provide evidence on vulnerability factors of concomitant environmental risks during heat waves and promote the implementation of public health response. The aim of the work was to:

1. summarize and provide start-of-the-art evidence on vulnerable groups to heat wave and co-exposures (air pollution, wildfires and drought) and
2. assess the level of implementation and response actions
3. to identify gaps and needs for public health adaptation in Europe.

Methods: A scoping review was performed to identify clinical and social vulnerabilities to heatwaves and concomitant exposures and prevention measures in place. Following a stakeholder analysis carried out in Europe a climate change adaptation within ENBEL, interviews with key stakeholders were carried out to provide additional information on response measures addressed to vulnerable groups as well as identifying needs and gaps for adaptation. Furthermore, an assessment of how Covid-19 recovery plans and funding across Europe are supporting climate adaptation and health care resilience was carried out through a document review and follow-up questions were also included in the interviews.

Results: From the literature review, common vulnerability factors both in terms of chronic illnesses, demographic factors and area-level factors were identified for the different environmental exposures in study. This aspect is important when designing awareness campaigns and response plans in public health. Interventions mainly focused on outdoor workers and athletes, include guidance, plans and actions on hydration, rest in the shade, cooling clothes and food, as well as acclimatization procedures. The elderly is among those consistently targeted in heat prevention plans, with health and social care surveillance, tele-medicine and awareness campaigns carried out during summer in several high-income countries. Regarding multiple environmental exposures, studies on preventive measures are scarce, and stakeholders reported the need for further research, sharing of knowledge and evaluation of measures to enhance action. To a limited extent European and national Covid-19 recovery funding are perceived as an opportunity for climate change adaptation. Better collaboration between sectors and an evaluation of funding and resources for health care services can help understand the indirect benefits for climate resilience.

Conclusions: Considering future climate change impacts, it is crucial to enhance adaptation of the public health sector. Key barriers to climate adaptation in terms of limited resources, personnel capacity; governance constraints and unclear policy remit still remain. Collaboration across sectors and policy levels is vital to enhance use of resources and promote action.

Vulnerability to heatwaves and other environmental co-exposures: a scoping review of prevention programs and interventions within the ENBEL project

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Keywords: climate-change, public health prevention plans, vulnerable population, heatwaves

Introduction: Climate Change (CC) is enhancing the occurrence of extreme events, such as heatwaves, drought and wildfires. The health effects of their interaction, together with air pollution, depend on individual and area-level vulnerabilities but also on the awareness and preparedness of communities. Within the ENBEL project, a review was carried out to summarize scientific evidence on public health preventive measures specifically addressing vulnerable populations, considering exposure to heat and other environmental co-exposures.

Methods: A scoping review was performed on Medline and Embase (Ovid) through search terms focused on clinical and social vulnerabilities, health outcomes like morbidity, mortality and hospitalization, heatwaves, drought, air pollution, wildfires, and response measures and plans. Articles published between 2000 and 2023 in English language were included and screened according to PRISMA guidelines.

Results: 3806 records were screened after duplicate removal. 75 full texts were assessed for eligibility, 21 of which were included in the qualitative synthesis. Articles describing theoretical plans, providing generic recommendations, or not targeting vulnerable groups were excluded. 15 studies considered actual interventions and focused mainly on workers of agricultural, healthcare or waste management sector, and on athletes. The interventions on workers took place in Florida, Nicaragua, El Salvador, Greece, Spain and Qatar, while those on athletes considered football players in the United States. The role of hydration, rest in the shade, the use of clothes made of cooling material, consumption of cold beverages and food, and the compliance with acclimatization procedures were highlighted for both groups as key factors to reduce heat-related illnesses. The guidelines on acclimatization strategies to work or train in the heat and on actions to reduce heat stress provided by the National Institute for Occupational Safety & Health and the National Athletic Trainers' Association were deemed to be effective. The education programs for healthcare professionals working in emergency departments to identify and treat heat emergencies improved the accuracy in diagnosis and management of patients with heat-related conditions. Another study evaluated an intervention to strength the community networks of the elderly, either socially isolated or sick, through periodic assessments of their needs during heatwaves by phone calls or home visits, the involvement of neighbours in volunteer care actions and the improvement of the community awareness. These approaches seemed to have contributed in reducing the heat-related mortality of the target population. The local prevention plans came from high-income countries and were often focused on the elderly. They showed a possible role of education and information tools in reducing heat-related deaths. For institutionalised people, cooling measures at institution level seemed more effective to protect the residents than those at individual level. Regarding co-exposures, studies on preventive measures are scarce.

Conclusions: These findings provide limited evidence on the effectiveness of preventive measures aimed at protecting vulnerable subgroups from heat-related health effects. The current interventions concentrate on workers and specific type of athletes. A lack of local heat health prevention plans coming from low- and middle-income countries emerges. The present study can help orienting the public health agenda and research priorities on CC adaption measures.

Climate services for heat-health adaptation: costs, benefits, and societal implications

Shilpa Rao[1], Isabelle Budin-Ljøsne[1], Prayash Chaudhary[1], Matthew Chersich[2], Franscesa De'Donato[3], Susan Sitoula[4]

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Keywords: climate services, heatwave warning system, economic assessment, sustainability

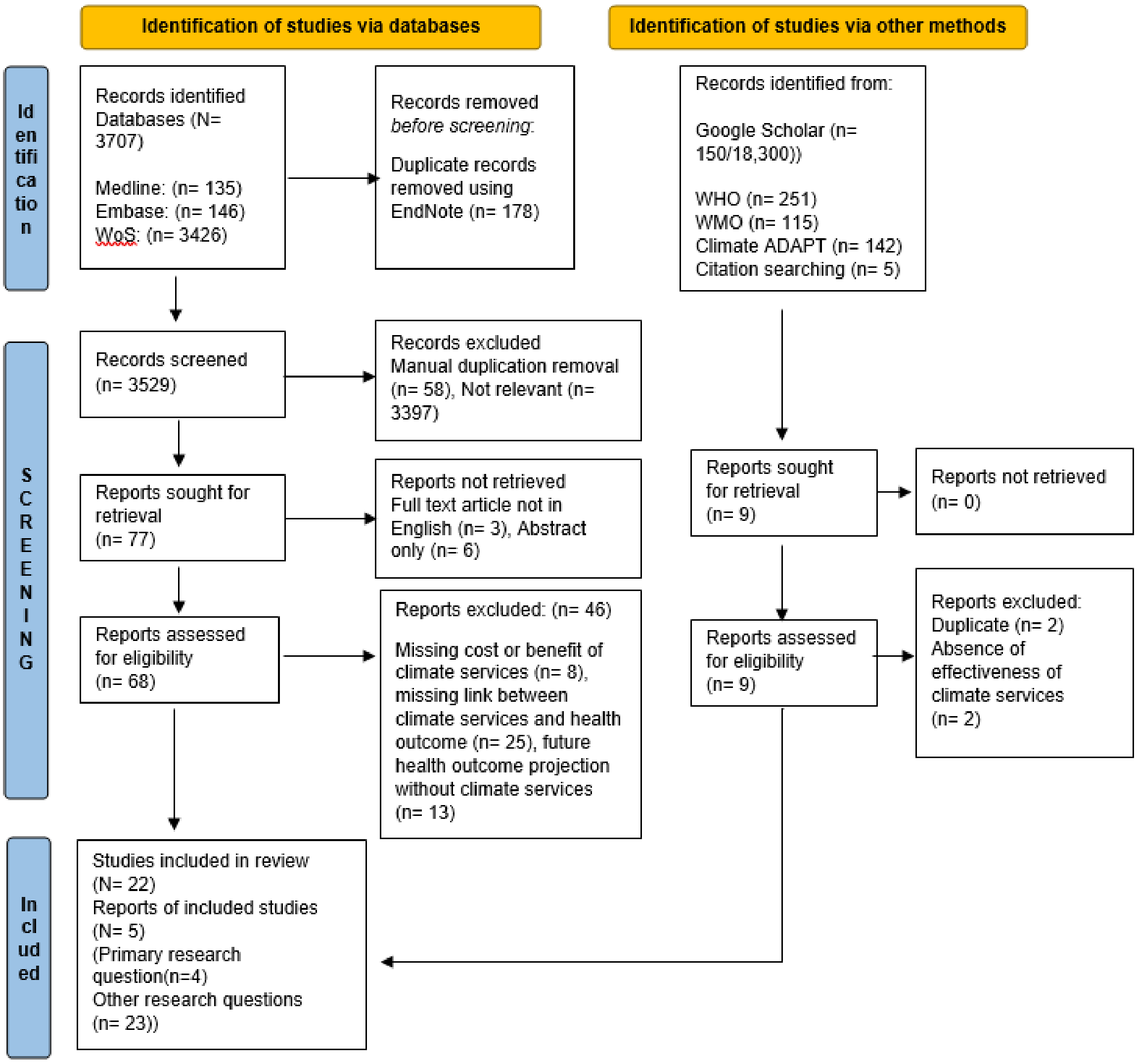
Introduction: Climate services aim to support informed climate decision-making and enable early action and preparedness. The development of heat-health early warning systems (HHEWS) while using climate indices relevant to health outcomes is one of the most notable examples of collaborative activities between the meteorological and health communities and are prerequisites for the effective delivery of climate services for health. However, the use and impact of climate services for health care/public health preparedness and response remains unclear. More knowledge is needed regarding the costs and benefits of climate services for health, as well as effectiveness, and technical, structural, and societal barriers and facilitators to implementation and use. This study aimed to map the evidence on the economic assessment and use of climate services for health in reducing heat-associated mortality and morbidity, and explore the societal impact of climate services, particularly in Europe and Africa.

Methods: We focus on two methods: 1) a scoping review of literature on the economic assessment and health benefit of climate services for heat-health adaptation. Three databases: Medline (Ovid), Embase (Ovid) and Web of Science were searched for peer reviewed journal articles. Sources of unpublished studies/ grey literature were searched in WHO Institutional Repository for Information Sharing (IRIS), the WMO website, the Climate Adapt website, and Google Scholar. 2) a set of interviews with climate service developers and providers in Europe and Africa to understand further technical and societal aspects as well as evaluation of such services.

Results: A total of 27 peer-reviewed articles all presenting HHEWS that work on a weather and short-term forecast timescale were identified. Twelve studies were carried out in Europe, 9 in North America, 2 in Australia and 4 in Asia. Four studies presented an economic assessment and other 23 studies reported changes in health outcomes or changes in healthcare services utilization after heat warning or implementation of heat warning systems and heat action plans. The results from 2 economic assessment studies suggested that operational HHEWS can be cost-effective producing benefit-cost ratio greater than 1. Other 2 studies using climate change projection concluded HHEWS to be a 'no/low regret adaptation'. While most of the studies assessing health, outcomes have suggested that HHEWS can help in reducing heat-related mortality and morbidity, some concluded no significant impact on mortality or morbidity and some suggested increased healthcare services utilization after implementation of HHEWS.

The finding from the interview identified challenges such as lack of long-term and reliable funding, difficulties in making the weather and climate data relevant, comprehensible, and accessible to different end-users, cultural differences between climate and health professionals, and limited ability to assess the services' real impact, although the services were believed to improve preparedness in the case of heat-related events.

Conclusions: Climate services for health such as HHWS can be cost-effective and effective in reducing heat-related mortality and morbidity. Mechanisms are needed, which support more thorough evaluation of public health plans and actions related to weather and climate services to maximize impact.



Implementation of adaptation in the health sector in Southern and Eastern Africa

Julian Natukunda[1], Caradee Wright[2], Grace Turner[1], Francesca de-Donato[3], Vincent Pagiwa[4], Caroline Muthoni[5], Shaban Mawanda[6], Shakoor Hajat[1], Sari Kovats[1]

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Keywords: climate change, health adaptation priorities, climate adaptation policies, developing countries

Introduction: Many countries in Africa are likely to experience an aggravated impact of climate change on infectious diseases and other climate-sensitive health illnesses and outcomes. Adaptation planning in the health sector is necessary to increase resilience. Several African countries are developing national policies that include health adaptation priorities – others have developed adaptation plans specific to the health sector. Evidence is scarce regarding how health is addressed in current policies, and the level of implementation of health adaptation response measures. The aim of this study is to identify health adaptation priorities in East and Southern Africa; map stakeholders working on climate and health adaptation, their interlinkages and evidence needs; and identify the key factors influencing climate and health adaptation.

Methods: Key informant interviews were conducted with 16 stakeholders in five countries between July and September 2022 using a WHO stakeholder analysis framework. The stakeholders included environmental experts/officers, health adaptation leaders, public health experts, representatives from NGOs and networks supporting health adaptation and climate justice, as well as academics and researchers. In addition, the adaptation policies, and strategies of 14 countries in East and Southern Africa were reviewed, including national/health adaptation plans, climate change and response strategies, and nationally determined contributions. A thematic analysis was conducted using NVivo software to identify factors that influence climate-health adaptation in the region.

Results: Six themes emerged from the interview responses regarding implementing capability for adaptation strategies. The themes include power and mandate of health adaptation institutions, the formation of partnerships, the presence of departments and multidisciplinary working groups, the policy environment, the COVID-19 response, and the availability of resources (finance, information, and human resources). Evidence needs identified were: the need to improve access to local/regional climate and health research, to conduct health risks and vulnerability assessments, and to develop national adaptation plans for health.

Analyses of adaptation strategies and plans found that:

- Health is recognized as a vulnerable sector in all countries, and in all recent national adaptation strategies or plans

- A few countries (4/14) had prepared health sector-specific national adaptation plans or conducted health risk and vulnerability assessments (5/14)
- There were no policies targeting extreme heat's effects on health, and only one country has a national heat health action plan
- Infectious disease prevention and control are the focus of health adaptation strategies, but disease-specific adaptation strategies are lacking

Conclusions: Policy development on climate-health adaptation is increasing in Eastern and Southern Africa, and it is well understood from both an environmental and a public health perspective. Adaptation support should focus on developing disease-specific adaptation strategies, heat-health plans, and identifying additional funding mechanisms.

Advancing climate change & health agenda in Africa through networking

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Keywords: climate change, climate adaptation and mitigation, evidence to decision, health policy, Africa

Introduction: Global temperatures have already increased by over 1.2°C, resulting in significant health implications, such as cardiovascular and respiratory challenges, poor nutrition, and mental health issues, and a rise in infectious diseases. Many effects of current climate change shocks are expected to occur over time, with disproportionate effects on the most vulnerable populations. If no additional actions are taken, substantial increases in morbidity and mortality are expected over the coming decades, potentially causing breakdowns in health systems especially in resource constrained nations. Building more resilient health systems can create communities resilient to the impacts of climate change and reducing greenhouse gas emissions have many co-benefits for improving health outcomes. Thus, it is imperative that people working on climate or health issues work together, coordinate, and develop new ideas together. The Horizon 2020 project ENBEL (Enhancing Belmont Research Action to support EU policy making on climate change and health), facilitates these interactions and creates greater coherence between these sometimes-siloed communities of practice. In Africa, ENBEL established the Climate Health African Network for Collaboration and Engagement (CHANCE Network) - which facilitates interactions between policy makers from East and Southern African countries, representatives of international organisations, funders, researchers, and WHO to harness synergies between climate change and health. To achieve this, the CHANCE Network conducts bi monthly virtual webinars, side events at scientific conferences and yearly international onsite workshops. This paper aims to review the current knowledge base on climate action and health policymaking in Africa, identify policy gaps, and opportunities for action - based on experts' perspectives.

Methods: This is a qualitative study based on expert perspectives and workshop proceedings. The ENBEL project through the CHANCE Network organised a workshop in Pretoria in June 2022 and hosted a side event at the WHO Health Pavilion at the COP 27 in Sharm El Sheikh, Egypt. Presentations on advancing climate change and health agenda in Africa were made at both events; 55 participants consisting of policymakers, international researchers and public health experts participated at the Pretoria conference and 6 in a panel discussion at COP 27 in Egypt. Presentation recordings were transcribed and thematically analysed by the CHANCE members.

Results: Data analysis is on-going and the final results will be discussed at the symposium.

Conclusions: Preliminary results indicates that, as the climate change impact becomes evident in Africa, more capacity is needed to monitor health effects and inequities, evaluate adaptation and mitigation interventions, strengthen health systems resilience, translate research into effective policymaking and incorporate community traditional knowledge for effective early warning systems.

How are national infectious disease surveillance systems taking climate change into account? Gap analysis of health adaptation in Africa

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Keywords: climate change, public health surveillance, health adaptation, infectious diseases

Introduction: Climate change will adversely affect health and well-being in Southern and East Africa, including an increase in infectious diseases. The future burden of climate-sensitive diseases and conditions will depend on adaptation efforts and the effectiveness of public health systems. Most countries in the region have prioritised strengthening surveillance systems as a key health strategy to address climate change in their national and health adaptation plans. It is; however, unclear how disease-specific and national programs are collaborating with the climate community (including national weather services) and integrating climate information into public health surveillance activities. ENBEL is conducting gap analyses to evaluate the implementation of climate-related measures within national surveillance systems that could be considered "adaptation", to identify gaps in implementation and knowledge to support future decision-making.

Methods: The study uses an exploratory qualitative approach. Literature reviews (evidence and document reviews) are being conducted to gain a better understanding of the tools and methods used to integrate climate information in public health surveillance in the region. Primary data will then be collected using semi-structured interviews. We will identify key informants – stakeholders who oversee or are involved in implementing climate change and health-related activities. Recruiting participants for the study will be done through existing professional networks and snowballing. Organisations identified in the literature/document review will be contacted as well. The participants will answer questions about the organisation/institutional surveillance capabilities, the implementation of integrated systems (barriers and facilitators), the flexibility and adaptability of surveillance systems, collaboration with other stakeholders and the national weather service, and their future needs. A descriptive summary will be used to present the results of the literature and document review. A transcription software program (www.happyscribe.com) will be used to convert interview responses (audio recordings) into text. Key themes will be identified through thematic analysis using NVivo.

Results: This study is in progress and results will be presented and discussed at the conference.

Conclusions: This study will draw evidence from the syntheses to generate policy advice relevant for stakeholders, practitioners, and researchers at the international, regional, national, and local levels to make evidence-based decisions and decide the best action to reduce climate change-related health impacts, particularly infectious diseases.

Oral 1: Climate change health impacts and transformation of disease patterns

El Niño and epidemic malaria in Ethiopia: a new climate tool to enhance malaria surveillance and response

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Keywords: El Niño, epidemic malaria, surveillance, ENACTS, Ethiopia

Introduction: Malaria is a priority public health concern for more than half of the population of Ethiopia. Malaria transmission is mainly seasonal and unstable with a high propensity to epidemic occurrence under anomalous weather and climate conditions. Technical failures in control measures coupled with climate variability and change can also facilitate the resurgence of malaria making enhanced malaria surveillance, through the use of climate information combined with parasite and vector monitoring, essential. Following the committed high-level demand for quality climate data from the health sector in Ethiopia, the National Meteorological Agency (NMA) or currently Ethiopian Meteorological Institute (EMI) in partnership with International Research Institute for Climate and Society (IRI) has worked to improve the availability, access, use and interpretation of climate information through an initiative called "Enhancing National Climate Services" (ENACTS). Upon demonstrating the functionality of ENACTS in Ethiopia, the approach has been expanded to more than a dozen countries in Africa and beyond. In the case of Ethiopia and since the early 2000s, the country's malaria program has had a strong collaboration with the NMA not only for discerning the influence of climate on epidemic malaria but also in focusing on improving the NMA's infrastructure to advance its service and sharing climate information for informed action. In 2014 malaria and climate community agreed to work together to create advisory information targeted to the projected 2015 El Niño event. However, there was limited evidence related to the influence of the El Niño Southern Oscillation (ENSO) on epidemic malaria in Ethiopia. Investigation into the historic association of ENSO events and recorded malaria epidemics across Ethiopia was made using ENACTS.

Methods: The geographic location, extent, and timing of onset, peak, and offset of local and widespread epidemics were extracted from peer review and grey literature and matched with concurrent ENSO phases and climate conditions prior to or during the epidemic period.

Results: Thirty-six epidemic malaria events in Ethiopia were identified from 31 publications and reports. Of the 19 epidemic/outbreak events classified as widespread 10 were associated with years

classified as El Niño; two with La Niña; one with Neutral years; and two with ENSO periods (Table 1). Widespread epidemics mostly occur following the July-Sep rainy season and are often associated with increased rainfall, higher temperatures, and El Niño. This exploratory analysis was undertaken using authoritative, publicly available, information on ENSO phases from the NMA ENACTS database and Maproom and information on recorded malaria epidemics from varied peer review and grey literature sources. The epidemic reports indicate that both local and widespread epidemics usually follow the Jun-Sep Kiremt rainfall season.

Conclusions: This study reiterates the complexity of the Ethiopian climate and its relationship with the ENSO phase, which varies by climate variable, region, and season. Combined with political instability and declining investments from international donors, climate-related risks to malaria (and other climate-sensitive health outcomes) is a concern. Moreover, projected warming trends and fluctuation of rainfall should alert malaria control managers to the likely climate risks to achieving malaria elimination by the end of this decade.

West Nile Virus infection in Europe: a case-crossover study on the short-term effect of meteorological parameters

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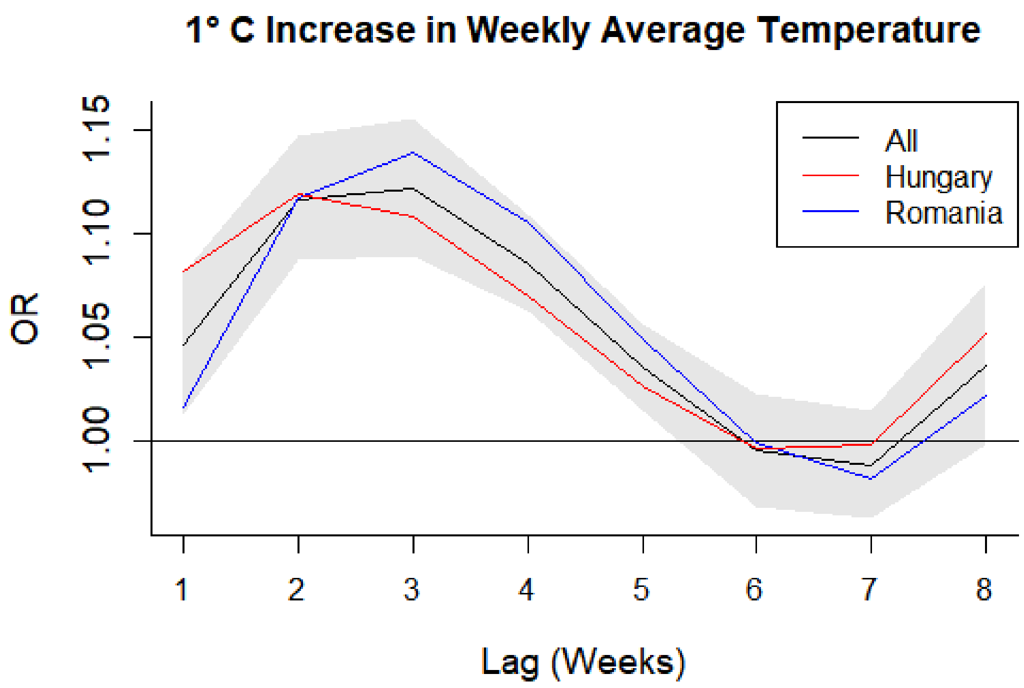
Keywords: West Nile Virus, meteoclimatic determinants, Short-term effects, Early Warning Systems, One Health

Introduction: West Nile Virus (WNV) is a mosquito-borne human pathogen that can cause a potentially fatal disease known as West Nile Neuroinvasive Disease (WNND) in ~1% of infected individuals. In Europe, human cases of WNND are reported each year during the summer and autumn. Previous studies have suggested that seasonal average temperatures can significantly influence the annual probability of WNV outbreaks between different countries. However, the short-term ("within year") effect of meteorological parameters on the incidence of human cases has been less studied. Analysis of short-term effects can provide useful information on the intra-seasonally delayed (lagged) effect of meteorological parameters on the number of human cases of WNV. The aim of this study is to identify the potential role of temperature in triggering WNV infection cases recorded in Romania and Hungary, the two Central European countries most affected by WNV outbreaks.

Methods: Human cases of WNND reported in Romania and Hungary between 2013 and 2018 according to national surveillance activities were obtained from ECDC (European Centre for Disease Prevention and Control) based on day of diagnosis/symptom onset and province of residence. Daily mean temperature data were obtained from high-resolution Copernicus gridded satellite data with a resolution of 10 x 10 km. To estimate the association between (lagged) weekly mean temperature and WNND cases, we used a time-stratified case-crossover study design. For each case, we selected 3 to 4 control periods before and after the index time matching by province, year, calendar month and day of the week to adjust for potential time trends and seasonality. We used conditional logistic regression to compare the average weekly temperature in the 8 weeks before the index time with the temperature in the 8 weeks before the control period. We explored the exposure-lag-response relationships by fitting distributed non-linear models (DNLMs), modelling the temperature effect with a linear function and the lag effect with a cubic polynomial function.

Results: In Hungary and Romania, 853 cases of WNND were observed between 2013 and 2018. We found an association between WNND cases and temperatures recorded 1 to 4 weeks before the date of symptom onset. The highest effect was observed for temperatures recorded 2-3 weeks before the date of symptom onset (odds ratio (OR) for 1 °C increase in weekly average temperatures at lag 2: 1.11, 95% CI: 1.08-1.16; OR for 1 °C increase in weekly average temperatures at lag 3: 1.12, 95% CI: 1.09-1.17). The overall cumulative effect of a 1°C increase in weekly average temperatures, i.e. the sum of each specific lag contribution over the whole analysed lag period (8 weeks), was 1.50, 95% CI: 1.34-1.67. The analysis stratified by country showed similar results.

Conclusions: Increased temperatures show a lagged effect on the incidence of WNND infection. Climatic parameters may be useful to inform early warning systems to identify areas and time periods at higher risk of WNV outbreaks. As this is based on an ongoing study, the analyses will be extended to other European countries, and the results will be updated as more data become available.



European projections of West Nile virus transmission under climate change scenarios

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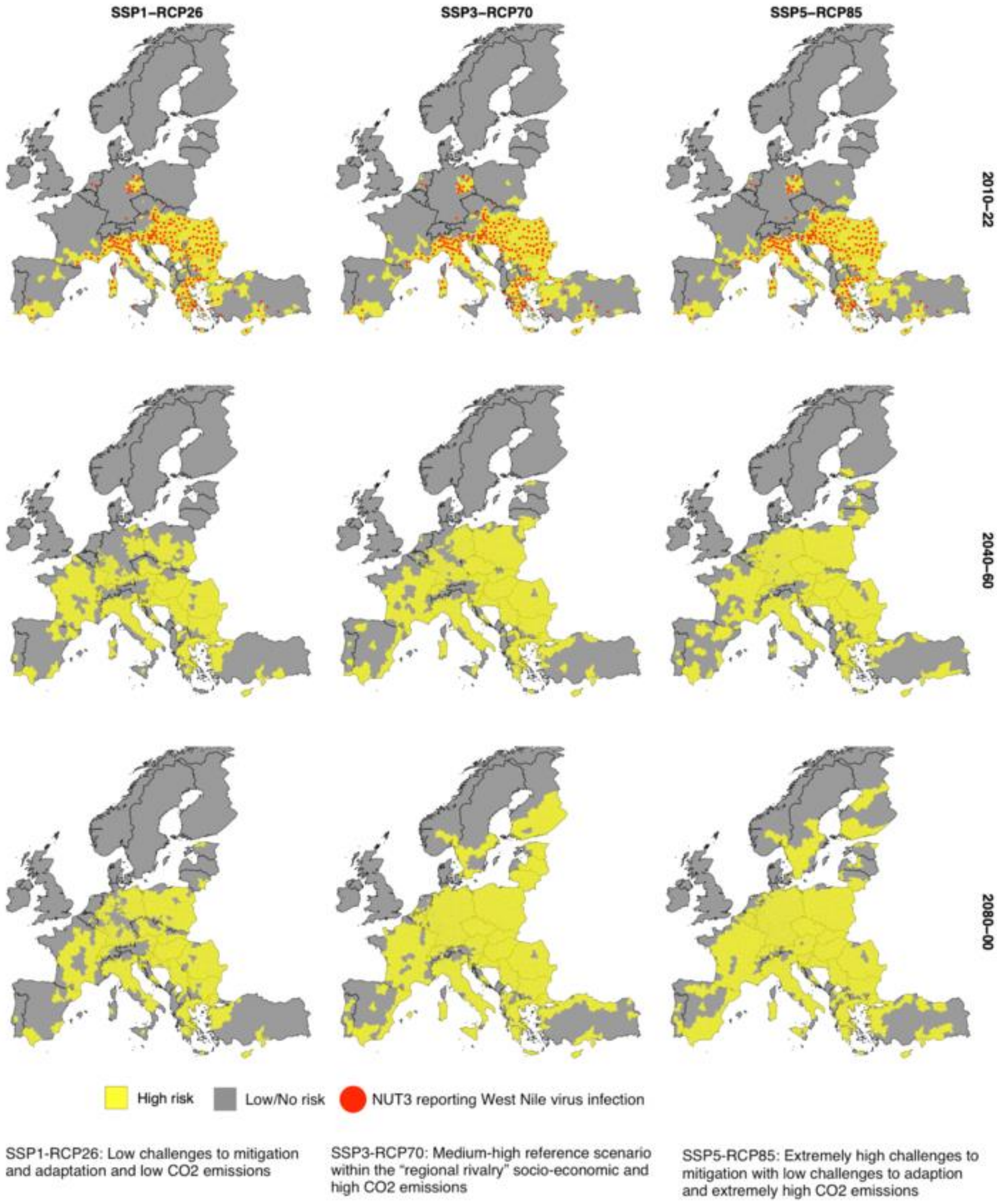
Keywords: West Nile virus, XGBoost, WNV risk projections, climate change, CBPE method

Introduction: West Nile virus (WNV), a mosquito-borne zoonosis, has emerged as a disease of public health concern in Europe. Recent outbreaks have been attributed to suitable climatic conditions for its vectors favouring transmission. However, to date, projections of the risk for WNV expansion under climate change scenarios are lacking. Here, we estimate the WNV-outbreaks risk for a set of climate change and socioeconomic scenarios. We delineate the potential risk-areas and estimate the growth in the population at risk (PAR).

Methods: We used a supervised machine learning classifier, XGBoost, to estimate the WNV-outbreak risk using an ensemble climate model and a multi-scenario approach. The model was trained by collating climatic, socioeconomic, and reported WNV-infections data (2010-22) and the out-of-sample results (1950-2009, 2023-99) were validated using a novel Confidence-Based Performance Estimation (CBPE) method. Projections of area-specific outbreak risk trends and corresponding PAR were estimated and compared across scenarios

Results: Our results show that the risk of the virus is projected to increase by 0.3 to 5-fold depending on the geographical region and climate scenario during 2040-60 when compared with 2000-20. Resultantly, the current proportion (15%) of disease-reported European land areas, the geographical areas at risk could increase to 23% to 30% and the population at risk increase to 161 to 244 million, depending on climate scenarios during the same period.

Conclusions: Across scenarios, Western Europe appears to be facing the largest increase in the outbreak risk of WNV. The increase in the risk is not linear but undergoes periods of sharp changes governed by climatic thresholds associated with ideal conditions for its vectors. Increased risk could have major impacts on adaptation requiring considerable public health responses to manage the expansion of WNV with climate change in Europe. These analyses show on the need for designing public health responses to adapt to the expansion of WNV with climate change in Europe.


SSP1–RCP26
SSP3–RCP70
SSP5–RCP85
2010–22
2040–60
2080–00
High risk
Low/No risk
NUT3 reporting West Nile virus infection
SSP1-RCP26: Low challenges to mitigation and adaptation and low CO2 emissions
SSP3-RCP70: Medium-high reference scenario within the "regional rivalry" socio-economic and high CO2 emissions
SSP5-RCP85: Extremely high challenges to mitigation with low challenges to adaption and extremely high CO2 emissions

Temperature around conception and metabolic health in adulthood: evidence from the UK Biobank

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Keywords: temperature deviations, metabolic health, epigenetic adaptation

Introduction: Global rising temperatures have been shown to be associated with various health conditions, such as respiratory and cardiovascular diseases. Moreover, animal studies and correlational evidence on humans have linked paternal cold exposure around conception to an increased amount of active brown fat in adult offspring, which is associated with improved metabolic outcomes. Since the prenatal environment co-shapes health along the life course via epigenetic adaptions, the question arises whether global rising temperatures have underestimated externalities for long-term health. However, causal evidence on humans is to date lacking.

Methods: We use UK Biobank individual-level health data on ca. 450,000 individuals born between 1934 and 1971. Metabolic health is measured in terms of anthropometric measures (BMI, waist circumference) and biomarkers for cardiovascular disease (HbA1c, total cholesterol and triglycerides). Periconceptional temperature exposure is defined as the deviation from the long-run historical temperature trend for an individual's place of birth and time period of the year during which the person was conceived. To exploit quasi-random variation in temperatures per location and provide causal estimates, we use region-by-month of birth fixed effects. Our regressions also control for sex, year of birth and year of assessment.

To calculate temperature deviations, we use weather station temperature recordings from MIDAS Open and calculate regional temperature trends. The period around conception – for which the temperature trends and deviations are calculated - is identified by calculating backwards from the exact date of birth of the study participants. We define the time around conception as the two weeks before conception. This is a critical time window for epigenetic modification in sperm cells, which happens during spermatogenesis and post-testicular maturation and thus before fertilization. In alternative specifications, we use wider exposure windows (e.g., 5 weeks before calculated date of conception to 3 weeks after conception), since the gestational age at birth is unknown in the UK Biobank cohort.

Results: Our findings show that individuals who were conceived when it was colder exhibit lower levels of triglycerides (-0.002, SE: 0.001) and cholesterol (-0.005, SE: 0.001). We do not find associations with BMI or weight circumference. When using wider exposure windows, the improved outcomes for triglycerides and cholesterol persist, and we also find that individuals with periconceptional exposure to colder temperatures have a lower BMI (-0.017, SE: 0.007) and waist circumference (-0.037, SE: 0.017).

Conclusions: This study provides first causal evidence on the link between temperature around conception and human metabolic health in later adulthood. The effect sizes appear to be small, however since we only look at the deviation from long-term temperature trends, our findings demonstrate that adulthood metabolic health is influenced by comparably subtle prenatal shocks. Since colder temperatures around conception are associated with improved metabolic health outcomes in adulthood, this protective effect may diminish as climate changes progresses.

Delayed effect of temperature and precipitation on Lyme neuroborreliosis incidence in Europe

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Keywords: INLA, DLNM, Europe, Lyme neuroborreliosis, Bayesian

Introduction: Lyme neuroborreliosis which is prevalent in Europe is a neurological disease transmitted by ticks. In this study, we assessed the association between temperature and precipitation on Lyme disease incidence while considering the delayed patterns.

Methods: We used daily reported Lyme disease data reported by ECDC between the years 2017 to 2020 for each country in Europe with data. The following countries in Europe were included: Czechia, Hungary, Poland, Slovakia, Denmark, Ireland, Norway, Britain and Italy. The daily data were aggregated to monthly totals. We then linked the monthly data by country to ERA5 mean monthly temperature and total precipitation. We also included annual population as denominator for the incidence rate computations. We used distributed lag nonlinear methodology in a Bayesian framework using INLA to model the monthly Lyme cases. Lyme cases we assumed to follow a negative binomial distribution. The Bayesian model included monthly random effect to adjust for season, country effect using exchangeable structure, the cross-basis terms for precipitation and temperature and an offset term for the population.

Results: Between 2017 and 2020, there were a total of 2698 cases of Lyme neuroborreliosis reported by ECDC in nine countries in Europe. The highest number of cases were reported in Czechia (895) with an incidence of 4.2 per 100,000 population, followed by Norway (740), rate of 4.6 per 100000 population. In Czechia, the highest number of cases were reported in 2019.Ireland reported the least number of cases. We observed significant association between mean monthly temperature and Lyme incidence, however there was no significant association between Lyme disease and precipitation. In comparison with reference mean monthly temperature of 10 °C, temperature above this reference were significantly associated with elevated risk of Lyme disease. For example, with a monthly mean temperature of 12.5°C,15.5°C, and 17.0°C, the risk increased by 10% RR=1.10 (1.01-1.19), 19% RR=1.19 (1.02-1.49) and 23% RR=1.23 (1.01-1.52) respectively at lag 0. Meanwhile temperatures below the reference value were significantly associated with low risk of Lyme disease, for example at lag 0 at mean monthly temperatures of 6.5°C we observed 14% reduction in risk RR=0.86 (0.75-0.99)

Conclusions: We observed significant delayed effect of temperature on the incidence of Lyme disease in Europe. The identified lagged association can be used to develop a climate driven early warning system with a lead time ranging from 1-3 months.

An extended One Health approach for analysing coastal pathogens and their drivers

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Keywords: biopsychosocial model, climate change, One Health, pollution, waterborne diseases

Introduction: Human life has changed radically in only a few millennia from kin-group based social interactions and deep connectivity to nature, to individualism, industrialisation, social media, and urbanisation. Connection to nature is crucially related to mental health and well-being as well as to physical health. Approximately 71% of the Earth is covered by sea saltwater, where approximately 50% to 80% of the planet's oxygen comes from; therefore, oceans are considered the aquatic lungs of the Earth. However, antimicrobial resistance, climate change hazards (e.g. drought, heavy precipitation, ocean temperature increase), environmental pollution, and land use and management are harming these lungs, and provoke cascading risks of waterborne and foodborne diseases due to coastal pathogens. Inland and coastal waters are reservoirs for faecal coliforms stemming from humans and domesticated animals. Subsequently, aquatic health as well as terrestrial health are negatively impacted by these coastal pathogens, being responsible for diseases that are transmitted by faecal-oral route. Thus, there is a crucial need of getting a better understanding of the relationships between pathogens, water, health, climate change, and other natural and anthropogenic perturbations. This research aims to develop a systemic holistic approach based on an extended One Health vision.

Methods: A multi-perspective review was conducted following a conceptual framework where the biopsychosocial model defined by Engel resurges. Mental, physical and social aspects are the pillars of Engel´s model, and the interconnection among them key for understanding health as a whole, and nature as the foundation while considering vulnerabilities and syndemics.

Results: Causal maps are developed based on a multi-perspective literature review, aiming at identifying how hazards related to climate change and environmental pollution interact to affect the health of humans and marine species through different pathways. These include interactions with the ecology and virulence of coastal pathogens, as well as other paths increasing exposure or vulnerability, such as behavioural changes, socio-economic inequalities, pre-existing comorbidities, and impacts on mental health.

Conclusions: Our analysis suggests the need for interdisciplinary approaches in order to identify synergies among multiple hazards, multiple exposure and multiple vulnerabilities towards a more holistic vision of prevention in line with an extended One Health.

Oral 2: Climate, heat, and air quality interactions on health

Small-area analysis of heat effect on mortality and effect modification by air pollution in Europe

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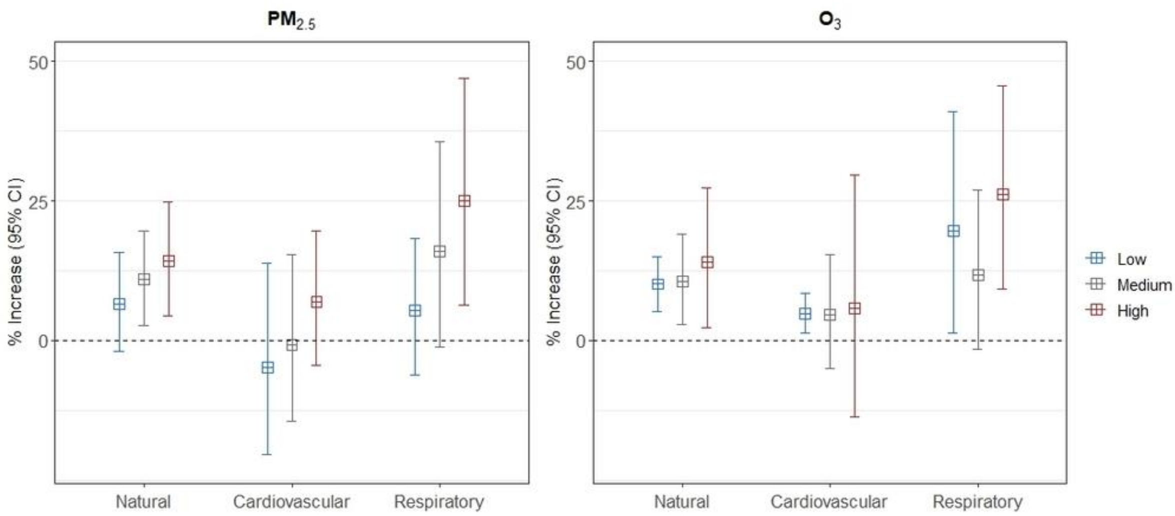
Keywords: air temperature, climate change, fine particulate matter, ozone, health impact

Introduction: Previous studies have reported interactive health effects of temperature and air pollution in large cities. However, evidence for heat effect modification by air pollution is inconsistent. Besides, few studies have included data from rural areas in analyses. In this study, we examined heat effects on cause-specific mortality and effect modification by ambient fine particulate matter ($PM_{2.5}$) and ozone (O_3) using national or regional data from five European countries.

Methods: We obtained daily numbers of deaths from natural causes, cardiovascular diseases (CVD), and respiratory diseases (RD) between 2000 and 2018 from Norway, England and Wales, Germany, Italy (only all-cause mortality), and the Attica region in Greece. The mortality data were aggregated at the level of small areas, defined as Lower Layer Super Output Areas in England and Wales, districts in Germany, and municipalities in other countries/regions. Daily mean air temperature and air pollutant concentrations were estimated by country-specific spatial-temporal models and were assigned to small areas. We applied over-dispersed Poisson regression models with a tensor smoother between air temperature and air pollution to analyse their interactive effects on mortality in warm months (May-September) for each small area. Two-day moving averages of the same- and the previous-day air temperature and pollutant concentrations were used. We extracted the temperature-mortality relationships at the low, medium, and high air pollution levels, defined as the 5th, 50th, and 95th percentiles of the small-area-specific air pollutant distributions, respectively, from the three-dimensional surface. Heat effects at each air pollution level were estimated for an increase in air temperature from the 75th to the 99th percentile of small-area-specific temperature distribution. Country-specific and overall heat effects across countries were pooled by random-effects meta-analyses.

Results: Heat exposure was associated with elevated risks for natural-cause and RD mortality. The overall percentage increases in natural-cause mortality associated with heat were 6.6% (95% confidence interval: -1.9%-15.8%), 10.9% (2.7%-19.7%), and 14.2% (4.5%-24.9%), respectively, at low, medium, and high $PM_{2.5}$ levels, and the estimates for RD mortality were 5.3% (-6.2%-18.2%), 15.9% (-1.1%-35.7%), and 25.0% (6.4%-46.9%), respectively. We observed a trend of stronger heat effects on CVD mortality at higher $PM_{2.5}$ levels, but the overall associations were non-significant. There was a suggestion of heat effect modification by O_3 on natural-cause and RD mortality, with estimates highest on days with high O_3 levels, whereas there was no difference between heat effects at medium and low O_3 levels.

Conclusions: Our study provides evidence for stronger adverse heat effects on mortality at higher levels of air pollution using small-area data from both urban and rural settings. The heat effect modification was more pronounced by $PM_{2.5}$ on natural-cause and respiratory mortality.



Modelling past and future air pollution levels over Europe and associated premature mortality under various emission scenarios

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Keywords: particulate matter, ozone, premature mortality

Introduction: The H2020 funded EXHAUSTION (Exposure to heat and air pollution in EUrope – cardiopulmonary impacts and benefits of mitigation and adaptation) project aims to develop exposure projections over Europe to investigate the relation between heat, air pollution and mortality.

Methods: We used three state-of-the-art chemistry and transport models (CTMs); the Danish Eulerian Hemispheric Model (DEHM), the Weather Research and Forecast model with Chemistry (WRF-Chem), and the System for Integrated modeLling of Atmospheric composition (SILAM), to simulate the ozone (O_3) and fine particulate matter ($PM_{2.5}$) surface levels over Europe in the period 1981-2050, under several future emission projections adopted from the Coupled Model Intercomparison Project Phase 6 (CMIP6). We will further use the Economic Valuation of Air Pollution (EVA) model to estimate the premature mortality due to exposure to O_3 and $PM_{2.5}$.

Results: Results showed that under the high emission mitigation scenario (SSP1-2.6), surface O_3 and $PM_{2.5}$ levels will decrease by up to 20% and 80%, respectively, compared to the 2015 levels, while middle-of-the-road scenario (SSP2-4.5) will lead to a 3% and 60% decrease in O3 and $PM_{2.5}$ levels, respectively. The low mitigation scenario (SSP3-7.0) will lead to an increase of 3% in European O_3 levels, while a 40% reduction is calculated for the European $PM_{2.5}$ levels in 2050. Results also showed that O_3 levels are expected to increase mainly over the southern Europe in all scenarios, while $PM_{2.5}$ levels are expected to decrease in particular over central Europe.

Conclusions: Multi-model simulations of future O_3 and $PM_{2.5}$ under several climate and emission scenarios show that O_3 and $PM_{2.5}$ levels will decrease in the future, suggesting improved air quality with reduced impacts on human health.

Impact of ambient air pollution on preeclampsia in 2001-2019, Rome, Italy

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Keywords: ambient air pollution, environmental epidemiology, preeclampsia, pregnancy, vulnerable groups

Introduction: Preeclampsia can lead to maternal and perinatal morbidity and mortality, but the cause of the condition is not well understood. Ambient air pollution has been associated with preeclampsia, but few studies rely on assessment of fine-scale variation in air quality and the impact on mild and severe preeclampsia, which have been reported to have different pathogenesis, is understudied. Our aim is to study the impact of long-term exposure to air pollution on preeclampsia.

Methods: We obtained data from 440,965 liveborn singletons born by women with residence in Rome during 2001-2019 from hospital, birth and administrative registries. Land-use regression models at 100 m spatial resolution assigned to the maternal residential addresses at birth with temporally adjustment were used to estimate the exposure during the first trimester to fine particulate matter (PM2.5), nitrogen dioxide (NO2), black carbon (BC), and ozone (O3). Logistic regression models with adjustment for maternal age, education, occupation, origin, parity, season of conception and area-specific socio-economic status were used to estimate the associations.

Results: Increased risk of preeclampsia was observed for all pollutants with except for O_3 in adjusted single-pollutant models. For instance, a 5-mg/m^3 increase in $PM_{2.5}$ exposure during the first trimester was associated with an adjusted odds ratio (OR) of 1.16 (95% confidence interval: 1.10, 1.23) for all subtypes of preeclampsia (n=1,815). For $PM_{2.5}$, NO_2 and BC, increased risks were evident for mild preeclampsia (n=1,357), but not for severe preeclampsia (n=337).

Conclusions: The preliminary results of our study suggest that maternal exposure to ambient air pollution with $PM_{2.5}$, NO_2 and BC increases the risk of preeclampsia and that the observed risk is driven by mild subtypes of preeclampsia. Although the observed risk is relatively small, the population attributable risk is likely to be large, given the widespread exposure to these pollutants in ambient air.

The contribution of wildfires and natural aerosols to PM2.5 exposure and human health under future climate change scenarios

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Keywords: PM2.5, wildfires, climate change, health impact assessment

Introduction: Globally, exposure to ambient PM2.5 is associated with about 4.2 million deaths per year. A large fraction of PM2.5 globally comes from anthropogenic sources and efficient measures to mitigate them may result in substantial health benefits. However, in some regions, natural aerosols are the dominant source of PM2.5. For example, in arid and semi-arid regions, wind-blown dust is a major contributor to PM2.5 levels and around forests and other vegetation-rich areas, biogenic aerosols can contribute to PM2.5 levels. These natural aerosols which can only be negligibly mitigated, are the single largest contributor to ambient PM2.5 exposure and the related excess deaths globally, more than contributions from transportation, industrial and power generation combined. Globally the contribution of wildfires to ambient PM2.5 related excess deaths has been increasing and is expected to be enhanced further under changing climate.

Methods: Considering this, the current work aims to understand the contribution of natural aerosols and wildfires on ambient PM2.5 and related health burden from 1991 to 2100 and understand their importance in the changing climate and future emission projections. We utilize the SILAM model simulations driven by CEDs emissions and CESM (Community Earth System Model) meteorology for the historical period (1991-2014) and future CESM meteorology for three scenarios namely SSP126, SSP245, SSP370, corrected by a well validated geographically weighted regression model to estimate the contribution of wildfires and natural sources including desert dust, sea salt and biogenic secondary organic aerosols to ambient PM2.5 and related health burden over the time period and attempt to understand their impact on projected health burden. We further quantify the impact of climate change and projected emissions, epidemiological and demographic transition on future health burden.

Results: We find that population weighted PM2.5 has been increasing by ~0.2 µg/m^3 in most developing countries of sub-Saharan Africa and South Asia from 1991 to the present day, leading to ~1.5 million excess deaths in these countries attributed to the increase of PM2.5 alone between this period. On the other hand, most developed countries have experienced a decrease in population weighted PM2.5 exposure during this period, associated with effective clean air policies, however, the contribution of wildfire has been increasing in these countries. This trend in wildfire contribution to PM2.5 is found to override the decrease in anthropogenic contribution, most prominently in developed countries under the future scenarios. We also analyse the rationality of the current WHO guideline and interim targets for regions where a large fraction of ambient PM2.5 comes from natural sources and wildfires.

Conclusions: The increase in climate change induced wildfire and natural emissions (like biogenic emissions) and demographic transition are found to override the benefits of reducing anthropogenic emissions considerably. Our results point to the importance of mitigation and adaptation measures to control wildfires, and the importance of stricter measures in developing countries to tackle anthropogenic sources of PM2.5. Our work also helps to recognize the rationality of WHO guidelines for PM2.5 and interim targets in regions impacted by natural aerosols and wildfires and propose region-specific alternative standards as appropriate.

Ancillaries of household air quality intervention on health & climate change mitigation in Ethiopia-a methodological framework

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Keywords: air pollution, biomass fuel, Ethiopia, household, climate change

Introduction: The use of biomass fuel is a major source of household air pollution in Ethiopia. In Ethiopia, more than 95% of households use firewood, charcoal and dung as an energy source, and this has contributed to the loss of 3% of the GDP ascribed to deforestation and soil erosion. Exposure to household air pollution (HAP) has been associated with a high prevalence of Pneumonia, COPD, stroke, IHD, Lung cancer and many other diseases involving the airways and lungs. In Ethiopia, HAP was reported to cause approximately 5% of the national burden of disease and more than 50,000 deaths annually. Common global policies and international development indicators such as the SDG opt nations to lift households on the energy ladder. This has proven to have an ancillary effect on overcoming deforestation and supporting climate change mitigation efforts. However, crafting optimal policy and strategy contextualizing national situation is always considered as an ideal approach, but with a daunting task of controlling factors that make the system complex.

Methods: our methodology is therefore designed to address the complexity, applying modelling tools that could demonstrate the spill over effect of the intervention in the energy sector on the health outcomes and climate change mitigation programs of the country.

Results: To devise optimal policy alternatives, first, modelling of the health effect change with changes in air quality levels will be calculated. A real-time evaluation of technologies and policy alternatives, such as improved cook stoves over unimproved cook stoves, or LPG/electricity over improved cook stoves will be explored. To link the air quality and technology-based improvement of health outcomes, the ideal scenarios will be identified through household exposure modelling (a function of technology, energy source, housing/ventilation and behavioural intervention). This model will be used as a base for defining plausible scenarios of intervention. Indirect estimation of gain in carbon sequestration will be estimated, back calculating the amount of wood or charcoal avoided due to the implementation of the optimal scenario. Nonetheless, truncated plausible policy alternatives will be optimized against economic models, while maintaining the principal interest of reduced disease burden and improved forest stoke for carbon sequestration. Data sources from national surveys such as energy and housing, registry of emission factors of improved cook stoves, household time activity pattern, cooking and boiling norms across geographies of the country, population statistics, diseases and mortality registries, the initial investment to technologies and annual expenditure to energy sources will be used to develop the suggested framework.

Conclusions: Tools and models developed during the project will have immense utility in addressing the ever-existing gap in household air quality data and distribution of exposure to criteria pollutants across the agroecology of the country. Furthermore, techniques and modelling tools can have applicability in intervention and case-control epidemiological studies. Above all, the system framework can act as a facilitator to harness the planning and implementation of programs designed to realize the climate-resilient green economy of the country.

California's early transition to electric vehicles: observed health and air quality co-benefits

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Keywords: electric vehicles, zero-emissions vehicles, co-benefits, air pollution, asthma

Introduction: The transition to electric vehicles is projected to have considerable public health co-benefits, but most evidence regarding air quality and health impacts of this transition comes from projections rather than observed real-world data. We evaluated whether population-level respiratory health and air quality co-benefits were already detectable at the relatively low levels of zero-emissions vehicles (ZEV: battery electric, plug-in hybrid, hydrogen fuel cell vehicle) adoption in California. Additionally, we evaluated the ZEV adoption gap in underserved communities.

Methods: We conducted a zip code-level ecologic study using linear mixed effects models relating changes in annual number of ZEVs (nZEV) per 1000 population from 2013 to 2019 to: (i) annual average monitored nitrogen dioxide (NO_2) concentrations using 629 records from 107 air monitoring stations in 95 zip codes and (ii) annual age-adjusted asthma-related emergency department (ED) visit rates using 8163 observations in 1238 zip codes. Models were adjusted for calendar year and educational attainment to control for possible confounding.

Results: The average nZEV increased from 1.4 (standard deviation [SD]: 2.1) to 14.7 (SD: 14.7) per 1,000 population between 2013 and 2019. ZEV adoption was considerably slower in zip codes with lower educational attainment ($p<0.0001$), a proxy for socioeconomic status. A within-zip code increase of 20 ZEVs per 1,000 was associated with a -0.41 ppb change in annual average NO_2 (95% confidence interval [CI]: -1.12, 0.29). A within-zip code increase of 20 ZEVs per 1,000 population was associated with a 3.2% decrease in annual age-adjusted rate of asthma-related ED visits (95% CI: -5.4, -0.9). Findings were supported by a variety of sensitivity analyses.

Conclusions: Observational data on the early phase ZEV transition in California provided a natural experiment, enabling us to document one of the first real-world associations between increasing nZEV and changes in air quality and health. Results suggest co-benefits of the early-phase ZEV transition but with an adoption gap among people with lower socioeconomic status which threatens the equitable distribution of possible co-benefits.

Oral 3: Perception, communication and partnership on climate change and health

Building communities of practice for transdisciplinary research in climate and health in Latin America and the Caribbean: a conceptual model

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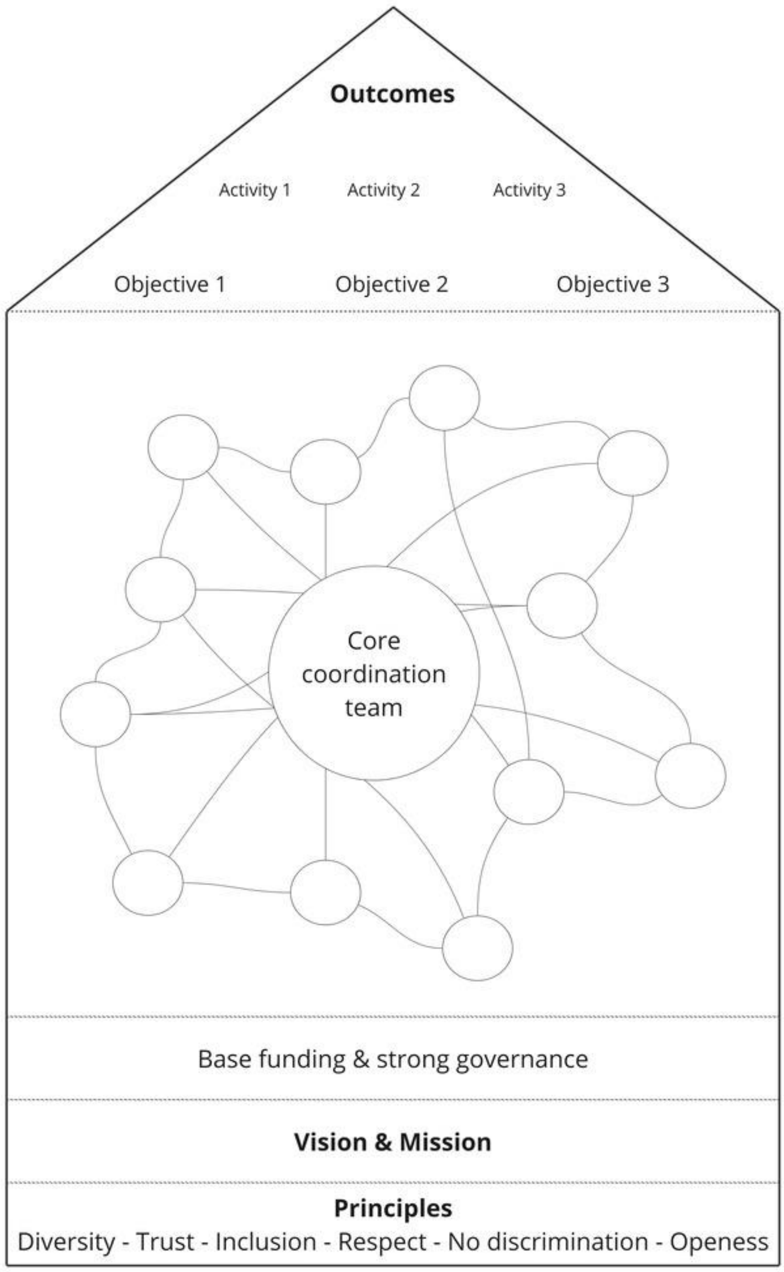
Keywords: communities of practice, transdisciplinary research, climate change, Latin America and the Caribbean

Introduction: The complex nature of climate-related health risks requires a collaborative and transdisciplinary approach that goes beyond the traditional research and policymaking silo mentality/perspective, which is commonly perceived in Latin America and the Caribbean (LAC). Communities of practice (CoPs) are proposed as a way to bridge this gap, overcome the challenge, and create a space for researchers, policymakers, practitioners, and communities to come together to exchange knowledge, build relationships, and develop innovative solutions, among other purposes. This study presents a conceptual model to illustrate how CoPs for transdisciplinary research and action (TRA) in climate and health can be promoted and built in LAC.

Methods: Key people who are working on the intersection between climate and health in LAC were invited to participate in a series of eight participatory workshops. Workshops were carried out according to LAC sub-regions, namely, North America, Central America, the Caribbean, and South America. A variety of actors participated, including people from academia and research institutions, governmental bodies, and civil society. Each session was 1 hour and 30 minutes long, and consisted of two main sections: a brief introduction to the topic and then a general discussion session guided by open questions about what a CoP for TRA in C&H in LAC should be like.

Results: Participants identified several elements for CoPs to be built and successful, including values, structure, functioning, and purposes (Figure 1). First, CoPs should promote trustable relationships, inclusiveness and diversity of members and cultures, openness to different ideas and perspectives, and be supportive of all of their members. Second, CoPs for TRA in C&H should have a clear organisational structure and communication channels, with a core team that leads, plans, and carries out all administrative work for CoPs to progress. Also, safe spaces for dialogue should exist, as well as regular meetings. Third, roles and responsibilities should be clear for each member of CoPs. Fourth, CoPs should develop a common and clear language, goals, outcomes, and sustainable funding strategy, all of which should be continuously evaluated and adapted as CoPs progress. Finally, some purposes of CoPs include increasing awareness of the topic in the population; informing practice, influencing public policies, and supporting action; generating and translating evidence; and articulating disciplines.

Conclusions: In summary, CoPs are a good opportunity for promoting TRA in LAC. In doing so, CoPs may advance in proposing innovative approaches and solutions to the complex and intertwined problems imposed by climate change. Key people in LAC consider basic elements for CoPs to be successful and achieve the main purpose of building bridges between stakeholders and disciplines. The proposed model provides a useful framework for researchers, policymakers, practitioners, and communities to foster collaboration in the region.



Defining and conceptualizing planetary health literacy – a concept mapping approach

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Keywords: planetary health literacy, concept mapping, conceptualization

Introduction: Environmental degradation and climate change are inevitably interlinked with human health and well-being. Planetary health, as a concept, deals with these overlapping issues. The interconnection of the health of humanity and the planet is not fully acknowledged by many to date, which bears the risk to impede action for health promotion and for sustainable behaviour towards nature. Health literacy can serve as a valuable tool to achieve this goal. This master thesis study aimed to define and conceptualize planetary health literacy with the goal of recognizing, increasing and accelerating the impact of the planetary health concept.

Methods: Based on a systematic literature review, which highlighted the scarcity of literature on planetary health literacy and similar concepts, an empirical study was conducted. The research tool of choice was concept mapping, an approach that entails qualitative and quantitative aspects. Strongly building on group knowledge and the involvement of a diversity of stakeholders, it finally generated a pictorial structured conceptualization of a complex, novel research area. The concept mapping was conducted with two groups representing the perspectives of experts and students, in order to gain comparable results of two diverse groups.

Results: A systematic review underlined the gap of conceptualizing planetary health literacy. The subsequent empirical study resulted in several dimensions that constitute planetary health literacy, ranging from predecessors to tools for action and implications. The analysis of the concept mapping yielded a list of 18 unique as well as overlapping dimensions from the two sample groups. In the final conceptual model, the following three pillars of what planetary health literacy can do were identified: (1) recognizing aspects of the status quo in a world in crisis, (2) delivering tools and emphasizing requirements for a sustainable and healthy transition and (3) depicting possible outcomes for a thriving future.

Conclusions: Planetary health literacy can serve as a means to make the connections between human and planetary health more evident and drive positive, sustainable change for a healthy future for all. Its holistic, multi-layered conceptualization encompasses several dimensions and targets a multitude of stakeholders. The concept may serve as a valuable tool to address, frame and accelerate the planetary health movement, moving from a world in crisis to a thriving, healthy future. Further research to deepen these findings is warranted.

Knowledge, attitude, practices, and expectations on climate change and sustainable development among French healthcare professionals

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Keywords: climate change, sustainable development, health workforce, hospital, cross-sectional study

Introduction: Climate Changes affect directly and indirectly health systems, already under stress. Moreover, they contribute through their activities to many environmental impacts, including impacts on CC through the emission of greenhouse gases. Although many initiatives are underway, it is necessary to move faster to evolve health care institutions and prepare them to carry out their missions in a changing context. The main objective of this study was to evaluate the knowledge, attitude, and practices (KAP) of health professionals (HP) regarding CC and sustainable development (SD) in hospital. The secondary objective was to specify the expectations of these HP towards their health institution.

Methods: This study is an observational, cross-sectional and multicentric survey in five French hospitals (four in the Nouvelle Aquitaine region and one in the Occitanie region) conducted between June 2021 and July 2022. A self-administered questionnaire was designed to assess the KAP regarding CC and SD in their health care institution, based on the review of relevant literature from different studies and existing questionnaires on CC. A working group of professionals from three different hospital and several disciplines (doctors, pharmacists, manager in charge of sustainable development, and health and economic students) worked on the construction of the questionnaire. It consisted of six parts: i) characteristics, ii) knowledge and perception related to CC, iii) attitude, iv) practice concerning ecological transformation actions, v) expectations and vi) priority level in the hospital (scale of 1 to 10). The questionnaire was pilot-tested by the working group to ensure clarity, scientific accuracy and length. The final questionnaire took about 12 minutes to complete.

Results: The total number of participants was 3,847 (8.1%) out of a total number of 47,626 salaried staff. Overall, 1,573 (50.6%) were under 40 years of age, and 2,961 (78.1%) were women. The participants were nurses (44.3%), administrative staff (18.3%), and doctors (16.5%). Among the participants, 2094 (56.3%) had been working in their institution for more than 10 years. Respondents considered energy consumption (70.1%), waste and discharges related to medical activities (56.6%) and waste and discharges related to non-medical activities (51.4%) to be the three activities with the greatest environmental impact. The average level of priority given to CC by their hospitals was estimated at 4.8 (± 2.4). Concerning the means of transportation, 2,093 (54.5%) participants used soft mobility or public transport and 1,384 (36.0%) did not use it, but 365 (9.5%) wanted to start. Among the 3847 respondents, 887 (23.2%) have already initiated at least one action in favour of ecological

transformation. To implement projects related to ecological transformation, participants indicated that they mainly needed dedicated time (40.6%), hierarchical support (32.1%) and methodological support (28.3%). Other needs such as access to training (23.3%), and a simplified project validation circuit (27.3%) were also identified

Conclusions: HP have an overall misperception of the impacting activities of their institution. However, they are motivated and are waiting for an institutional commitment and support to implement concrete actions to fight against CC.

Clear climate communication: ENBEL's research highlights in plain language

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Keywords: climate change communication, health, plain language

Introduction: Climate change is a global phenomenon that poses significant risks to public health but communicating these risks to the public can be challenging given the complexity of the science and the associated terminology. Plain language factsheets that translate research findings from climate change research into accessible information for a broader audience are one tool that can be used to effectively convey complex information. The ENBEL consortium, a collaboration of research projects dedicated to climate change and health, has published dozens of scientific publications and chapters on climate change and health. Dissemination of these research findings, however, has been limited to the scientific community, thus hindering potential impact on society. To address this, a plain language factsheet series dedicated to findings from climate change and health research was developed for broad dissemination to the general public and relevant stakeholders.

Methods: The development process of the 'Climate Change and Health Research Highlights' series involved gathering and synthesizing research produced by ENBEL projects. To cover the range of climate health issues, the series includes twelve topics focused on climate change and health. The design and formatting of the series was developed in consultation with a graphic design specialist. Each factsheet is written in plain language, ensuring clear expression and structure, and incorporates good document design with visual images, making the content easily understandable for non-expert audiences. To ensure scientific accuracy and readability, factsheets are reviewed by ENBEL researchers and pilot-tested with potential stakeholders.

Results: The factsheets provide clear and concise summaries of ENBEL's research findings on climate change and health issues. They cover a wide range of topics including heart and lung disease, heat and air pollution, wildfires, mobile health tools, heat stress in the workplace, chronic kidney disease, diarrheal disease, schistosomiasis, mosquito-borne diseases, food security, nutrition, and agriculture, heat effects on pregnant women, and early warning systems. The series aims to help raise awareness of these issues, challenges, strategies, and solutions to address them and assist the general public and professionals from all sectors to understand the evidence and make informed choices based on this information.

Conclusions: This series provides a means for ENBEL's research findings to reach a broader audience, beyond the scientific community, and make a greater impact on society. The development process incorporated clear expression, structure, and good document design to ensure that the content is easily understood by non-expert audiences. The series covers a wide range of climate change and health issues and aims to raise awareness of these issues and the strategies and solutions to address them. There is potential for this series to be used by a wide range of stakeholders around the world and can contribute to a better understanding of health-related climate change issues.

Innovation methods, techniques and narratives for communicating climate change public health risks to diverse audiences

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Keywords: climate change, public health, communication, risk, global health

Introduction: Climate change is now widely accepted to be anthropogenic and occurring. The task now lies in communicating the public health risks and inspiring action to face the health challenges that will come with a changing climate, including inspiring policymakers to enact strong, health-focused climate policies. New, innovative communication forms are needed to keep audiences engaged, highlight new information and inspire rapid action to prevent public health harm. Using novel communication methods, techniques and narratives, engagement and motivation can be inspired in individuals, communities and policymakers.

Methods: The diverse public health-based stakeholders of the EPHA membership were involved in a capacity building event on climate change where the background and challenges of climate change and health were presented, and then, using this basis, a communication specialist helped to co-create new methods, techniques and narratives through which to present previously unexplored fields and messages, and highlight future challenges of importance to stakeholders. New technologies for synthesising information, as well as artistic theories, were introduced to develop new frames of risk communication. Through using the diverse public health-focused membership of the Alliance, a holistic overview of the challenges, as well as emerging niche areas of health concern, were able to be established and built upon.

Results: Multiple techniques for how to communicate climate change-related public health risks were identified and built upon. The capacity building section of the workshop allowed that the attendees were able to build upon their climate change scientific knowledge, and able to reflect on their own field of work to identify anticipated public health challenges, some of which were identified as new fields of inquiry. The facilitation of the communication expert meant that these new needs were able to be articulated, and novel techniques for reaching target audiences were able to be discussed and built upon to inform how public health organisations can inspire change.

Conclusions: Through a collaborative approach with diverse public health-based organisations, the use of innovative, novel techniques, including art theory and new technologies, as well as establishing a baseline of scientific and health knowledge, meant that communication methods and narratives were able to be built. This could be taken forward to advance the public health argument for rapid climate action, including those focused at policymakers. The outputs and findings of the capacity building were able to help individual public health organisations to think about how they can communicate public health risks, concerns and messages in a way that engaged audiences and inspired change.

Impact Beyond the Impact Factor

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Keywords: impact, communication, outreach, decision makers, media

Introduction: Impact of research through outreach to society is increasingly acknowledged as an important part of the overall research efforts.

Decision makers in the public or private sphere do not base their regulations or policies solely on research findings published in peer-reviewed journals. Reaching decision makers successfully requires that the research is relevant and that it is shared and discussed in a way that is understandable and meaningful for them.

Regular communication and building partnerships and collaboration as well as using the right tools and channels to reach them where they are, are also important. One way of overcoming the challenges in research reaching levels of informed decision making, is to ensure research is made relevant through the use of impactful media coverage from respected news organizations. This allows for the research to have context, and its impact be reflected in the lives and stories of the populations that will benefit from informed policy making in the public and the private sector.

By laying out the basic need for and results from carefully considered collaboration with decision makers, stakeholders and media partners, while pointing to the case study provided by La Isla Network's (LIN) experience, we hope to inspire our colleagues in their efforts to ensure their hard work has the societal impact it could have and that is expected by funders.

Methods: In addition to publishing data in respected journals, LIN and CICERO work with its communications teams to develop lay summaries, visual material and other relevant materials, involve stakeholders in their projects and establish relationships and communication channels with both decision-makers directly and the media. LIN developed relationships with filmmakers and photographers to produce their own content and also work with leading media outlets through carefully developed relationships with editors and journalists.

Demonstrating the good will, intent and import of the effort over time, LIN has been able to ensure that their research is distributed and made relevant to the wider population, and decision makers by then utilizing these human and understandable stories that reflect both the science, and the conditions that prompted the research, to change minds through persuasion.

Results: LIN and CICERO have achieved policy change on the:

- Local and national political level
- Brand
- Producer
- Commodity Trader
- Certification body level

We will explain during the presentation how these targets were designated, how those goals informed the research, and the media outreach that followed, and finally how the dissemination and engagement with these assets in hand was utilized to drive improvements to protect workers in a changing climate.

Conclusions: In this presentation we will showcase how strategic use of different communication tools and platforms to reach the audiences that can make a change within the specific field of research to give others tools to disseminate their work and make it as impactful as possible.

The presentation will be organised as a short conversation between a moderator and two speakers and make use of visual material such as video clips, photos and visualisations to illustrate our methods.

Oral 4: Economics and policies for a just transition

Green dreams, local realities: the complexities of the European Union's energy transition

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Keywords: climate change, energy transition, environmental health, health and well-being, systems approach

Introduction: The European Union's (EU) green deal aiming to achieve net-zero greenhouse gas emissions by 2050 requires EU countries to transition from a fossil-fuel-based to a renewable energy system. While this transition will bring significant global health benefits, it's crucial to understand how it will affect local communities' daily lives and well-being. This study explores the implications for health and well-being in Estonia's ongoing transition from an oil-shale-based energy system to green energy, which the EU Just Transition Fund supports.

Methods: In our qualitative research, we employed a systems approach to develop a conceptual framework based on socio-technical systems theory and the production of space theory. Our methods included four focus group discussions, ten in-depth interviews, and the analysis of publicly available documents such as public records, policies, reports, news articles, scientific papers, theses, interviews, and government meeting notes. We conducted thematic data analysis using NViVO software.

Results: The energy transition has disrupted the daily lives of locals inhabiting the industrial area, whose socio-economic status is already poor, by creating uncertainties on employment and socio-cultural practices (Figure 1). While efforts are being made to find alternative economic sources and ensure job security, the transition is still struggling to establish trust among the inhabitants that they will indeed have access to new job opportunities. The transition has planned to conduct a biomonitoring study, but it has yet to address the long-term environmental health consequences of the fossil fuel industry and the disruption of the socio-cultural space that supports mental health and social well-being. Locals' health is rested on a weak healthcare system. Different actors have varied understandings of health and well-being, often leading to paradoxical stands. Protecting and promoting positive health and well-being is a challenge due to disruption created by energy transition and accumulated problems over time regarding socio-economic conditions, environmental health impacts, and social well-being at the local level. The lack of support mechanisms for inhabitants to navigate the changes in social, economic, and working conditions has blurred future perspectives taking a toll on their mental health. Thus, the compound effects of multiple existing and emerging issues can harm locals' health and well-being.

Conclusions: Considering the multiple systems interconnected with fossil fuel-based energy systems during the transition is important. Failing to do so could worsen the local population's health and well-being as opposed to the motto of just transition. Thus, the just transition mechanism, including the new business and energy systems, should carefully evaluate the short- and long-term impacts on the population's physical, mental, and social health and well-being to avoid unintended consequences.

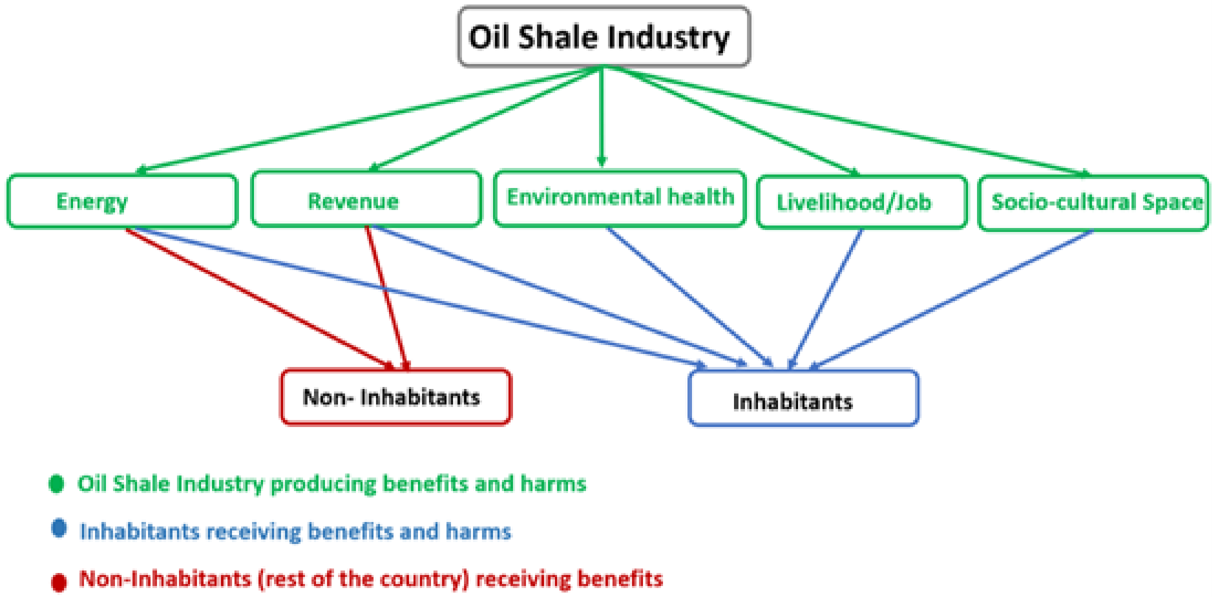

Figure 1 Oil Shale Industry holds several systems together where the benefits and harms are distributed to inhabitants and non-inhabitants of the industrial region in Estonia.

Pathfinder Initiative: analysing the effects of implemented climate mitigation actions on health and greenhouse gas emissions

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[1]London School of Hygiene and Tropical Medicine

Keywords: climate mitigation actions, co-benefits, health, equity

Introduction: Urgent action is required to keep global warming within the 1.5 - 2° C target of the Paris Agreement. Demonstrating the benefits to human health from decarbonisation can increase motivation and capacity for climate action among decision makers. Reductions in air pollution from the use of clean, renewable energy and the transformation of our food and transport systems would reduce the burden of NCDs, including obesity and heart disease. Most existing evidence on the health co-benefits from climate mitigation is from modelling studies and little is known about the health benefits achieved from implemented action. The Pathfinder Initiative analysed evidence from implemented actions that benefit health and wellbeing, while mitigating greenhouse gases (GHGs) across a range of sectors and scales. To understand the implementation process of actions, and identify barriers, and facilitators as well as positive and negative, planned and unplanned effects on GHG emission reductions, health and equity.

Methods: Evidence from implemented action was collected through collaboration with partner organisations taking action on the ground (OECD, C40 Cities, CDP, SDSN), a search of the published and grey literature and an open call for evidence in The Lancet. We restricted our selection to implemented actions with quantified GHG reductions that also had observed and reported impact on health outcomes directly, quantified outcomes that have an evidence-based pathway to health or reported quantifiable associations to health outcomes. We further assessed the identified examples against their feasibility and potential for scale-up, as well as their impact on promoting just transition, equity, and transformational change.

Results: We found evidence on examples of implemented climate actions with quantified mitigation and health impacts for 26 actions. The case studies cover a wide range of sectors and scales across the globe, including renewable energy projects in the United States, replacement of cook stoves in the Casamance region, a waste management project in India, and a bicycle scheme in Buenos Aires. Some actions also had benefits for improving safety and equity in the target populations, for example, bicycle scheme and new cycle lanes increased gender equity and encouraged active travel by women in Buenos Aires. When assessed for scale up and ambition to reach emission reduction targets, such schemes will not be sufficient alone to substantially reduce emissions in the transport sector. Wider systems change that reduce car dependency and promote active travel are required to accelerate change to a healthy net zero future.

Conclusions: Our results demonstrate that there is a lack of evidence on the health impact of implemented climate mitigation actions and that there is an urgent need for more evidence. We identified a missed opportunity for researchers, cities, stakeholders, decision-makers to capitalise the potential opportunity to improve health while reducing GHG emissions. Only a few examples of implemented actions are highlighting the health and equity benefits that can be potentially achieved. A focus on the health co-benefits of climate action can help to motivate more ambitious cuts in emissions and support progress towards net zero greenhouse gas emissions by 2050.

Productivity costs of temperature changes – micro-study from Norway

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Keywords: temperature variability, labour productivity loss, sick leave, health impacts, econometric method

Introduction: In this paper, we aim to investigate how temperature affects direct productivity loss in production in Norway. Labour productivity loss is defined as the working hours or days lost from contracted working time. In particular, we examine the relationship between temperature and absenteeism due to sickness using an econometric method.

Methods: We conduct our analysis using a panel dataset in the year 2018, a year with high temperatures, which contains individual-location-specific daily temperatures and sick leave records from a national registry in Norway based on the Cohort of Norway (CONOR). We use the dataset to estimate the relationship between temperature and sick leave for winter and summer by employing a general linear model (GLM). In addition, we implement a week-day-smoothing technique on the sick leave data to ensure efficient estimates in the primary regression. Akaike Information Criterion (AIC) is also applied to select the lagged temperature as the explanatory variable in the regression.

Results: Our estimation shows that temperature has a statistically significant impact on labour health and productivity in Norway. Especially our results reveal that both hot and cold temperatures increase the expected number of sick leaves, indicating a loss of working time and productivity. However, this effect varies over based on season and individual characteristics. In the summer, we find that a 16-day lagged temperature has a small but significant effect on the likelihood of sick leave. This finding reveals that heat temperatures have a delayed impact on health and productivity in Norway. It also implies that the cumulative effect of consecutive days of high temperatures is sub-optimal for labour productivity. In contrast, short-term temperature has a significant and negative impact on the probability of sick leave during the winter. Our results reveal that as temperature decreases, the likelihood of sick leave rises, and cold temperatures have an immediate effect on the loss of labour productivity.

Moreover, our results show that individuals with higher education levels are less likely to take sick leave. This may be explained by their healthier lifestyle choices and better access to healthcare. We also noticed that females take more sick leave than males during both seasons, which potentially indicates gender differences in the perceptions or needs of taking sick leave.

The temperature impacts conditional on industry bases are also examined. We find that physically demanding individuals have higher sick leave rates in both seasons. Additionally, individuals across all occupations are more likely to take sick leave in winter compared to summer in Norway. We also conduct sensitivity analysis to investigate the robustness of regression estimates.

Conclusions: To summarize, extreme temperatures have become more frequent due to climate change which causes substantial economic costs. Our findings suggest significant economic implications. The reduction in working time and productivity caused by temperature-related health issues leads to decreasing output and increasing labour costs for industries.

Our results also indicate that Norway, a country with relatively mild weather conditions, will potentially witness a significant reduction in labour productivity and economic losses due to increased temperature variability in the future.

Assessing the health impacts associated with active transportation within four different pathways to net-zero carbon emissions in France

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Keywords: health impact assessment, public health, net-zero carbon, transition scenarios, active commuting

Introduction: To mitigate the effects of climate change, societies must reduce their greenhouse gas emissions to reach net-zero emissions by 2050. Significant efforts are thus necessary to identify desirable pathways towards carbon neutrality. Beyond climate objectives, efforts to reduce greenhouse gas emissions may generate significant public health co-benefits. This is particularly true in the transportation sector, as decarbonised mobility can increase physical activity, through walking and cycling. This study aims to quantify the public health impacts associated with active transportation within four different net-zero scenarios developed for metropolitan France, 2021-2050.

Methods: The French Agency for Ecological Transition developed four detailed scenarios achieving carbon neutrality by 2050: "Frugal generation" is based on sufficiency attitudes; "Regional cooperation" relies on shared governance; "Green technologies" puts innovation at the service of decarbonised energy systems and "Restoration gamble" bets on future technological developments to achieve carbon neutrality. Additionally, the business-as-usual (BAU) scenario extends current lifestyles until 2050, without reaching net-zero. Each scenario details the overall mobility demand, expressed in passenger-kilometre, by transport mode. For each scenario, we distributed the mobility demand for walking, cycling and e-cycling across age groups. Relying on the health impact assessment framework, we quantified the impact of the corresponding physical activity on all-cause mortality. The impact of each of the four carbon neutrality scenarios was determined by comparison with estimates from the BAU scenario. Intangible costs associated to mortality were estimated in each scenario based on the value of a statistical life year (VSLY).

Results: Volumes of active transportation are projected to increase in "Frugal generation" and "Regional cooperation", while they increase slightly in "Green technologies" and decrease in "Restoration gamble". For a large age range (20-69 years), "Frugal generation" and "Regional cooperation" imply sufficient walking- and cycling-associated physical activity to fulfil the World Health Organisations recommendations by 2035. "Regional cooperation" reaches the highest levels of health co-benefits, with 427,000 (Uncertainty interval, UI: 230,000 – 583,000) deaths prevented between 2021 and 2050. This scenario would translate in a life expectancy gain of 4.0 (UI: 2.3 – 5.4) months for the general population in 2050, mainly driven by e-bikes. These health benefits would correspond to over 40 (UI: 22 – 54) billion euros of intangible costs saved annually from 2035 onward. "Frugal generation" would provide smaller but important health benefits, while these benefits would be modest for "Green technologies". On the contrary, "Restoration gamble" implies 37,000 (UI: 14,000 – 58,000) additional deaths as compared to the BAU scenario, and a loss of 0.2 (UI: 0.1 – 0.4) month in life expectancy.

Conclusions: Different ways to decarbonize mobility in a net-zero perspective may achieve very contrasting public health co-benefits. Especially, scenarios relying on energy sufficiency and active transportation are expected to provide the highest levels of public health benefits. This study illustrates how the public health dimension may provide a relevant insight in choices of collective transformation toward net-zero societies.

Linking climate change adaptation and public health: perspectives of Norwegian policy makers

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Keywords: climate change, climate adaptation, public health

Introduction: Climate change has large implications for public health including the increased prevalence of infectious diseases, heat-related respiratory conditions, mental stress, and morbidity due to extreme weather events. Addressing climate change impacts requires developing adaptation strategies that are tailored to each country's specific context and situation. Climate adaptation strategies for instance include consolidating the country's physical infrastructure to resist climate emergencies, implementing risk and warning systems to inform populations about climate risks, and preparing the health care system for the emergence of new health issues. As public health risks related to climate change become more discernible, integrating health aspects in climate adaptation plans, and allocating resources to support the implementation of adaptation strategies, becomes urgent. With this study we aimed to explore the perspectives of selected Norwegian climate and health policymakers working at national and municipality level regarding how health is accounted for in climate change adaptation plans. We focused on barriers and facilitators identified in the implementation of adaptation strategies, evidence needs related to climate, environment, and health, and implications of the Covid-19 pandemic recovery for adaptation in the short and long-term.

Methods: Fourteen semi-structured digital interviews were conducted between October 2021 and September 2022 with representatives from municipalities (N=8) participating in a national network for climate adaptation, one political unit and national public administrations (N=5) working in climate, health, environment, preparedness and civil protection. The interview data were analysed using a simple content analysis approach.

Results: Municipalities coordinate the development of climate adaptation plans with support from key national actors. Although municipalities were experienced in preparing for climate-related events and securing infrastructure, limited consideration was given to health in the climate adaptation work. Such integration was hindered by lack of resources and knowledge regarding what to do, and lack of collaboration between municipality sectors. To better connect climate adaptation and health, the representatives suggested providing evidence-based information regarding health impacts of climate change, developing concrete tools including warning systems, and implementing regional, national, and international projects to map the impact of climate change and raise capacity. The representatives called for more stringent national guidelines for the integration of health in climate adaptation, and pinpointed that lessons learnt from the Covid-19 pandemic will enable municipalities to be better prepared and more adaptable in the future.

Conclusions: Governmental authorities should provide more concrete guidance regarding the integration of health in climate adaptation plans. Public health authorities have a central role to play in supporting such endeavour.

Relationship between universal health coverage and healthcare-related carbon emissions: a comparative analysis

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Keywords: healthcare decarbonization, universal health coverage, net-zero healthcare, fair energy transition

Introduction: The primary intent of any health system is to improve population health and quality of life and achieving Universal Health Coverage (UHC) is the globally agreed means by which this can be done. Nevertheless, a large number of factors can affect the health of an individual. Some of them lie outside the boundaries of the health sector. Climate change, however, is an environmental factor interconnected with the health sector and with many other determinants of health. The temperature increase is modifying the global ecological dynamic and has negative implications for the planet and the individual's life. Health services are facing the consequences of climate change on population health. At the same time, they are notable contributors to emission of greenhouse gases. An initiative to decarbonize the health sector was launched by the WHO at the COP26 Health Program in November 2021. Delivering this agenda requires a deeper understanding of the connections between UHC and healthcare-related carbon emissions.

Methods: An observational descriptive study to assess the association between healthcare carbon emissions and UHC index for 64 countries for the year 2015. The data was extracted from publicly available databases and recent studies. A multiple linear regression model was used for the statistical analysis. The Lorenz curve was used to explore the cumulative distribution of healthcare carbon emissions according to the GDP per capita.

Results: The results of the multiple linear regression indicated that increments in the UHC service coverage index (β 0,023; CI 0,002, 0,043; P=0,031), in the disease burden measured in DALYs per 100,000 people (β 0,821; CI 0,393, 1,543; P=0,026), in the carbon intensity of the economy (β 1,642; CI 0,100, 2,891; P=0,011), and in the GDP per capita (β 0,948; CI 0,616, 1,279; P=0,000) were factors associated with an increase in healthcare carbon emissions, after adjusting for the other variables. The correlation between UHC service coverage index and carbon emissions in healthcare is stronger in High-Income Countries (HICs) compared to Middle-income countries (MICs), evidencing that economic development is associated with more resource-intensive health systems. The cumulative distribution of total, direct, and supply chain carbon emissions in health care have a pro-rich pattern, especially for the latter.

Conclusions: Achieving low-carbon UHC will require trade-offs. Addressing the determinants of health, investing in health promotion and disease prevention are relevant strategies to decrease the disease burden and consequently the need to use health services. The economy and the energy system affect emissions in healthcare and should be taken into consideration as countries commit to net-zero healthcare. HICs have more resource-intensive health systems than MICs and there is a pro-rich distribution of carbon emissions in healthcare. HICs and MICs face different challenges in their health systems and the supply chain is an international opportunity for climate mitigation and equity in healthcare.

Multiple linear regression analysis on variables correlated with total GHG emissions in healthcare per capita.

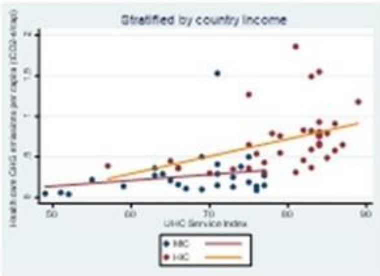
	Coeff.	SE	t-value	p-value	[95% CI]		Sign.
UHC Service Coverage index	0,023	0,010	2,22	0,031	0,002	0,043	**
Hospital beds (per 1000 people)	0,024	0,030	0,79	0,432	-0,036	0,083	NS
Physicians (per 1000 people)	-0,033	0,046	-0,73	0,466	-0,125	0,058	NS
GHE/CHE	-0,008	0,005	-1,69	0,097	-0,018	0,002	*
DALYs per 100,000 people[1]	0,821	0,360	2,28	0,026	0,100	1,543	**
GINI	-0,008	0,011	-0,68	0,498	-0,030	0,015	NS
Urban population (% total)	0,004	0,005	0,72	0,476	-0,007	0,015	NS
Mean years of schooling	0,003	0,047	0,06	0,952	-0,091	0,097	NS
Carbon intensity of the energy (tCO2/TJ)	-0,005	0,005	-0,96	0,342	-0,016	0,006	NS
Carbon intensity of economy (kgCO2/$GDP)	1,642	0,622	2,64	0,011	0,393	2,891	**
GDP per capita[1]	0,948	0,165	5,74	0,000	0,616	1,279	***
Constant	-20,266	4,222	-4,8	0,000	-28,738	-11,794	

Number of obs = 64 | R-squared = 0.783 | [1] Log ransformed | *** p < 0,001

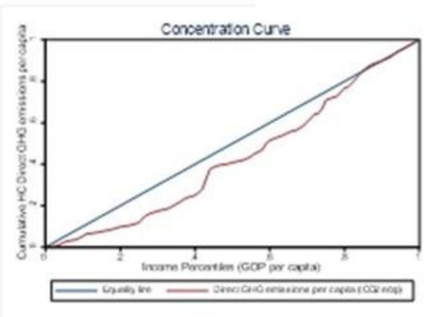
F(11, 52) = 17.11 | Adj R-squared = 0.737 | * p < 0,05

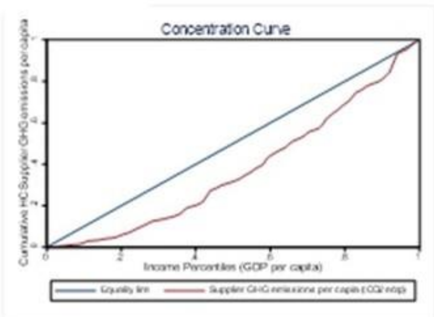
Prob > F = 0.0000 | Root MSE = .4399 | NS- Non significant | * p < 0,1

Coeff. – coefficient; SE- Standard error; 95% CI – 95% confidence interval; Sign – significance; GHG- Greenhouse gases; UHC- Universal health coverage; GHE/CHE - Domestic general government expenditure as % of current health expenditure; GDP- Gross domestic product; tCO2 – ton of carbon dioxide; kgCO2- kilogram of carbon dioxide; TJ- Terajoule



Regression lines for GHG emissions in healthcare per capita stratified by country income.





BELMONT Symposium: Transdisciplinary research to improve understanding of the climate, environment and health links

Climate change and health risk early warning systems

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Keywords: climate and health, early warning system, heat and precipitation, diarrheal disease, heat stress

Introduction: The UN launched The Early Warnings for All Initiative (EW4All) at the COP27 meeting in November 2022. The Initiative calls for the whole world to be covered by an early warning system by the end of 2027. According to the UN Climate Change Adaptation, an early warning system (EWS) is an adaptive measure for climate change, using integrated communication systems to help communities prepare for hazardous climate-related events such as heatwaves and flooding. Different climate hazards and warning target groups require different monitoring variables, warning thresholds and lead times. In addition to global, national, regional, and local levels, EWSs such as heat-health EWSs targeting individual levels and specific vulnerable groups remain to be further developed and personalized to assess individual heat health risks. This abstract presents three examples of the development of climate and health risk EWSs.

Methods: The ongoing Belmont Forum AWARD-APR project applied time-series neural network models to predict diarrheal disease risk with sub-seasonal and seasonal lead time based on epidemiological studies on historical climate and diarrheal disease data from Nepal, Taiwan, and Vietnam. The EU ClimApp project integrated heat and cold stress indices and human heat balance models based on international standards and thermal physiological studies and incorporated individual vulnerabilities to personalize the early warning. In the recently kicked off EU High Horizons project, an EWS for maternal, newborn, child and healthcare workers (MNCH) is being developed to provide heat stress warning. Heat stress indices and thresholds of negative health outcomes in relation to the vulnerabilities of this specific MNCH target group are being analyzed and discussed.

Results: The Belmont AWARD-APR project developed a web-based sub-seasonal and seasonal EWS of diarrheal disease case rate in Taiwan, Nepal and Viet Nam (https://www.award-apr.org/map-of-the-month). The smartphone-based ClimApp for both Android and iPhone provided the possibility to personalize EWS by allowing users to interact with and input individual vulnerability factors into the

app. ClimApp works globally by extracting local weather data through GPS and internet connections. The app integrated heat stress indices and human heat balance models in contrast to most heatwave warnings that use only air temperature to provide extreme heat warnings https://www.lth.se/climapp/). A new smartphone-based EWS for maternal health care is under development. Integrated heat stress indices and thresholds for heat stress warnings are being investigated (https://www.high-horizons.eu/).

Conclusions: The development of climate and health risk early warning systems requires scientific evidence to select variables and indices for comprehensive health risk assessment. In addition to the existing EWS for the general population, EWS for vulnerable groups should provide the possibility to integrate individual risk factors into warning thresholds to personalize the health risk warning systems.

Global Disparities in Heat Exposure

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Keywords: heat stress, inequalities, environmental Gini index, Lorenz curve

Introduction: There have been growing global inequalities in the exposure to heat, leading to significant public health concerns. Such issues have particularly drawn a lot of attention in the context of climate change. Meanwhile, heat exposure varies under different socioeconomic status across the world. Therefore, this study aims to shed light on the disparities in heat exposure and study the development of the inequities in the long run.

Methods: In this study, we use the environmental Gini coefficient and Lorenz curve to evaluate the global inequalities in exposure to heat. These distributional metrics are quantified using 0.25-degree spatially disaggregated data on GDP and heat stress for both historical period and future periods under different Shared Socioeconomic Pathways (SSPs). The environmental Gini coefficient and Lorenz curve provide a method to assess the joint relationship between income and heat exposure distribution. In this analysis, we use the population-weighted Wet Bulb Globe Temperature (WBGT) index as a measure of heat-related stress on the human body under direct sunlight.

Results: The historical data in 2010 uncovers a significant negative relationship between heat stress and GDP per capita on both global and regional scales. However, there have been considerable variations across regions and economic groups. African countries with the lowest and most diverse income levels experience the highest average temperatures. In contrast, Europe, characterized by lower income dispersion, registers the lowest levels of heat stress. We also find a negative and statistically significant Spearman correlation coefficient between global WBGT and GDP per capita.

Our assessment of the environmental Gini index at the country level shows a substantial variation in heat exposure across income levels among countries. We find large volatility and negative skewness in the heat-income Gini index distribution, indicating a significant level of heat inequality among countries.

Furthermore, in this analysis, we find a clear pattern of heat exposure inequality across all regions. On the one hand, this inequality is particularly severe within the regions of Africa, Oceania, and South America, where the lowest income quartile groups bear more than 60 percent of the regional heat stress. On the other hand, strong disparities also exist between regions. The between-region inequalities account for 74 percent of the overall inequality.

Employing predicted data on WBGT and GDP data under different SSPs, we find strong and growing inequality in heat stress across income levels globally in the long run. In addition to African countries, developing countries in Asia and Western European countries will experience the second-highest increase in heat-income inequality. From the counterfactual analysis, we find that global warming accounts for over 35 percent of the change in heat stress inequality among income levels in the year 2095.

Conclusions: To conclude, this analysis shows that the world exhibits considerable inequality in heat exposure across different income levels. Such inequality appears both within and between regions. African countries experienced the highest inequality in heat-income distribution in 2010. In the long run, the disparity of heat exposure persists world widely in which climate change plays a crucial role.

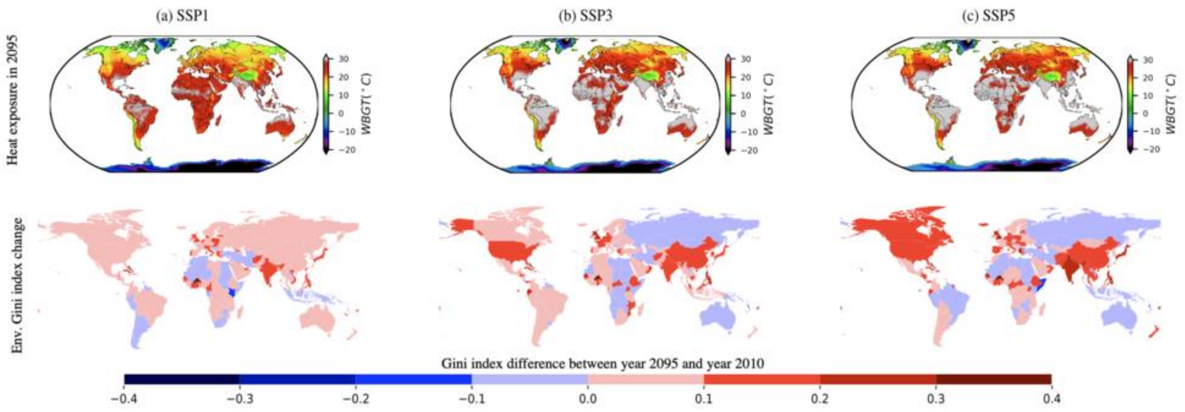

Figure. Global heat inequality over the long run

Protection Resilience Efficiency and Prevention (PREP) for workers in industrial agriculture in a changing climate

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Keywords: heat stress, prevention, workplace intervention, kidney disease

Introduction: Chronic kidney disease of non-traditional cause (CKDnT) affects millions of workers in Latin America and Asia. Treatment is expensive, resulting in early death for those affected. Industrial agricultural workers are the most affected, especially in the sugarcane sector. Heat stress from strenuous work in extreme heat without sufficient rest and hydration is a main driver of the disease. Without prevention, this epidemic is likely to accelerate due to climate change.

Methods: At a large sugar mill in Nicaragua, a workplace intervention designed to prevent heat stress with focus on regulated rest in shade, sanitation and hydration (RSH intervention) has been implemented and continuously improved over a 5-year period. The PREP research program evaluates i) the immediate and long-term impact the intervention has on workforce health (kidney health and heat- related injuries) and productivity; ii) the economic and social impacts on those affected by the disease, including the health system, and whether our intervention aids in resilience, including mitigating migration pressures; iii) an analysis of public health policies to understand what policies, or absence of policies have contributed to the disease while investigating what policies are required to effectively address it.

Results: The socioeconomic burden of CKDnT disease in the workers' communities has been substantial. The RSH intervention, when well implemented, attenuates the decrease in kidney function over the harvest periods. The long-term follow-up after 6 harvest seasons is now underway. Workers had higher daily productivity as the RSH intervention was enhanced, even though this led to a shortened active working time.

Conclusions: The knowledge gained has already created the groundwork to expand the RSH intervention to other sugarcane mills in the region and other industries at-risk for heat stress. Climate change leads to more extreme temperatures in already impacted regions, but regions further north and south of the equator are also impacted by heat-related diseases. Thus, sustainable models to protect worker health and productivity must be developed, further evaluated and implemented more widely.

Impact of environmental heat and a rest-shade-hydration intervention program on agro-industrial worker productivity

Erik Hansson[1, 2], Jason Glaser[2], Ilana Weiss[2], Catharina Wesseling[2, 3], David Wegman[2, 4], Esteban Arias Monge[2, 5], Denis Chavarria[6], Kristina Jakobsson[1, 2, 7]

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Keywords: productivity, heat, occupational, kidney, prevention

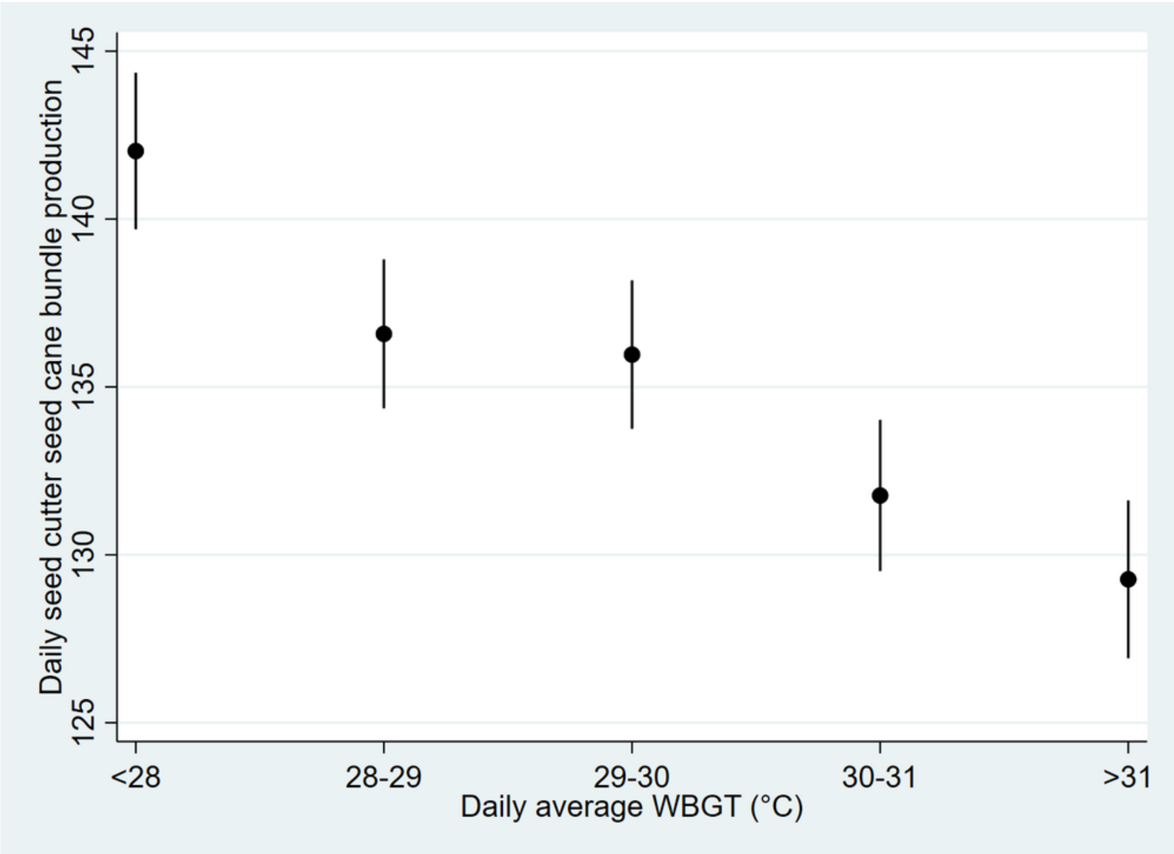
Introduction: Piece-paid Mesoamerican sugarcane cutters are at high risk of chronic kidney disease of non-traditional origin (CKDnt). These workers suffer from heat strain due to high metabolic heat production in a hot environment, resulting in hyperthermia and dehydration causing repeated kidney heat injury. Rest-shade-hydration (RSH) intervention studies support that CKDnt can be prevented by heat stress mitigation, but the impact of such efforts on productivity is not known. Quantifying the link between agricultural productivity and heat could help assess the vulnerability of low-and middle-income countries (LMICs) to global warming.

Methods: We accessed routine daily individual productivity data from 749 sugarcane seed cutters over 5 harvests, for a total of 102,280 worker-days, at Ingenio San Antonio (ISA), a large Nicaraguan sugarcane mill. An existing RSH intervention consisting of acclimatization, education, health monitoring, hourly rest, shade and hydration was gradually enhanced at ISA over these 5 harvests.

Hourly field-site wet-bulb globe temperature (WBGT) was recorded by mill staff and summarized as a daily mean. Mixed linear regression was used to model daily productivity, adjusting for age (18-29, 30-44 and >45 years), sex, WBGT (<28°C, 28-29°C, 29-30°C, 30-31°C and >31°C), harvest season (2017-18 to 2021-22), month, and acclimatization status (<1 week, 1-2 weeks and >2 weeks after start of harvest work).

Results: The daily productivity was approximately 15% higher in 2021-2022 than in 2017-2018. Over the same period, there was an inverse dose-response relationship between average workday WBGT and productivity, with workers producing approximately 10% less on days with an average WBGT >31°C than <28°C. Women, workers <45 years old and workers during their first 1 and 2 weeks of each harvest, i.e. not heat acclimatized, had a lower productivity.

Conclusions: This study adds to evidence from exercise physiology by providing workplace evidence of the link between high external heat exposure and reduced productivity. We found that workers had a higher daily productivity as the RSH intervention was enhanced, even though this led to a shortened active working time. A tentative explanation is that well-hydrated, euthermic and healthy workers are more productive while working, and that these beneficial effects was more than offsetting production losses from reduced working time. The improved productivity with enhanced RSH occurred in the presence of environmental heat effects over the harvests. This is relevant for countering challenges facing manual workers, their employers, and societies in LMICs as the climate gets warmer.



The CHAMNHA project: a behaviour change intervention to reduce the adverse health impacts of heat on pregnant and postpartum women and neonates

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Keywords: heat exposure, pregnancy, postpartum, behaviour change, Kilifi.

Introduction: High temperatures increase the risk of maternal complications and adverse birth outcomes. The Climate, Heat, and Maternal and Neonatal Health in Africa (CHAMNHA) consortium conducted qualitative research in Kilifi, Kenya, to examine perceptions of maternal and neonatal heat risks among women, household members, and community stakeholders. We found that heat adversely affects the health and wellbeing of pregnant and postpartum women and neonates, and impacts women's ability to perform household chores (including farming, fetching water and firewood). Women perform these chores while pregnant, regardless of the heat, which leads to exhaustion and other signs of heat stress. Knowledge of the dangers of heat for maternal and neonatal health was low in this community, highlighting the need health measures. We developed an intervention to sensitise and educate pregnant and postpartum women about heat exposure, the importance of hydration, frequent breastfeeding, and the need to shift harmful socio-cultural practices that may increase the vulnerability of women and their neonates. The intervention also sought to mobilise the support networks of pregnant and postpartum women (specifically, mothers-in-law and male spouses) and key influencers, such as community health volunteers (CHVs), chiefs, and religious leaders, to assist women with their heavy workload and to incorporate messages about the dangers of heat exposure into their daily work.

Methods: The intervention was co-designed. We used facilitated discussions using photographs and videos to raise awareness of the heat risks and to identify potential solutions to support women with their heavy workload. Groups included: (1) pregnant and postpartum women; (2) mothers-in-law and male spouses; and (3) community stakeholders and CHVs. Researchers then followed up the pregnant and postpartum women for four months to reinforce heat-health messaging and encourage them to take protective measures when it is hot. Mothers-in-law and male spouses were encouraged to support pregnant and postpartum women with their workload in the heat. Researchers attended weekly public meetings (‘*barazas*’), together with chiefs and church leaders, to disseminate heat-health messaging.

Results: Women and their support networks reported an improved understanding of heat effects on pregnant and postpartum women and neonates, including the importance of remaining hydrated, breastfeeding frequently, and not layering their new-borns with heavy clothing. The women also reported that their mothers-in-law and male spouses had started to assist with household chores and were disseminating heat-health messaging to other families outside of the intervention. Women with unemployed male spouses and younger mothers-in-law received more help than those with employed spouses and older mothers-in-law. Some reported that their spouses had challenges to perform activities traditionally associated with women, owing to stigmatization among their male peers.

Conclusions: Community approaches to supporting pregnant and postpartum women during periods of heat are feasible but shifts in behaviour take time. It is feasible to train key community influencers to include heat-health messaging in their daily routines. Research is needed to examine whether repeated training is needed to ensure sustainability. Future heat adaptation interventions focused on maternal and neonatal health should consider factors such as employment, age, and support networks.

Biological traits variability of schistosomiasis intermediate host snails (Bulinus and Biomphalaria) from three climatic zones of Côte d'Ivoire

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Keywords: biological traits, variability, Bulinus, Biomphalaria,

Introduction: Schistosomiasis is endemic throughout all regions of Côte d'Ivoire, however, species of the obligate intermediate snail host vary across bioclimatic zones. Hence, a deeper knowledge of the influence of climatic factors on the life history traits of the intermediate snail host is crucial to understand the environmental determinants of schistosomiasis in a rapidly changing climate. The aim of this study was to determine the responses to climate conditions of intermediate host snails of *Schistosoma* parasites from populations sampled in different climatic regions in Côte d'Ivoire.

Methods: A cross-sectional malacological survey was conducted in February 2021 in three localities in the south, center and north of Côte d'Ivoire. We sampled two populations of *Bulinus truncatus*, the intermediate host snail of *S. haematobium*, from northern and central Côte d'Ivoire, and two populations of *Biomphalaria pfeifferi*, the intermediate host snail for *S. mansoni,* from the southern and central regions. Snails were collected at the human-water contact sites and the first generation for each population was reared for 7 weeks. We used a common garden experiment under controlled laboratory conditions to estimate survival, somatic growth and fecundity in snails collected in the three different bioclimatic areas of Côte d'Ivoire.

Results: We found that *Bulinus* populations from the north showed higher survival and growth rates during the study and higher number of eggs at first reproduction, compared to the ones from the central region (5.51 ± 0.34 mm versus 5.31 ± 0.33 mm, P =0.008). For *B. pfeifferi*, no significant difference in survival rate was observed between the populations in the south and center, whereas those from the south had a higher growth rate and a higher number of eggs per individual at first reproduction (5.12 ±0.51 mm versus 4.29 ±0.57 mm, respectively, at week 7 (GLM ,P < 0.001).

Conclusions: This study highlights the variability of survival, growth rates, reproduction and fecundity parameters of the life cycle of populations of *B. pfeifferi and B. truncatus* according to the bioclimatic areas. Our common garden experiment showed that *B. truncatus* populations sampled in the north, a more arid climatic zone, exhibited higher survival rates than snails from population sampled in the central regions of Côte d'Ivoire. *Biomphalaria pfeifferi* from the southern population grew larger, matured faster and were more fecund than snail from the central population. Hardness of climatic conditions can select for traits that make individuals more resilient. If climate change creates harsher environmental conditions faster than snails can adapt, then we expect snails of the south and the center to adapt and those from the north to expand or shift toward south, but it is hard to say whether temperature will exceed the maximum critical threshold in the north.

Amplifying community voices: sharing experiences on climate change and health

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Keywords: community, health, climate change, co-design, video communication

Introduction: The importance of communicating climate change and health issues to the general public has become increasingly recognized. The aim of this presentation is to showcase how ***local community voices*** provide unique perspectives on climate change and health issues and how these fit into the development priorities as understood by local stakeholders. Local communities, particularly coastal communities in developing states, that are most affected by climate change and health issues are often underrepresented in mainstream media and public discourse so providing this platform can increase awareness of the challenges they face. Engaging local voices in video production may also help to build trust and engagement among the audience. Local messages, moreover, are more likely to resonate with the audience and be viewed as credible.

Methods: Through a series of 4 videos (https://www.youtube.com/watch?v=v7JZJSV4h08&t=633s) featuring a variety of community members from a set of rural coastal villages in Trinidad and Tobago, this presentation highlights how community narratives can demonstrate the impact of climate on the pre-existing challenges in individuals' lives, livelihoods, and communities. Co-design methods were used to engage communities to share their perspectives and experiences using authentic, understandable language and compelling stories. Video development and production involved many different stakeholders from a variety of sectors.

Results: The format of this presentation is structured as an interview with the researcher/producer. The interview questions and answers will be interspersed with video cuts that highlight different themes. This format will further explore the development, context, and content of the video series. The findings discuss how voices from local communities articulate needs and priorities related to health and climate change that many differ from national, regional, and global views. Findings reveal that challenges expressed by the community reflect pressing issues related to economic well-being, poverty, infrastructure, and other health issues. Community members from farming and fishing for example describe climate and weather-related impacts that add to the stressors related to poverty, unemployment and remoteness among other more challenges.

Conclusions: Creating and sharing videos on climate change and health using local voices and perspectives is vital as it can help to amplify underrepresented voices, build trust and engagement, mobilize action, and promote social justice and equity. By providing community members with platforms to share their experiences, perceptions, and perspectives, we can gain a deeper understanding of the complex interplay between climate change and health and the relevance and impact of these within the wider and pressing concerns of the local community. In turn, this understanding can contribute to more relevant and effective communication strategies that address local needs and priorities. By amplifying the voices of these communities and giving them a platform to share their experiences and perspectives, we can help to promote greater awareness and understanding of the social and economic injustices that underlie these issues.

Oral 5: Health impacts of heat stress

Regional variation in the role of humidity on city-level heat related mortality

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Keywords: humid heat stress, thermal discomfort, mortality, health impacts, excess deaths

Introduction: The continuing increasing humid heat stress is believed to be a severe threat to human survivability, and many humid heat indicators (HHIs) have been previously proposed to quantify its

severity. However, to date, there is a lack of robust epidemiological evidence associating them to city-level mortality. Moreover, the local-scale geographic and others features that make humidity relevant for heat-stress associated health risks remain unexplored. Here, we examine the suitability of multiple HHIs in modelling/predicting city-level human mortality in addition to the commonly used meteorological exposure variable air temperature (T_{air}), and quantify the spatial diversity of their performances.

Methods: We utilized well-established distributed lag non-linear models (DLNMs) to assess the exposure-response associations between multiple HHIs and daily human mortality, and used supervised machine learning methods to identify the key factors influencing the lethal heat stress type (humid vs. dry) experienced at the city level. The analysis is conducted using daily counts of all-cause or non-external cause deaths for 739 cities from 43 countries, with state-of-the-art epidemiological and climatological datasets.

Results: Our study revealed notable differences in the long-term trends and timing of hot days among these HHIs. Using HHIs produced a more accurate predictive model for city-level mortality in 521 of the 739 cities, whose most recognizable feature is a positive correlation between the daily air temperature and relative humidity during the warm season. Moreover, notable differences are found in heat-related excess deaths and length of heat stress period when quantified using HHIs. However, marginal differences were found in country-level excess deaths estimated using best-fit HHI and T_{air}.

Conclusions: Our analyses suggest many locations around the world vulnerable to humid heat stress for which HHIs are marginally better suited in modelling heat-related deaths compared to the commonly used T_{air}, though the uncertainty associated in the quantification of the predictive skills remains to be explored in future works. We also found that the correlation between daily T_{air} and relative humidity during the warm season explains best the type of lethal heat stress experienced at the city level. While our findings suggest that at broader regional scales such as country-level, T_{air} remains a more practical exposure variable for modelling public health impacts, our study has a potential to provide important insights for climate change health impact studies and the development of early warning systems for more localised urban heat stress.

Ambient temperature exposure and foetal size, foetal growth, and birth outcomes in three European birth cohorts

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Keywords: environmental health, climate change, foetal development, pregnancy, cohort study

Introduction: Climate change has resulted in increased temperatures and extreme weather events, with research finding adverse effects of extreme heat and cold during pregnancy on birth outcomes. However, studies have not examined the impact of temperature during pregnancy on foetal size and growth metrics. We aim to evaluate the association between temperature exposure during pregnancy

and foetal size, foetal growth, and birth outcomes in three European birth cohorts and identify susceptibility windows.

Methods: We studied 18630 pregnant women from the English Born in Bradford cohort, the Dutch Generation R Study, and four sub-cohorts from the Spanish INMA Project (Asturias, Gipuzkoa, Sabadell, Valencia). We estimated weekly levels of ambient temperature exposure at mothers' homes during pregnancy using the UrbClim™ model. Foetal size at mid and late pregnancy (estimated foetal weight, head circumference, and femur length) and birth outcomes (weight, head circumference, and length) were collected following guidelines within each cohort and converted into standard deviation scores (SDS). Foetal growth between mid and late pregnancy was calculated in grams or centimetres per week. Distributed lag non-linear models were fitted in each cohort separately to estimate the delayed association between weekly temperature exposure and each outcome, adjusting for various socio-economic characteristics. Coefficients were combined using a random effects meta-analysis to obtain the best linear unbiased predictions. All associations are in reference to the median temperature exposure.

Results: The INMA-Valencia cohort experienced the hottest temperatures (95th percentile at 28.5 ºC) and Born in Bradford the coldest (5th percentile at 1.2 ºC). Exposure to hotter temperatures was associated with a smaller change in weight (e.g., -4.2 g/week [95% CI -8.2; -0.2] at 21 ℃), femur length at mid pregnancy (e.g., -0.2 SDS [-0.5; -0.0] at 20 ℃) and birth length (e.g., -0.9 SDS [-1.8; -0.0] at 26 ℃). Exposure to cold temperatures was associated with a larger estimated foetal weight at mid pregnancy (e.g., 0.4 SDS [0.1; 0.7] at 7.0 ℃), and a smaller change in weight (e.g., -7.2 g/week [-13.7; -0.7] at 5.5 ℃), head circumference at mid pregnancy (e.g., -0.2 SDS [-0.4; -0.0] at 4.0 ℃), change in head circumference (e.g., -0.1 SDS [-0.2; -0.0] at 6.0 ℃), and femur length at late pregnancy (e.g., -0.6 [-1.0; -0,1] at 9.0 ºC). No associations were found with all other exposure windows and outcomes. We also observed three susceptibility periods. Exposure to temperature at 5.5 ºC in weeks 2 to 3 or at 21.0 ºC in week 18 was associated with a smaller change in weight. Exposure to temperature at 4.0 ºC in weeks 12 to 14 was associated with a smaller HC at mid pregnancy.

Conclusions: Exposure to hot and cold temperatures during pregnancy was associated with smaller foetal size and growth. Weeks within the first half of pregnancy seem to be susceptible periods for temperature exposure for the developing foetus. Additional research is warranted to further understand the long-term effects of temperature exposure on deviated foetal growth.

High and low temperature during pregnancy and childhood and brain structural connectivity in children

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Keywords: temperature, child neurodevelopment, neuroimaging, time series, cohort study

Introduction: Human activity is responsible for the greenhouse gas emissions situation, which has led to an increase in extreme temperatures, especially in urban settings. Both extreme heat and cold have been associated with mental health problems in children and adolescents. Cognitive functions may be also impaired by extreme temperatures; studies found that academic performance is worse under these circumstances. To date, temperature effects on children's brain have been assessed clinically, but the underlying brain alterations remain unexplored. Brain white matter microstructure organization appears to be suboptimal when cognitive functioning is impaired or psychopathological symptoms are present. Therefore, we evaluated the association between temperature exposure during pregnancy and childhood and white matter microstructure in preadolescents and adolescents, and attempted to identify susceptibility windows.

Methods: We used data from Generation R, a prospective population-based birth cohort based in Rotterdam, The Netherlands. We included 3542 children who had information on the exposure and good quality data from at least one magnetic resonance imaging (MRI) assessment performed at 9-12 (n=2867) and 13-17 years of age (n=1983). Daily mean temperatures were estimated at each participant's residential address with a 100x100m resolution using the UrbClim™ model. We used distributed lag non-linear models to assess the time-varying effects of temperature exposure – using one-week lags for pregnancy and 28-day lags for childhood (birth to 12 years) – on the brain structural connectivity parameters fractional anisotropy (FA) and mean diffusivity (MD). Lower FA and higher MD values correspond to a less optimally organized white matter microstructure. All models were adjusted by sociodemographic and lifestyle variables.

Results: The 50th percentile of mean temperature distribution for the study period was 12.2ºC, ranging from 0.8ºC (1st percentile) to 23.0ºC (99th percentile). We found lower FA values at 9-12 years related to both cold and heat cumulative exposure from conception to 8.5 years and concurrent higher MD

values related to heat cumulative exposure for the same period. FA values at 9-12 years were lower around 5ºC (β= -27.5, 95%CI -42.0, -12.9) and 23ºC (β= -34.9, 95%CI -52.4, -17.4) compared to 16.3ºC, identified as the optimum temperature. MD values were higher around 23ºC (β= 18.0, 95%CI 1.6, 34.3) compared to 16.3ºC. In particular, the exposure between the second trimester of pregnancy until 5-7 years of age explained the delayed effects, of both cold and heat, observed in FA and MD at 9-12 years. No associations were found between heat and cold cumulative exposure from conception to 12.5 years of age and FA and MD at 13-17 years.

Conclusions: Exposure to low and high temperatures during the prenatal period and from birth until middle childhood, was associated with a delayed development of white matter microstructure in children 9-12 years of age, but not at 13-17 years. These findings suggest that the effects of temperature exposure observed in preadolescence may be attenuated at a later age. Further research is required to elucidate the long-term effects of temperature exposure on children's brain and neurodevelopment.

The effect of heat on daily mortality in 10 cities in India

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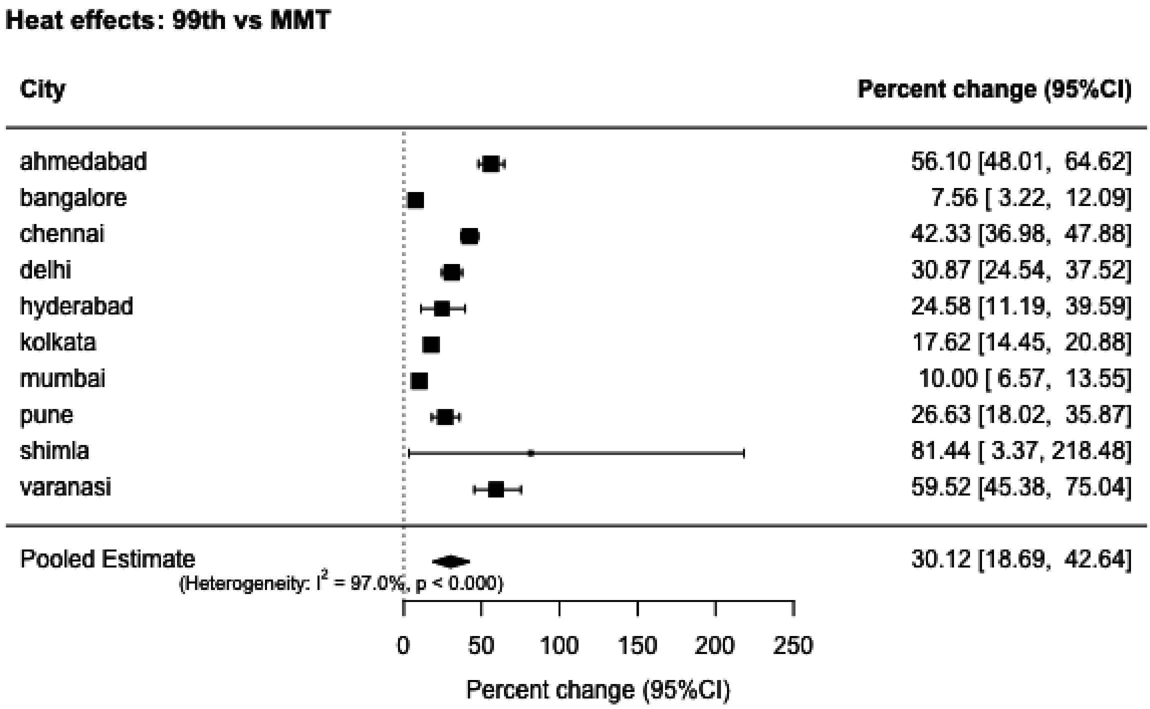
Keywords: heat, mortality, short-term effects, India, climate change

Introduction: Extreme heat influence human health, and are expected to rise within the context of climate change. Only limited evidence is available in India, which is characterized by extreme heat events and having the largest population in the world. In this study, we evaluated the association between daily high temperatures and all-cause mortality, and we quantified the attributable fraction to nonoptimal ambient temperature.

Methods: We applied a time-series analysis including all-cause mortality counts for ten cities in India between 2008-2019. We obtained city-wide daily mean temperature levels from satellite data. We estimated city-specific nonlinear effects of temperatures through a generalised additive Poisson regression model, and then meta-analysed the estimates. The effect estimates were reported as the percentage change in daily mortality, with 95% confidence intervals (CI), for an increase in mean 5-day average temperature (lag 0-4) from the minimum mortality temperature (MMT) to the 99th percentile. We further estimated the attributable deaths for heat exposures (99th) as temperatures above the MMT.

Results: In this study including more than ~3.6 million daily deaths, we observed that an increase of temperature from the MMT to the 99th percentile was associated with a percent change of 30.1 (95%CI: 18.7; 42.6) in daily mortality. Large differences were observed across cities, as highest effects were observed in Varanasi [59.5 (95%CI: 45.4; 75.0)] and lowest effects in Bangalore [7.6 (95%CI: 3.2; 12.1)]. In total, 2.6% (95%CI: 1.8; 3.3) of mortality was attributable to extreme heat temperatures above the MMT, with the highest attributable fraction found in Ahmedabad [5.2% (95%CI: 3.1; 7.2)] and Varanasi [4.6% (95%CI: 2.3; 7.0)]

Conclusions: To our knowledge, this is the largest time-series studies in India finding very strong effects of extreme temperatures on daily mortality. The results of this study emphasize the importance of policymakers to plan public health interventions to prevent present and future health risks of extreme temperatures.


Heat effects: 99th vs MMT
City
Percent change (95%CI)
ahmedabad
bangalore
chennai
delhi
hyderabad
kolkata
mumbai
pune
shimla
varanasi
56.10 [48.01, 64.62]
7.56 [3.22, 12.09]
42.33 [36.98, 47.88]
30.87 [24.54, 37.52]
24.58 [11.19, 39.59]
17.62 [14.45, 20.88]
10.00 [6.57, 13.55]
26.63 [18.02, 35.87]
81.44 [3.37, 218.48]
59.52 [45.38, 75.04]
Pooled Estimate
(Heterogeneity: I^2 = 97.0%, p < 0.000)
30.12 [18.69, 42.64]
0
50
100
150
200
250
Percent change (95%CI)

Integrating adaptation scenarios informed by SSPs in projecting temperature-related mortality burdens under climate change: a case study in Scotland

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Keywords: temperature extremes, climate change, socio-economic factors, mortality, Scotland

Introduction: The health burdens of high and low temperatures vary with temperature, population size, ageing, and adaptation. While some research has shown that adaptation contributes substantially to the uncertainties in future mortality burdens related to temperature, previous studies have mainly concentrated on the effects of climate change with adaptation frequently disregarded or assessed using arbitrary and unsupported assumptions. In addition, previous studies predominantly assume a decrease in the vulnerability to heat under climate change scenarios because of heat acclimatisation. The heat burden in future worlds with decreased adaptive capacities to heat is rarely explored, which is a probable situation where the vulnerabilities are intensified, e.g. as experienced during recessions and the COVID-19 pandemic. Therefore, this study utilises an evidence-based approach to construct adaptation scenarios with both high and low adaptive capacities informed by the Shared Socioeconomic Pathways (SSPs) and aims to investigate future mortality burdens associated with extreme temperatures in Scotland under consistent climate and socioeconomic scenarios.

Methods: The temporal variations in the association between daily mean temperature and mortality (TM) were estimated for two age groups (0-74, 75+) in Scotland in the historical period between 1974-2018, which was assumed to reflect changes in socioeconomic adaptive capacities to extreme temperatures. Three future scenarios on adaptive capacities were constructed in line with the SSPs (high under SSP1, low under SSP3 and 4 and no change under SSP2 and 5). The TM associations were constructed for each adaptation scenario based on the historical variations in the susceptibility to extreme temperatures. The TM association under adaptation scenarios were combined with temperature data under climate change and population data under the SSPs to estimate future mortality burdens associated with extreme temperatures up to 2060-2080 under five main RCP-SSP scenarios.

Results: The mortality burden attributable to extreme heat and cold in Scotland was estimated to be the highest under RCP8.5-SSP5 and RCP4.5-SSP4 respectively considering changes in climate, socioeconomic adaptive capacity and population. The combined heat and cold burden were the lowest under RCP2.6-SSP1. The adaptive capacity played the largest role in the cold burden and temperature rise drove the increase in the heat burden. The magnitude of the burden increased due to population ageing under the SSPs.

Conclusions: This study projected the mortality burdens attributable to extreme temperatures in Scotland under climate change and adaptation scenarios informed by both empirical evidence and the SSPs. Heat is projected to be a substantial health concern under climate change, even in a cool place such as Scotland. The lower mortality burden attributable to extreme temperatures under RCP2.6-SSP1 than the other scenarios reinforces the health benefits of climate change mitigation and adaptation.

Exploring the association between drought and mortality in South Africa

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Keywords: drought, cause-specific mortality, gender assessment, South Africa

Introduction: Drought is among the most complex and severe climate-related hazards. This phenomenon affects millions of people and contributes to water and food insecurity, malnutrition, poverty, and ultimately mortality. South Africa is highly vulnerable to drought, however, its impact on human health remains unclear

Methods: We applied a two-stage time series analysis to assess the association between droughts of different duration and mortality (all causes; infectious and parasitic diseases; endocrine, nutritional and metabolic diseases; circulatory diseases; respiratory diseases) in the 52 district municipalities of South Africa between 2009 and 2016. We identified different types of drought events using the weekly Standardized Precipitation Evapotranspiration Index (SPEI) calculated at different time scales: 1,3,6,9 accumulation months (short, short/medium, medium, and long-term droughts, respectively). We estimated risks for each time scale of the SPEI, sex, age categories and specific causes of mortality. Relative risks were calculated for each unit of increase of drought severity represented by the negative scale of the SPEI using normal conditions as the reference.

Results: All types of drought events were associated with an increased risk of all-cause mortality, with particularly larger risks for short-term droughts (RR [95%CI]: 1.044 [1.035,1.053). By causes, mortality due to circulatory diseases and infectious and parasitic diseases seemed to be mostly associated with short-term droughts (1.047 [1.034, 1.06], 1.037 [1.023, 1.051], respectively), while for endocrine, nutritional, and metabolic diseases, and respiratory diseases, it tended to be mainly associated with prolonged droughts (1.042 [1.008, 1.077], 1.064 [1.04, 1.088], respectively). Overall, slightly higher risks were found in pre-adults, younger adults and men for shorter droughts, and females and the youngest and oldest population groups for prolonged droughts. However, the differences were not statistically significant. Drought-mortality risk was particularly pronounced in children for medium-term droughts.

Conclusions: Drought events were associated with an increased mortality risk in South Africa. Our results suggest that drought effects on specific causes of death may differ according to different drought duration. Further evidence on the role of social conditions in drought-related mortality risks is needed to implement more effective measures.

Oral 6: Inequities in climate change impacts and health risks

Advancing the right to health in planetary health

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Keywords: Right to health, climate justice, health inequities, extreme weather events

Introduction: Global planetary warming and extreme weather events (EWE) have impacted the health and well-being of approximately 5 billion people. However, due to social inequities, these effects have vastly different impacts across populations. In this context, countries must act to protect community health and well-being. Central to an equitable protective response is community engagement and participation, fairness, and accessibility in the design, plan, and delivery of climate policies and inclusivity. Also, to understand the complexity of climate-related emergencies on health and to formulate an effective response action, we need to involve communities in climate policymaking and incorporate and strengthen solutions that already exist locally.

A rights-based approach - framed in terms of the right to health and underlying determinants of health – allows us to develop this understanding as it holistically addresses the circumstances of those most at risk and analyses and highlights inequalities, discriminatory practices, and unjust distributions of power. In designing policies for climate-related emergencies, a rights-based approach must adhere to the following core principles: participation, equality and non-discrimination, accountability, and transparency.

Despite this, existing climate change efforts rarely tackle the adverse human rights impacts of climate change. Rights-based frameworks remain underused tools for accountability and monitoring in climate-related EWE. Human rights indicators are a means of measuring progress in governmental obligations. Yet, climate change health indicators, such as those developed for the Lancet Countdown to track the complex ways in which climate impacts health, do not currently consider a rights-based approach.

Methods: Demonstrating evidence of the impact of human rights-based approaches is complex. It challenges diverse groups to bridge methodological differences, like what constitutes evidence and its impact. We proposed a hybrid workshop to discuss the means to applying the right to planetary health. Preparations for the workshop took place over six months with the goal of including a diverse group of stakeholders working on the climate impacts on community mental health.

Results: In October 2022, a hybrid workshop led by climate, health, and human rights scholars at Stanford University examined how the right to health can address the mental health and wellbeing of communities affected by climate change. Presenters addressed concepts of a rights-based approach to health, such as: What might implement a rights-based approach to health looks like in policy and community-based context? What evidence could inform the vulnerability drivers and recovery mechanisms in the context of climate disasters?

Conclusions: We propose that the right to health can be translated into measurable indicators in the context of climate disasters. These health indicators are designed within a contextual framework that accounts for community needs and priorities could form the basis of an adaptable, community-based tool that allows for the monitoring of rights-based obligations in health and provides a means for accountability of governmental action to provide resilient health services in the context of climate change.

Unraveling the Social Determinants of Climate Impacts on Mental Health: An ethnographic study in two vulnerable Bangladeshi communities

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Keywords: climate change, mental health, social determinants, vulnerable, Bangladesh

Introduction: Climate change represents one of the most significant public health challenges of our time, with its impact on mental health becoming an increasingly important concern. The complex interplay between social determinants, climate impacts, and mental health outcomes, however, remains insufficiently understood. Our study aims to deepen our understanding of the social determinants of climate impacts on mental health, and provide insights to inform policies and interventions addressing this critical public health issue.

Methods: We employed ethnographic methods, including participant observation, in-depth interviews, and focus group discussions, to collect data from two vulnerable communities in Bangladesh. These communities were selected based on their susceptibility to climate change impacts: an urban slum in a large city and a rural area exposed to both chronic and acute events. Participants were recruited using snowball sampling. In total, 3 FGD and 62 participants were interviewed for this study, comprising 38 women and 24 men. Data analysis was conducted using a thematic analysis approach.

Results: Our study found that social determinants play a significant role in shaping the relationship between climate impacts and mental health outcomes. Firstly, social status was identified as a key factor exacerbating the mental health impacts of climate change. Participants reported experiencing stress, anxiety, and depression due to the impacts of climate change on their economic security and livelihoods. Secondly, the combination of environmental events and economic conditions on participants' social trajectories appeared to be a precipitating factor for mental health outcomes. In the slum setting, acute environmental events such as flooding and heatwaves exacerbated mental health issues, while in the rural area, long-term environmental degradation combined with acute events were linked to chronic mental health issues. The environmental effects on participants' survival-oriented economic strategies led to a negative feedback loop on the mental health of these communities. Finally, gender was also found to influence the mental health impacts of climate change, with women being particularly vulnerable due to their gender roles and responsibilities. Women in these communities faced additional challenges such as increased domestic work, childcare, and food insecurity.

Conclusions: To tackle the social determinants of mental health amid climate change and associated inequalities, it is essential to explore the configuration of determinants, encompassing the intricate links among diverse factors and events (social, environmental, economic), and the differences in accessing resources and opportunities. The dynamics of interrelations within these configurations are decisive, shaping individual trajectories with varying mental health outcomes. Prominent determinants

found within these configurations involve social status, gender, economic strategy, and the interplay between environmental occurrences and economic aspects at the community level. Policies and interventions targeting mental health promotion in the context of climate change should take into account these intersectoral climate change impacts to mitigate the mental health effects.

Case Study on a Wintertime Slip Injury in Helsinki – Inequity Perspective

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Keywords: sidewalk, slipperiness, pedestrians, injuries, sick leaves

Introduction: About one third of Finnish population slip and fall every winter on slippery sidewalks and about 50 000 slip injuries – mainly fractures – require medical attention. More than half of the injuries happen to women. The annual costs of slip injuries have been estimated to be from 1.4 to 2.4 billion euros annually. These estimates include the direct costs of medical care, sick leaves and reduced well-being. Finnish Meteorological Institute has developed a model to predict slippery conditions and issues specific warnings about slippery sidewalks for pedestrians to prevent slip injuries. Awareness of the slip and fall risks among Finns has increased over time and e.g., the use of anti-slip guards is common. However, the incidence of slip-and-fall injuries remains high. Winters are becoming milder because of changing climate, and as consequence the slippery sidewalk conditions are becoming more frequent in mid-winter.

Methods: As a meteorological topic expert of slip-and-fall injury risks, I will present a narrative of my own slip injury in January 2023, and describe both meteorological conditions and other confounding factors that lead to realization of the slip and fall risk on icy sidewalk. Based on the narrative I will extend the discussion on generic level on psychosocial factors affecting behaviour of people at risk and the role of sidewalk winter maintenance contributing to the risk. Furthermore, I will discuss the costs of slip injuries for society.

Results: On Jan 12, 2023, FMI operational weather service had issued a warning for pedestrians on slippery sidewalks in Helsinki region. However, there were substantial differences on the slipperiness of sidewalks within the city due the varying quality of winter maintenance. Regardless of understanding the risks on the very slippery surface conditions, I slipped on the icy sidewalk after day at work with a consequence of a fracture in the wrist. The fracture needed an operation and led to several weeks' sickness absence. The quality of life was reduced due to limitations in activities and deteriorating physical fitness. The case study supports the results of surveys on pedestrian slip injuries in Finland.

Conclusions: Wintertime slip injuries may lead to long sick leaves and substantial costs for health care and society. However, winter maintenance of sidewalks is often poorer quality than the winter maintenance of roads. This indicates that walking is not considered as an equal form of transport compared to road traffic. Further development towards higher spatial resolution in sidewalk weather observations and predictions are needed as well. On the individual level, awareness campaigns may help in reducing the slip-and-fall risks.

Extreme urban heat increases death in drug overdose: predictive modeling, Phoenix, USA

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Keywords: climate, overdose, opioid, amphetamine, death

Introduction: Unintentional drug overdose (OD) is a major health issue in the USA which disproportionately impacts underserved communities. An important, but underappreciated risk for OD death is high environmental temperature. Phoenix, the fifth largest US city (1.8 million; Phoenix metropolitan area (PHX) 4.95 million), experiences the highest temperatures among the 100 largest US cities (Tmax 50^{o}C). Its rapid growth has also resulted in marked a rise in summer minimum temperatures (Tmin), an indicator of the urban heat island effect. Tmin is important in heat related mortality. Previous studies have shown that most deaths during environmental heat events are not registered as deaths from heat-related illness, in terms of ICD10 code, but rather as deaths from a wide range of disease comorbidities (eg sepsis, myocardial infarction, respiratory diseases) which increase during heat events. Moreover, individual sensitivity to heat stress differs widely based upon both the well understood vulnerability factors of age and exposure, as well as disease comorbidities and health related social needs. We examined the temporal pattern of OD death in PHX to explore the association between elevated ambient temperature and OD mortality.

Methods: We investigated the temperature-OD deaths association in two stages. Initially, we used weekly data on total OD deaths in Maricopa county (https://www.azdhs.gov/opioid/#dashboards-overdose-deaths), the geographic area of PHX, for the period 2017-2021 and the corresponding weekly mean land surface temperatures for Day and Night retrieved from the MODIS sensor onboard the Aqua satellite (2 m above surface of PHX) as the exposure variable. We then investigated the influence of a range of potential modifying factors including analysis of housing, death at home or in hospital, comorbidities, age, sex, race, and access to health care using the Arizona Health Care Cost Containment System and birth and death records from the Bureau of Vital Records, Arizona Department of Health Services. To improve the temperature exposure variables, we built a land-use regression model using a broader set of data, including monitoring station data, ERA5 reanalysis data, land-use data, NDVI.

Results: Our initial analysis demonstrated a significant ($p<0.005$) association between night-time temperature and OD mortality through July-August even though research has shown that 16% of sudden deaths, 19% of motor vehicle fatalities, 20% of occupational heat deaths are drug related, thus underestimating OD related death. We are currently merging more granular datasets from climate, comorbidities, chart reviews of heat attributed deaths, all cause hospitalizations. and health related social needs to build computational risk model of both OD death and hospitalizations.

Conclusions: High ambient temperature may be a risk factor for OD deaths. The magnitude of impact of heat may be underestimated since a proportion of deaths where opioids and amphetamines are present are classified as heat alone, accident, or sudden death and not included in OD data. Further merged dataset analysis will provide a better understanding of the impacts of specific climate patterns, disease comorbidity associations, and health related social needs. This understanding will offer the ability to predict individual risk and vulnerability phenotypes for use by health systems and public health planning.

Modelling vulnerability to heat stress: transdisciplinary research on heat-related risks for human health in cities

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Keywords: vulnerable groups, heat stress, urban heat, climate impacts

Introduction: Climate change affects human health by exacerbating disease (morbidity) and death (mortality) rates. With heat waves increasing in frequency and intensity due to global warming, the risk of heat stress is expected to become more prominent in the future. Urban populations, in particular, face amplified health risks to the elevated temperatures in the built environment.

Recent epidemiological evidence suggests that population groups with certain demographic and socio-economic characteristics such as age, sex, education, and income are associated with increased risk of mortality and morbidity during heat events. Older adults (aged ≥ 65 years), children (aged < 5 years), infants (aged <1 year), women or those with low socio-economic status or pre-existing health conditions are more vulnerable to the health risks associated with climate change. Furthermore, evidence shows that vulnerability decreases with higher degrees of education.

Research on the impacts of heat on human health, however, consists mostly of studies carried out at the regional, national or city level, with a focus on total population mortality and morbidity outcomes. Decision makers require local information to develop and implement adaptation solutions targeting those most vulnerable. Findings from coarse resolution data on aggregated (total) population may mask differences in vulnerabilities of certain population subgroups and thus may not provide the information that is needed.

Methods: We address the research gaps related to scale and demographically differentiated vulnerabilities in two steps. First, we develop a framework for quantifying differential vulnerability based on demographic variables at very high resolution (census tract level - approximately 2400 intra-urban subdivisions) for the case study of Madrid. Spatial and temporal decadal projections between 2010 and 2050, using Bayesian model averaging are developed in line with three scenarios of the Shared Socioeconomic Pathways (SSPs): SSP1 - sustainable development, SSP2 - middle-of-the-road and SSP3 – regional rivalry. Here, educational attainment is used as a proxy for socio-economic status. Second, we develop high resolution climate projections by dynamically downscaling global climate simulations from the Coupled Model Intercomparison Project phase 6 (CMIP6) to realize convection-permitting, 1 km horizontal resolution simulations for Madrid, using the Weather Research Forecasting (WRF) model. We then combine the WRF output with the vulnerability projections and health data in Madrid, to develop projections of mortality risk attributable to urban heat stress. The resulting modelling framework aims to investigate the empirical drivers of change in the heat-related mortality risk and compute future projections using Bayesian additive regression trees, a method that is useful for integrating non-linearity in causal inference.

Results: The resulting spatiotemporal distributions of vulnerable population groups (differentiated by age, sex, and level of education), and their projected changes enables spatial mapping of vulnerable areas at the intra-urban level and projected changes of vulnerability patterns and their associated health outcomes across three alternative scenarios.

Conclusions: This research framework informs local decision-making regarding the development of adaptation strategies that target specifically vulnerable groups, with the aim to decrease the burden climate change might impose on future public health. The framework is transferable to other location but the degree of detail in the projections depends on the input data.

Ambient temperature and cardiovascular-respiratory adverse health outcomes in Spain

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Keywords: temperature, cardiovascular and respiratory diseases, morbidity, mortality, socioeconomic factors

Introduction: Ambient temperature is a major environmental determinant of cardiovascular and respiratory health. However, evidence on the association between temperature and cause-specific cardiovascular and respiratory health outcomes is still limited. Moreover, little is known about the differential effects across population groups and the contextual factors that exacerbate or reduce vulnerability. We aimed to comprehensively assess the association of temperature (including heat waves and cold spells) with cause-specific emergency hospital admissions and mortality from cardiovascular and respiratory diseases as well as the effect modification of this association by individual and contextual factors in Spain.

Methods: We collected data on health (hospital admissions and mortality), weather (temperature and relative humidity) and relevant contextual indicators for 48 provinces in mainland Spain and the Balearic Islands during 2004-2019. The statistical analysis was separately performed for the range of months mostly causing the heat- (June-September) and the cold- (December-March) related morbidity/mortality. We first applied a generalised linear regression model with quasi-Poisson distribution to estimate province-specific temperature-health associations, and then we fitted multilevel multivariate meta-regression models to evaluate effect modification of the contextual characteristics on heat- and cold-related health risks.

Results: Health risks were almost wholly dominated by daily mean temperature, while heat waves had a minor contribution. Health risks varied widely depending on cause-specific disease, sex (higher in women), age (higher for infants and the elderly) or education (higher for less educated). Heat did not contribute to the risk of hospitalisation from cardiovascular diseases, but it considerably increased the risk of mortality across all the analysed cardiovascular diagnoses, with the strongest effect for hypertension (RR at 99th temperature percentile vs optimum temperature: 1.505 [1.251 to 1.809]) and heart failure (1.505 [1.343 to 1.687]). Heat also had an impact on all respiratory hospitalisations (excepting asthma), with similar risks between pneumonia (1.239 [1.197 to 1.283]), acute bronchitis and bronchiolitis (1.279 [1.196 to 1.368]) and COPD (1.279 [1.168 to 1.401]), whereas the impact on mortality from pneumonia (2.244 [1.825 to 2.759]) was the strongest. Risks related to cold were generalised to all cardiovascular and respiratory diseases, with heart failure (RR at 1st temperature percentile vs optimum temperature: 1.630 [1.419 to 1.873]) and acute myocardial infarction (1.585 [1.245 to 2.019]) showing the greatest risk for hospitalisation, and ischaemic heart diseases (1.880 [1.552 to 2.278]) for mortality. Moreover, regarding respiratory diseases, COPD (2.159 [1.938 to 2.405]) had the highest risk for hospital admission due to cold, and pneumonia for mortality (2.013 [1.400 to 2.896]). Results from meta-regression showed that the removal of spatial inequalities in heating access could reduce cardiovascular hospitalisations and deaths due to cold in 39.4% (95% eCI 34.2 to 48.6) and 39.8% (34.1 to 51.0), respectively.

Conclusions: Exposure to heat and cold temperatures was associated with a greater risk of morbidity and mortality from multiple cardiovascular and respiratory conditions, and heating was the most effective societal adaptive measure to reduce cold-related cardiovascular health outcomes. This evidence holds important implications for climate change health adaptation policies, and for the projections of climate change impacts on human health.

Oral 7: Climate resilient health systems

Evaluating wildfire risk against hospital facility location: a perspective to inform health facility resilience globally

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Keywords: resiliency, fire, risk, health systems, GIS mapping

Introduction: Fire events across the planet are more extensive, more frequent, and more intense than ever before and present an increasing threat to essential services, including health care facilities. Despite the essential nature of health care facilities, there remains a limited awareness in the health sector of the potential impacts, vulnerabilities, and therefore overall risk of the health care sector to climate-change-responsive environmental hazards such as bushfires. Direct and indirect impacts on individual facilities, for example closures, can have ripple effects across a regional health system, with implications for EMS transportation, patient safety, and access to emergency healthcare. The escalating threat of bushfire, the vital role that hospitals play, and the current uncertain level of risk to these facilities at individual, regional, and national scales calls for further investigation into the risk of bushfire to health care facilities and is the impetus for this study.

Methods: Inpatient facilities from the Australian Institute of Health and Welfare Myhospitals database were geospatially mapped against publicly available data sets on fire risk for each Australian state to determine each facilities distance from fire risk zones. Complexity was added by each state defining bushfire risk differently (i.e., high/low/medium, or binary risk/no risk). This data was then analysed to provide a risk profile for the potential threat of fire to the Australian health system as a whole, and for each state individually.

Results: Most health care facilities in Australia fall within fire risk zones. This is particularly significant in regional and rural areas, as there may be considerable distances between hospitals and the loss of an operating hospital can present an insurmountable barrier to care, particularly when social and economic factors prevent travel. The variation between data classification and availability across states prevents adequate preparedness on a national scale.

Conclusions: This research is intended to aid development of resiliency through providing information that can inform a system wide approach to bushfire risk assessment, and to enable decision makers to rethink health care facility resiliency in a community wide context. This research is the first study in Australia to evaluate the risk not only to individual health care facilities, but also across health care systems, and the first globally to do this on a national scale. This has significant implications for displaced populations and continuity of care for patients. The loss of a health care facility, or of access to it, has profound implications on the ability of a community to receive care, particularly at a time of crisis when care needs may be increased.

The importance of preparedness in a community wide context (as opposed to individual facility risk planning in isolation) and the importance of data sharing and homogeneity of data across large geographical areas are critical lessons that can be extrapolated to other countries across the globe. This study prompts an important discussion relevant on a global scale of the importance of health system preparedness that involves a community wide approach, and broader concepts of population displacement and climate impacts on facilities, and planning for these.

Developing a Theory of Change for "net zero" healthcare at sub-national level in Europe through stakeholder engagement

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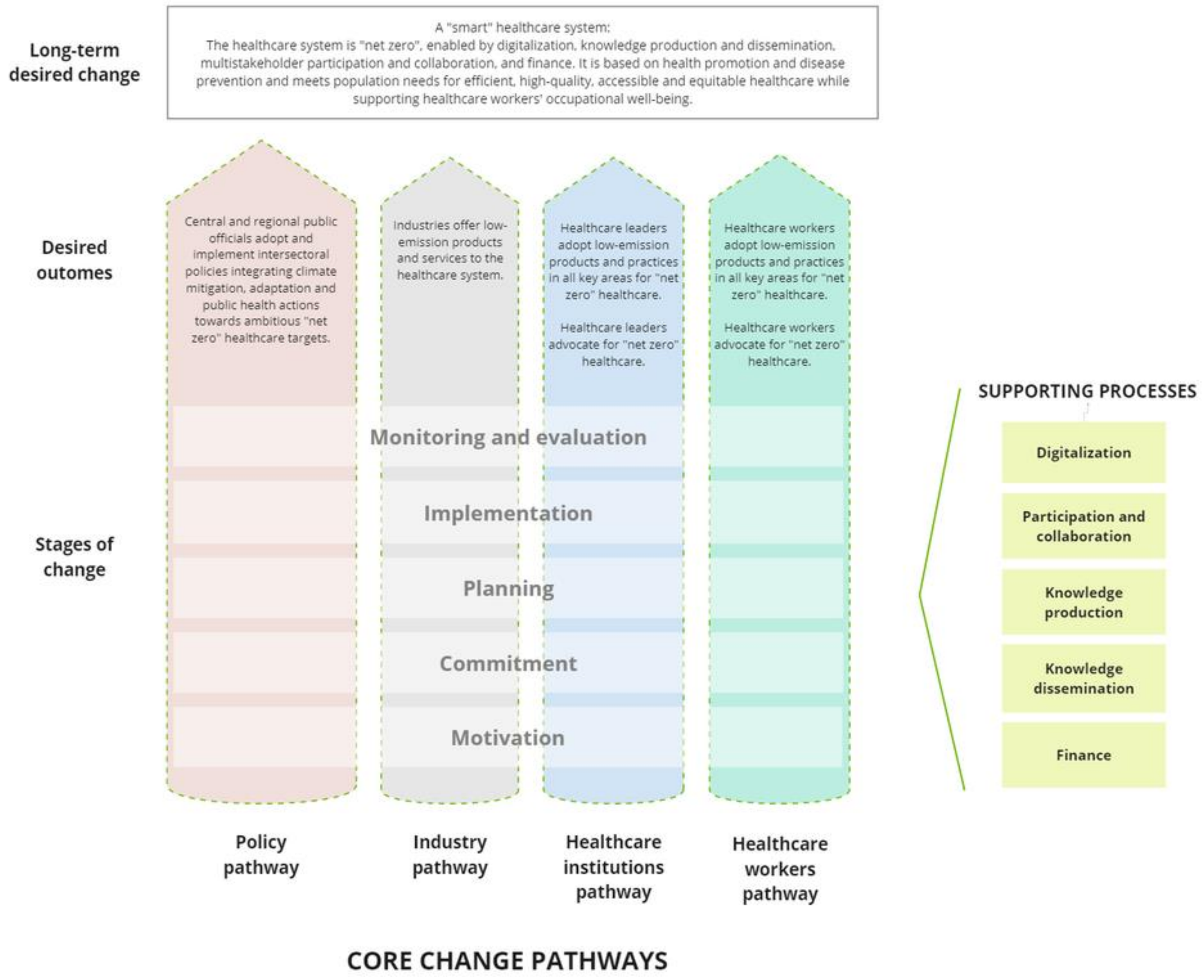
Keywords: knowledge translation, stakeholder engagement, theory of change, climate mitigation, healthcare

Introduction: Healthcare systems paradoxically contribute to the climate crisis and to its' growing burden of disease. Healthcare fuels climate risks by generating over 5% of global greenhouse gas (GHG) emissions and millions of tons of air pollutants. As a result, research and recommendations to develop sustainable "net zero" healthcare systems are on the rise. Effective knowledge translation strategies are needed to translate these recommendations into practice, taking into account social, political and behavioural change challenges in addition to technical aspects. The multi-stakeholder research project "Climate Action To Advance HeaLthY Societies in Europe" (CATALYSE) aims to tackle these challenges. There is a need to orient researchers' efforts in knowledge production and dissemination by answering the question: How can healthcare systems change towards sustainability, and how can scientific evidence contribute to this change in the real world? In this context, a Theory of Change (ToC) approach is a multi-stakeholder co-creation process which can help explain how and why change towards sustainable health systems can happen in Europe.

Methods: The general objective of our study was to initiate the co-creation of a Theory of Change for climate change mitigation in healthcare at sub-national level in Europe, integrating the perspectives of academic and non-academic stakeholders. Qualitative participatory methods integrating Theory of Change practices and policy change theories were used to gather stakeholders' perspectives on a case study of the Catalan healthcare system. Twelve stakeholders in Catalan healthcare participated in six virtual focus groups and remote co-creation activities. Participants included government officials, climate mitigation experts, healthcare institution leaders, healthcare workers and researchers from the CATALYSE project. Thematic and axial analysis of data was used to generate themes, categories and sequential relationships.

Results: A Theory of change (ToC) with a long-term desired change of a "net zero" healthcare system was developed. Key stakeholder groups for change were identified and described. Change was explained through sequences of necessary events co-constructed based on stakeholders' perspectives. Events were categorized into four core change pathways (policy, industry, healthcare institutions and healthcare workers) and five supporting processes (digitalization, participation and collaboration, knowledge production, knowledge dissemination, finance). Change in every pathway and process was explained through a sequence of events taking into account context-specific political, social and operational constraints in five stages of change: motivation, commitment, planning, implementation and monitoring and evaluation. The role of knowledge production and dissemination in the change process was explained through stakeholders' views, and allowed to identify opportunities for researchers to contribute to change towards "net zero" health systems at sub-national level.

Conclusions: The Theory of change (ToC) approach allowed to generate a detailed, sequential, context-specific multi-stakeholder understanding of expected change processes and implementation constraints towards "net zero" healthcare systems in a sub-national setting in Europe. The ToC can inform climate and health knowledge production and dissemination to increase the social impact potential of research, generate hypotheses for future research and monitor the advancement of climate mitigation efforts in healthcare. The ToC methodology is useful to engage diverse stakeholders in constructive dialogue and collaboration on climate and health challenges.



Breaking down the WHOs climate change and health assessment framework to a regional level – first results of a systematic vulnerability assessment

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Keywords: climate resilience, vulnerability assessment, healthcare system, indicators, data visualization

Introduction: The impacts of climate change on human health and healthcare systems exhibit complex interrelationships, varying across time and space. Population groups already disadvantaged due to their demographics, health, socioeconomic status, or geographical location tend to be particularly vulnerable to climate-related health risks. Our work aims to identify those vulnerabilities and conditions of double burden by conducting a structural quantitative vulnerability assessment on a regional level in Austria.

Methods: Based on the WHO framework on Climate Change and Health Vulnerability and Adaptation Assessment (2021), a Climate-Resilience-Check Health *(KLIC Health)* for Austrian municipalities and regions has been developed and an assessment of vulnerabilities has been carried out. To transfer the international framework on climate-sensitive vulnerabilities into Austrian "data reality", a comprehensive set of indicators for the representation of the different relevant vulnerability dimensions (demographic, socio-economic, biological and health-related, socio-political, and geographic/climate) was compiled. Data mapping was carried out to systematically prepare the quantitative data basis for assessment on a regional level. To map also smaller-scale vulnerabilities and to enable a differentiated analysis of different vulnerabilities, the defined health care regions were used as a spatial reference.

Results: The WHO framework was adapted to adequately fit the Austrian regional context and a set of 28 quantitative vulnerability indicators was compiled. This data mapping revealed multiple challenges. Whereas data availability was the main obstacle for geographical indicators like drought, storm, and flood risk zones, the application and suitable adaptation of the socio-political indicators like freedom of speech or political instability, suggested by the WHO framework, are not available on a regional level or not applicable for a country of the Global North at all.

Results of individual vulnerability indicators were visualized as geographical maps and spider charts to allow for easy and understandable communication to regional stakeholders, policymakers, and affected population groups. Specific regions could be identified that appear to be particularly vulnerable due to their population composition, disease burden, and geographical location (e.g., *Waldviertel* or *East Tyrol* with disproportionately high shares of persons over 65 years of age, heart attacks, and heat stroke while having a low density of hospital care; Eastern Austria with disproportionately high shares of persons under 18 years of age, chronic diseases, and heat days per year).

Conclusions: The WHO proposes assessments to make health systems resilient to climate-sensitive health risks. The future health status of the population will largely depend on how current strategies are successful in reducing climate-sensitive health outcomes. Systematically assessing vulnerabilities is key to identify pressure points and pre-existing inequalities in population groups. The *KLIC Health* offers a standardized methodology to increase climate-resilience of regional health systems and is align with the WHO assessment framework. Its vulnerability assessment is based on a multidisciplinary and

multidimensional perspective. Our work derived concrete quantitative indicators for each of the five vulnerability dimensions and an easily understandable visualisation. This facilitates the implementation of climate change adaptation measures tailored to regionally requirements. Furthermore, it transfers an international framework into the European context and eases the integration of health in National Adaptation Plans.

Climate change and public health: barriers and levers for implementation of climate adaptation in Europe (qualitative thematic analysis)

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Keywords: climate change, public health, adaptation, barrier, facilitator

Introduction: Climate change has significant implications for population health and wellbeing. Climate adaptation policies (reducing health impacts from climate change) are being implemented across Europe at national and local levels driven by high-level political action, public support, and more extreme weather. The European Climate Law [2021] commits the European Union and its Member States to make continuous progress to boost adaptive capacity, strengthen resilience and reduce vulnerability to climate change. All countries in the EU now have national climate adaptation policies but the extent to which these actions or policies address public health is limited. Implementation of climate adaptation action in the public health community is underestimated.

Aim: Identify key issues in climate adaptation implementation for public health in Europe.

Methods: Key informant interviews were undertaken with decision makers in international, national, and local governments across 20 European countries (Norway, England, Cyprus, Spain, Ireland, Finland, Lithuania, Belgium, the Netherlands, Sweden, Latvia, Italy, Estonia, Austria, Croatia, France, Germany, Hungary, Denmark, and Scotland) following WHO stakeholder analytical framework. Participants were recruited if based in European governments, working in public or environmental health, and involved in climate adaptation policy. An interview schedule with key themes (barriers, public health agenda, levers, networks, evidence needs, and COVID-19 recovery) was used. Transcripts were thematically analysed. Interviews were conducted online, recorded, transcribed, and analysed through Nvivo. LSHTM Research Ethics committee approved this study in June 2021 (Ref No. 25707).

Results: 32 interviews were completed between June-October, 2021; four international, five national level and 23 city-level decision makers or network representatives. Most reported inadequate resources for health adaptation implementation (funding, training, and personnel) and the marginal role of health in climate adaptation policy. Having a clear mandate to act was key for climate and health adaptation implementation and resource allocation. It is seen as critical to have public support for the implementation of interventions and the prioritisation of action at city and national levels. A key reported challenge was limited departmental cross-collaboration across governance levels, and city-level stakeholders were less aware of the public health role in climate change policy. European-level stakeholders reported strength in ability to coordinate expertise to national and regional-level governance partners highlighting the importance of interagency and inter-sectoral collaboration e.g.

WHO Healthy Cities Network. Furthermore, participants acknowledged that health in all policies is necessary for adaptation implementation across government.

Conclusions: Across Europe, there is varied progress in the implementation of climate-health adaptation. Providing appropriate resources, inter-departmental collaboration, training, knowledge mobilisation, and multi-level governance support will facilitate climate and health policy implementation. Integrating public health into all policies is key for delivering climate adaptation action.

Effects of ambient temperature on preterm birth, stillbirth, and low Apgar score in South Africa: a case-crossover analysis

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Keywords: ambient heat, temperature extremes, preterm birth, stillbirth, Apgar score

Introduction: Exposure to high ambient temperature during pregnancy has been shown to increase the risk of preterm birth (PTB) and stillbirth. However, evidence is lacking from sub-Saharan Africa. There is also limited information on the role of individual risk factors, including chronic conditions, that may increase pregnant women’s susceptibility to heat-related adverse birth outcomes. This study evaluates acute effects of ambient temperature extremes on risk of preterm birth (PTB), stillbirth, and low Apgar score (indicating poor physical condition of the new-born) in a low-income urban setting in sub-Saharan Africa.

Methods: Time-stratified case-crossover analysis of 18,226 singleton live PTBs (<37 weeks’ gestation), 4,201 stillbirths, and 748 cases of low Apgar score (≤3 at 5 minutes of age) between April 2016 and March 2022 in Soweto, South Africa. Gridded daily mean temperatures (ERA5-Land reanalysis) were linked with outcomes by date of delivery and location of birthing facility (n=10). Low and high temperatures were defined as the 5th and 95th percentiles of daily mean temperature, respectively, and compared with the temperature of minimum effect (TME). We explored effect modification by season of birth, facility type, infant sex, maternal age, parity, and HIV status.

Results: High temperature (22.5°C vs TME) 0-6 days before delivery was associated with an increased risk of preterm birth (odds ratio [OR]=1.07, 95% CI: 1.02 to 1.12) and stillbirth (OR=1.19, 1.02 to 1.39). Point estimates of association between high temperature and stillbirth were greater among women living with HIV, women who gave birth in primary (vs tertiary) facilities, younger women (<35 years), and female foetuses. Women living with HIV were also at slightly higher risk of PTB when exposed to high temperatures than women without HIV (OR=1.13, 1.02 to 1.25 vs OR=1.07, 1.00 to 1.14). Low temperature (9°C vs TME) 0-6 days before delivery was associated with an increased risk of stillbirth among nulliparous, but not multiparous, women (OR=1.74, 1.02 to 2.97; OR=0.93, 0.65 to 1.34, respectively) and with an increased risk of PTB among HIV-negative women (OR=1.24, 1.01 to 1.52),

but not among women living with HIV (OR=0.94, 0.69 to 1.29). Exposure to high or low temperatures did not increase risk of low Apgar score.

Conclusions: High ambient temperatures increase the risk of preterm birth and stillbirth in a low-income setting. To our knowledge, this is the first report of potential effect modification by maternal HIV status. Overall, a positive HIV status appears to increase sensitivity to adverse effects of high temperature and protect against adverse effects of low temperature. Further research is needed to understand the physiological mechanisms behind this finding.

Challenges and opportunities for climate change and health policies & financing in the African region

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Keywords: climate change and health, climate financing, health policy, evidence to decision, Africa

Introduction: Climate change and weak health systems are two of the most pressing issues facing Africa. They interact in sometimes unexpected ways and present great challenges as evidenced by the human health impacts of extreme heat, nutrition implications of extreme droughts, compound emergencies arising from floods, locust outbreaks, and COVID-19 seen in 2020. This is exacerbated by the lack of interaction and coherence between the often-siloed climate change and health communities of practice. Another impediment to the development of effective climate-health policies is limited financing. Most African countries have no budget allocation for climate change and health related activities. In addition, international financing has been unfairly distributed to the African region increasing the burden of climate change health risks, especially to the vulnerable population. It is imperative that people working on climate or health issues coordinate and develop new ideas together on how to effectively develop policies and financing climate induced health risks. The CHANCE network aims to bring together policy makers, research climate scientists, and other stakeholders on climate change and health in Africa to coordinate their work, and develop new ideas together. The network falls within an international climate and health network of research projects called ENBEL (Enhancing Belmont Research Action to support EU policy making on climate change and health), which is funded by the EU Horizons program. The CHANCE network aims to develop synergies in East and Southern Africa; advance policy making across the region; facilitate knowledge exchanges, learning and cooperation; and provide support for national or regional applications for funding climate change and health programming and research. In June 2022, the CHANCE Network organized a conference in Pretoria for stakeholders to collaborate on climate change and health policy development and work together to take advantage of available climate financing in the region and globally. This paper aims to determine the challenges and opportunities for climate change and health policies and financing in the African region based on the current knowledge base and outcome from the CHANCE Network Pretoria meeting.

Methods: The CHANCE Network, funded through the ENBEL project, organised a workshop in Pretoria in June 2022 and 55 participants consisting of policymakers, international researchers and public health experts participated. Data were collected from presentations and breakout groups. With permission from participants, presentations were recorded and notes taken during group discussions. Recordings were transcribed, and together with notes were thematically analysed.

Results: Data analysis is on-going and the final results will be presented at the conference.

Conclusions: The results from this study will be instrumental to inform policy and identify opportunities for policy development and climate financing in the African region. Funding is a contributor to implementing national policies. Without resources the policies cannot be implemented. Therefore, this study will help draw a connection between effective policy development and financing to strengthen health systems resilience in Africa.

Oral 8: Climate hazards and population exposure

High-resolution projections of ambient heat for major European cities using different heat metrics

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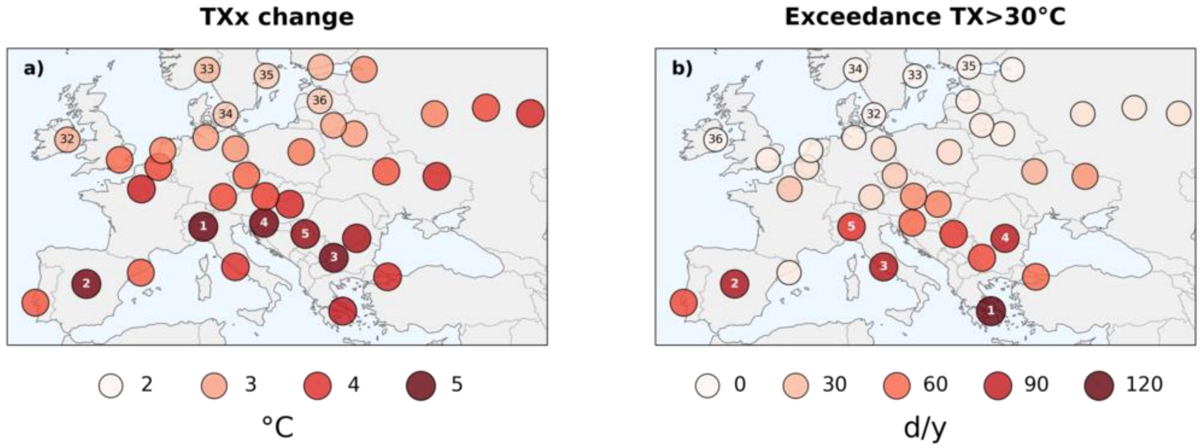
Keywords: climate change, ambient heat, heat metrics, climate models, adaptation

Introduction: Heat stress in cities is projected to strongly increase due to climate change. The associated health risks will be exacerbated by the high population density in cities and the urban heat island effect. However, impacts are still uncertain, which is among other factors due to the existence of multiple metrics for quantifying ambient heat and the rather coarse spatial resolution of most climate models. Here we investigate projections of ambient heat for 36 major European cities based on a recently created ensemble of regional climate model simulations for Europe (EURO-CORDEX) at 0.11° spatial resolution (~12.5 km). The 0.11° EURO-CORDEX ensemble provides the best spatial resolution currently available for an ensemble of climate model projections for the whole of Europe and makes it possible to analyse the risk of temperature extremes and heatwaves at the city-level.

Methods: We calculate three different temperature-based heat metrics based on climate data from the EURO-CORDEX ensemble to analyse projections of ambient heat at 3 °C warming in Europe compared to 1981-2010. The heat metrics are 1) changes in yearly maximum temperature between 1981-2010 and the time of 3 °C warming in Europe, 2) the number of days with temperatures exceeding 30 °C at 3 °C warming in Europe, and 3) Heat Wave Magnitude Index daily (HWMId) at 3 °C warming in Europe. We separately investigate daytime conditions (based on daily maximum temperatures) and night-time conditions (based on daily minimum temperatures). Further, we analyse how the location of cities as well as their temperature climatology and the projected changes in temperature influence the spatial patterns of ambient heat projected by the three metrics, and we compare the results to climate projections from global Earth system models.

Results: Southern European cities will be most affected by high levels of ambient heat, but depending on the considered metric, cities in central, eastern, and northern Europe may also experience substantial increases in ambient heat (Figure 1). In several cities, projections of ambient heat vary considerably across the three metrics, indicating that estimates based on a single metric might underestimate the potential for adverse health effects due to heat stress. Night-time ambient heat shows similar spatial patterns as daytime ambient heat, except for HWMId, which is much higher during night-time. The identified spatial patterns of ambient heat are generally consistent with results from global Earth system models, though with substantial differences for individual cities.

Conclusions: Our results emphasise that using different metrics for projections of ambient heat gives important insights into the risk of future heat stress that might be otherwise missed, e.g., in the preparation of heat adaptation plans. Further, the results highlight the importance of high-resolution climate model simulations for analysing climate extremes at the city-level, particularly for cities located close to the sea. Improving the representations of urban areas in climate models would make their simulations even more valuable for planning adaptation measures in cities.



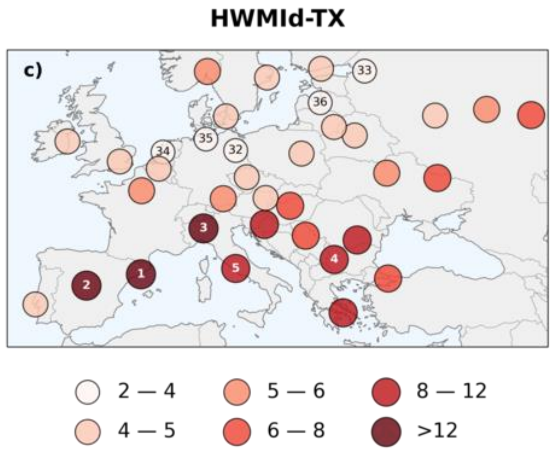


Figure 1: Projections of ambient heat at 3 °C European warming according to three different metrics for 36 major European cities as simulated by the EURO-CORDEX ensemble. a) Change in yearly maximum temperature (TXx) between 1981-2010 and 3 °C European warming, b) exceedance rate of TX>30 °C at 3 °C European warming, and c) Heat Wave Magnitude Index daily based on TX (HWMId-TX) at 3 °C European warming. The values indicate the median of the EURO-CORDEX ensemble. Numbers in the circles from 1 to 5 (32 to 36) indicate the five cities with highest (lowest) ambient heat according to the different metrics.

The burden of temperature-related neonatal deaths attributable to climate change in 29 Low- and Middle-income countries

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Keywords: temperature, stillbirths, neonatal deaths, climate change, attribution

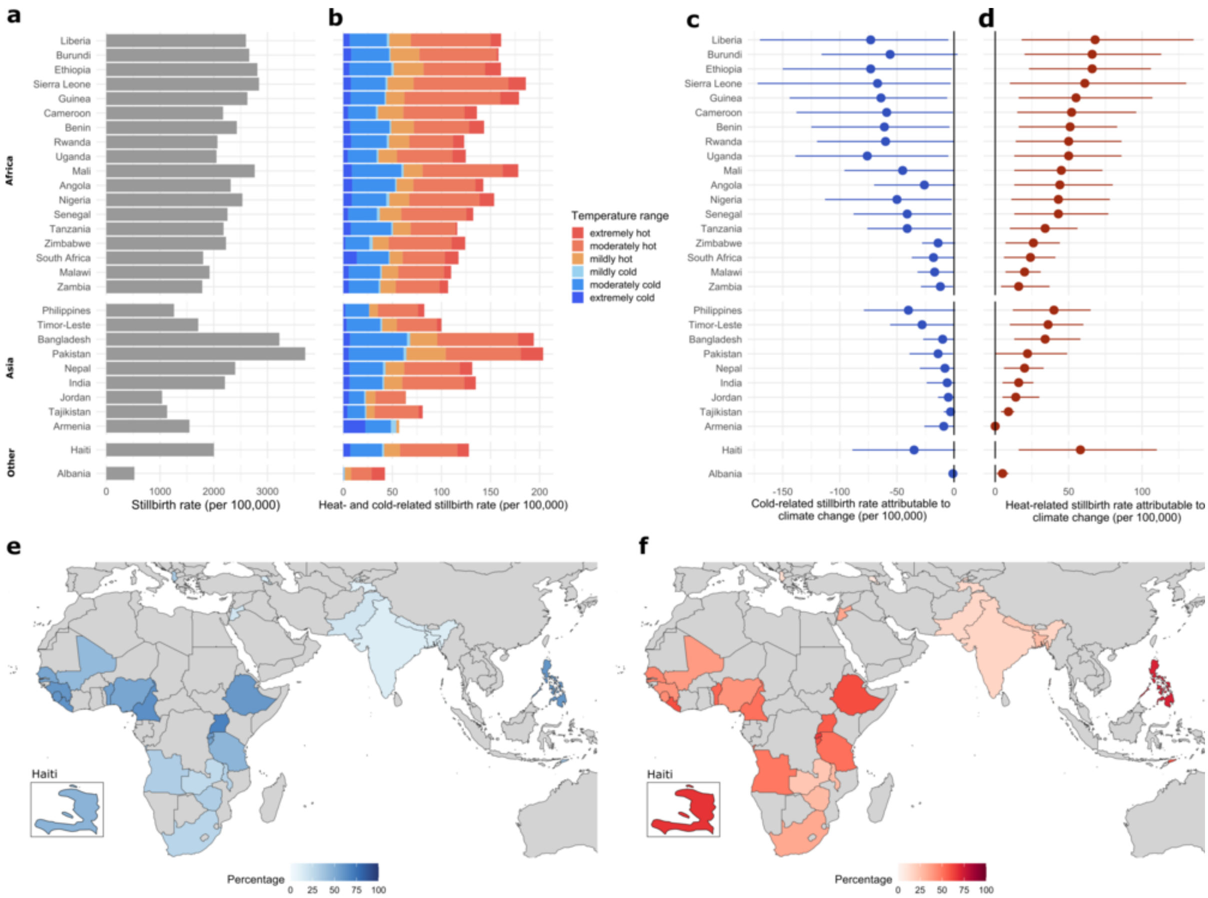
Introduction: Climate change is increasingly affecting the health of vulnerable populations, including pregnant women, the developing foetus and new-borns. There is growing epidemiological evidence on the association between ambient temperatures and stillbirths and neonatal mortality. A few studies so far have quantified these exposure-response relationships in low- and middle-income countries (LMICs), where the majority of the global burden of stillbirths and neonatal death occurs. However, none of them has attempted to isolate the role of historical climate change in the temperature-related disease burden.

Methods: We combine data from the Demographic Health Survey (DHS) for 29 low- and middle-income countries with global observational data generated within the Inter-Sectoral Impact Model Intercomparison Project (ISIMIP) to quantify the non-linear and delayed association between daily mean temperature and stillbirths and neonatal deaths. We estimate the associations using a time-stratified case-crossover design and apply a distributed lag nonlinear model on the pooled data across all countries. Based on the exposure-response functions we estimate the burden of temperature-related stillbirths and neonatal deaths under two scenarios – a factual scenario consisting of three reanalysis temperature datasets and a counterfactual scenario generated from the reanalysis datasets by using a novel de-trending methodology to remove long-term variations due to climate change. We obtain the excess number of stillbirths and neonatal deaths attributable to climate change by subtracting the temperature-related burden between the factual and the counterfactual scenarios accordingly.

Results: The results for stillbirths and neonatal deaths indicate a J-shaped and an inverse J-shaped exposure-response function, respectively, with risk of mortality increasing below and above an optimum temperature. Overall, 6 % of stillbirths and 4.3% of neonatal deaths in the period 2001-2019 were associated with sub-optimal temperatures in the factual scenario. We find that across all

countries, climate change has increased the burden of heat-related stillbirths by a third (range: 8-72%) and doubled heat-related neonatal deaths (range: 19-79%), while reducing the respective cold-related burdens by approximately a third. Climate change impacts on child health have been uneven, with largest losses from increased heat but also gains from decreased cold observed in African states.

Conclusions: Our results demonstrate that by altering outdoor temperatures climate change is already directly affecting pregnancy outcomes and the survival of new-borns in LMICs across the world, both by exacerbating heat-related and alleviating cold-related stillbirths and neonatal deaths. While the decline in the cold-related burden may facilitate the reduction in total stillbirths and neonatal deaths, with ongoing climate change these gains are likely to be outstripped by progressively increasing heat-related mortality. Our findings add to the accumulating evidence of the large burden of climate change on the health of younger generations and underscore the need of ambitious mitigation and effective adaptation measures to safeguard the health of most vulnerable populations.



Recent extreme heatwaves are dwarfed by projected future events

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Keywords: extreme heat, heat exposure, heatwave trends

Introduction: In recent decades, unprecedented heatwaves have resulted in substantial impacts on human health and their environment. Previously, heatwave trend analysis has largely focused on trends across global warming thresholds or on specific regions. Furthermore, a variety of diverse heatwave parameters has been applied across separate studies, hampering direct comparison. What is more, there has been limited information on how future projections of individual events compare to recent extreme heatwaves.

Methods: In our study, we define heatwaves as periods of at least three consecutive days where daily area-weighted mean temperature exceeds the regional 90th percentile. We utilize a comprehensive analysis framework based on four heatwave parameters and additional sub-parameters where appropriate: (1) heatwave duration in days, (2) heatwave severity, an intensity index enabling interpreting excess heat relative to the regional climatology, (3) cumulative heat, and (4) percentage of locally affected area. The latter is an area-based parameter developed for this study providing information on the exceedance of local (grid cell level) climatology thresholds during the course of an individual heatwave in percent of the respective region's overall area. For parameters (2) and (4) we, moreover, investigate two sub-parameters, namely median and maximum values. The first sub-parameter refers to the median value of the entire heatwave, whereas the second indicates that this maximum value is being reached for at least one day during the event. This analysis framework greatly increases the ability for individual heatwave-based and regional intercomparison, and, furthermore, explores both regional as well as local scale trends, thereby providing critical human-impact-oriented information. In addition to daily output from multi-model ensembles from models taking part in the Coupled Model Intercomparison Project Phase 5 and 6 and a large initial-condition CanESM5 ensemble, we employ our framework to 14 regional events observed during the period of 2010-2021 and analysed based on Berkeley Earth and ERA5 reanalysis products. This provides crucial insights into how future heatwaves compare to recent events.

Results: Our results indicate that recently observed extreme heatwaves are dwarfed by projected 21st century events. Moreover, without even moderate reduction in greenhouse gas emissions the probability of reoccurrence or exceedance of these recent extreme reference values is significantly increasing, and they are still plausible under aggressive emission reduction scenarios.

Conclusions: In conclusion, we can see that a lack of mitigation and adaptation measures could considerably increase human exposure to extreme heat. In particular as we found, depending on the scenario, significant increases in the percentage of locally affected area and the heatwave severity. Thus, these findings stress the necessity for substantial and ambitious mitigation efforts and for considering heatwaves well outside the lived experience for adaptation strategies, to limit human exposure to such intense heatwaves and avoid the most severe consequences.

Mortality due to extreme temperatures in South Korea by SSP scenarios

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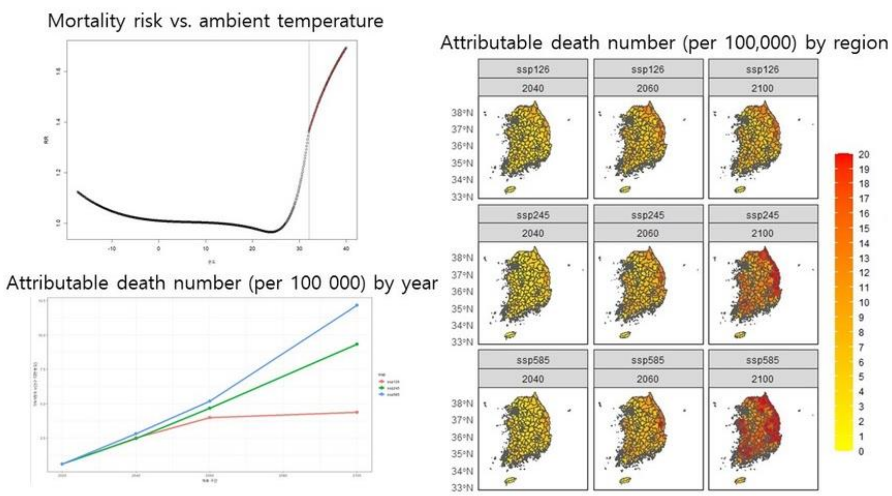
Keywords: SSP scenario, heat wave, mortality, attributable deaths

Introduction: This study tries to forecast district-level attributable mortality brought on by upcoming heat waves and cold waves in South Korea using SSP scenarios. Additionally, we attempted to assess the district characteristics that were susceptible to future burdens brought on by climate change.

Methods: The analysis of this study was done in three parts. First, utilizing daily temperature and death data for each district over the preceding 20 years (2000-2019), the relationship between temperature and death for each district was quantified. The best linear unbiased predictor from a meta-regression research employing district-level regional characteristics was then used to construct the temperature—mortality model for each district. In addition, the attributable deaths in the years 2021-2040, 2041-2060, and 2081-2100 was estimated using daily temperature and mortality data for the SSP 126, SSP 245, and SSP 585 scenarios. The final criteria for cold wave and heat wave were 2.5% and 97.5% percentiles of previous temperatures, respectively.

Results: From 2000 to 2019, the annual average number of deaths attributable to heat or cold waves was 366. According to the SSP 126 scenario, heat or cold waves were expected to be the cause of 935 yearly deaths from 2021 to 2040, 2308 deaths from 2041 to 2060, and 2,387 deaths from 2081 to 2100, respectively. These numbers are 2.8, 6.3, and 6.9 times greater than the baseline (2000 to 2019). An estimated 1,378 fatalities per year on average (3.8 times) from 2021 to 2040, 4,121 deaths per year (11.3 times) from 2041 to 2060, and 7,668 deaths per year (21.0 times) from 2081 to 2100 were based on the SSP 245 scenario. The number of days with cold waves will continue to decline as the temperature rises in the future, however the number of days with heat waves will grow quickly. The majority of projected deaths were brought on by heat waves rather than cold waves. We have shown that we must take immediate action to cut greenhouse gas emissions or a catastrophic health burden will soon be upon us.

Conclusions: Using SSP models, we calculated future heat-related mortality in South Korea. By different scenarios, the number of deaths attributable to heat will grow by up to 10 times by 2100.



Projecting future temperature-mortality impacts under various population and climate change scenarios; the role of population development

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Keywords: climate change, projections, demography, temperature, impacts

Introduction: Climate change and progressive population development (i.e., ageing) are altering the temporal patterns in temperature-related mortality in Switzerland. However, limited evidence exists on how current trends in heat- and cold-related mortality would evolve in future decades under composite scenarios of global warming and population development. Moreover, the contribution of these drivers to future mortality impacts is not well-understood. Therefore, we aimed to project heat- and cold-related mortality in Switzerland under various warming scenarios based on a set of emission and population development pathways and to disentangle the contribution of each of these two drivers using high-resolution mortality and temperature data.

Methods: We combined age-specific (< 75 and ≥75years) temperature-mortality associations in each district in Switzerland (1990–2010), estimated through a two-stage time series analysis, with 2-km downscaled CMIP5 temperature data and population and mortality rate projections under two scenarios: RCP4.5/SSP2 and RCP8.5/SSP5. We derived heat and cold-related mortality for different warming scenarios (1.5°C, 2.0°C and 3.0°C) using different emission and population development trends and compared this to the historical period (1990–2010).

Results: We estimated that heat-related mortality will increase from 312 (116; 510) in the 1990–2010 period to 1,274 (537; 2284) annual deaths under 2.0°C scenario (RCP4.5/SSP2) and to 1,871 (791; 3,284) under 3.0°C scenario (RCP8.5/SSP5). Cold-related mortality will substantially increase from 4069 (1898; 6016) to 6558 (3223; 9589) annual deaths under 2.0°C scenario (RCP4.5/SSP2) and to 5997 (2951; 8759) under 3.0°C scenario (RCP8.5/SSP5). Moreover, while the increase in cold-related mortality is solely driven by population development, for heat, both components (i.e., changes in climate and population) have a similar share of around 50% to the projected heat-related mortality trends.

Conclusions: In conclusion, our findings suggest that both heat- and cold-related mortality will substantially increase under all scenarios of climate change and population development in Switzerland. Population development will lead to an increase in cold-related mortality despite the decrease in cold temperature under warmer scenarios. Whereas the combination of the progressive warming of the climate and population development (i.e., ageing) will further exacerbate heat-related mortality, leading to a substantial increase in the total temperature-related mortality burden in Switzerland.

Temperature modifies the association between air pollution and respiratory disease hospitalisation in an industrial area of South Africa

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Keywords: temperature, air pollution, respiratory disease, hospitalisation, South Africa

Introduction: There have been limited investigations into the modifying effects of temperature on the health impacts of air pollution in Africa, and no studies have explored the effects of black carbon on respiratory disease (RD) hospitalisations. The aim of this study was to assess whether the association between RD hospitalisations and air pollution in the Vaal Triangle Air Pollution Priority Area was modified by the apparent temperature (Tapp) between January 2013 and February 2020.

Methods: RD admission data (ICD10 J00-J99) were obtained from two hospitals located in Vanderbijlpark and Vereeniging. Ambient PM10, PM2.5, BC, NO2, SO2 and O3, temperature and relative humidity data were obtained from six monitoring stations. A case-crossover epidemiological study design was applied. Lag0-1 was investigated, i.e. the average air pollutant level on the day and the day before hospitalisation. Regression models were adjusted for public holidays and Tapp. Effect modification was investigated by stratifying days into low, moderate and high Tapp days. Susceptibility by age and sex was investigated.

Results: Out of a total of 43386 hospital admissions, 50.9% were females and 51.4% were children aged 0-14 years. Air pollutants exceeded the World Health Organization's (WHO) daily air quality guidelines on more than 50% of the days. Moderate Tapp, in general, exacerbated the adverse effects of PM2.5, PM10, SO2, and BC, while high Tapp amplified the effects of NO2 and O3. The elderly and females were more susceptible to the effects of air pollution, particularly on days with moderate Tapp.

Conclusions: The findings suggest that the risk of hospitalisation for RD due to exposure to ambient air pollution varies on days with low, moderate and high Tapp in Vanderbijlpark and Vereeniging.

POSTER PRESENTATIONS

Poster discussion 1: Health impacts of heat stress

Impacts of ambient heat exposure on acute kidney injury

Shakoor Hajat[1], Anna Casula[2], Daniel Omoyeni[1], Peninah Murage[1], Tom Gray[2], Zoe Plummer[2], Retha Steenkamp[2], Dorothea Nitsch[1, 2]

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[2]UK Renal Registry

Keywords: heat, acute kidney injury, climate, case-crossover study, UK

Introduction: High ambient temperature is increasingly recognised as a risk factor for Acute Kidney Injury (AKI), however this has not been extensively explored in the UK setting. Identification of high-risk patients is crucial for targeted intervention measures designed to reduce the health impacts of current and future climate change. The automated e-alerts system run by the UK Renal Registry (UKRR) provides a unique opportunity to link exposure information to acute kidney injury (AKI) episodes. We use these data to characterise acute relationships between climate variability and AKI episodes and identify important modifiers of heat risk in renal patients.

Methods: Episodes of AKI were obtained from the UKRR who receive automated e-alerts of AKI when triggered by a short-term change in serum creatine level in renal patients. Each AKI episode occurring between April-September in years 2017-2021 was linked to daily temperature measures at postcode sector level using data from the 1kmx1km HadUK-Grid dataset modelled by the Met Office. A fixed-stratum case-crossover design was used to assess associations between high temperatures and AKI matched on day-of-week.

Results: Over 1 million AKI episodes were successfully linked to exposure data. The number of reported alerts were lowest on Sundays and Saturdays, most likely due to fewer blood samples being processed by laboratories at weekends. There were clear spikes in alert counts associated with heat-wave episodes. The odds of an AKI episode increased by 2.1% for every 1°C increase in maximum temperature above 20°C based on a distributed lag of 0 and 1 day.

Conclusions: This study identifies the climate conditions when renal patients are at greater risk of an AKI episode which can inform intervention measures such as the national heat-plan. Renal patients should be advised to undertake preventative measures whenever hot weather is forecast.

The cost of inaction: comparative projection of heat and cold-related mortality in 854 European cities under climatic and socio-economic scenarios

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Keywords: temperature, mortality, climate projections, Europe, urban areas

Introduction: It is well established that heat and cold widely impact human health with differing degrees of vulnerability across Europe. In a climate change context, this matter of fact calls for action to adapt to changing temperatures, to avoid the temperature-related mortality situation to worsen. In this contribution, we assess the expected impact of heat and cold under future climatic conditions under the assumption that no adaptation occurs, providing a picture of the human cost of inaction. We account for projected demographic changes as well as risk differentials across age groups.

Methods: We consider temperature series extracted from 21 general circulation models (GCM) from NASA-NEX for 854 European cities in the period 2015-2099, as well as country level projections of population and death rates from the Wittgenstein Centre. Using recently derived age-group and city-specific exposure-response functions, we compute expected excess death rates by decade for three SSP/RCP scenarios, namely SSP1/RCP2.6, SSP2/RCP4.5 and SSP3/RCP7.0. We also assess excess death rates for three warming targets that are 1.5°C, 2.0°C and 3.0°C above pre-industrial levels. Uncertainty around the estimates is computed through Monte-Carlo simulations.

Results: Preliminary results indicate a slight decrease of cold-related mortality due to climate change only, although it increases when considering the expected aging of the population. By contrast, heat-related mortality shows a clearly increasing trend, largely overtaking the decrease in cold-related deaths which results in a positive net effect in all considered scenarios. By 2090-2099, we estimate a net increase of 13.1 (95%eCI: 7.6 – 33.3), 28.3 (95%eCI: 16.2 – 26.4) and 72.2 (95%eCI: 28.1 – 108.0) deaths per 100,000 person years compared to historical levels for the three scenarios respectively. These trends show wide spatial heterogeneity with a slight decrease in temperature-related deaths expected in few Northern cities with a minimum of -11.2 (95%eCI: -15.7 – 17.7) deaths by 100,000 person-years in Ireland under the SSP2/RCP4.5 scenario. By contrast deaths are expected to widely increase in the Mediterranean area and in central Europe with a maximum increase of 261.1 (95%eCI: 101.9 – 336.4) deaths by 100,000 person-years in Malta under the SSP3/RCP7.0 scenario. Spatial patterns are consistent between scenarios with mainly the magnitude of the impact being affected.

Conclusions: We find a clear net effect of climate change on temperature-related health showing that failing to adapt to climate change is expected to result in an important mortality burden, even under the mildest scenarios. This burden is expected to be especially heavy in the Mediterranean region as well as central Europe.

Heat and perinatal mortality: a time-stratified case-crossover study from 16 hospitals in Benin, Malawi, Tanzania and Uganda

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Keywords: heat, perinatal mortality, short-term study, Sub-Saharan Africa

Introduction: Evidence is increasing that women and their offspring are negatively affected by sudden extreme heat events, but very few studies have examined the effect of these events on perinatal deaths in Sub-Saharan Africa where temperatures are rising in the context of climate change. In this study, we assessed the acute effect of ambient temperature on perinatal mortality in four Sub-Saharan African countries.

Methods: We applied a time-stratified case-crossover study including 89,271 singleton births in a prospective observational study in 16 hospitals in Benin, Malawi, Tanzania and Uganda between July 2021 and December 2022. The study included mothers aged 13-49 years seeking childbirth care at any of the 16 included hospitals. Perinatal deaths included stillbirths, defined as the death of a fetus before onset of labor or during labor and weighing at least 1000 grams, and neonatal deaths within 24-hours after birth. Daily mean, maximum, minimum, and standard deviation temperatures were estimated at the hospitals obtained from European Centre for Medium-Range Weather Forecasts. We first estimated country-specific nonlinear effects of temperature through conditional logistic regressions, and then meta-analysed the associations. We estimated the odds ratios (OR) and 95% confidence intervals (CI) of perinatal deaths comparing the 99th vs the minimum perinatal death temperature (MMDT) up to six days before birth.

Results: A total of 3,955 (4.4%), 3,267 (3.7%) and 1041 (1.2%) were perinatal deaths, stillbirths, and intrapartum stillbirths, respectively. Highest and lowest perinatal deaths were observed in Benin (8.5%) and Tanzania (2.1%), respectively. We observed a non-statistically significant association with increased temperature and perinatal mortality (OR = 1.82 (95% CI, 0.89; 3.74). consistent associations were observed for increased minimum and standard deviation temperature on intra-still births. We observed that increased minimum temperature (lag 0-6), comparing the 99th vs MMDT, was associated with 3.32 higher odds of perinatal death (OR = 3.32 (95% CI, 1.08; 10.21). Similar effects were found for other temperature indicators on all perinatal mortality categories, but associations did not reach statistical significance.

Conclusions: In this unique African setting, higher levels of temperature might have acute effects on intrapartum stillbirths. Pregnant women and their offspring need improved intrapartum protection

against heat in the most affected countries to prevent that present mortality reductions are not reversed in the context of climate change.

Mortality burden due to heat during summer of 2022 in Switzerland: the contribution of human-induced climate change

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Keywords: heat, mortality, attribution, time series, impacts

Introduction: The summer of 2022 in Europe was particularly exception for climate and health. On one hand, it was a season of weather extremes, with intense heatwaves affecting many European countries, along with a severe drought and amplified wildfire season. On the other hand, it was one of the summers of the post-pandemic era, with a still fragile healthcare system and ongoing transmission of COVID-19. The combination of both, increased vulnerability of the population and extreme weather events, might translated in an exceptional increase of excess mortality, as reported by officials. Taking Switzerland as case study, we aimed to quantify how much of the excess mortality burden could be attributed to extreme heat, and more importantly, what was the contribution of human-induced climate change

Methods: We combined state-of-the-art methods in climate science and epidemiology with high-resolution mortality and temperature data to estimate the number and fraction of all-cause deaths that could be attributed to heat between June and August 2022. In a second step, we modelled counterfactual daily temperatures representing 2022 summer in absence of anthropogenic climate change. Then, we quantified the hypothetical heat mortality burden in absence of climate change, and finally, estimate the contribution of climate change by subtracting it from the observed heat mortality impacts.

Results: We estimated that 623 [95% CI: 151 - 1,068] all-cause deaths could be attributed to heat between June and August 2022, representing 3.5% [95% CI: 0.9-6.1] of total all-cause mortality during the same period. In contrast, in absence of an anthropogenic climate change, the heat-related burden would have amounted to 1.4% [95% CI: -0.2 - 3.4] of all-cause mortality, corresponding to 253 deaths [95% CI: -27;594]. Thus, 2.1% [95% CI: 0.8 - 3.7] of the all-cause mortality in summer 2022 would have been avoided in absence of anthropogenic warming. This corresponds to 370 [95% CI: 133-644] deaths and 60% of the observed heat-mortality burden between June-August 2022. Females and the oldest age group were the most affected. Specifically, 60% of heat-related deaths attributed to climate change were in females (220 [69 - 393] vs. 150 [62 - 250] in males), and 90% in older adults (330 [129-565] vs. 39 [-5 - 84]).

Conclusions: Our findings confirm that climate change is already affecting the health of the population in Switzerland by amplifying the heat-related mortality burden, with a stronger impact on females and older adults.

Health risks of temperature variability on hospital admissions in Cape Town, South Africa

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Keywords: temperature variability, cardiovascular disease, respiratory disease, hospitalisations, South Africa

Introduction: In developed countries, epidemiological studies provided evidence of associations between temperature variability (TV) and health outcomes. However, such studies are lacking in developing countries. This study aimed to investigate the association between TV and hospital admissions for cardiovascular diseases (CVD) and respiratory diseases (RD) in Cape Town, South Africa.

Methods: Daily counts of CVD and RD hospitalisation data (1 January 2011 to 31 October 2016) were obtained from seven hospitals. Hourly temperature, relative humidity and air pollution data were sourced from the South African Weather Service. A time-series epidemiological study design was applied along with quasi-Poisson regression models, which adjusted for seasonal trends, daily mean temperature, relative humidity and air pollution. TV is calculated as a composite of intraday and inter-day variability using the minimum and maximum temperatures. Lag0-1 to lag0-7 of TV were investigated as well as vulnerability by age (all ages combined, 0-14 years, 15-64 years, and ≥65 years) and sex.

Results: For the entire study group, the highest increase in CVD hospitalisations (2.84% 95% CI: 1.44% to 4.27%) was observed at 0-5 exposure days and at 0-1 days for RD hospitalisations (2.79% 95% CI: 1.44% to 4.17%). The elderly and the 15-64-year-old group were more at risk for RD and CVD hospitalisation, respectively. Men were more at risk for RD and CVD disease hospitalisation than females.

Conclusions: The results indicate that more attention should be paid to the effects of TV and change on human health in Cape Town. Furthermore, different weather and climate metrics, such as TV, should be considered in understanding the climate component of the epidemiology of these (and other diseases), especially in the light of climate change, where a wider range and extreme climate events are expected to occur in future.

UTCI trends in south-eastern Asia and its correlation with ENSO

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Keywords: thermal stress, climate change, health, extremes, weather

Introduction: Climate change is a global issue where spatial differences risk exacerbating health risks for already strained populations. Working and living conditions are forecasted to become worse during the hotter months of the year. The local climate is also influenced by teleconnections such as the El Niño Southern Oscillation (ENSO) which is known to affect the countries in the Asian pacific region. When assessing climate change, focus is commonly at air temperature which is a well-known variable with a long track record but human exposure to thermal environment is more complex and requires more information. Exposure to thermal stress depends on the climate variables air temperature, relative humidity, air velocity and radiant temperature as well as the personal factors metabolic rate and clothing insulation. Many thermal models and indices exist that predict thermal stress using a mix or all these variables and one such comprehensive index is the Universal Temperature Climate Index (UTCI). In this study, UTCI was evaluated in the study period 1990-2019 for south-eastern Asia and possible health implication and correlation to ENSO.

Methods: Reanalysed hourly UTCI data was downloaded from the Copernicus Climate Data Store for the period 1990-2019. The data was analysed using Matlab R2020b. The temporal trend was evaluated using a linear model and the correlation between UTCI and ENSO was evaluated using Wilcoxon rank sum test. The mean daily UTCI was evaluated for the 30-year trend as well as the minimum UTCI (5^{th} percentile) and maximum UTCI (95^{th} percentile). The UTCI-ENSO correlation was done on a seasonal level where each season was identified as a warm episode (El Niño), a cold episode (La Niña) or a neutral episode based on the Niño 3.4 index provided by NOAA.

Results: The spatial pattern shows similar trends for min, mean and max UTCI where mean UTCI is visualized in Figure 1. The northern regions all show increasing trends resulting in almost 1-2 C increase over the last 30 years while southern India and the coastal countries and isle countries in the southern region all show an increase for min UTCI, no change for mean UTCI and decrease in max UTCI.

When evaluating the correlation between UTCI and ENSO, most signals are found in spring and winter for El Niño for several regions such as southern and north-eastern China and northern Thailand while La Niña primarily correlates with a decrease of UTCI in spring, several spatial differences during summer and a few regions with strong signals during autumn and winter.

Conclusions: As UTCI better reflects the exposure to thermal stress than the more commonly used climatic variable air temperature, this study further emphasizes the increasing trends of thermal stress that is expected with climate change. A novel comparison with ENSO is undertaken where spatial differences are observed. Further analysis of the UTCI trends and its correlation to weather events can provide better understanding for future heat warning systems.

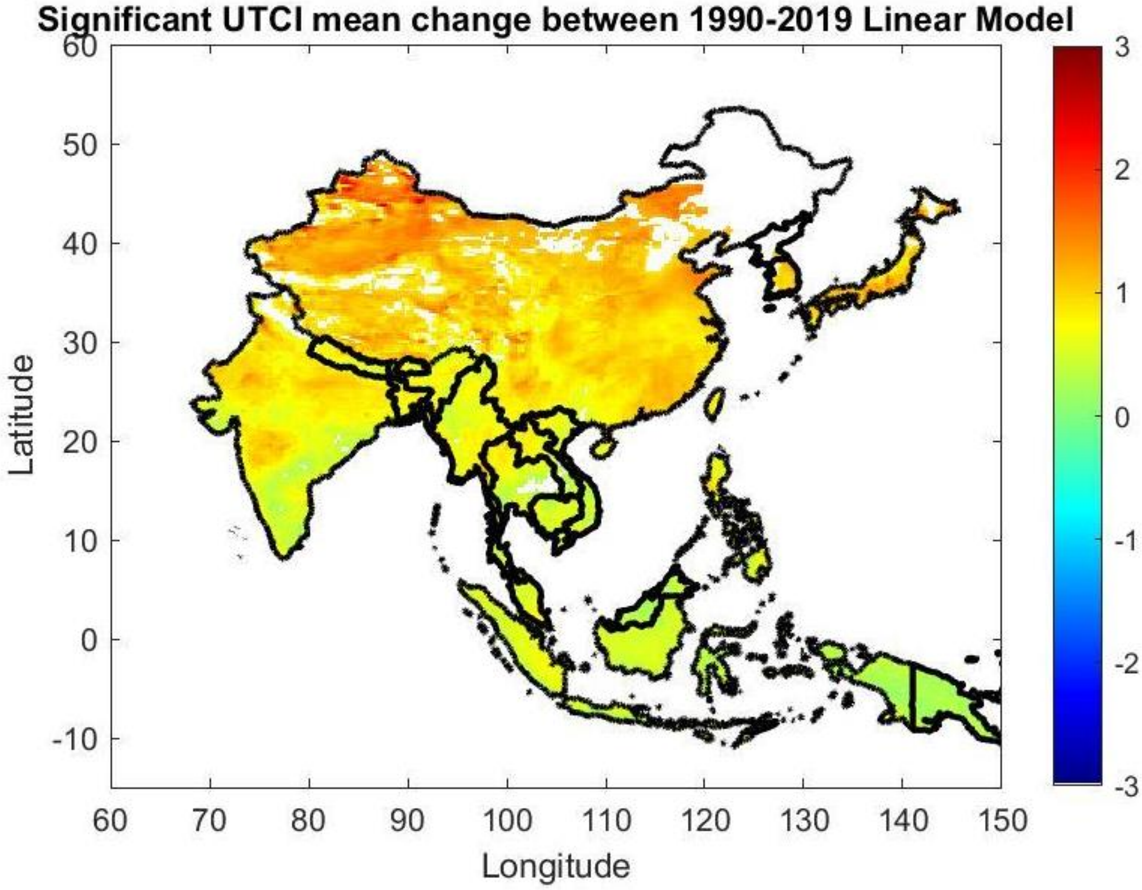

Figure 1. The mean UTCI change between 1990-2019. Only significant data is coloured.

Is the ICD-10 code T67 “heatstroke and sunstroke” a reliable indicator for heat morbidity?

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Keywords: heat, morbidity, vulnerable groups, climate change, resilience

Introduction: Extreme heat days, heatwaves, and tropical nights put extreme strain on the human body and can have a serious effect on health. The effects of extreme high temperatures, and heatwaves in particular, are among the most significant direct health effects of climate change. Direct exposure to extreme heat can lead to exhaustion, dehydration, hyperthermia, and heat stroke, as well as exacerbate existing cardiovascular problems and in the worst-case lead to death. According to the WHO, one of the important building blocks for a climate-resilient health system is integrated risk monitoring and early warning. Talking from a climatology perspective indicator for heat and high temperatures are well established, but their insecurities when measuring the impacts of heat on human health. Therefore, there is need in addressing the question regarding which epidemiological indicators are suitable for monitoring populations morbidity in Austria.

Methods: We combined state-of-the-art methods in climate science and epidemiology to elaborate the research question. Data on inpatient health care and hospital discharges from the legally regulated diagnosis and service documentation of hospitals were analysed for the period 2002-2020. We selected the ICD-10 diagnosis T67 “heatstroke and sunstroke” grouped by gender, and age. Further information on place of residence of the patients, the length of stay, type of discharge, as well as on the hospital location have been considered. The analysis was restricted to the summer month (June, July, August). Spatial and temporal high-resolution temperature data were provided from GeoSphere Austria, the Austrian official weather service.

Results: During the last 20 years, an average T67-incidence of 1.6 per 100,000 population was observed, but with noticeable variations between years. In summers hotter than average, the mean incidence was 26.7% higher than in other summers. A 2.5-fold higher incidence was observed in children and adolescents (<19 years) than adults (≥20 years). The incidence is 1.6 times higher in men than in women.

Conclusions: Within the framework of this study, the indicator for Austria was evaluated for the first time. Vulnerable groups have been identified and should be specifically addressed when planning and implementing measures to protect them or deal with heat. In any case, further research is needed to subsequently develop strategies to minimise health risks caused by heat and sunlight. This is particularly necessary in view of the increasingly frequent occurrence of extremely high temperatures due to climate change, especially in cities due to the urban heat-island effect and socio-spatial inequalities. The indicator presented here is not comprehensive enough to reliably represent all health effects of heat. Nevertheless, it has been identified as one of the important indicators for an indicator set. Finally, the increasing health risks and the rising number of heat-related inpatient stays are also associated with new challenges for the healthcare system.

Association between short-term increases in ambient temperature and hospital admissions in Copenhagen, Denmark

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Keywords: cardiovascular diseases, morbidity, respiratory diseases, temperature

Introduction: Global warming, which is a significant aspect of climate change, has direct and indirect effects on human health. Most available studies on the effects of increased ambient temperatures focus on mortality, but less on morbidity. This study aims to investigate the association between short-term increases in daily mean ambient temperature and cardio-pulmonary hospitalizations in Copenhagen, Denmark.

Methods: Daily mean levels of meteorological factors, including temperature, relative humidity, and wind speed, as well as air pollutants, were monitored at an urban background station in central Copenhagen during 2002-2018. Daily counts of hospital admissions (in-patients) due to respiratory or cardiovascular diseases were obtained from the Danish National Patient Register. Percentage increases and 95% confidence intervals (CI) in hospital admissions associated with temperature increases for up to 21 days preceding the admission were examined in a case-crossover study design. Additionally, we analysed effect modification by sex and age.

Results: We observed 110,746 respiratory and 130,176 cardiovascular hospital admissions between 2002 and 2018. A 1°C increase in the three-day average of daily mean temperature was significantly associated with a 0.71% (95% CI: 0.44, 0.98) and a 0.47% (0.26, 0.67) increase in respiratory and cardiovascular hospital admissions, respectively. Associations were stronger for older people (>65 years) and respiratory diseases (0.87% [0.56, 1.18]), and for men and cardiovascular diseases (0.7% [0.44, 0.97]).

Conclusions: We found significant positive associations between short-term exposure to increased temperatures and cardio-pulmonary hospitalizations in Copenhagen, Denmark, with higher associations among elderly people and men.

Calculating Wet Bulb Globe Temperature within non-urban environments in the Community Land Model 5

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Keywords: heat stress, climate change, Earth System Models, labor capacity, human thermophysiology

Introduction: Global heat stress is a phenomenon that impacts the livelihood of humans worldwide. Due to climate change, heatwaves are already increasing the incidence of morbidity and mortality, but also negatively impact outdoor laborers and activities. However, calculating heat stress on a global scale is criticized due to the interplay and treatment of temperature, humidity, and radiation. To better resolve this issue, the Wet Bulb Globe Temperature (WBGT), a standardized heat stress metric, is implemented into the Community Land Model (CLM5), the land surface component of the Community Earth System Model (CESM2), a model used in the Intergovernmental Panel on Climate Change (IPCC).

Methods: WBGT is measured by standardized instruments and procedures. Here, we use a mechanistic physical representation of WBGT within all non-urban environments in CLM5. The environments in CLM5 include wind, temperature, humidity, and short/longwave radiation transfer between multiple different plant and ground surface types, and the atmosphere. To capture all non-urban environments where humans live and work, WBGT is calculated above vegetated canopy, below the vegetated canopy (shaded), bare ground, and lake environments.

To demonstrate the capabilities of WBGT within the land surface model, CLM5 is driven by reanalysis from 1991-2010 and global 4x daily output is generated from the online calculation showing the advantage of simulating the WBGT within multiple environments. Then, as a case study, the 1995 Chicago Heatwave is examined, specifically the rural regions impacted by the heatwave. Here, the individual environments differ substantially from the grid cell average at the CLM5 30-minute time step. Furthermore, expanding upon these differences between grid cell and individual environments, exposure to heat stress is calculated through a standardized labor response function to calculate labor capacity.

Results: The magnitude of WBGT is dependent on regional climate. For example, in the African Sahel, the differences between extreme WBGT in shaded and exposed environments is up to multiple degrees. In contrast, for Southeast Asia, the differences are as small as a half degree. WBGT is operationally used to reduce workplace injuries from heat and is commonly used to calculate labor capacity. We show how common approximations applied to Earth system model output introduce large biases to labor capacity results. Results show that with our case study, the 1995 Chicago Heatwave, approximating the shaded environments as compared to explicit calculation result in up to 40% change in labor capacity (fig. 1). In this case, the WBGT approximation is substantially overestimating exposure, when the approximation assumes minimal exposure.

Conclusions: Earth system models have the capacity to calculate heat stress within environments where humans live and work. Calculating WBGT in these environments resolves a long-lasting complex issue within global heat stress: the treatment of solar and thermal radiation. Our results show that the approximations used by the current state-of-the-art assessments introduce large biases of up to 40%

or more when not considering the explicit environments where humans live and work. To accurately assess the direct exposure, risk, and damage of climate change on people, it is critical to implement diagnostics directly into Earth system models.

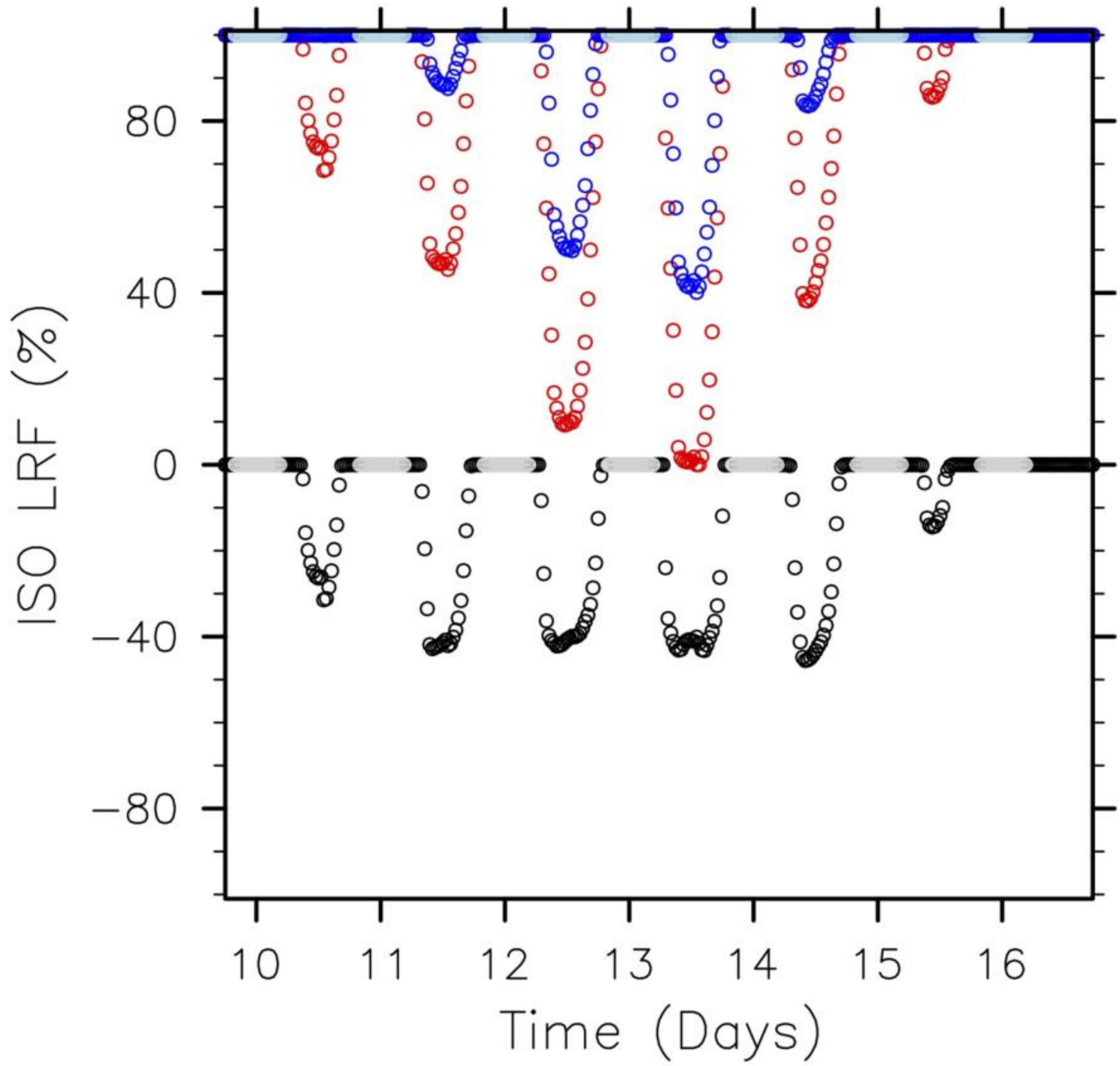

Figure 1: Labor response function from ISO 7243 at 300W metabolic output (moderate work) to calculate labor capacity (0-100%). Results from CLM5 rural Chicago area for the July 1995 Chicago Heatwave outputting 30-minute time step for the duration of the heatwave. State-of-the-art methods assumes shaded conditions by setting the solar radiation to zero and calculate grid cell averaged WBGT (red), as compared to explicitly calculated shaded conditions (blue), and the difference between the two (black). The light and dark hues denote nighttime and daylight conditions, respectively.

Australian heatwave related mortality attributed to climate change

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Keywords: detection and attribution, heatwave, epidemiology, modelling, mortality

Introduction: Heatwave length and intensity have significantly increased in recent decades as a result of anthropogenic climate change. Heatwaves have had a significant negative influence on people's health. Detection and attribution assess the causes of observed changes in the climate system through comparison of climate models with and without the effects of anthropogenic climate change. In 2009 in Victoria, Australia, maximum daily temperatures were near 44°C for a number of days in a row (maximum 20° C higher than the average temperature). We conducted an attribution analysis of this heatwave event in an effort to comprehend how human-caused climate change contributes to rising mortality risk. We wished to examine how mortality during this event could be attributed to anthropogenic climate change.

Methods: We used the Australian Bureau of Statistics' death statistics from 1996 to 2015 in our epidemiological research. A time series Poisson generalised additive model (GAM) was used to analyse the relationship between heatwave mortality and mortality. Relative risk was used to calculate the excess mortality for each heatwave (a moving average of three days with a maximum temperature above various intensity) threshold (90th to 99th percentiles) using generalised additive models.

We used event attribution methods to assess anthropogenic forcing's contribution to mortality outcomes, using data from various types of climate models. Return periods were calculated and bootstrapped to enable calculation of confidence intervals. The relationship between heat and mortality was fitted to the daily climate model output using multiple physical model ensembles, including initial-condition ensembles of simulations from both atmospheric and coupled models, to link heat-related excess deaths to the exceeding of temperature percentile thresholds under simulated anthropogenic and counterfactual climate conditions. The extra deaths in these models were then examined to see how they had evolved across heatwaves similar to the one that occurred in 2009 Victorian event as a result of human influence on the climate system.

Results: When applying the 99th percentile standard, there were 77 heatwave days between the years 1996 and 2015. Longer return times were associated with a greater number of excess heat deaths. Models of return time were comparable, with return times between 20 and 40 years resulting in about 40 extra deaths from heat. Models that did not account for the post-1850 addition of carbon to the atmosphere saw 10–12 fewer heat deaths for the 2009 event than models that did. Despite some differences in the models, the outcomes were generally in the same direction. While models varied somewhat the results were similar in direction across models.

Conclusions: Most models attribute between one third and fifty percent of mortality from excessive heat to anthropogenic greenhouse gas emissions. These results show that the risk of heat-related death will continue to rise unless considerable mitigation and adaption measures are undertaken.

Municipality assessment of temperature-related mortality risks in Norway

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Keywords: temperature, environmental epidemiology, mortality

Introduction: Heterogeneity in the distribution of drivers of vulnerability can lead to local differences in health risks associated with heat and cold. Identifying these risks factors is crucial to characterize local vulnerability and cope with the trends in changes in temperature improving adaptation to climate change by designing tailored public health interventions. We aimed to analyse the association between ambient air temperature and non-accidental mortality in mainland Norway, and to characterize municipal-level patterns in the risks and impacts of temperature-related mortality.

Methods: We estimated the association of heat- and cold-related non-accidental mortality by designing case time series and distributed nonlinear lag models on mean daily temperature and series of non-accidental mortality between 1996 and 2018 for 356 municipalities in Norway. We then derived pooled associations of heat and cold mortality for the 11 counties through multivariate meta-regression and assessed potential vulnerability factors among predictors of socioeconomic, climate, and other environmental factors at the municipality level.

Results: The analysis included 899 733 deaths with a non-accidental-cause related ICD-10 code, of which 86.6% corresponded to over 65 years. On average, the relative risks (RR) due to temperatures were highly dissimilar geographically, with the minimum mortality temperature (MMT) varying from 7.1 °C to 21.3 °C, and minimum mortality percentile spanning from the 78th to 99th percentile. The small-area assessment estimated that each year in Norway, there was on average 182 excess deaths (empirical 95% CI 107-251) due to cold temperatures and 4 (0-8) attributable to heat. The highest relative risks due to cold were found in the municipalities of the northernmost regions, while for heat it was in the Southeast region. We estimated country pooled RR at 1st percentile and 99th percentile vs. the MMT, respectively 1.35 (95%CI 1.26-1.45) and 1.00 (95%CI 0.99-1.01).

Conclusions: Our analysis suggests that public health and climate policies should consider both local and tailored interventions for greater implementation and effectiveness.

Opportunities and barriers for occupational heat stress prevention implementation among sugarcane workers—An Interpretative Phenomenological Analysis

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Keywords: occupational health and safety, implementation quality, heat stress, agriculture, safety climate

Introduction: Chronic kidney disease of non-traditional origin (CKDnt) is an ongoing epidemic that has taken the lives of tens of thousands of people in Mesoamerica, also affecting other tropical geographies. Occupational heat stress, which will increase worldwide as climate change persists, has been identified as a primary trigger of kidney injury and reduced renal function. At Nicaragua's largest sugarcane mill, the water, rest, and shade (WRS) intervention has proven to reduce the risk of heat stress and kidney injury effectively as assessed by the research and policy NGO La Isla Network (LIN) and their academic partners, who have worked with the sugar mill to improve the design of their intervention system. However, discrepancies between intervention design and implementation have been found. This study explores the perceptions of the WRS intervention in the company, with a focus on perceived opportunities and barriers, from the perspective of positions responsible for the workers' environment and heat stress prevention implementation.

Methods: A qualitative design was used in the study. Twenty-one key informants of low and middle management, field assistants, and two members from LIN took part in the study. Semi-structured interviews were used to collect the data. Interviews' transcriptions were analyzed using interpretative phenomenological analysis (IPA).

Results: Four main themes were developed in the analysis of the data: “A worthwhile struggle,” “Culture of care”, “Traditional production culture Vs. Culture of care,” and “The importance of the formalization of care.” Each theme contained sub-themes, all of which were further discussed in the light of organizational psychology.

Conclusions: Discretionary differences resulting in low and middle management prioritizing production over health protection appeared to relate to a fair part of the implementation challenges and indicate that more efforts are needed to align operations' production and health goals. Education enhancement might be necessary, while further focus on health metrics for performance assessment might offer an opportunity to level perceived incentives and value of health and production. The study’s findings accentuate the need for governments to consider legislation that regulates workers’ health protection, and incentives that support companies’ initial investing and evaluation of heat stress prevention programs. This way, as long as health and production metrics are improved, the former will be more easily considered into the norms of companies’ operations.

Poster discussion 2: Climate change health impacts and transformation of disease patterns

Early warnings for Malaria incidence using climate variables in Mozambique

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Keywords: climate variables, early warning, Malaria incidence, DLNM, Mozambique

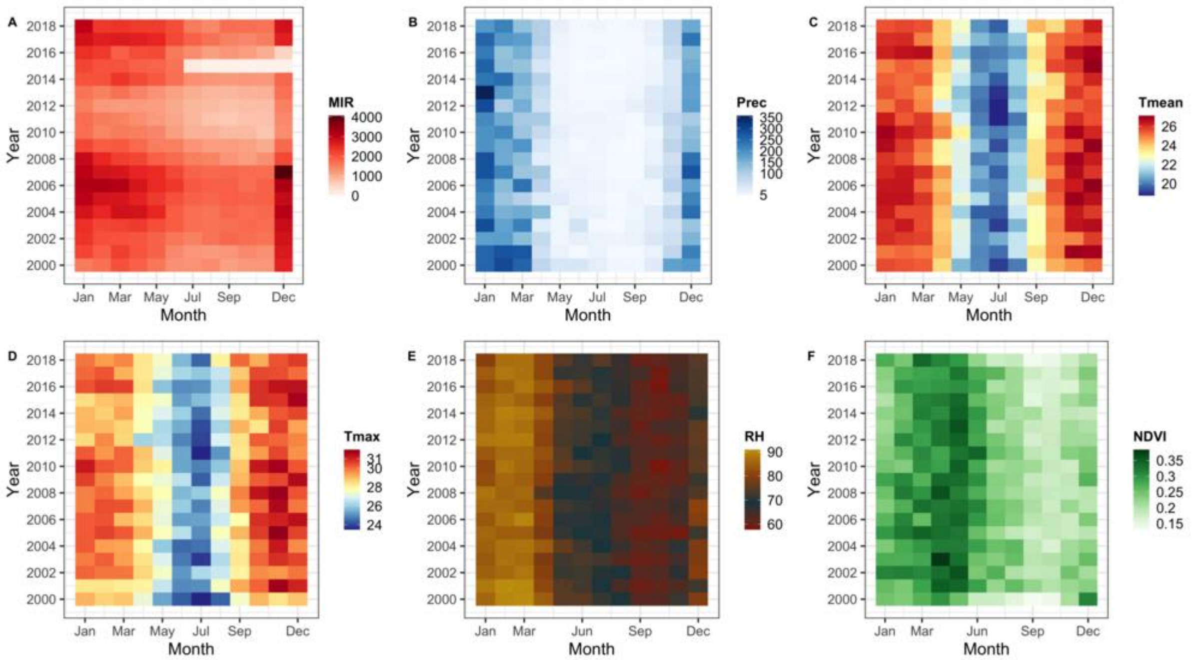
Introduction: The early warning for malaria incidence is an important first step towards implementing effective interventions to control and reducing morbidity and mortality in vulnerable populations. *Anopheles arabiensis, Anopheles funestus sensu stricto and Anopheles gambiae* are the main vectors for malaria, and the predominant malaria species is Plasmodium falciparum over Mozambique. Climate variables in combination with suitable environmental conditions for vector breading, can be considered the major natural risk factors which regulates the life cycle, longevity, abundance, and vectorial capacity of the mosquito. This study aims to assess the ability of a combination of Malaria Early Warning Systems (MEWS) indicators for predicting the spatial-temporal risk of Malaria in Mozambique.

Methods: We used weekly reported malaria cases from 2000 to 2018 provided by the Ministry of Health (MoH) in Mozambique. We also used precipitation, minimum and maximum temperature, relative humidity, Normalized Different Vegetation Index data from NCEP-reanalysis II. We calculated monthly totals for malaria cases and precipitation and monthly means for the other climate variables. This study we used a Distributed lag nonlinear model (DLNMs) in order to investigate the nonlinear and delayed relationship between malaria cases and climate variables. We used model selection and estimation in a Bayesian framework applying Integrated Nested Laplace Approximation (INLA). The model was estimated in `leave one out' cross-validation mode by excluding the month for which the prediction is valid when estimating model parameters.

Results: Malaria transmissions occurred in the malaria seasons 2003±2004, 2004±2005, 2005±2006, 2006±2007, 2007±2008 and 2017±2018. Malaria seasonality varies across the country, with the peak transmission season occurring earlier in the year in Gaza, Maputo City and Maputo and later in the year in Niassa, Cabo Delgado, Nampula. The wet season lasts from November to Abril, though most precipitation is concentrated within December to February. During wet seasons, malaria transmission tended to peak earlier in the malaria season, in November.

Conclusions: In high-malaria transmission settings, we expect high values of climate variables to be associated with increased cumulative risk of malaria outbreaks, with risk peaks at variable lag times.

Probabilistic of malaria outlooks could be valuable for designing strategies for early warning, prevention, and control of seasonal malaria surges and epidemics.



Impact of climate change on prevalent diseases: Vulnerability and fragility in health

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Keywords: climate change, health, prevalent diseases, fragility, research.

Introduction: Our Institution is a University health referral centre in Catalonia, serving around 300,000 inhabitants covering primary, specialized, mental and elderly health care. The added value of our institution and which allows us to tackle the scientific objective of this project is based on the fact that we are a comprehensive healthcare institution covering the entire life trajectory of a person. This differential fact poses a great scientific challenge: to assess whether certain variables related to climate change have a negative impact on the clinical condition of people with highly prevalent diseases.

The aim of our study is to evaluate the impact that climate and environmental factors have on the diagnosis and evolution of chronic, prevalent, and debilitating diseases, as well as to identify the phenotypes most vulnerable to these factors, either because of the characteristics of the disease itself or because of the fragility they cause.

Methods: Retrospective cohort analyses from 2008 to 2022, among our referral healthcare of 300.000 inhabitants, covering primary, specialized, mental, and elderly population. We have selected 5 prevalent chronic diseases: Diabetes Mellitus type I and II; Chronic Obstructive Pulmonary Disease; Parkinson's disease; heart and stroke cardiovascular disease and Autism spectrum disorder. Data integration with geo-referenced meteorological and environmental data of the study period will be performed. Analyses will be done through big data techniques, artificial intelligence, deep learning, and deep phenotyping.

Results: This project has been conceived in partnership with several research groups, Universities, and the Catalan Meteorological Service. Currently, we are analyzing Individual (clinical, biological, geographical, and pharmacological data), Climatological, Environmental and Epidemiological variables in order to ascertain indicators or biomarkers on the impact of climate change on cardiovascular, metabolic, neurological, respiratory, and mental prevalent diseases. Finding indicators that identify those patients with the most vulnerable conditions to climate change among people carrying prevalent chronic diseases will allow us to design protocols to better prevent and protect this targeted population.

Conclusions: Hospitals are a key source of greenhouse gas emissions. Currently, most hospitals rely on non-renewable sources of energy, although studies have shown switching to renewable sources can contribute to SDGs while also creating savings for hospitals. Climate science must continue helping governments and the public understand climate change's impact. We need to warrant that research supports climate monitoring and innovation everywhere, not just in richer nations. Moreover, science and innovation will be equally important to driving ever-bolder climate policies.

Estimation of the carbon footprint of tuberculosis diagnosis and treatment in India

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Keywords: tuberculosis, carbon footprint, climate change, sustainability, India

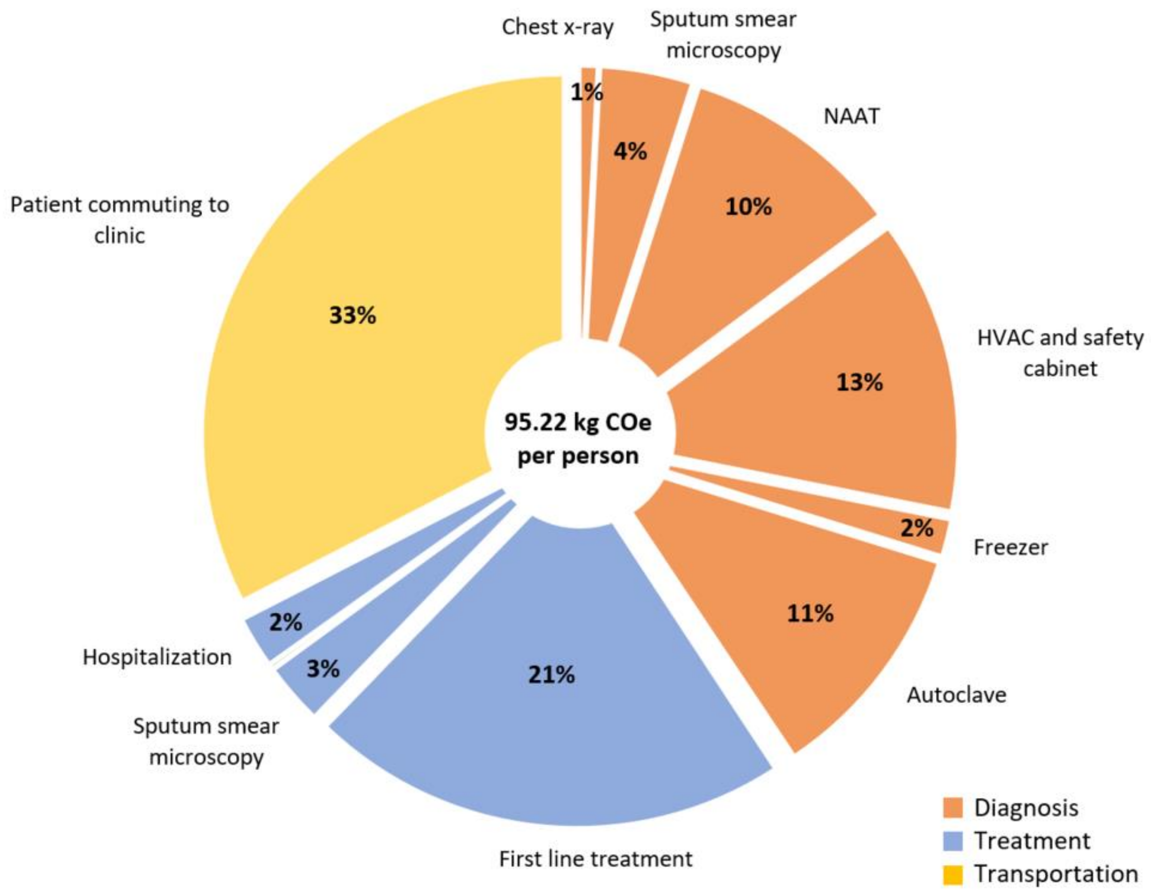
Introduction: In 2021, an estimated 2.95 million Indians developed tuberculosis (TB) and approximately 60% of them received several months of therapy. The processes involved in TB diagnosis and treatment require significant material and energy input, which produce carbon dioxide emissions (CO2e) that directly impact climate change. This study estimates the carbon footprint (CF) of TB management in India in order to raise awareness of its environmental impact and highlight the importance to accelerate the investment to end TB.

Methods: We defined and quantified the processes involved in the therapy of one person with drug-susceptible pulmonary TB (DS-PTB) in India, based on the *National TB guidelines*. Subsequently, we used the *Carbon footprint Ltd calculator* to estimate the carbon emissions associated with pharmaceuticals, electricity use, and transportation. We categorized the carbon emissions into three categories: diagnostics, treatment, and transportation. Diagnostic processes included costs of considering electricity usage of BSL3 laboratory machines and 1 outpatient diagnostic visit. Treatment accounted for costs of first line drugs for DS-TB and 2 sputum smear microscopies; as well as electricity usage of 8 outpatient visits and inpatient bed days if required. Regarding transportation, we assumed the average Indian person with TB travelled 10 km to their TB clinic in a 4-wheel vehicle.

Results: The CF of diagnosing and treating 1 person for DS-PTB in India is estimated to be 95.22 kg CO2e: 40.8% attributable to diagnostic tests, 26.7% to treatment, and 32.5% to transportation. Assuming that carbon costs of treating extra-pulmonary TB are similar to pulmonary TB, the CF of treating all the 2.83 million people with DS-TB in India in 2021 would have been 269,472 metric tons CO2e.

Conclusions: Despite conservative assumptions, we estimated that treating all the DS-TB in India emits the equivalent of 58,581 passenger cars in the United States. To our knowledge this is the first study to calculate CF of TB therapy in any part of the world. The carbon costs are likely to be even higher for extra-pulmonary TB and drug-resistant TB. Our study is limited by the use of a calculator not optimized for India. Further, we likely underestimated the total CF as we only included the main processes involved in TB therapy, excluding some collateral consumables, energy consuming processes and potential complications. However, despite our conservative estimates it is evident that one of India’s leading public health challenges also contributes meaningfully to climate change.

Carbon footprint of TB therapy sorted by category



Do extreme heat events alter the infectivity of human viruses found in the intertidal zone

Jessica Kevill[1], Kata Farkas[1], Nick Woodhall[1], Shelagh Malham[1], Davey L Jones[1]

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Keywords: virology, climate change, human health, intertidal zone, environmental virology

Introduction: The UK experiences extreme heat events during the summer, these conditions cause dry ground that losses its ability to absorb water, ultimately leading to increased rainwater runoff. Most of the UK has a combined sewerage system, where both rainwater and sewage are transported to wastewater treatment works in the same pipes. Rain events after dry weather cause the sewer network to become overloaded, resulting in the discharge of rain and untreated sewage into UK rivers and coastal areas. In this way enteric viruses and harmful bacterial pathogens pollute coastal areas. During extreme heat events, record numbers of people travel to the UK coast to participate in recreational bathing or swimming. Here, they are exposed to enteric viruses that cause stomach-ache, nausea, vomiting, and diarrhoea, plus respiratory, eye and ear infections. It is predicted that extreme climate events will become common place in the future, therefore we can expect increased pollution events and environmental conditions (temp, salinity, pH, turbidity) to change. As a result, the viability of viruses to infect humans may also be impacted. The aim of this research is to fill the knowledge gap about the viability of viruses in changing environmental conditions.

Methods: To do this, we have created microcosm experiments where artificial and environmental seawater was spiked with viruses detected in wastewater (Hepatitis-A, Adenovirus, Astrovirus, Polyomavirus, Rotavirus, Enterovirus, Respiratory syncytial virus, Norovirus, Influenza-A and SARS-CoV-2). These samples were then exposed to different environmental conditions. The variables under investigation are time, temperature, turbidity, pH, and salinity. After exposure to different environmental conditions, the viruses were concentrated using a polyethylene glycol (PEG) precipitation method. Half of each viral concentrate had total nucleic acids extracted whilst the other half was exposed to PMAxx dye for viability PCR. Once the PMAxx dye had been incorporated, samples underwent total nucleic acid extraction. RT-qPCR was then performed on samples, for all viral targets. Furthermore, we tested the environmental seawater for Hepatitis-E, Influenza-B and faecal indictors (CrAssphage, Pepper mild mottle virus). Comparisons were then made between the total nucleic acid extracted and the samples that underwent viability PCR, to assess the amount of virus recovered that is still capable of infection.

Results: Our research group have preliminary data for Maurine Norovirus, Human Norovirus and Adenovirus virus viability in seawater samples. This data shows that Norovirus and Adenovirus have a log reduction in detection after 6 days exposure to seawater. A Maurine Norovirus infectivity assay revealed a log 2.83 reduction in tissue culture infectious dose (TCID) by day 8 exposure in seawater. These preliminary results are promising and indicate that reduced infectivity of target viruses may occur for the viruses detailed.

Conclusions: The importance of this study is to understand how a multitude of climate scenarios can impact the viability of viruses and provide insight into human exposure risk in coastal environments. This is of major importance in a changing climate, where extreme heat events result in people enjoying coastal waters, which are likely polluted with enteric viruses found in human sewage.

Association of daily temperature with suicide mortality: a comparison with other causes of death and characterization of attenuation across 5 decades

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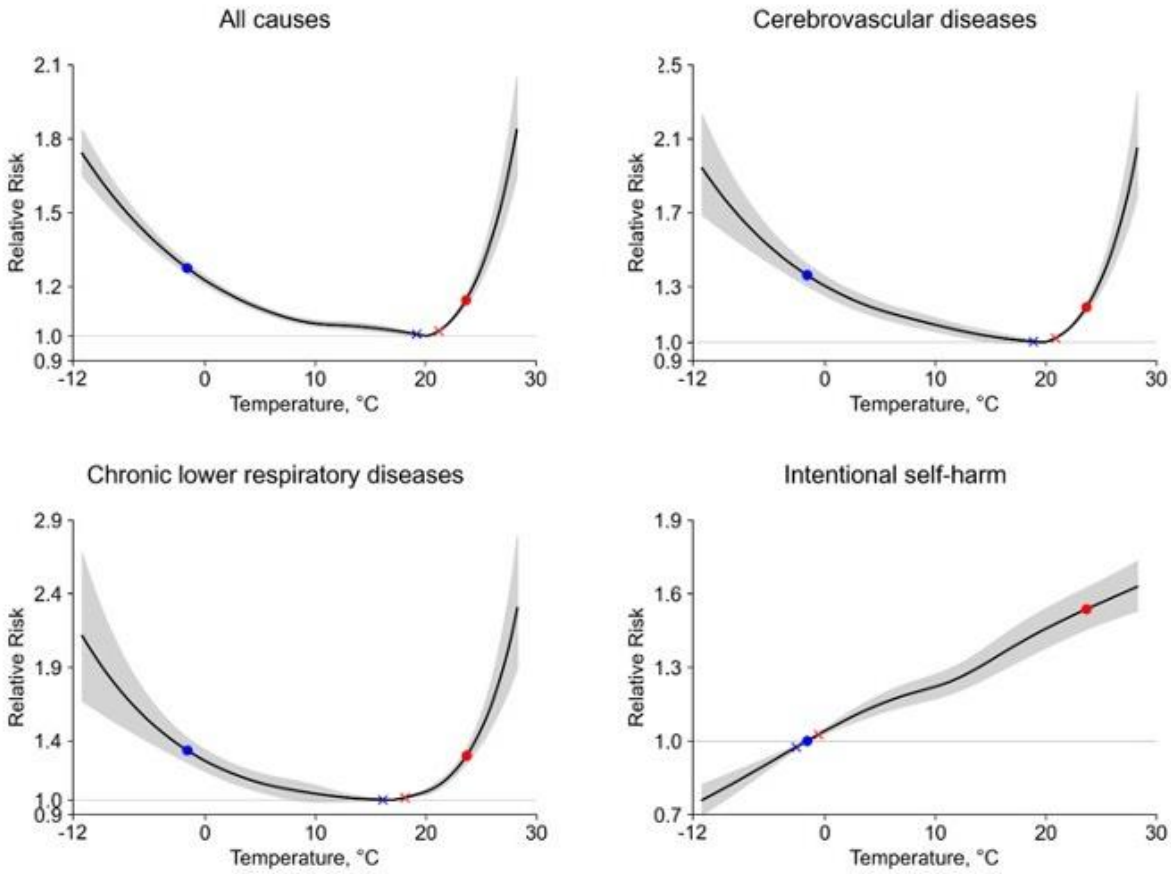
Keywords: adaptation, climate change, mortality, suicide, temperature

Introduction: Introduction: Suicide is one of the leading causes of death in young adults in many Western countries. In addition to sociological and psychological factors, environmental factors such as temperature may influence suicide rate. A putative biological mechanism relates to the serotonergic system, which is sensitive to temperature and involved in depression and impulsive-aggressive behaviour, two major proximal risk factors of suicide. We examined the short-term association of temperature with cause-specific mortality, comparing suicide with other causes of death. We also aimed to describe possible attenuation of associations with temperature across decades.

Methods: We considered all deaths that occurred in France between 1968 and 2016. For each cause of death, we conducted a two-stage meta-analysis of (short-term) associations with daily temperature. We stratified the association across time-periods.

Results: A total of 24,402,693 deaths were recorded over 49 years, including 502,017 deaths by suicide. Temperature was monotonously associated with suicide mortality. The relative risk of suicide mortality at the 99th (compared to the first) temperature percentile was 1.54 (95% confidence interval: 1.46, 1.63). The temperature- and lag-specific association was strongest at lag 0, with barely any association at lags 1 or 2 days. Relative risks of death for all other causes than suicide presented a U-shape association with temperature. Most “optimal temperatures” (i.e., those with the lowest mortality risk) were between 17.1°C and 21.7°C, according to cause. Among all causes of death, suicide was the only one displaying a monotonous trend with temperature and ranked seventh for heat-related mortality; two other causes of death implying the nervous system ranked third and fourth. Associations with temperature attenuated between the 1968-1984 and 1985-2000 periods for all-cause mortality and suicide mortality, without clear further attenuation in the 2001-2016 period.

Conclusions: To our knowledge, this study relies on one of the longest published daily time series of temperature and suicide deaths, and is the first one to provide estimates of the attenuation of the temperature-mortality daily association over time. The robust short-term monotonous association between temperature and suicide risk could be considered in heat effects- and suicide-related prevention campaigns. There was some evidence of an attenuation of the effect of warm (and possibly low) temperatures on overall mortality, at least during the first 30 years of the study period.


All causes
Relative Risk
2.1
1.8
1.5
1.2
1.0
0.9
-12
0
10
20
30
Temperature, °C
Cerebrovascular diseases
Relative Risk
2.5
2.1
1.7
1.3
1.0
0.9
-12
0
10
20
30
Temperature, °C
Chronic lower respiratory diseases
Relative Risk
2.9
2.4
1.9
1.4
1.0
0.9
-12
0
10
20
30
Temperature, °C
Intentional self-harm
Relative Risk
1.9
1.6
1.3
1.0
0.7
-12
0
10
20
30
Temperature, °C

Heat stress and preterm birth - results of the Mid German Climate Preterm Birth study

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Keywords: heat, preterm birth, temperature

Introduction: Preterm birth (PTB) is a major public health issue that is associated with increased neonatal morbidity and mortality, as well as long-term health consequences. Pregnant women are particularly vulnerable to heat stress, and exposure to high temperatures during pregnancy has been identified as a potential risk factor for preterm birth. The number and duration of heat waves in Europe have significantly increased in the last decade as a result of global warming. Heat stress during pregnancy can have a lag time between exposure and outcome and may even accumulate during the limited time of gestation. The impact of heat stress on PTB rates has been shown in several analyses from different regions worldwide, but not for Germany so far. Here, we present the results of the Mid German Climate Preterm Birth study.

Methods: This study cohort is based on the German national birth registry of the state of Thuringia from 2014 to 2018, comprising 84,568 pregnancies. For climate data analysis, open access data from 134 Thuringian measuring stations during the study period were used. For each station, maximum temperature percentiles were calculated per year, and days with maximum temperatures above the 75th, 90th, 95th, and 98th percentiles were categorized. The station data was then linked to women's postal codes using an accuracy of 0.5° in longitude and latitude.

A Case-Cross-Over Model was utilized to estimate the relative risks of preterm birth in the categories of term, below 37, 32, and 28 weeks of gestation. The model considered the frequency of heat events during pregnancy and investigated the implications of high temperatures during the last 7 days leading up to PTB. This approach allowed for an estimation of the effect of temperature exposure during the critical period leading up to PTB.

Since the probability of giving birth increases as the estimated due date approaches, the relative risks of preterm birth were adjusted proportionally to those of term births. This adjustment takes into account the increased likelihood of spontaneous birth occurring closer to the estimated due date and ensures that the estimated risks of PTB are accurately reflected in the analysis.

Results: After excluding induced labor, elective caesarean sections, and births without affiliated temperature data, a total of 31,273 cases were included in the analysis, of which 6.4% were preterm births. Our analysis revealed a significant correlation between maximum temperatures above the 98th percentile during the last week before delivery and preterm birth rates for all gestational age categories: below 37 weeks (RR: 1.2, 95% CI: 1.09-1.31), 32 weeks (RR: 1.8, 95% CI: 1.37-2.36), and 28 weeks (RR: 2.35, 95% CI: 1.51-3.66) (Figure 1).

Conclusions: Our findings are consistent with current international research and studies from Mediterranean European countries, highlighting the significant impact of climate change on reproductive health even in middle European countries such as Germany. This underscores the potential health consequences not only in metropolitan but also rural regions.

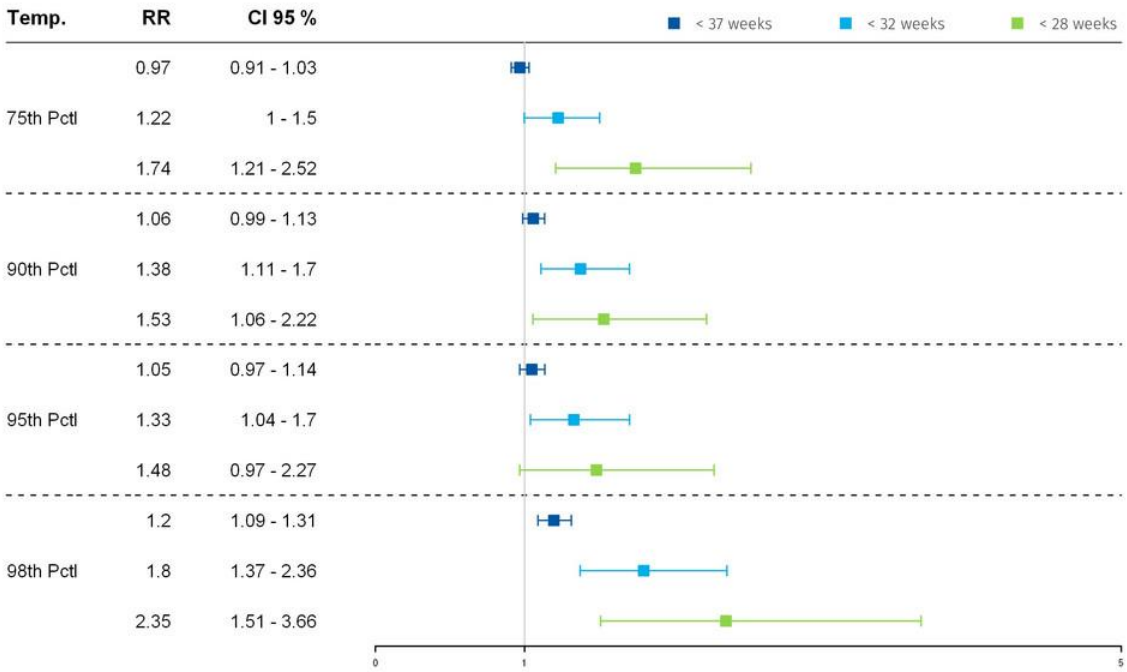

Figure 1: Relative risks of preterm birth associated with heat events above the 75th, 90th, 95th, and 98th percentiles (pctl) during the final 7 days preceding delivery.

Climate change and health effects during pregnancy, delivery and postnatal period: a scoping review

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Keywords: scoping review, climate change, maternal health, perinatal health, infant health

Introduction: Pregnant women and neonates have increasingly been identified as vulnerable groups to climate change and its health impacts, but it remains to be understood in what specific terms the different manifestations of climate change can affect maternal and fetal health. Our main objective was to conduct a scoping review to determine what research has been conducted so far on the direct or indirect health effects of climate change during pregnancy, delivery and postnatal period concerning maternal, fetal or child-health. We furthermore explored to what extent the so far published research considered the differences in vulnerability between populations in different climatic and socio-economic settings.

Methods: We included peer-reviewed original and review publications in English from year 2000 onward on maternal, fetal and child health outcomes after exposure to climate change related impact during pregnancy, delivery and postnatal period. The literature search in PubMed, Web of Science, Embase, Cochrane, Global Health and WHO regional databases was conducted with search blocks based on the population of interest and on multiple climate change related impacts described in the latest IPCC-reports.

Results: The initial search yielded 8905 documents. 304 studies were included in the final synthesis, 234 original research articles and 70 review articles. The included studies were unevenly distributed over the globe, both in numbers and in climate change impact. Most studies came from high income countries 136 (63%) with a third of all studies from the United States, second most common study location was China, followed by India, Israel and Australia. The emphasis was maternal health in 25 (11%) original articles and child-health or both (i.e. pregnancy outcome) in the remainder. Of the included original articles 152 (65%) explicitly mentioned climate change in association to the studied exposure. It was more commonly mentioned in heat-studies, than in those studying cyclones, drought or wildfire. Of the 70 review articles included approximately half were systematic reviews and the other half were general reviews. Most studies were published from year 2010 and onward. There was wide distribution of climate change impact studied, but heat (n = 131) was clearly the single most common exposure studied in the original research studies, followed by tropical cyclones (n = 38).

Conclusions: The findings from this review demonstrate that climate change contributes to significant health risks during perinatal period for both maternal and infant health, not previously synthesised with a systematic approach. A broad spectrum of mechanisms has been studied in both original and review articles, but there are large differences in quantity and type of research. Articles on extreme heat and rising temperatures are strongly overrepresented and this is the area of research that is most advanced, including several systematic reviews. Concerning other mechanisms, the evidence base is

still weak. Advancing research on the most vulnerable subpopulations is essential. Although research gaps persist, policy makers and practitioners must act to ensure health and well-being of pregnant women and infants everywhere.

Increased late preterm birth risk and altered uterine blood flow upon exposure to heat stress

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Keywords: heat stress, preterm birth, pregnancy, climate change, temperature

Introduction: Climate change impacts human health and can trigger disease and concern about increased heat exposure is of particular concern. Pregnant people are considered a potentially vulnerable group given the physiologic changes during pregnancy and the potentially long-lasting consequences for the offspring. Evidence published to date on higher risk for pregnancy complications upon heat stress exposure are from geographical areas with high ambient temperatures. Studies from geographic regions with temperate climates are sparse; however, these areas are critical since individuals may be less equipped to adapt to heat stress. This study addresses a significant gap in knowledge due to the temperature increase documented globally.

Methods: Birth data of singleton pregnancies (n=42 905) from a tertiary care center between 1999–2021 and matching climate data were retrospectively obtained from registries to calculate the relative risk for preterm birth. Heat events were defined by ascending temperature percentiles in combination with humidity over exposure periods of up to 5 days. Further, ultrasound data documented in the prospective pregnancy cohort study PRINCE (Prenatal Identification of Children's Health; n=612) since 2012 were used to identify pathophysiological causes of heat-induced preterm birth.

Results: Both extreme heat and prolonged periods of heat exposure increased the relative risk for preterm birth (RR: 1·59; 95% CI: 1·01-2·426; RR: 1·17; 95% CI: 1·02-1·40). We identified a critical period of heat exposure during gestational ages 34-37 weeks that resulted in increased risk of late preterm birth (95% CI: 1·14–1·43; p=0·009). Pregnancies with a female fetus were more prone to heat stress-associated preterm birth. We found heat exposure was associated with altered vascular resistance within the uterine artery.

Conclusions: Heat stress caused by high ambient temperatures increases the risk for preterm birth in a geographical region with temperate climate. Prenatal routine care should be revised in such regions to provide active surveillance for women at risk

Short-term effects of extreme temperatures on cause-specific mortality in Italy. Results from the BIGEPI project

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Keywords: time series studies, extreme temperatures, heat, cold, cause-specific mortality

Introduction: The effects of extreme temperatures on total mortality have been well documented in epidemiological studies. However, the relationship between temperatures and cause-specific deaths is still limited. The aim of this study is to investigate the association between daily exposure to extreme temperatures (heat and cold) with cause-specific mortality in the entire Italian population.

Methods: We collected daily counts of deaths from natural, cardiovascular, respiratory, metabolic, diabetes, nervous and mental causes from the Italian National Institute of Statistics (ISTAT) for all the 8,092 Italian municipalities for the period 2006-2015. Through the application of spatio-temporal models based on meteorological data, satellite data and spatiotemporal variables, population-weighted exposures of daily mean air temperature (2006-2015) were estimated at municipal level. First, we applied time-series models adjusted for seasonal and long-term trends; then, we meta-analysed results to obtain national estimates of the association between air temperature and different causes of death. Estimates were calculated separately for heat, defined as increases in temperature from 75th to 99th percentile and for cold, decreases from 25th to 1st percentile of province-specific air temperature distributions.

Results: Analyses were conducted on 1,7 million total deaths in the period 2006-2015 in Italy. We found significant effects of low and high temperatures on all study outcomes. The effects of heat, expressed as a % change in risk, showed a greater risk in mortality from disease of the central nervous system (58.3%; 95%CI: 49.7%, 67.5%), mental disease (48.4%; 95%CI: 40.4%, 56.9%), diabetes 45.8%; 95%CI: 39.7%, 52.1%) and respiratory disease (36.9%; 95%CI: 30.6%, 43.5%). For exposures to cold, a greater mortality risk was found for cardiovascular disease (10.1%; 95%CI: 8.7%, 11.6%) and diabetes (13.9%; 95%CI: 4.5%, 24.1%). For both heat and cold a rising trend in effects was observed by age group, with greater risks among the elderly. Furthermore, similar associations were found in both urban, sub-urban and rural municipalities for both heat and cold.

Conclusions: The study showed a strong association between daily exposure to extreme temperatures, especially heat, with all mortality outcomes. Considering future climate change scenarios of rising temperatures and extreme events, it is crucial for public health to promote adaptation policies and interventions to reduce the climate-related health risks.

Poster discussion 3: Perception, communication and partnership on climate change and health

Education on climate change and health – the ENBEL library

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Keywords: climate change, learning materials, policy, health effects, courses, library

Introduction: Climate change is the greatest threat to human health in the 21st century, but the knowledge of climate change health effects is limited among decision-makers. To fill this gap, we aimed to develop a library on online learning courses and training materials, that could be useful for policy-makers, key stakeholders and as well as a wider audience.

Methods: We looked for online courses and materials, which are currently available, open, free or paid, in all languages and suitable for our target group. To find courses and training materials we used internet search, snowballing and the Horizon 2020 project ENBEL (Enhancing Belmont Research Action to support EU policy making on climate change and health) network.

Results: We included in the library a total of 96 online courses and 157 training materials that integrate climate and health. Most of the courses are in English, but some courses are available also in Arabic, Russian, Chinese etc. The most frequently covered topics in the courses were heat-related health effects, food and agriculture, vector-borne and waterborne infections. Few courses address allergies and pollen, mental health problems, migration and work capacity in extreme hot environments. All the materials address mitigation and adaption aspects. The ENBEL library is situated on ENBEL website under knowledge section: https://www.enbel-project.eu/knowledge

Conclusions: We believe that it is important to continue to increase the flow of information and knowledge on climate change and health among decision-makers and the general public to make people act for just transitions and climate adaption.

Mapping evidence and gaps for links between air pollution and children's health

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Keywords: air pollution, children, health effects, epidemiology, environmental health

Introduction: One million children worldwide die each year from pollution-related causes (air, water, soil, and chemical pollution), with two-thirds of those deaths occurring in children younger than five years. Most child deaths from pollution-related causes occur in low- and middle-income nations due to the unequal distribution of pollution. The majority of these are caused by digestive and respiratory conditions brought on by contaminated water and air. Children's health problems caused by pollution include low birth weight, asthma, cancer, and neurodevelopmental issues, and these conditions are becoming more prevalent. Since patterns of chemical pollutants are poorly mapped and quantified, the true impact of pollution, particularly chemical pollution, on the worldwide burden of diseases affecting children is unknown and probably undercounted, as many chemical pollutants have not been characterised.

Our objective is to identify existing evidence that has examined the relationship between air quality and pollution, and child health indicators and quality of life, and to map these using an evidence gap mapping approach. Evidence and gap maps are a valuable communication tool that convey where research evidence is strong or lacking and does so by providing a visual and interactive output that engages users with the evidence. They are an increasingly valued evidence synthesis output.

Methods: The first stage of this project is to carry out a targeted search, across health and environmental databases, to identify existing systematic reviews of the health impacts of air pollution on children aged 0-18 years. Air pollution will include particulates, smoke, dust, chemicals, and gases derived from fossil fuel burning for power generation and transportation, wildfires and the burning of agricultural waste. Eligible outcomes include mental or physical health outcomes and quality of life. Two reviewers will independently screen a proportion of the results and, having clarified and agreed eligibility criteria, one reviewer will screen the rest. Data will be extracted by one reviewer and checked by a second and will include citation details, country focus, literature search date, type of analysis, type of pollution, outcomes, strength of relationship between pollutant and outcome, and conclusions of each included review. EPPI-Reviewer will be used to manage the review, and EPPI-Mapper to create a map of pollutants against health outcomes according to a framework we have prepared in consultation with experts.

Results: The map will show where systematic review evidence exists and where there are gaps in the evidence base. We will demonstrate where evidence about links (or lack of links) between pollutants and health outcomes are strongest and where further research is needed. Further work involves searching for primary studies that may not have been included in a systematic review and evaluating the quality of the evidence base.

Conclusions: There is a lot of international evidence about the impact of air pollution on children and this evidence gap map will clarify where strong evidence shows impact and where more work is required. It will provide an up-to-date, accessible, visual and interactive tool for stakeholders who want to explore how pollution impacts the health and wellbeing of children and young people.

Heat stress: a primer for maternal and perinatal health

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Keywords: heat stress, climate change, maternal health, perinatal health, extreme heat

Introduction: Heat stress is a significant concern for maternal and perinatal health. Heat stress can be defined as 'a rise in body heat as a result of the exertion and/or the external environment' and considers compounds such as periods of high humid-heat. Exposure to hotter environmental surroundings can lead to negative birth outcomes, these include pre-term birth, lower birth weight and still birth. Despite heat stress indices capturing the body heat-balance response better than ambient temperature most studies in the field rely on ambient temperature alone. Here the objective is: *To review and synthesize current evidence on the use of heat stress and heat indices in maternal health studies and their association with adverse birth outcomes.*

Methods: An updated PRISMA scoping review of maternal and perinatal health studies (n=374) and heat indices (n=25) was carried out using Scopus, in addition to literature that was returned by the PubMed review carried out in Cherisch et al., 2020. Only peer-reviewed English language literature for heat indices were included, with 2 papers further excluded as the method for the heat index did not have further literature consensus. The protocol for the updated review is registered: https://osf.io/nm4q3.

Results: Four heat indices are used in maternal health studies, heat index, apparent temperature, wet bulb globe temperature (WBGT), and universal thermal climate index (UTCI). These capture heat-humid compounds and in the case of WBGT and UTCI also consider solar radiation interactions with the body heat balance. Exposure to elevated levels of heat stress has been associated with preterm birth and sometimes lower birth weight. In addition, there is a greater risk of stillbirth for more intense and longer durations of heat stress exposure. Factors suggested to lead to negative outcomes include: change in hormonal levels, dehydration and blood flow diversion away from the fetus. All studies demonstrate that certain contextual factors may have a confounding effect such as access to electricity, high levels of air pollution, and diabetes and gestational diabetes.

Conclusions: Heat indices have been shown to be more beneficial in indicating heat stress and the body heat balance. The recommendation is for the maternal and perinatal field to incorporate heat indices into research and eventual move away from only using ambient temperature.

Risk assessment and mapping of heat-related impacts on public health in an urban area

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Keywords: heat stress, public health, large urban agglomeration, georeferencing, risk assessment

Introduction: Climate change is impacting public health and large urban agglomerations are particularly affected in this respect. However, urban scales are difficult to deal with as data on at least 1-km horizontal resolution are usually needed to capture the very fine details in climate variability and change. On the other hand, relevant socio-economic data aggregated at fine resolution are also necessary for developing impact indices to be coupled with the climate ones in the process of risk assessment. We address here the challenges related to climate and impact data available to assess some of the heat-related effects on public health in the Bucharest municipality (Romania).

Methods: In our study, we used a risk matrix approach (Papathoma-Koehle et al., 2016) to develop heat-related hazard, impact, and risk maps. We used satellite-derived land surface temperatures (LSTs) to cope with the need of having fine horizontal resolution for the hazard index. We have defined the impact index based on the emergency (paramedic) interventions for daytime and night-time from the period June-August 2012-2017. The risk matrix displays on the vertical axis five impact levels based on normalized counts of paramedic interventions per day and per number of people in each of the six administrative units (level NUTS-3) of Bucharest. On the horizontal axis, the risk matrix shows five hazard levels based on the normalized values of the urban heat island (UHI) index. Here, the UHI index is defined by the day and night-time averaged values of MODIS-derived LST at 1-km resolution for the interval June-August 2012-2017 (Figure 1). The paramedic interventions related to heat stress were georeferenced and aggregated at 1-km resolution, too. The risk matrix allows us to define which are the acceptable and non-acceptable levels of heat-related risk under the identified levels of hazard and impact.

Results: Both day and night-time risk maps shows higher levels of risk in the Eastern part of the town, where blocks of flats dominate the urban skyline. However, it is difficult to attribute these results to a specific factor or set of factors, at this stage. The results suggest that emergency service and local administration must implement risk reduction measures related to heat stress especially in the administrative units Sectors 2 and Sector 3 of Bucharest.

Conclusions: The risk maps for day and night-time need further work to better capture the hotspots with higher risks of heat stress in Bucharest and to effectively serve urban planners, emergency service and other institutions from central and local administration. However, our exercise has identified several data challenges and suggests ways to define, collect, monitor, and predict specific heat and public health indices in the process of risk reduction management in large urban agglomeration under climate change.

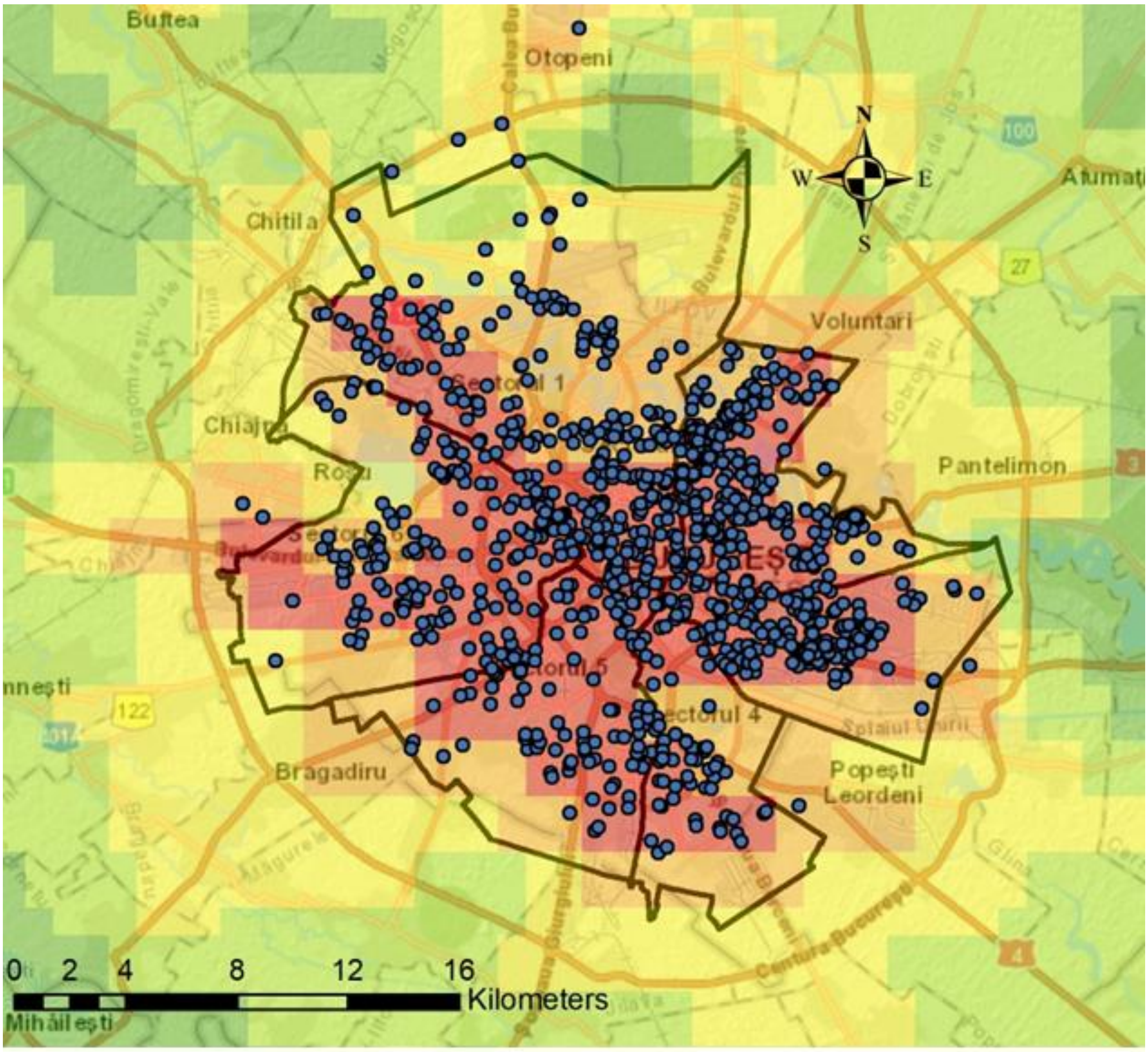

Figure 1. Heat-related hazard levels (color shaded) and locations of paramedic interventions (blue circles) during daytime (June-August 2012-2017) for Bucharest municipality. Black contours define the administrative units (NUTS-3) within the town.

Transdisciplinary research and action in climate and Hehlth in Latin America and the Caribbean: a network analysis

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Keywords: climate change, transdisciplinary research, Latin America and the Caribbean, collaboration

Introduction: Climate change is affecting the health and wellbeing of populations in Latin America and the Caribbean (LAC). Transdisciplinary research and action (TRA) are critical to addressing complex and interrelated challenges imposed by climate change and other social vulnerabilities. However, for TRA, there is a need to better understand the existing networks of collaboration among stakeholders involved in climate and health initiatives.

This study identified who has been working and publishing on climate and health, and analysed co-authorship relationships to discover collaboration patterns between people and institutions in LAC.

Methods: First, a review of scientific literature indexed on Web of Science, SciELO, and BIREME/LILACS was performed. Searches were done in December 2022 and included keywords related to climate change, human health, and LAC countries. Full strategy can be found here (https://osf.io/gchv9)

Documents were included if they included i) climate and human health intersection; ii) individualised authors; and iii) LAC countries. There were no limits on publication date or language. Selection of documents and data extraction were done by two researchers. Data extraction covered name and institutional affiliation of each author (first affiliation was considered).

The network analysis was done in R. Nodes (authors and institutions) and edges (relationships between nodes) were identified. If institutions were a university, college, or research centre, it was considered as a "Academic/Research" node. Otherwise, it was considered as a "Policy/Implementer" node.

Results: A total of 310 articles, published between 2000 and 2022, were included. There were 1,505 unique authors, 629 unique institutions, and 71 unique countries.

There were around 700 authors with less than 5 connections. Some authors had a high degree of connection (60 to 80). Figure 1 identifies authors and collaborations, as well as nine clusters. Big clusters of authors (e.g., 1 and 2) are affiliated in the United States of America or the United Kingdom and only tend to include a couple of researchers from LAC. Most of the relationships between authors occurred between people from the same institution.

Among the top 10 publishing institutions, all are academic/research institutions, including three from Brazil, three from Mexico, and one from Chile. There is a low degree of collaboration between academic/research institutions and policy/implementation institutions (Figure 2).

Conclusions: There are relevant groups from USA and UK publishing on LAC and other small clusters in LAC, especially in Brazil, Mexico, and Chile. People tend to publish with people of the same institution, and collaboration between academic/researcher and policy/implementer institutions is very limited

There is a need for greater investments in TRA in climate and health in LAC, as well as promoting the importance of building networks that foster equitable and inclusive participation, knowledge exchange, and collective action. Leveraging the strengths and expertise of diverse stakeholders can help to advance the development and implementation of effective policies and interventions that promote climate-resilient and healthy communities in the region.

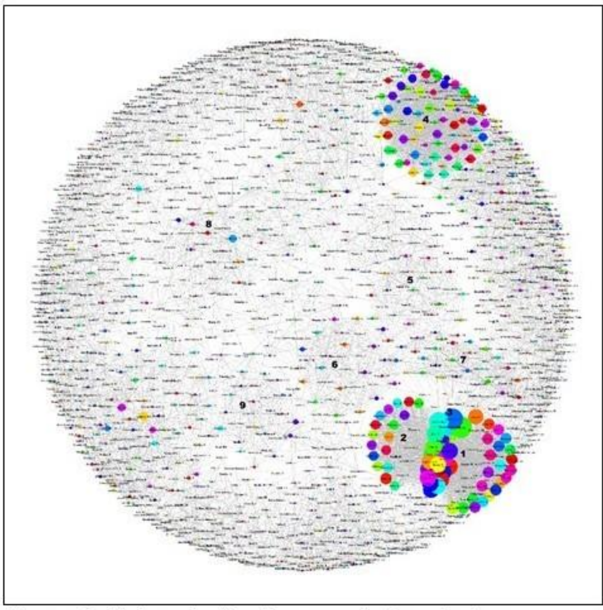

Figure 1. Network of authors and nine clusters

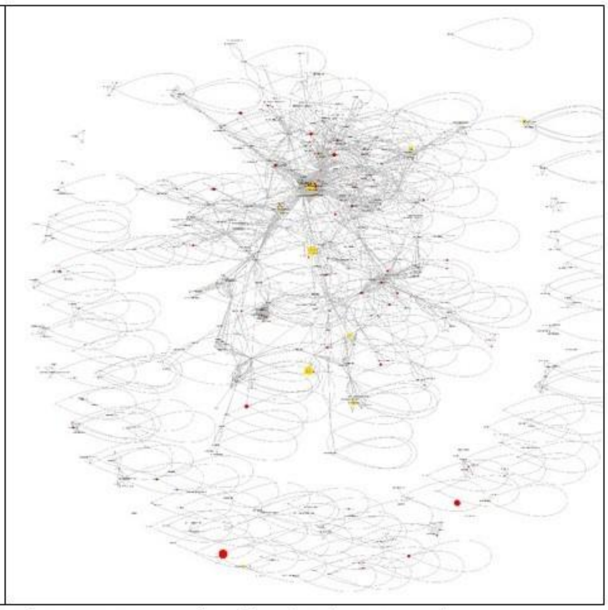

Figure 2. Network of institutions. In red academic/research institutions, in yellow policy/implementation institutions.

Communicating climate change through visual metaphors: costs and benefits

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Keywords: visual metaphor, climate change, communication, human health, environmental risks

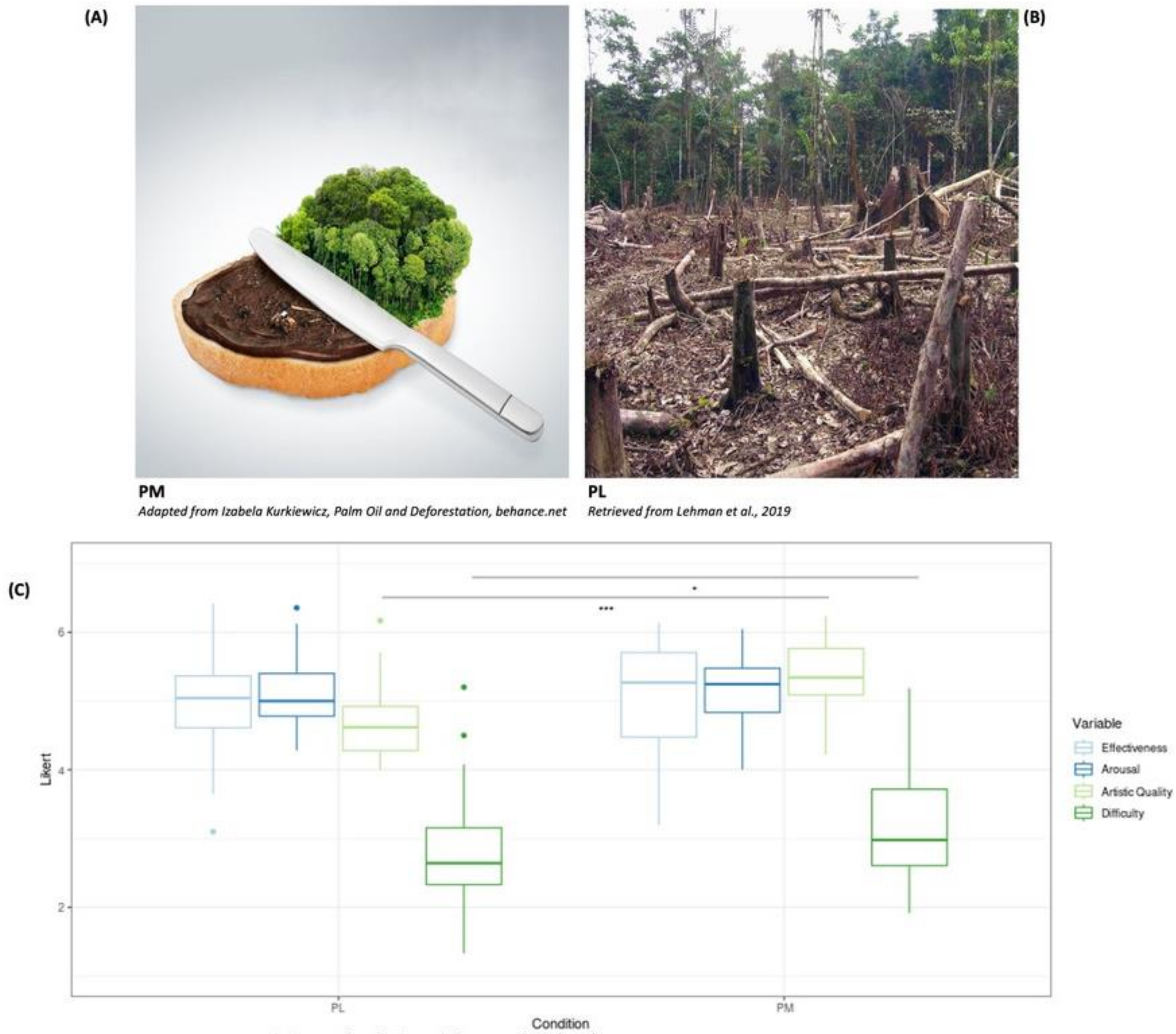
Introduction: The collapse of the ecosystems, paired with the enhanced risk of physical and mental illness, requires effective communication to motivate people to fight climate change (CC). The current suboptimal results obtained through verbal communication call for innovative approaches. Nowadays, CC communication often uses pictorial metaphors, images characterized by perceptual incongruity between two core visual elements, e.g., a knife acting as a bulldozer in clearing a forest that turns into chocolate cream (Fig. 1A). Research on the characteristics of this form of communication is still scarce. In this study, we aimed to evaluate processing characteristics of pictorial metaphors related to CC, contributing also to creating a database of these images for further studies on improving CC communication.

Methods: 50 pictorial metaphors and 50 pictorial literals focused on environmental issues (Fig. 1A and 1B) were retrieved from commercial websites. The main difference was that pictorial literals did not contain perceptual incongruence. Seventy-five participants (45F, mean age = 27.08, SD = 4.74) were recruited and exposed to pictorial literal and metaphoric images. They were asked to evaluate the image effectiveness, difficulty, artistic quality, and arousal. Secondly, participants were asked to generate tags to explain the message conveyed by each image.

Results: Pictorial metaphors and pictorial literals did not differ in effectiveness and arousal (ts < 1). Conversely, the two types of images significantly differed in difficulty and artistic quality: pictorial metaphors were rated as more difficult (p = .013) and with better artistic quality (p <.001) (Fig.1C) than pictorial literals. The tags analysis further confirmed the greater difficulty (p <. 001) and lower emotional impact of pictorial metaphors compared to pictorial literals (p =.007).

Conclusions: Results of the participants' rating identified pictorial metaphors on CC as more difficult and more aesthetically pleasing than pictorial literals. However, ratings as well as tag analysis showed that pictorial metaphors were not more effective neither more emotionally engaging than pictorial literals. We argue that CC communication through pictorial metaphors must consider the multifaceted nature of these images. Rather than an emotional impact, our data suggest that pictorial metaphors have the capacity to lead to greater elaboration, including complex ideas on the interlink between human health and the environment. Yet their use must be fully informed by solid research to monitor their complexity as well as effectiveness. In the long term, we aim to provide stakeholders and researchers engaging in CC communication with a fully characterized database of pictorial metaphors.

Fig.1: Examples of items and results of ratings



A Example of pictorial metaphor (PM).
B Example of pictorial literal (PL).
C Mean ratings of Effectiveness, Arousal, Artistic Quality, and Difficulty computed on PL and PM.

Awareness, perception, commitment and expectations in terms of initial training on climate change among French health students

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Keywords: climate change, sustainable development, health students, initial training

Introduction: Climate change (CC) has been identified as the greatest global health threat of the 21st century and one of the greatest challenges of our time. In order to foster the resilience of our health system and promote sustainable health, it is essential to rely on aware and trained actors. We conducted an evaluation of the level of awareness, perception and commitment of health students in New Aquitaine with regard to CC and sustainable development (SD) issues. We also assessed their expectations in terms of initial training on these subjects.

Methods: We conducted an observational, cross-sectional, multicentre study targeting students enrolled in Medicine, Pharmacy, Odontology, Maieutics, Nursing, Physiotherapy, and Medical Electroradiology in south west region in France. The questionnaire used was designed to identify the Knowledge, Attitudes and Practices on SD and CC during their studies. It was distributed in a format to be completed online on April 2022.

Results: A total of 529/7000 (7.5%) health students participated in our survey. Our results show that students have little perception of the impact of the health system on CC. However, they are already committed to reducing energy (97%) and water consumption (94.5%) and sorting their waste (87.8%) in their daily lives. They project themselves as future actors in eco-responsible health in 73.6% of cases. Although they expect a strong commitment from their training institution, 92% of them think that students are the most active on these issues. Regarding their training, 83% of them think that it should integrate CC and SD issues, while 58.7% say that they have never dealt with this topic at this stage of their studies.

Conclusions: In France, the initial training of future health professionals must be rapidly adapted and must enable them to acquire the knowledge and skills necessary to understand the health impacts of CC on the one hand and to reduce the impact of the health sector on the climate on the other in order to collectively build an eco-responsible and sustainable health.

Human health impacts of climate change: a global scoping review

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Keywords: climate change, human health

Introduction: The evidence base on the human health impacts of climate change is growing rapidly. This can make it difficult to find and use relevant information. Quantitative information about these impacts is needed for climate policy, response, and research.

Methods: We conducted a global scoping review to collect and synthesize this information focusing on studies examining changes in direct or indirect health impacts, risks, exposures, or hazards. We searched Scopus, Embase, and PubMed for quantitative, English language literature published between January 2000 and June 2021 that referenced climate change and human health in titles, abstracts, or keywords. After two screening steps relevant data were extracted from each included study.

Results: From 36,956 records we identified 766 articles providing quantitative information about human health impacts of climate change. Research output on the subject is increasing globally. There is noticeably more evidence available for the Americas and Europe compared to other WHO regions. Temperature-related health impacts and infectious diseases, particularly those transmitted by vectors such as mosquitos and ticks, are frequently studied in all regions. In Europe and the Americas (specifically the United States) there is also significant attention for the effects of climate change on air quality. For other subjects such as mental health or food safety, available evidence is very limited. Effects of climate change are already being observed worldwide. Examples include increasing exposure to heatwaves, effects on the production of pollen, and shifting habitats for certain tick and mosquito species to higher latitudes and altitudes. Some of these retrospective studies show interaction with other developments including adaptation, indicating changes in exposures do not always result in equivalent changes in impacts. For example, heat-related mortality is decreasing in some places despite increased exposure to high temperatures. Based on studies projecting future impacts we could see increases in extreme events such as wildfires, increased disease burden attributable to air pollutants such as ozone, and greater diarrheal disease risks. However, projections are often variable, primarily showing local differences in the direction of an impact (increase/decrease). Additionally, results are sometimes uncertain. For example, the direction of change can vary between climate change scenarios or methodological assumptions about socio-economic developments.

Conclusions: Climate change already affects health worldwide, and could further alter the dynamics of many future health outcomes. Our findings underline the complexity of climate change impacts; they often vary locally, and we should not only consider changes in exposures and existing risks, but also the introduction or (re-)emergence of new risks. Studies demonstrate adaptation can effectively reduce impacts, but capacity to adapt is not unlimited and differs greatly between population groups. Currently, there is limited harmonization of research on climate change and health. This makes it

difficult to compare outcomes from different studies, and to prioritize based on the available evidence. The regions most vulnerable to climate change, such as Africa, are relatively understudied. These regions should be prioritized for future research, with greater attention for the diversity of possible impacts beyond those related to temperature and vector-borne diseases.

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

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Keywords: climate change, respiratory disease, lung, air pollution

Introduction: The European Respiratory Society (ERS) is an international medical organization that brings together physicians, nurses, other healthcare professionals, epidemiologists, patient representatives, scientists and other experts working in respiratory medicine. ERS is one of the leading medical organizations in the respiratory field, with a growing membership from over 160 countries. ERS mission is to promote lung health and alleviate suffering from respiratory diseases and drive standards for respiratory medicine globally. Science, education and advocacy are at the core of everything ERS does. The ERS itself has the responsibility to adopt internal strategies to severely reduce its carbon footprint before 2030 and become a carbon-neutral organization before 2050 and is currently developing its internal Sustainability Policy. ERS has published its first Climate Change Statement in 2009, realizing early connections between climate change and respiratory health, and seeking out to educate its members on this matter.

Methods: In this Statement by the ERS, we aim to provide an overview of the state-of-the-art knowledge on the impact of climate change on respiratory health, and guidance to clinicians and other healthcare professionals and institutions, patients and patient organisations on how climate change and global warming can be addressed in clinical practice. In particular, we focus on how climate change mitigation and adaptation strategies synergise with other policies for respiratory health (i.e. clean air policies, sustainable urban development), how climate change impacts daily activities in clinical practice and patient behaviour, and how clinicians and patients can act as advocates for climate-friendly policies from the clinical practice.

Results: This Statement is intended to be a reference resource on the impact of climate change on respiratory health and a call for action against this threat from the clinical and public health perspective and as members of today's society. The Statement also expresses the position of the ERS and European Lung Foundation in support of all policies that mitigate climate change impacts, which are imperative

to improve the health of lung patients in Europe and prevent new climate-related lung diseases. Specifically, statement described the close links between climate change and air pollution, and expresses ERS support of the stricter air pollution standards fully aligned with the 2021 WHO Air Pollution Guidelines, as a part of the current EU revision of the Air Quality Directive. This statement has been developed by the Environment and Health Committee of the ERS and the European Lung Foundation, and approved by the Advocacy Council, Science Council and the Executive Committee of ERS.

Conclusions: In conclusion, climate change is a major threat to lung patients, causing global warming, more frequent and extreme weather events, such as heatwaves, flooding, prolonged aeroallergen seasons, and poorer air quality from droughts, dust storms, and wildfires. ERS calls on the health community to help alleviate the health risks to the lung patients, and policymakers to act now and prepare for a complex future.

Climate change and health: a call for papers on implementation research in low- or middle-income countries from health policy and planning

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Keywords: climate change, health, low income countries, middle income countries

Introduction: The impacts of the climate crisis, already profound, are escalating rapidly. While all countries are affected, some specific areas and populations are especially heavily affected. Health Policy and Planning, the journal on health policy and systems research, has launched an open call for implementation research papers on climate change and health, guest edited by Kathryn Bowen, Matthew Chersich, and Joanna Schellenberg. We are particularly interested in manuscripts sharing methods and results for formative research on intervention development, including co-design, or on process evaluation methods or outcomes. Summative overall evaluation papers would also be welcome.

Methods: We encourage manuscripts on the themes presented below. For each of these themes we suggest research questions or topics. Articles can cover any of the manifestations of climate change that affect health including extreme weather events, heat exposure, food and water insecurity, infectious diseases, as well as social disruptions such as migration:

Results:

- Papers presenting formative research on intervention development;
- Papers presenting process evaluations of interventions to address climate change and health;
- Papers presenting summative evaluation of interventions to address climate change and health.

Conclusions: Depending on the response to this call, we plan to publish papers that survive the peer-review process in a collection in the journal.

Poster discussion 4: Inequities in climate change impacts and health risks

Countrywide analysis of heat- and cold-related mortality trends in the Czech Republic: growing inequalities under recent climate warming

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Keywords: climate change, heat, cold, mortality, inequalities

Introduction: As some population subgroups are more susceptible to nonoptimal temperatures, it can be assumed that recent climate warming amplifies these inequalities. However, little is known about trends in temperature mortality associations among the most vulnerable subgroups, especially in the areas of central and eastern Europe, which are considered major climatic hotspot in terms of heatwave exposure. Thus, we aimed to assess trends in temperature-related mortality in the Czech Republic by sex, age, and cause of death and to quantify the temporal evolution of possible inequalities.

Methods: We collected daily time series of all-cause (1987-2019) and cause-specific (1994-2019) mortality by sex and age category and daily mean 2-meter temperatures for each region of the Czech Republic. We applied a quasi-Poisson regression model to estimate the trends in region-specific temperature-mortality associations, with distributed lag non-linear models (DLNM) and multivariate random-effects meta-analysis to derive average associations across the country. We then calculated mortality attributable to nonoptimal temperatures and implemented the indicator of sex-, and age-dependent inequalities.

Results: We observed a similar risk of mortality due to cold temperatures for men and women. Conversely, for warm temperatures, a higher risk was observed for women. Results by age showed a clear pattern of increasing risk due to non-optimum temperatures with increasing age category. The RR related to cold was considerably attenuated in most of the studied subgroups during the study period, whereas a significant increase in the RR associated with heat was seen in the overall population, in women, in the age category 90+ years, and with respect to respiratory causes. Moreover, underlying sex-, and age-dependent inequalities experienced significant growth. Spatial analysis showed high geographical variability in RRs, their trends, and inequalities at both cold and hot temperatures across regions.

Conclusions: Our findings suggest ongoing adaptation to cold temperatures. Mal/adaptation to hot temperatures occurred unequally among population subgroups and resulted in growing inequalities between the sexes and among age categories. Additionally, through the observed regional variability, this study also demonstrated the need for planned adaptation policies and interventions that are more suitable for specific locations and populations rather than designed for general implementation.

Insights into holistic approaches of climate change and social inequalities in health: A scoping review

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Keywords: climate change, health inequalities, one health, planetary health, ecohealth

Introduction: Social inequality is affected by the consequences of climate change, and may be aggravated by policy responses. These interdependent effects create a vicious loop exacerbating the impact of climate dysregulation on health in an uncontrolled and poorly known way. Holistic approaches to public health such as One Health, EcoHealth or Planetary Health are well fitted to tackle the huge and complex environmental and social issues underlying climate dysregulation. However, the extent to which researchers using such frameworks investigate social determinants of health is not clear.

Objectives: We aimed to ascertain the proportion, nature, content and type of research papers where social factors, holistic models of public health (namely One Health, EcoHealth and Planetary Health) and climate were being simultaneously addressed or discussed.

Methods: We conducted a scoping review of the scientific literature in NCBI Medline PubMed and Clarivate Web of Science databases and identified 279 eligible articles that were further analysed for their social components and their methodological treatment (as a variable of exposure / outcome, a covariable or as a variable only discussed / mentioned).

Results: Our results highlight that little empirical research which focused on the interdependency between climate, health and social determinants of health, is conducted in such holistic approaches. Social determinants were often discussed but rarely studied as the main variables of interest.

Conclusions: Our work highlights the gaps in the current status of this type of research, and provides a knowledge framework to help understand comprehensively the relations at stake and enable adequate research analysis, variable selection and design of actions. There is an urgent need to investigate empirically to what extent social factors influence the relation between climate and health and to take these interdependencies into account in mitigation and adaptation strategies.

Quantifying intra-urban socioeconomic and environmental vulnerability to extreme heat events in middle-income African countries

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Keywords: climate, health, remote-sensing, vulnerability, inequity

Introduction: Extreme heat events pose risks to human health, this risk can be further exacerbated by socio-economic dynamics and differences in environmental exposure in urban settings. Understanding how heat-stress vulnerability varies across urban populations is important for planning mitigation and adaptation responses by authorities. Different demographic groups, delineated by age, gender, living conditions, occupation, income, nationality, health and wellbeing tend to have different health outcomes during extreme heat events. Evidence suggests that these social determinants play a vital role in understanding the health outcomes of different sub-populations. While heat-stress vulnerability is well studied and understood in developed countries, there is still a gap to be filled by developing countries on how their unique contexts influence what is currently understood on how socio-economic and environmental dynamics influence heat-stress and the subsequent health impacts.

Developing appropriate health sector responses and adaptive interventions relies on identifying these vulnerable populations along with their level of environmental risk. Socio-economic factors such as poverty, food and water insecurity, and limited access to healthcare facilities perpetuate vulnerability among these communities.

Methods: To address the lack of understanding of the environmental risk impacts on the changing epidemiology in sub-Saharan Africa, the proposed work outlines a framework to quantify the intra-urban socio-economic and environmental vulnerability across African cities through a fixed threshold-based, spatial multicriteria analysis approach. Our results describe the process of developing a vulnerability metric from the combined environmental and socio-economic datasets through a geospatial analysis platform. We structure our analysis to assess the hypothesis that people living in areas which are densely populated, highly built-up and which have low vegetation cover are more susceptible to the impacts of extreme heat events and adverse health outcomes. Considering both environmental and socio-economic factors such as population density and access to healthcare services, allows us to better understand the subtleties and inequities of vulnerability.

Geospatial approaches including remote sensing data have been recognized for their utility in providing instantaneous and synoptic views of extreme weather events. There are various challenges in acquiring high resolution environmental datasets, primarily, limitations in meteorological station data due to sparse spatial and temporal coverage. Hence, we make use of high-resolution and multi-temporal, satellite images to derive variables such as; Land Surface Temperature (LST), Normalised Difference Vegetation Index (NDVI) and Urban Thermal Field Variance Index (UTFVI).

Results: We implement this framework for Gauteng, a highly urban province in South Africa, which covers a land area of 18 176 km^2, and has a population of approximately 16.1 million. Preliminary results for Johannesburg, are presented as detection of vulnerability hotspots based on their combined environmental and socio-economic contexts.

Conclusions: Our findings highlight areas such as Alexandra and Tembisa, which are considered highly built up, constituting informal dwellings, densely populated and low resourced areas, as being of most concern for extreme heat events. This confirms that subtleties and inequities in vulnerability exist within African cities. This framework will be extended to similar cities across sub-Saharan Africa.

What role does the inequity of climate change impacts play in the revival of the Global Health Policy Framework?

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Keywords: climate change impacts, public health policy, climate justice, polycentric governance

Introduction: Environmental research and reports by the Lancet and the Intergovernmental Panel on Climate Change have already projected that, those who are socially, economically, and otherwise marginalized will be most vulnerable to the effects of climate change. This vulnerability is rarely attributable to a single cause. These risks consist of death and injuries from heat waves, storms, floods, infectious diseases, food and water insecurities. Most of these risks are unevenly distributed and each extreme weather event exacerbates the existing inequities; and are projected to increase with each additional unit of warming.

This research is a review of literature on the imbalanced impacts of climate change globally and the associated health risks on the basis of vulnerability. The analysis of literature has shown that, the mitigation policies addressing the health risks of climate change have so far been narrow in scope. Because countries in ratcheting up their ambition to meet the Paris Agreement targets, are at a risk of adverse social outcomes especially its intergenerational dimensions. Our analysis suggests that governments should review their health policies incorporating climate change using a pro-poor approach involving polycentric governance. The revival of health policy should involve conscious effort, careful planning and multi-stakeholder engagement to yield the best results. The purpose of this analysis is to provide markers that can guide the review process for the public health policy framework to better incorporate the social stratification of the climate change impacts.

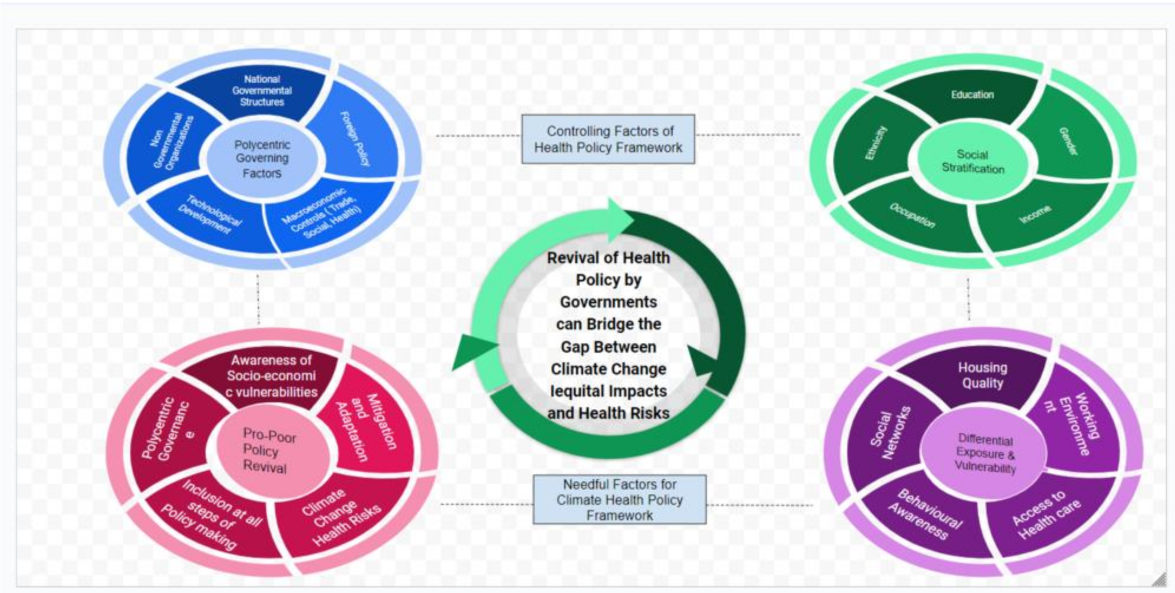
Methods: This analysis was based on the literature review addressing the distribution of climate change impacts with a focus on their socio-economic distribution and associated health risks. The review was primarily conducted between October 2022 and March 2023. The primary sources are papers published in peer-reviewed scientific journals and other literature.

Results: The vulnerability to climate change impacts has proven to be unjustly distributed and is a complex problem with many factors playing interdependent roles. The literature review analysis concluded that governments should review their public health policies using an equity lens. Because our current healthcare systems allow them to be compromised by damage from extreme weather events and consequential disease outbreaks without considering the social vulnerability of various groups.

Conclusions: There is still much to learn about how climate change affects health equity and what can be done effectively in different socio-political and socio-economic contexts to improve the health policy and consequentially the relationship between humans and their environment. However, community and individual adaptation and resilience to climate change can be possible when local and national policy frameworks institute equitable and just reforms.

Our research confirms that climate-just policies can only be formed when attention to social-economic vulnerability of the population is given along with mandatory participation of all stakeholders i.e a polycentric governance approach and consideration to potential inequality impacts of climate change

should be at all stages of policy-making. The figure is a graphical representation of factors that need to be incorporated while governments review their new climate mitigation and/or health policies.



The effects of diurnal temperature range on mortality and emergency presentations in Victoria, Australia: a multi-strata study

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Keywords: diurnal temperature ranges, mortality, ED presentation, triage, Australia

Introduction: Victoria, Australia has a wide variation of diurnal temperatures ranges (DTR). DTR has been reported to be associated with risk of mortality and morbidity. We examined the association between exposure to DTR and risk of all-cause mortality and emergency department (ED) presentations in the Victoria, Australia.

Methods: A time series analysis was conducted to examine the association between DTR, mortality, and ED presentations. We obtained data on daily counts of deaths and ED presentations, and weather data from 1st January 2000–2019. We applied a quasi-Poisson time-series regression analysis to examine the association between daily DTR exposures and risk of mortality and ED presentations. The analyses were queried by age, sex, seasons, ED presentations triages, and departure status.

Results: A total of 703, 377 deaths and 22.7 million ED presentations were reported in the State of Victoria from 1st January 2000 to 1st January 2019. The mean DTR over 6940 counts of days of the study period (1st January 2000 to 1st January 2019) was 9.88℃, where the mean maximum and minimum temperatures were 19.67℃ and 9.79 ℃, respectively. Risk of mortality and ED presentation increased by 0.33% (95% CI: 0.24% – 0.43%), and 0.094% (95% CI: 0.077% – 0.11%) in relation to a degree increase in the daily DTR. The association between DTR and ED presentations was stronger in children (0-15 years) (0.38% [95% CI: 0.34% – 0.42%]) and the elderly (75+ years) (0.34% [95% CI: 0.29% – 0.39%]). Resuscitation, which was consistently accounted for the highest vulnerability to DTR variation, increased by 0.79% (95% CI: 0.60%-0.99%).

Conclusions: This study suggests that the risk of mortality and ED presentations associates with the increase of DTR. Interventions such as public health alerts systems, and warnings which may potentially reduce health outcomes especially during high DTR levels Children, the elderly, and their caregivers need to be made aware of the health risk posed by DTR.

Climatic impacts on mortality variability in pre-industrial Sweden

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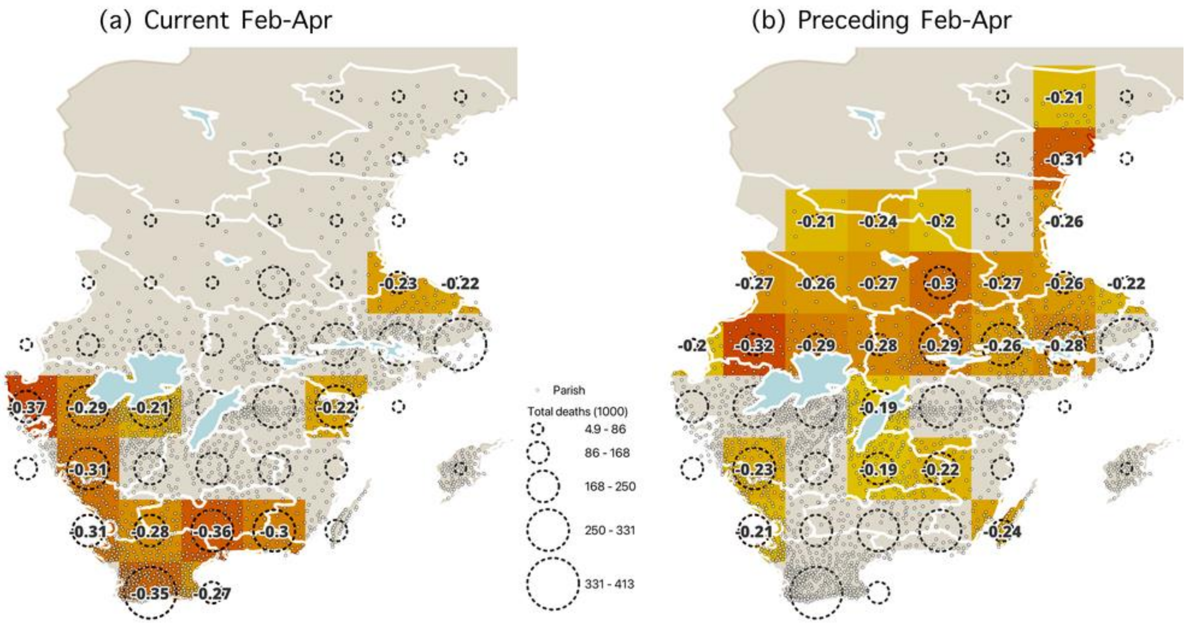
Keywords: mortality, climate change, historical data, pre-industrial, Sweden

Introduction: Climate change and variability, as well as extreme weather, can have significant effects on human health and mortality. During historical times the effects of climate on health and mortality was presumably even stronger than in modern times due to climatic impacts on food production and, consequently, nutrition status. In the absence of reliable census data from the pre-industrial period, quantitative estimates of climatic impacts on mortality levels remains poorly understood.

Methods: In this study, we used census records of annual mortality in Sweden between 1749 and 1859, to estimate excess deaths for all persons and selected subgroups (male, female, three age groups). The spatial-temporal analysis of climate-associated excess deaths was further conducted using monthly Berkeley gridded temperature data and the Palmer Drought Severity Index (PDSI) at a grid cell size of 1°x1° across most populated districts in Sweden.

Results: The results revealed a persistent, and statistically significant, negative relationship between winter and spring temperature and mortality levels, indicating that cold spring and winter lead to higher mortality and *vice versa*, not only in the current year, but also in the following year. The effect of winter—spring temperature on mortality was strongest in southern Sweden for the current year, but this effect shifted to central Sweden for the following year's mortality.

Conclusions: These findings provide a valuable perspective on the potential consequences of future climate change that cannot be fully captured by short-term studies alone. Further research is needed to investigate the specific diseases and other factors that may have contributed to the observed increase in mortality under cold climatic conditions.


(a) Current Feb-Apr
(b) Preceding Feb-Apr
Parish
Total deaths (1000)
4.9 - 86
86 - 168
168 - 250
250 - 331
331 - 413

Climate change: an overlooked threat multiplier for drowning

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Keywords: injury prevention, future-proofing, flooding, temperature, urbanisation

Introduction: Climate change threatens human health in numerous ways. However, the effects on injury are often overlooked. The World Health Organization describes drowning as an under-recognised threat to public health, and climate change is liable to exacerbate that threat. Nevertheless, there has been little research that considers how climate change acts as a threat multiplier for drowning risk. This paper considers the mechanisms through which climate change may affect drowning risk globally, and provides three case studies: a child-focused drowning prevention intervention in rural Bangladesh, a fisher-focused drowning prevention intervention on the Tanzanian shores of Lake Victoria, and the operations of a coastal search and rescue organisation in UK and Ireland.

Methods: Based on the World Meteorological Organization's climate risks to the Sustainable Development Goals, a literature review was conducted on seven key climate risks linked to drowning. These include heat and cold waves, drought and water scarcity, flooding and tropical cyclones, aquatic ecosystem collapse, damaged infrastructure, displacement, and rising poverty and inequality.

In addition, national-level climate change predictions to 2050 in Tanzania, Bangladesh and UK were assessed and used to identify the likely impacts of climate change on each of the three case studies, with a focus on the impacts of temperature change, sea level rise, and extreme weather events.

Results: Flooding, cyclones and other hydrometeorological hazards have a clear link to drowning deaths, though these deaths are not included in global drowning estimates. Hotter temperatures are expected to result in more recreation-related drowning deaths, and droughts and water scarcity will likely change population risk exposure profiles as access to safe water changes. Similarly, greater risk-taking behaviour is expected by people reliant on aquatic ecosystems for their livelihood, e.g. fishers. Displacement may be linked to transport-related drownings and migrant populations often experience new risk factors at their destination. These risks are exacerbated by growing populations, urbanisation, and rising inequality.

In Bangladesh, millions more people will be affected by river and coastal flooding by 2050, and the country will experience more intense and more frequent cyclones. Increasing internal migration to urban centres is expected. Whilst approaches to preventing child drowning in rural areas will still be valid, there is a need to also consider and address urban drowning risks.

In Tanzania, more variable rainfall and more intense rainfall events may cause flooding. Food precarity will increase, and population is expected to double by 2050 with large increases in urban population. Uncertainty around these predictions means that a fisher-focused drowning prevention campaign will need to be designed to be flexible.

In UK, warmer drier summers and population growth are likely to increase lifesaving demand associated with recreational activities. Increasingly frequent floods, accelerated coastal erosion, and extreme weather events could have wider impacts for operating a lifeboat and lifeguard service and keeping lifesavers safe.

Conclusions: Climate change is already impacting drowning and will continue to increase drowning risk exposure and alter risk factors at a local scale. Climate change adaptation and mitigation actions can help reduce drowning risk and future-proof existing drowning prevention efforts.

Manual labour in an increasingly hot climate: workplace regulations influence physiological workload and heat stress in industrial sugarcane workers

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Keywords: heat exposure, heart rate, physiological workload, industrial agriculture.

Introduction: Industrial agriculture workers in developing countries are required to undertake strenuous manual labour in hot environmental conditions, often within a low regulatory environment. Climate change-related increases in global temperatures and heat wave events alongside increased crop production demands pose a compounded risk to industrial agricultural workers, who are already at high risk of occupational heat stress and related impacts (including heat-related productivity reductions, heat illness, heat stroke, kidney injury). Improved work practices (i.e., regulated rest breaks, with access to shade and water) have been shown to reduce physiological strain in burned cane cutting (BCC) workers and mitigate adverse heat effects. This study aimed to examine the physiological workload of industrial sugarcane workers employed by mills with lower regulatory environments (i.e., limited work practice controls) and compare this to workers employed by mills with higher regulatory environments (i.e., rest, shade, hydration [R.S.H] intervention).

Methods: Physiological workload was evaluated in job tasks of differing intensities (BCC, observed as high work intensity; pesticide application [PA], observed as moderate work intensity) in workers from Nicaragua (R.S.H. intervention, BCC-R.S.H.), El Salvador (limited work controls, BCC-non), and eSwatini (PA-non), using heart rate (HR) recorded continuously across a work shift. Workers' percentage of maximal HR (%HR_{max}), time spent in different HR zones, estimated core temperature (ECTemp), and the proportion of the work shift spent at an ECTemp over 38°C (above which heat strain is considered present) were calculated. Local workplace wet-bulb globe temperatures (WBGT) were recorded.

Results: A total of 95 male workers participated in this study (40 BCC-R.S.H., 35 BCC-non, 20 PA-non). Daily average WBGT was 26.7 [95% CI 25.6-27.9] °C for BCC-R.S.H., 26.4 [95% CI 23.9-28.9] °C for BCC-non, and 27.8 [95% CI 27.3-28.3] °C for PA-non. Average %HR_{max} across a work shift was 58% [95% CI 56-60] in BCC-R.S.H., 64% [95% CI 61-66] in BCC-non, and 58% [95% CI 55-61] in PA-non-workers. On average, BCC-R.S.H. workers spent 14% of their shift working at hard-to-maximal intensities (i.e., >70 %HR_{max}), compared to 28% for BCC-non-workers. PA-non-workers spent 9% of their shift working at hard-to-maximal intensities. BCC-R.S.H. and BCC-non-workers maximum ECTemp reached 38.1 [95% CI 38.0-38.2] °C and 38.3 [95% CI 38.1-38.4] °C, respectively, while PA-non-workers reached 37.9 [95% CI 37.8-38.1] °C. The proportion of the work shift spent over 38°C was 14% (range: 0-56%) for BCC-R.S.H. workers, 26% (range, 0-92%) for BCC-non-workers, and 11% (range, 0-77%) for PA-non-workers.

Conclusions: Physiological workload in all observed worker groups indicate a risk of occupational heat strain regardless of job task or regulatory workplace intervention. However, physiological strain appears greatest for BCC workers employed in low regulatory environments. PA workers may also benefit from regulated rest periods with water and shade access to lower physiological workload and mitigate heat stress across their work shift. With rising global temperatures, further work to implement or improve existing regulatory practices in industrial sugarcane are needed to lower physiological strain and minimise the negative health outcomes associated with repeated heat exposure and manual labour, particularly in lower regulatory work environments.

Occupational injuries and heat in the Italian agricultural sector

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Keywords: work-related injuries, extreme temperatures, heatwaves, agricultural sector

Introduction: The last ten summers in Italy registered above-average values and although the effects of extreme temperatures on human health are well known, the association with occupational injuries in different sectors, and m specific subgroups, have been scarcely investigated. The aim of this study is to estimate the effects and impacts of heat and heatwave days on occupational injuries in the agricultural sector in Italy.

Methods: We collected work-related injuries occurred in the agricultural sector in the 8,090 Italian municipalities between 2014 and 2018 from the Italian national workers' compensation authority (INAIL). Daily air temperatures from Copernicus ERA5-land were used to define exposure at municipal level. First, we applied distributed lag non-linear models (DLNM) to estimate the association between daily mean air temperature and injuries at regional level; then, we meta-analysed results to obtain overall estimates. The relative risks (RR) and attributable cases (AN) of agriculture-related injuries, for an increase in mean air temperature above the 75th percentile, were estimated, both in the total period and during heatwave days (defined as 3 or more consecutive days above the warm season 90th percentile). Analyses were also stratified by age, duration of leave, professional qualification and working process.

Results: Analysis were conducted on 150,422 agricultural injuries. The overall relative risk of work-related injuries in the agricultural sector for increases in temperature above the 75th percentile was 1.13 (RR 95% CI: 1.08; 1.18). A higher risk was observed among young workers (RR 1.23 95% CI: 1.14; 1.34) and seasonal workers (RR 1.25 95% CI: 1.03; 1.52). When considering duration of leave as a proxy of severity of heat-related injuries, the greatest risk was observed for short duration between 0-14 days (RR 1.21 95% CI: 1.10; 1.33) with a decreasing trend. A significant risk of injury was also found for workers carrying out land preparation (RR 1.18 95% CI: 1.08; 1.30). Considering extreme events of heatwave days, the risk of injuries in the agricultural sector was of 1.06 (95% CI: 1.03; 1.08). The number of injuries attributable to heat is of 2050 cases in the five years considered, and a stronger impact has been observed among workers in 35-60 years class (AN 1258 95% eCI: 1024; 1487) and self-employed workers (AN 1051 95% eCI: 801; 1300).

Conclusions: Considering climate change, occupational exposure to extreme temperatures and events is a critical issue, especially among sectors engaged in outdoor and labour-intensive activities such as the agricultural sector. These results can help the promotion of prevention actions for specific subgroups of workers.

Poster discussion 5: Climate resilient health systems

Healthcare seeking behaviour for children under 5 with febrile illness in Malawi and Rwanda: the impact of drought

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Keywords: drought, health equity, paediatric, sick child

Introduction: Climate change is linked to increasingly frequent extreme weather events, such as drought, which disrupt healthcare systems. Timely healthcare seeking for acutely ill children, such as those with febrile illnesses, is critical for survival. The impact of drought on healthcare seeking behaviour for children with febrile illness is poorly understood. The objective of this study is to examine the relationship between drought and healthcare seeking behaviour in children under 5 with febrile illness in two countries in sub-Saharan Africa.

Methods: We investigated the association between drought and health care seeking behaviour for fever, acute respiratory infection (ARI) and diarrhoea using a retrospective analysis of Demographic and Health Survey data in 2 sub-Saharan African countries (Rwanda and Malawi) among 8689 children. Drought was defined as a binary variable of annual rainfall less than or equal to the 30th percentile relative to the prior 29 years, using contextual environmental data from the IPUMS-DHS datasets. We considered four binary outcomes of healthcare seeking behaviour: appropriate care seeking for an episode of fever or diarrhoea or ARI and each of these illnesses separately in children under-5 during the two weeks prior to interview. In this study, appropriate care-seeking behaviour was defined as seeking care from public or private facilities who have authorized to treat children with signs of fever, ARI and diarrhoea. We analysed the potential confounding effects of sociodemographic variables that have associations with healthcare seeking behaviour independently of drought.

Results: 8689 children who experienced ARI, fever, diarrhoea were included in this analysis. Overall, 5764 (66.2%) of infants experienced no drought while 2925 (33.8%) experienced drought. For the combined care seeking outcome (ARI, diarrheal disease or fever), 6008 (67.4%) of children sought care. This analysis found differing associations between care seeking behaviour and drought. For overall care seeking, the adjusted estimate, (aOR 0.97, 95% CI: 0.85-1.12, p=0.706), demonstrates no evidence of an association between diarrhoea care seeking and drought. Similarly, no evidence of an association was found between fever care seeking and drought (aOR 1.02, 95% CI: 0.88-1.19, p=0.758).

There was moderate evidence of an association of ARI care seeking and drought, (aOR 0.69, 95% CI: 0.48-0.98, p=0.037) After controlling for maternal and child characteristics, the effect of drought on care seeking for ARI was found to differ according to the country. Infants under 5 from Malawi exposed to drought had 0.47 times the odds of care seeking for ARI compared to those infants not exposed to drought. (aOR 0.47, 95% CI: 0.30-0.70, p=0.002). In Rwanda, infants exposed to drought had 1.17 times the odds of care seeking for ARI than infants unexposed to drought. (aOR 1.17 95% CI: 0.76-1.79, p=0.474).

Conclusions: Further study is needed to determine if the differing associations of healthcare seeking for febrile illness and drought found in this study is representative of other countries. More nuanced

data needs to be gathered on individual and community characteristics impacted by drought. A deeper understanding of the impact of drought on care seeking for febrile illness will allow for more effective health programming for acutely ill children in communities impacted by climate change.

Planetary health education in medical schools in Germany: perspectives of medical students participating in the cross-sectional PlanetMedEd Survey

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Keywords: planetary health, planetary health education, medical education, curriculum development

Introduction: The accelerating climate crisis is the biggest threat to human health in this century and requires more resilient and sustainable health systems. To fully leverage health professionals' potential to promote health system transformation, curricular integration of planetary health education (PHE) is considered an essential prerequisite. To support tailoring of educational offers to student needs, we investigated (1) satisfaction with current teaching in PHE, (2) perceived relevance of PHE, and (3) preferences for future PHE among medical students in Germany.

Methods: Students from 37 medical schools in Germany were invited to complete a cross-sectional online survey between November 2022 – January 2023. The survey included multiple choice and open-text questions and captured student satisfaction with current educational offers, perceived relevance of PHE and student preferences for future PHE. Quantitative data were descriptively analysed. Qualitative data were inductively coded by two independent researchers and themes iteratively refined by group consensus.

Results: In 515 returned surveys from 32 medical schools, most students reported that PHE was either not taught (64%) or limited to 1-2 lectures (corresponding to 45-90 minutes; 23%). The most common teaching format was lectures, followed by seminars, self-study and group discussions. The most frequently taught topics included health effects of the climate crisis (46%), environmentally sustainable and healthy diets (32%) and health effects of the climate crisis among vulnerable groups (30%). 63% of students were very dissatisfied with PHE integration into core curricula, reporting high levels of dissatisfaction with content, teaching formats and depth, whereas many students (42%) were satisfied with PHE in elective courses.

Most students viewed PHE as very relevant (52%) or relevant (31%) for their professional career. Despite differences in the extent of perceived relevance, many students supported integration of the following topics into medical curricula: health effects of the climate crisis, environmentally sustainable and healthy diets, health effects of the climate crisis among vulnerable groups, sustainable healthcare and integration of planetary health into patient consultations (67-90%).

Extending our quantitative findings, the qualitative results suggested that educational offers were often dependent on initiatives of single faculty members. Students were mainly dissatisfied due to a limited range of topics covered in current educational offers, teaching formats as well as teaching materials with limited depth and quality. In contrast, some students were satisfied because PHE was well integrated into existing curricula and taught early in their program. Few students were satisfied with the status quo because PHE was perceived irrelevant and current curricula already as very time-intensive.

Conclusions: Given high levels of perceived relevance, our study reinforces prior calls to accelerate the integration of PHE into medical curricula. Our findings suggest several levers to guide curriculum development, tailoring educational offers to student needs and ultimately strengthening the quality of PHE while being considerate of the already time-intensive curricula in medical education. The non-probability sample in this study highlights the importance of research involving representative samples to further guide the development of PHE and its integration into medical curricula.

Fostering climate literacy in health professions to tackle future climate challenge

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Keywords: climate literacy, health workforce, education, training, resilience

Introduction: Climate change affects public and individual health as well as well-being in multiple ways increasingly. Therefore, strong action is needed by the health sector to mitigate and adapt to climate change and tackle preventable morbidity and mortality and adverse impacts on the quality of life and health equity. WHO's operational framework for building climate resilient health systems identifies the health workforce as a crucial building block to provide a comprehensive health response. To systematically strengthen technical and professional capacity of health professionals in terms of climate literacy, the project aimed (i) to develop a sound definition of the term 'health-related climate literacy' and (ii) to describe the status quo and the necessary literacy development in Austrian health professions.

Methods: An explorative and mixed-methods approach was chosen to elaborate the research question. In a first step, a comprehensive literature research on the topic of climate, health, and competences with the focus on health professionals as well as on their professional and continuing education was conducted. Since there is no uniformly valid definition of health-related climate literacy, a definition based on the international literature was derived. In addition, principles were formulated as a structural framework for further work as well as levels of action. Finally, the concept of health-related climate literacy was further elaborated in a qualitative workshop with health care professionals. Based on this, further options for action and the relevant needs in education, further education and training were identified.

Results: Health-related climate literacy describes a person's knowledge and understanding of the influence of one's own behaviour on climate and the influence of climate on oneself, the ecosystem, and subsequently on society, especially in area of health. Based on this, a climate-literate person can make informed and responsible decisions in this context. Three levels of action have been identified for fostering climate literacy on policy level, health system level, and on individual level. The health workforce has a crucial role to play based on their ethical obligation of non-harm, their good trust ratings in society, and their access to particularly vulnerable groups. On the other hand, the study shows that the topic area of climate, climate change, and their manifold effects on health-—and thus health-related climate literacy—has so far only been present in fragmentary form in professional or continuing education and training of health professions in Austria. Further, 12 out of 34 legally regulated health professions were identified and prioritised for whom health-related literacy is relevant in their professional activities.

Conclusions: Health-related climate literacy is an effective way of mitigating the diverse and significant impacts of climate change on people's health and well-being and of strengthening the resilience of the Austrian health system. To strengthen climate literacy in health professionals in their daily work, corresponding competences and skills must be systematically built up, and adequate training and further education offers must be developed. The results support decision-makers in the targeted and sustainable further development of the health and care professions regarding health-related climate literacy.

Barriers and motivational factors for implementing climate change mitigation measures in Austrian healthcare facilities

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Keywords: climate change mitigation, healthcare facilities, green hospitals, planetary health

Introduction: The Austrian healthcare sector contributes approximately 7 percent to the national carbon footprint and therefore is a crucial sector for reducing greenhouse gas emissions. So far, the degree of implementing mitigation measures in healthcare facilities is very limited. In order to achieve national and international climate goals it is important to promote the implementation of mitigation measures in healthcare facilities. This questionnaire study, therefore, aims to identify motivations and barriers to implementing mitigation measures. The results could then serve as a scientific basis for interventions at a policy level.

Methods: To assess motivating and obstructive factors for implementing climate mitigation measures, a quantitative, non-representative online survey among healthcare professionals (n = 141) from different healthcare facilities (hospitals, nursing homes, doctor's offices, pharmacies) was conducted. The interviewed healthcare professionals were part of the project "Consulting climate-friendly healthcare facilities" and therefore familiar with the need for climate mitigation in the healthcare sector. The survey comprises the following sections: knowledge about climate change mitigation and adaptation, effects of climate change on health and the healthcare system, motivation for and barriers against implementing mitigation measures, assessment of the current situation of the healthcare facility, and future needs to implement mitigation measures.

Results: Lack of time and financial resources were found to be the main barriers to implementing mitigation measures. Additionally, scarce data availability, hygiene regulations, and shortage of staff were mentioned as barriers. The crucial motivation for taking the first steps towards climate change mitigation is the perceived responsibility as a healthcare facility to achieve planetary health. Additional motivating factors are the personal interest of healthcare professionals, as well as an increase in climate resilience and potential cost-savings for the healthcare facility. Further, healthcare professionals assess their facilities to be rather climate-friendly in regard to waste management and general awareness among staff. In contrast, climate-friendliness was rated the lowest in the areas of food provisioning and sustainable procurement.

Conclusions: The results of the study point to a structural problem hindering the implementation of climate change mitigation in healthcare facilities. While healthcare professionals are well aware of their responsibility to protect human and planetary health and are willing to act on it, we find a substantial lack of financial and time resources to implement mitigation measures. These findings point to the need for policies that facilitate funding and legal frameworks of mitigation measures in healthcare facilities to achieve national and international obligations to reduce greenhouse gas emissions in all economic sectors.

Sustainable solutions in climate action - the role of medical doctors

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Keywords: climate change, medical doctors, sustainable solutions

Introduction: This study aims to measure physicians' awareness of climate change impacts on health and their perceptions of their role in climate action (Turkey, Serbia, international group)

Methods: Data were collected online using a questionnaire created by the researchers. Attempts were made to reach physicians in Turkey, Serbia, and Europe through medical professional associations.

Results: More than 500 physicians, 70% from Turkey, answered the questionnaire. More respondents were female, had at least one child, were clinicians, worked in a hospital, and lived in a large city. Most physicians indicated that climate change poses a serious threat to health, and they are concerned about it. They also noted that climate action can mitigate climate change and adapt to the climate by changing our habits, and changes in government policy can accelerate this adaptation. Responses showed that physicians are aware of the health impacts of climate change. Physicians believe that while their colleagues play an important role in addressing the health impacts of climate change, they need more expertise and capacity building, and the health sector is not adequately prepared.

Conclusions: Medical doctors have a privileged position in taking action for sustainable solutions to climate change. Their capacity should be expanded in climate mitigation and adaptation action.

How governance structures support the transformation towards climate resilient and sustainable net zero health systems

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Keywords: climate change, health, health systems, governance, transformation

Introduction: The health care sector contributes with 5.2% of global emissions to climate change and putting populations at risk for climate change related impacts and diseases. It remains a crucial challenge to address sustainability since health care lies at the forefront of Climate Change. Across the UK the National Health System (NHS) in England, Scotland, Wales, and Northern Ireland the English NHS aims to be the first in the world to achieve net zero in all emission classes (Scope 1-3). In Germany major efforts are led through a bottom-up approach mostly driven by medical doctors, while the government currently takes no active stance in reducing health care emissions, although international treaties have been signed to achieve net zero emissions.

Methods: An exploratory mixed method approach was applied through qualitative and quantitative methods to illuminate challenges and findings. We performed structured interviews with experts in the field in Germany and UK besides an online survey with health care professionals in both countries. The study draws recommendations to support the transition of the sector to a net zero future, dependently of the health care system.

Results: Results reveal the complex nature of health care systems and the need for engraining a systems-thinking approach. The findings call for the legal embedding of sustainability into the key principles of health care in Germany, endorses the ambition of the National Healthcare Systems in the UK, recommends collaborative cross-sector approaches for sustainability, and highlights the need for increased public awareness on the interrelation between human and planetary health to enable governance for sustainable health care.

Conclusions: Sustainability in health care is relatively new field and must be engrained in the culture of a hospital. In addition, governmental policies need to be in place to support the executive management in transformational management. Further research in this area should elucidate how to integrate sustainability in health care systems worldwide and enabling access to care through e-health.

A practical tool to assess the effects of climate and health

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Keywords: social determinants of health, ICD-10 codes, mnemonics, OCAREER

Introduction: We introduce a project with two components. One is a tool for clinical assessment of the climate change exacerbation of social determinants of health, the other is coding for the identified factors. OCAREER is a mnemonic to assess health impacts from climate change. OCAREER stands for: Occupation; Conditions; Activities; Residence; Environment; Education; and Resources. It was developed through three identified gaps in the literature: 1) practitioners are concerned about how climate affects health, but do not have the tools or the knowledge necessary to provide information; 2) existing training is knowledge, not skills based; 3) mnemonics are commonly used to quickly assess specific conditions. This new mnemonic for practitioners is designed to address climate factors that may exacerbate health, including the social determinants of health (SDoH). In the United States, ICD-10 codes are used to indicate reasons for clinical visits. We have mapped the appropriate ICD-10 codes to the identified factors exacerbated by climate change.

Methods: The mnemonic was developed based on research literature. We then developed the content for teaching the questions that should be considered for each letter. The content consisted of 7 modules including references and resources. Lastly, we constructed knowledge check questions for each module. We tested the construct and content validity through three experts, four clinicians and two other health professionals. We also used OCAREER mnemonic and the relevant questions in two medical school classes for student feedback. Currently we are piloting OCAREER teaching modules, along with the option for a certificate, with health professionals from Northeast Pennsylvania.

Results: Through the initial pilot we recognized the importance of whether OCAREER and the associated modules will be of clinical value to healthcare providers. Currently the educational material has been distributed to a population of healthcare providers in North-eastern Pennsylvania. We are aiming to assess the value of this tool by asking whether the participants will incorporate this tool into their clinical practice. The goal is to calculate the percentage of uptake over the following three months. Ultimately, the coding will contribute to data that can be collected to assess how climate is affecting the social determinants of health and as such impacting people's health.

Conclusions: Healthcare clinicians are concerned about how the health of their patient population will be impacted by climate change. There has been a steady growth of educational opportunities teaching about climate change and health. Introducing practical tools, such as a mnemonic, can afford providers to ask how climate change may increase the risks from social determinants of health. OCAREER incorporates a mechanism to document these risks through the clinical record (i.e. the electronic medical record) by way of ICD-10 codes. These two tools will help health practitioners implement knowledge and attitudes about the nexus of climate change and health.

Barriers and opportunities for transdisciplinary research and action in climate and health in Latin America and the Caribbean

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Keywords: climate change, transdisciplinary research, Latin America and the Caribbean, collaboration

Introduction: Climate change is a complex, global challenge that affects a wide range of systems and sectors, including human health. In Latin America and the Caribbean (LAC), climate-related health risks are increasing, demanding more intersectoral and transdisciplinary collaboration to address them; however, there are many barriers to achieving this kind of collaboration, including institutional and disciplinary silos, as well as funding and resource constraints. Nonetheless, some opportunities may be explored and encouraged to overcome them. In order to further advance in this area, this study explored the main barriers and opportunities for transdisciplinary research and action in climate and health in LAC.

Methods: This study involved an expert consultation with the Climate and Health Network in Latin America and the Caribbean. Two online 1-hour sessions were performed in December 2023. After a short introduction to the topic, experts participative brainstormed and analysed main barriers and opportunities for TRA in LAC.

Results: A total of 20 people participated in the two sessions. Geographically, four were from Argentina, five from Brazil, five from Chile, one from Colombia, two from Costa Rica, one from Honduras, one from Mexico, and one from Trinidad and Tobago.

Overall, barriers for TRA are related to limited capacities and resources; weak communication and public visibility of the topic; a culture that perpetuates working in silos; lack of financing; limited knowledge of and capacities for TRA; political contexts that make TRA difficult due to and power dynamics; lack of projects that include TRA; limited research translation into policy; weak society engagement, and lack of specific technical and professional training on the topic.

However, several opportunities are present and related to the aforementioned barriers. The main opportunities come up from the fact that there is a perceived momentum, politically, culturally, and socially, where people are feeling the effects of climate change on their lives and health; therefore, TRA and a variety of expertise seem increasingly necessary and welcome to face these effects. Also, communities and citizens are more aware of the problem and demand more engagement and commitment around the topic. Additionally, there is the potential to leverage existing networks and collaborations, build on local knowledge and expertise, and engage diverse stakeholders across sectors and disciplines. Key strategies for overcoming barriers and realising these opportunities include fostering trust and mutual understanding among stakeholders, sharing a common language, developing shared research agendas and frameworks, and building capacity for TRA collaboration and communication.

Conclusions: The complex and intertwined climate-related health risks in LAC require coordinated and coherent intersectoral and transdisciplinary collaboration. Although there are several barriers to achieving this kind of collaboration, several opportunities appear. Experts in climate and health call for greater coordination, leadership, and collaboration across all sectors and disciplines, which can be pushed forward by fostering trust, sharing common agendas and language, and building capacities for TRA.

Sustainable cooling strategies for mitigating heat stress and thermal strain in Bangladesh ready-made garment factories

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Keywords: heat stress, Thermoregulation, Sustainable cooling, Climate adaptation

Introduction: Bangladesh has been identified as one of the countries most vulnerable to climate change and to the future threat of extreme heat. Another defining feature of Bangladesh is its socio-economic reliance on the ready-made garment (RMG) industry, which employs approximately 4 million people nationwide. Working conditions in these factories are often characterised by long working hours undertaken in excessively hot and humid environments. Such environmental conditions are associated with increased worker absenteeism, increased risk of heat-related illness, and a reduction in productivity. The current study aimed to survey the internal environmental conditions of a typical Bangladeshi RMG factory and examine the efficacy of sustainable, low-cost cooling interventions applied at the building- and/or personal-level to reduce the levels of heat-related physiological strain and thermal discomfort experienced by workers.

Methods: *Factory surveying and modelling:* a three-storey RMG factory in Dhaka, Bangladesh was fitted with 33 ambient temperature and relative humidity (RH) sensors throughout 2021, during which the hottest period of the year and the hottest areas of the factory were identified. Using these data, the factory building was virtually constructed using DesignBuilder. Thermal simulations were then conducted using the software EnergyPlus to model the internal factory conditions with and without modification to the factory rooftop (e.g., installation of a "green", shaded, or reflective roof). The optimal building modification was selected based upon the greatest modelled reduction in temperature inside the factory. *Controlled human experiments:* the environmental conditions observed/modelled in the factory were subsequently simulated in a climate-controlled chamber. Twenty-one participants (13 females) completed five separate 3-hour work simulations which mimicked the factory tasks of sewing or ironing. These experimental trials were conducted under the following environmental conditions: 1) current-day factory control conditions (**CON** = 40°C, 38%RH); 2) CON with a pedestal electric fan (**CON+F**); 3) CON with a pedestal electric fan and *ad libitum* drinking provision (**C+F+W**); 4) modelled factory conditions with a green roof installed (**GREEN** = 37.5°C, 38%RH); 5) GREEN with a pedestal electric fan (**GREEN+F**). Core temperature (T_{core}), heart rate, and thermal discomfort (0mm = not uncomfortable to 100mm = very uncomfortable) were assessed in all participants throughout each work simulation.

Results: Compared to the rise in T_{core} during CON (0.50±0.28°C), no difference was observed during CON+F (0.50±0.43, P=0.977) or GREEN+F (0.43±0.31°C, P=0.264), however, smaller rises were observed during GREEN (0.34±0.37°C, P=0.020) and C+F+W (0.35±0.41°C, P=0.027). Mean heart rate was also highest during CON (109±21 $b{\cdot}min^{-1}$) and was unchanged during CON+F (104±23 $b{\cdot}min^{-1}$, P=0.103), however, was lower (P<0.001) during GREEN (97±18 $b{\cdot}min^{-1}$), GREEN+F (97±18 $b{\cdot}min^{-1}$) and C+F+W (96±18 $b{\cdot}min^{-1}$). The highest levels of thermal discomfort were also observed during CON (78±14mm) but were comparably reduced (P<0.006) in all remaining trials: GREEN+F (53±21mm), C+F+W (59±21mm), GREEN (66±19mm) and CON+F (68±20mm).

Conclusions: The combined implementation of sustainable, low-cost cooling interventions applied at the building- and personal-level reduced thermoregulatory strain and improved thermal comfort during simulated RMG factory work. These findings may inform the development and implementation of evidence-based heat management policy to help protect vulnerable factory workers from the adverse effects of future extreme heat exposure.

Poster discussion 6: Climate, heat, and air quality interactions on health

Effects of regional meteorological and air conditions on community-acquired pneumonia patients with pre-existing COPD and asthma

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Keywords: pneumonia, climate change, meteorology, air conditions, Germany

Introduction: Climate change will further increase the frequency and intensity of extreme weather events. As a result, weather conditions favouring pneumonia occurrence are expected to increase due to higher meteorological variability, which is also linked with climate change. These meteorological trends are expected to affect people's health adversely. Community-acquired pneumonia, in the following called pneumonia, is one of the most common causes of death worldwide. At the same time, clear linkages between this disease and both meteorological and air conditions are present. Consequently, it is crucial to understand the effect of these meteorological and air conditions on pneumonia more profoundly but also, more specifically, how these effects interact and depend on the patient's personal characteristics and medical backgrounds. It is well-studied that especially extreme weather and air conditions, the latter including air quality and wind conditions, impact the number of people hospitalized for pneumonia. However, many studies analyse the effects of meteorological and air conditions separately, with mortality data as an endpoint while predominantly covering the Asian continent and, specifically, larger cities. Therefore, data on other geographical regions and combinations of rural and metropolitan areas are required. Additionally, little is known about how personal characteristics (age, sex) and health background (chronic obstructive pulmonary disease (COPD), asthma) affect the sensitivity of pneumonia cases regarding meteorological and air conditions.

Methods: We close this research gap by analysing a prospective multicenter cohort that was treated in an in- or outpatient setting for pneumonia in 22 German hospitals or outpatient clinics. Due to the high prevalence of pre-existing COPD and asthma of pneumonia patients, a particular focus is placed on these two pre-existing diseases. The dataset contains personal and health information for more than 10,000 patients. We match this data with daily regional meteorological and air condition data while not only considering the conditions on the day of hospitalization but also up to four days before. Logistic regressions are used to examine the impact of meteorological and air conditions on pneumonia cases considering a short-term and long-term perspective as well as the modification effects of pre-existing COPD and asthma on these relationships.

Results: When analysing the entire cohort, we find that it is predominantly the combination of meteorological and air factors which have the strongest impact on pneumonia cases. The only

standalone factor that significantly impacts pneumonia cases is sulphur dioxide. Furthermore, it is the changes in meteorological and air conditions from one day to the next that strongly increase the risk of acquiring pneumonia. People with pre-existing COPD and asthma are especially vulnerable since they have an elevated risk of acquiring pneumonia in connection to meteorological and air conditions.

Conclusions: This research is valuable since it determines and, in the future, aims to predict when certain groups of people are at increased risk of pneumonia. During weather conditions favouring pneumonia, this study does not only support individuals in taking protective measures by following guiding prophylaxis but also informs healthcare providers regarding planning and preparing resources such as staff and treatments.

Spatiotemporal variations of the short-term association between ambient particulate matter and suicide in Finland: a nationwide epidemiological study

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Keywords: air pollution, particulate matter, season, suicide, mental health

Introduction: Growing evidence suggests outdoor air pollution is associated with an increased risk of suicide. However, no nationwide study has addressed the urban-rural discrepancy in the association, nor whether the association has changed over time. We examined the short-term association between suicide mortality and particulate matter (PM_{10} and $PM_{2.5}$) across 310 municipalities in Finland from 1985 to 2018.

Methods: We used a time-stratified case-crossover design with a conditional logistic regression model to estimate the PM-suicide associations, adjusting for daily mean temperature and relative humidity. We also examined whether the PM-suicide association differed by potential effect modifiers of sex, age, urbanicity, and subperiod and further stratified the associations by season.

Results: A total of 38,695 suicides were included. The $PM_{2.5}$-suicide associations were evident in warm season, particularly during the earliest subperiod (1985–1995) (odds ratio [OR]=1.018 per interquartile range increase on the current day, 95% CI=1.002–1.034) and in rural municipalities (OR=1.042, 1.003–1.083). The evidence was stronger among people who died by suicide in males (OR=1.015, 1.001–1.030) and aged 30–49 years (OR=1.022, 1.003–1.041). No evidence was found for the associations in the cold season. These patterns were broadly similar for the PM_{10}-suicide associations.

Conclusions: The PM-suicide association seems to have attenuated over time. The associations differed by season and urbanicity. Males, people aged 30-49, and those living in rural areas were in higher risks of suicide for PM exposure during warm season. This evidence on the susceptibility changes and vulnerable subpopulations in the PM-suicide association could be utilized in the continuous improvement of mental health promotion programs.

Urban heat and pollution island in global cities

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Keywords: urban heat island, cities, urban pollution island, NDVI

Introduction: It is well known that urban centers experience temperatures higher than the surrounding rural areas. This phenomenon known as the urban heat island (UHI) presents a hazard which exacerbates the effect of heat waves in cities. The urban centers also experience high ambient air pollution as compared to surrounding rural areas, a phenomenon known as Urban Pollution Island (UPI). Therefore, large urban populations are exposed to increased health risk from exposure to ambient heat and air pollution. Studies have confirmed that exposure to high air pollution on top of extreme heat increases the risk of dying from respiratory and cardiovascular diseases. To understand the UHI and UPI in 1000 cities globally, we utilized satellite retrievals and reanalysis datasets, aided by information on global human settlement and built-up areas.

Methods: We use a publicly available global dataset of human settlement that classifies each grid cell into multiple settlement classes. This dataset is used in combination with MODIS Aqua retrieved Day and Night land surface temperature (LST) to estimate the surface UHI (SUHI), its long-term trend and intensity and a publicly available dataset of ambient PM2.5 to understand the long-term trends of UPI. Further, satellite retrieved normalized difference vegetation index was used to understand the impact of greening in urban areas on SUHI.

Results: SUHI was found to have a positive trend in more than 70% of the cities globally and most prominently in the cities of Eastern Asia, South-Eastern Asia Southern and Western Africa. Whereas only 33 and 37% of the cities in Oceania and Northern Africa experienced an increase in SUHI from 2003 to 2020. We noticed a substantial greening trend in urban areas of South-Central Asia, where 40% of the cities experienced a decreasing trend in UHI. Conversely, UPI was found to be minimal in South-Central Asia, indicating comparative exposure to PM2.5 in rural areas as in urban areas. In Europe, a decrease in NDVI (Normalized Difference Vegetation Index) over time was associated with an increase in UHI in most cities. Overall, our results depict that UHI and UPI have been increasing in 60% of the cities globally, mostly prevalently in Eastern Asia out of which, NDVI decreased in ~90% of them.

Conclusions: Our results indicate that over the last 18 years less than 20% of the cities globally have had an increase in greenness and overall cities have experienced an increase in UHI and UPI. To address this issue, our results depict the importance of implementing measures such as increasing green and blue spaces, improving building and urban design and building airshed based management plans to combat heat and air pollution in cities. Additionally, public health interventions such as heat and air pollution warnings and cooling centers can help to protect vulnerable populations

Local approach to estimating the attributable burden of disease: a case study for air pollution and mortality

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Keywords: air pollution, burden of disease, comparative risk assessment, local approach, methodology

Introduction: Burden of disease estimates are often considered in shaping public health policy. In the burden framework, the impact of varying diseases and injuries is quantified according to a uniform metric, which makes evident its use for setting priorities in prevention and intervention measures. Comparative risk assessment is commonly applied to derive the share of the disease burden attributable to specific risk factors, including environmental stressors such as air pollution. This method is usually conducted at national level, meaning areas and population groups within the country cannot be compared. We propose a novel approach, where the burden attributable to ambient air pollution is derived locally. The method is tested and the results are validated in a Belgian case study.

Methods: Mortality in Belgium due to long-term exposure to particulate matter with diameter <2.5 µm ($PM_{2.5}$) and nitrogen dioxide (NO_2) is derived for the year 2019. In the local method, the attributable burden is calculated at the statistical sector, the smallest territorial unit. Results for individual sectors with small populations are potentially biased when using a concentration-response function (CRF) for the general population. Therefore, the local method is validated by comparing the results, summed to the Belgian total, to estimates derived with a 'global' national-scale approach. The discrepancy between the local and global methods is compared with the uncertainty related to exposure (the sector's 5th and 95th concentration percentiles) and uncertainty related to the CRF (95% confidence interval of the relative risk), where the central global estimate acts as a baseline.

Results: The difference due to methods is limited to under 2% for both pollutants: 8665 deaths derived globally vs. 8588 (-77) locally for $PM_{2.5}$, and 3688 globally vs. 3633 (-55) locally for NO_2. For $PM_{2.5}$, the method discrepancy and exposure uncertainty (-128, +236) are comparable in magnitude, while both are severely outweighed by CRF uncertainty (-2039, +990). For NO_2, the exposure uncertainty (-300, +735) is substantially higher, which could be expected given its greater spatial variability, although CRF uncertainty (-1819, +3495) is again greatest.

Conclusions: The local attributable burden method shows potential for comparing areas and population groups at subnational level, but care has to go to interpreting results for small sectors. The validation of the local estimates by comparing the summed total to global results for Belgium indicates that potential bias can be compensated by aggregation to a sufficiently large scale.

Environmental and social inequities in continental France: an analysis of exposure to heat, air pollution and lack of vegetation

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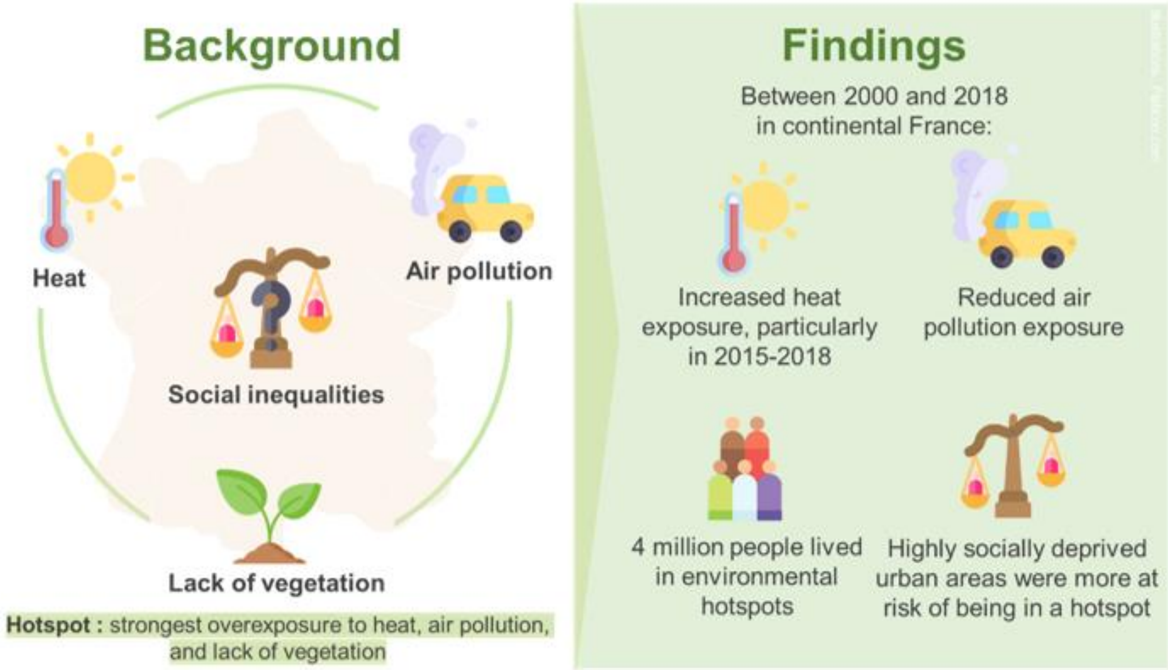
Keywords: temperature, particulate matter, green spaces, socio-economic factors, environmental disparities

Introduction: Cumulated environmental exposures and social deprivation increase health vulnerability and limits a population's capacity to adapt to climate change. Our study characterized fine-scale exposure to heat, air pollution and lack of vegetation in continental France between 2000 and 2018, described spatio-temporal trends and environmental hotspots (*i.e.* areas that cumulate the highest overexposures) and studied association with social deprivation.

Methods: European (EDI) and French (FDep) social deprivation indexes, vegetation (NDVI), and daily ambient temperatures, $PM_{2.5}$, PM_{10}, NO_2 and O_3 concentrations were estimated for 48,185 census districts. References values were selected to characterize (over-)exposures. Hotspots were defined as areas cumulating the highest over-exposure to temperature, air pollution and lack of vegetation. The associations of (over-)exposure to heat and hotspots with social deprivation were assessed through logistic regressions.

Results: Over-exposure to heat was higher in 2015-2018 compared to 2000-2014. Exposure to all air pollutants but O_3, decreased during the study period. In 2018, more than 79 % of the urban census districts exceeded the 2021 WHO air quality guidelines. Evolution of vegetation density between 2000 and 2018 was heterogeneous across space. In urban areas, the most deprived census districts were at higher risk of being hotspots (odd ratio (OR): 10.86, 95% CI: 9.87-11.98 using EDI and OR:1.07, 95% CI:1.04-1.11 using FDep).

Conclusions: Nation-wide fine-scale environmental data reveals inequalities in cumulated exposure to heat, air pollutants and lack of vegetation in France. Such approach can support the integration of inequities in adaptation strategies.


Background
Heat
Air pollution
Social inequalities
Lack of vegetation
Hotspot : strongest overexposure to heat, air pollution, and lack of vegetation
Findings
Between 2000 and 2018 in continental France:
Increased heat exposure, particularly in 2015-2018
Reduced air pollution exposure
4 million people lived in environmental hotspots
Highly socially deprived urban areas were more at risk of being in a hotspot

Interventions to safeguard maternal and new-born health from extreme heat and air pollution: a mapping of the literature

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Keywords: maternal health, new-born health, child health, adaptation, interventions

Introduction: Maternal, new-born and child health (MNCH) is disproportionately impacted by the effects of climate change. These groups are highly vulnerable to climate hazards, with evidence of links between exposure to air pollution and extreme heat and development of adverse health effects such as preterm birth, stillbirths, infections and exacerbation of existing comorbidities. Little is known on the interventions implemented globally to mitigate the effects of these environmental hazards on MNCH. The aim of this literature mapping is to identify recommended or previously implemented interventions tackling the impact of extreme heat and/or air pollution on MNCH in hopes of promoting the prioritization of MNCH-targeted interventions in adaptation programs.

Methods: Three electronic databases were searched (Ovid Medline, Embase and Global Health) to identify peer-reviewed literature using key words pertaining to: a) maternal, new-born or child populations, b) air pollution or extreme heat, and c) potential interventions. Additionally, relevant grey literature was requested from WHO partners, contacted via email. The aim was to identify references published from 2016 onwards describing interventions to mitigate the impact of either air pollution and/or extreme heat on MNCH, with no restriction on country of intervention and language.

Results: The database search identified 19,723 references. Following the screening phase, a total of 79 references were included for air pollution (87%) and 14 for extreme heat (15%). Most of the interventions were situated within the Americas (mostly the United States, 35%), followed by Europe (29%) and by the Western Pacific (26%). Children were the most common target of air pollution interventions (72%), while only 14% focused on maternal or new-born populations. The most common type of intervention was behaviour change (59%), particularly the utilization of personal air purifiers, followed by policy interventions (28%), predominantly focused on traffic, vehicle, and transportation. Health system interventions featured in only 6% of references. Children or the general population were the most common target of extreme heat interventions (57%). Policy interventions (either school-based or national in scope) were most common (43%), followed by urban landscape modifications (36%), and behaviour change (29%). Health system interventions featured in only three references (21%).

Conclusions: This mapping of the literature identified a varied landscape of interventions to protect MNCH from air pollution and/or extreme heat but various gaps emerged. Most interventions were conducted in high-income countries (74%), despite the greater vulnerability of low- and middle-income countries. The majority of interventions focused either on children or on the general population, with very few studies targeting pregnant and postpartum women and new-borns. Finally, a large gap between interventions theoretically discussed and those implemented, particularly in the literature surrounding extreme heat, was observed. The implemented adaptation strategies implemented were

primarily behavioural, with health systems interventions lacking and health workers largely overlooked as agents of change in both air pollution and extreme heat interventions.

Longitudinal associations between daylight exposure during winter months and self-reported mental health

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Keywords: daylight, global radiation, depression, climate change

Introduction: Natural daylight exposure in Scandinavian countries vary substantially across seasons with 4–6 hours of daylight in Sweden during winters. With climate change, precipitation is expected to increase during winter in these areas and might reduce daylight exposure during winters. Winter seasonal affective disorder is common in Sweden while its association with daylight exposure is scarcely studied. This longitudinal study aimed to investigate the associations for objective exposure to global radiation and self-reported daylight exposure with symptoms of depression during winter months from 2012 to 2016.

Methods: The analytical sample consisted of 25,200 respondents of the biennial Swedish Longitudinal Occupational Survey of Health from 2012 to 2016. Two exposure measures were used. The *objective exposure*, global radiation (MJ/m^2) was obtained from SMHI. Daily values were averaged over three (November to January) and four (November-February) months for each year. For sensitivity analysis, cumulative exposures for similar time periods were used. *Subjective exposure* was based on a question "How much time per day do you spend outdoors in daylight during November-January?" a) during business days, and b) during days off with response options: 1) less than 30 minutes 2) 30 minutes to one hour, 3) 1–2 hours, and 4) more than 2 hours. Time-weighted per day exposure to daylight was used to categorize exposure to daylight as 0 if exposure was less than one hour (ref), and as 1 if equal to or more than one hour. Symptoms of depression were evaluated using a six-item subscale of the (Hopkins) Symptom Checklist (SCL) resulting in SCL-Core Depression scale. Respondents scored on a five-category scale the extent that they felt blue, had no interests in things, were lethargic or low in energy, were worrying too much about things, blamed oneself for things, and felt everything is an effort. The scores on all items were summed to get a continuous scale measuring the severity of depression. A cut-off score of ≥17 was used to create a binary variable. Covariates in fully adjusted models were age, occupational position, civil status, work strain, number of children under 12, physical activity, alcohol use, and region of residence (North, Middle, South). To examine the association fixed-effects (within individual) method with conditional logistic regression was used.

Results: Using objective exposure, a unit increase in four-months averaged solar radiation was associated with lower odds of reporting symptoms of depression (OR 0.69; 95% CI 0.52–0.91). These findings were confirmed in four-month cumulative exposure (OR 0.91; 95% CI 0.85–0.98). Risk estimate for three-months averaged exposure window was positive but the association was not significant (OR 1.23; 95% CI 0.66-2.27). Using subjective exposure, when individuals were exposed to daylight more than or equal to one hour per day during winter months were less likely to develop depressive symptoms (OR 0.71; 95% CI 0.60-0.84) compared to time when their exposure was less than an hour daylight.

Conclusions: These findings suggest that higher exposure to daylight during winters may contribute to decrease in symptoms of depression and therefore darker winters due to climate change may increase mental health problems.

Solar-radiation management scheme by using aluminium oxide poses a severe risk to global mental health

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Keywords: geoengineering, solar-radiation management scheme, aluminium, global mental health

Introduction: A possible geoengineering method to mitigate the global warming aspect of climate change is the injection of aerosols into the lower stratosphere, closely mimicking the way large volcanic eruptions cool the climate. This method is called solar-radiation management (SRM) scheme or solar geoengineering. SRM has been suggested to be affordable and highly effective compared with other geoengineering schemes that have been suggested for mitigating global warming. While sulphate aerosols are the most studied, it has been recently shown that aerosols with aluminium oxide could be used to dramatically increase the amount of light scatter achieved on a per-mass basis. Nevertheless, increased human body exposure to this element would be associated with worldwide land precipitation following aluminium (Al) aerosol spraying into the lower stratosphere. Our research focused on mental health risks from Al exposure.

Methods: Medline and EMBASE up to March 2023 were searched for mental health risks after exposure to Al.

Results: Several epidemiological studies suggest Al may not be as innocuous as previously thought. A 2016 meta-analysis showed that individuals chronically exposed to Al were 71% more likely to develop Alzheimer's disease (AD), and 2021 data support the intricate associations of Al in the neuropathology of familiar AD. Furthermore, prolonged exposure to low levels of Al leads to changes associated with brain aging and neurodegeneration. These findings suggest that chronic Al exposure is associated with an increased risk of AD. The latter is the most common form of dementia and may contribute to 60 – 70 % of cases. Approximately 55.2 million people have dementia worldwide, over 60% of whom live in low and middle-income countries. The number of people living with dementia is expected to rise to 78 million by 2030. In 2019, dementia was the seventh leading cause of death worldwide, accounting for 1.6 million deaths and 28.3 million disability-adjusted life-years. The global cost of medical, social, and informal care associated with dementia in 2019 was estimated to be more than US$ 1.3 trillion, and this cost is expected to exceed US$ 2.8 trillion by 2030. The average residence time of a particle in the lower stratosphere is approximately 1-2 years. After eventual transport into the troposphere, the Al particles undergo relatively rapid mixing processes by weather events, turbulence, and cloud-scale overturning. These particles are mostly removed from the atmosphere by dry deposition, sedimentation, or scavenging by clouds, finally polluting the environment.

Conclusions: Worldwide land precipitation of aluminium following aerosol spraying into the lower stratosphere would increase human body exposure and severely threaten global mental health.

Copernicus Health Hub: access by the health community to the environmental data from Copernicus Program

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Keywords: climate, environment, data, policy, health

Introduction: Copernicus is the Earth observation component of the European Union's Space programme, looking at our planet and its environment to benefit all European citizens. The Copernicus services transform wealth of satellite and ground-based measurements into value-added information by processing and analysing the products. All the information is provided with an open and free data policy to help public national and European authorities, policy makers, international organisations and service providers to improve European citizens' quality of life.

Methods: There are six operational Copernicus Services covering the whole Earth System including ocean, land, atmosphere and more horizontal domains such as climate change, emergency and security. To facilitate the use of these information by the different user communities, some Thematic Hubs have been created and are under development. One of the first hubs is the Copernicus Health Hub (CHH) and it is focusing on the health community.

Results: The CHH collects and provides all the Copernicus environmental information that are pertinent to Health, following WHO definition: Physical, Mental and Well-being. The health Hub is also supporting the users in better exploiting and uptake Copernicus data and products (via documentation, access to catalogues, inspirational use case stories, …). In addition, the CHH should collect new requirements for the evolution of the Copernicus programme.

Conclusions: In this presentation, the CHH will be introduced in more details, the different types of environmental information will be presented accompanied by some use cases to inspire further developments and new applications for the health community.

An approach to track clean air health benefits of climate action

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Keywords: climate change, air pollution, health, co-benefits

Introduction: Reducing the emissions of CO_2 will also lower emissions of other air pollutants that adversely affect human health, such as fine particulate matter ($PM_{2.5}$). The benefits of clean air to our health are considerable and well-established, however, there remains gaps in policy tools for the assessment of the health and monetary co-benefits of greenhouse gas (GHG) mitigation actions. Such information would demonstrate the local value of taking those mitigative actions. Our project aims to bridge the translation from GHG emission reductions to air pollutant emissions, and thus facilitate analysis and greater public policy appreciation of the health co-benefits of decarbonizing our economies at the national level, with global coverage. This is expected to help promote a translation from climate ambitions to climate action.

Methods: We have derived ratios of CO_2 to air pollutants ($PM_{2.5}$, SO_2, NOx) based on the implied emission factors in the Greenhouse Gas - Air Pollution Interactions and Synergies (GAINS) model and the national and regional air pollutant emission data from International Energy Agency's World Energy Outlook 2020 report. These ratios were then applied to estimate air pollution emissions changes corresponding to estimated GHG changes reported by the Climate Action Tracker data (covering 37 countries and approximately 80% global carbon emissions).

Results: As a case study for India, we modelled regional $PM_{2.5}/CO_2$ ratios by different emissions sources and found varying patterns over time. We found significant $PM_{2.5}/CO_2$ ratio decreases from industrial combustion sector in 2000–2005 and over time from light-duty vehicle traffic in 1990–2005 in the Delhi region, India, indicating the changes in emission sources in the regional $PM_{2.5}$ air pollution profile. Future steps will include applying concentration-response functions from recent cohort studies to estimate health impacts, refining the predictions using source/sector-specific parameters, and estimating the monetary benefits using a value of statistical life approach.

Conclusions: This work proposes a framework enabling individual nations to utilize carbon-tracking data to document the health co-benefits associated with their GHG mitigation actions. This information will provide validation of those mitigation actions, and encourage ambitions to further reduce GHG emissions.

Microplastics drive a pro-inflammatory response in immune cells

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Keywords: microplastics, CD4+ T cells, macrophages, inflammasome, IL-1β

Introduction: Increasing amounts of plastics are produced by industries with the intention to ease our everyday life. However, this comes alongside a significant environmental pollution. Small plastic particles under 5 micrometres, referred to as microplastics, can be found as additives in daily products, such as cosmetics and toothpaste, and as debris broken down from big plastic products, e.g., plastic packages. Surprisingly, recent studies showed that these microplastics are present in the ocean, soil, air, but also inside the human body. However, little is known about how these particles are scanned by our immune cells, and more importantly, how this influences human health. In this study, we aimed to investigate *in vitro* the influence of microplastics on our immune system. Specifically, our goal was to study whether the immune system can recognize microplastics as foreign agents, and as a consequence trigger a pro-inflammatory response.

Methods: Human peripheral blood mononuclear cells (PBMCs) were isolated from whole blood by pancoll gradient. 500.000 PBMCs were cultured in the absence or presence of 4µm polystyrene microparticles (10, 100, 500 µg/ml) together with aCD3/28 beads to activate $CD4^+$ T cells. After 72h., cells were re-stimulated for 6h. with PMA and ionomycin. IFNg, TNFa, IL-17A and the transcription factor Foxp3 were stained intracellularly and analyzed by flow cytometry. IL-1β expression was measured by qPCR and ELISA. NLRP3 siRNA transfection in monocyte-derived macrophages was performed with the assistance of Invitrogen Lipofectamine 3000 Transfection Reagent. qPCR was used to confirm the RNA knockdown efficiency.

Results: Microplastics induced *in vitro* an up-regulation of the pro-inflammatory cytokines IFNg, TNFa, and IL-17A in $CD4^+$ T cells, as well as a higher expression of Foxp3 (Figure 1.A). Interestingly, this upregulation was abolished in the absence of antigen presenting cells (APCs)(Figure 1.B), indicating APCs as the main mediator of the influence of microplastics on $CD4^+$ T cells. Macrophages are an essential population among APCs, and the main phagocytes eliminating foreign agents. Interestingly, monocyte-derived macrophages co-cultured with microplastics showed a higher production of the pro-inflammatory cytokine IL-1β at both RNA and protein levels (Figure 1.C). Additionally, after knocking down NLRP3 –a molecule upstream IL-1β in the inflammasome signaling cascade-, microplastic-induced IL-1β production was also abolished (Figure 1.D). This suggests that IL-1β production depends on NLRP3.

Conclusions: Microplastics can induce the production of several proinflammatory cytokines on both $CD4^+$ T cells and macrophages. While the influence of microplastics on $CD4^+$ T cells is mediated through APCs, macrophages can directly recognize these particles and as a consequence increase the expression of IL-1β through an NLRP3-dependent pathway. Taken together, our results support microplastics as pro-inflammatory agents capable of triggering inflammatory response in immune cells.

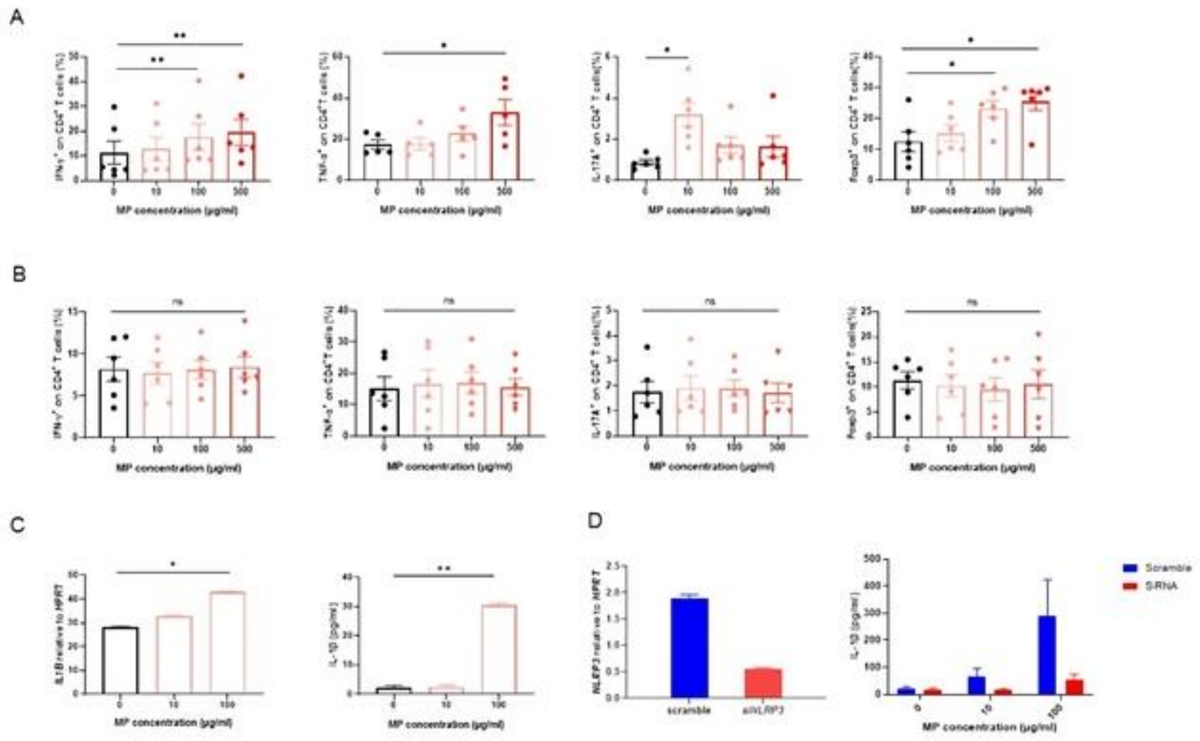

Figure 1. Human **(A)** total PBMCs or **(B)** purified CD4+ T cells were activated with anti-CD3/CD28 beads and cultured together with microplastics (0, 10, 100, 500µg/ml) for 72 hours. IFN-γ, TNF-α, IL-17A, and Foxp3 were measured intracellularly by flow cytometry. **(C)** Human monocyte-derived macrophages were stimulated with LPS (100ng/ml) and microplastics (0, 10, 100µg/ml) for 18 hours. *IL1B* RNA levels in macrophages (left) and IL-1β protein in the supernatant (right) were measured by qPCR and ELISA, respectively. **(D)** Macrophages were transfected with siNLRP3 and the expression of *NLRP3* was measured by qPCR (left). SiNLRP3-transfected macrophages were then cultured again with LPS and microplastics (0, 10, 100µg/ml) for 18 hours. IL-1β in the supernatant was analyzed by ELISA (right). * $P<0.05$, ** $P<0.01$