

## Environmental Stewardship Resource Desk

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### New Research

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#### COVID-19

- 1. Impact of COVID-19 pandemic on medical waste management in Lebanon.** Maalouf A, Maalouf H.  
<https://journals.sagepub.com/doi/full/10.1177/0734242X211003970> Waste Manag Res. 2021 Apr 2;734242X211003970. doi: 10.1177/0734242X211003970. Online ahead of print.  
Worldwide, there is a growing concern about the negative effects of infectious medical waste produced during the COVID-19 pandemic and the contamination risks associated with waste management. Therefore, measures to ensure that medical waste is managed safely and in an environmentally sound manner will avoid negative health and environmental effects from such waste, thus protecting the health of patients, health workers and the public in general. Despite that infectious medical waste generation rate is important for management planning and policy development, there is a limitation on national data availability and its accuracy, particularly in developing economies. This study analyses the infectious healthcare waste generation rates and management patterns in Lebanon before and after the COVID-19 pandemic. The estimated average of COVID-19-related infectious healthcare waste generation in this study is 39,035 kg per month or 1.3 tonnes per day, which constitute between 5% and 20% of total infectious healthcare waste in Lebanon. This study illuminates on the impact of COVID-19 on the existing challenges of waste management in Lebanon. It highlights the need for proper management and disposal of the amounts of medical waste generated to reduce contamination risks or related environmental threats, particularly during the pandemic. It also shows that Lebanon has a defective system for monitoring of waste from healthcare institutions and gaps in waste statistics. Finally, the study summarizes recommendations related to medical waste management, which can provide valuable insight for policymakers.
- 2. Eco-Environmental Aspects of COVID-19 Pandemic and Potential Control Strategies.** Nazir R, Ali J, Rasul I, Widemann E, Shafiq S. Int J Environ Res Public Health. 2021 Mar 27;18(7):3488. doi: 10.3390/ijerph18073488.  
<https://www.mdpi.com/1660-4601/18/7/3488>

A new coronavirus-strain from a zoonotic reservoir (probably bat)-termed as severe acute respiratory syndrome coronavirus 2 (SARS-CoV-2)-has recently claimed more than two million deaths worldwide. Consequently, a burst of scientific reports on epidemiology, symptoms, and diagnosis came out. However, a comprehensive understanding of eco-environmental aspects that may contribute to coronavirus disease 2019 (COVID-19) spread is still missing, and we therefore aim to focus here on these aspects. In addition to human-human direct SARS-CoV-2 transmission, eco-environmental sources, such as air aerosols, different public use objects, hospital wastes, livestock/pet animals, municipal wastes, ventilation facilities, soil and groundwater potentially contribute to SARS-CoV-2 transmission. Further, high temperature and humidity were found to limit the spread of COVID-19. Although the COVID-19 pandemic led to decrease air and noise pollution during the period of lockdown, increased use of masks and gloves is threatening the environment by water and soil pollutions. COVID-19 badly impacted all the socio-economic groups in different capacities, where women, slum dwellers, and the people lacking social protections are the most vulnerable. Finally, sustainable strategies, waste management, biodiversity reclaim, eco-friendly lifestyle, improved health infrastructure and public awareness, were proposed to minimize the COVID-19 impact on our society and environment. These strategies will seemingly be equally effective against any future outbreak.

- 3. Disasters without Borders: The Coronavirus Pandemic, Global Climate Change and the Ascendancy of Gradual Onset Disasters.** Yamori K, Goltz JD. *Int J Environ Res Public Health*. 2021 Mar 23;18(6):3299. doi: 10.3390/ijerph18063299.

<https://www.mdpi.com/1660-4601/18/6/3299>

Throughout much of its history, the sociological study of human communities in disaster has been based on events that occur rapidly, are limited in geographic scope, and their management understood as phased stages of response, recovery, mitigation and preparedness. More recent literature has questioned these concepts, arguing that gradual-onset phenomena like droughts, famines and epidemics merit consideration as disasters and that their exclusion has negative consequences for the communities impacted, public policy in terms of urgency and visibility and for the discipline itself as the analytical tools of sociological research are not brought to bear on these events. We agree that gradual-onset disasters merit greater attention from social scientists and in this paper have addressed the two most significant ongoing disasters that are gradual in onset, global in scope and have caused profound impacts on lives, livelihoods, communities and the governments that must cope with their effects. These disasters are the coronavirus pandemic and global climate change both of which include dimensions that challenge the prevailing definition of disaster. We begin with an examination of the foundational work in the sociological study of a disaster that established a conceptual framework based solely on rapidly occurring disasters. Our focus is on several components of the existing framework for defining and studying disasters, which we term "borders." These borders are temporal, spatial, phasing and positioning, which, in our view, must be reexamined, and to some degree expanded or redefined to accommodate the full range of disasters to which our globalized world is vulnerable. To do so will expand or redefine these borders to incorporate and promote an understanding of significant risks associated with disaster agents that are gradual and potentially catastrophic, global in scope and require international cooperation to manage.

4. **Global economic crisis, energy use, CO(2) emissions, and policy roadmap amid COVID-19.**

Aktar MA, Alam MM, Al-Amin AQ. Sustain Prod Consum. 2021 Apr;26:770-781. doi: 10.1016/j.spc.2020.12.029. Epub 2020 Dec 30.

<https://www.sciencedirect.com/science/article/pii/S2352550920314287>

The COVID-19 pandemic has emerged as one of the deadliest infectious diseases on the planet. Millions of people and businesses have been placed in lockdown where the main aim is to stop the spread of the virus. As an extreme phenomenon, the lockdown has triggered a global economic shock at an alarming pace, conveying sharp recessions for many countries. In the meantime, the lockdowns caused by the COVID-19 pandemic have drastically changed energy consumption patterns and reduced CO<sub>2</sub> emissions throughout the world. Recent data released by the International Monetary Fund and International Energy Agency for 2020 further forecast that emissions will rebound in 2021. Still, the full impact of COVID-19 in terms of how long the crisis will be and how the consumption pattern of energy and the associated levels of CO<sub>2</sub> emissions will be affected are unclear. This review aims to steer policymakers and governments of nations toward a better direction by providing a broad and convincing overview on the observed and likely impacts of the pandemic of COVID-19 on the world economy, world energy demand, and world energy-related CO<sub>2</sub> emissions that may well emerge in the next few years. Indeed, given that immediate policy responses are required with equal urgency to address three things-pandemic, economic downturn, and climate crisis. This study outlines policy suggestions that can be used during these uncertain times as a guide.

#### Health Impacts of Climate Change

5. **Pollen Exposure and Associated Healthcare Utilization: A Population-based Study Using HMO**

**Data in the Washington, DC Area.** Roblin DW, Jones JW, Fuller CH. Ann Am Thorac Soc. 2021 Apr 1. doi: 10.1513/AnnalsATS.202008-976OC. Online ahead of print.

<https://www.atsjournals.org/doi/pdf/10.1513/AnnalsATS.202008-976OC>

**Rationale** Most studies of the healthcare utilization impact of pollen exposure have focused on ED visits or hospital admissions. However, other frequent, but lower cost services - phone calls and e-mails to providers, office visits - may also be affected. **Objective** The objective of our study was to estimate the impact of tree and grass pollen exposures on respiratory-related healthcare utilization across a range of medical services: calls and e-mails to providers, non-urgent face-to-face visits, urgent and emergent care visits, and hospitalizations. **Methods** We conducted a retrospective observational study of daily tree and grass pollen counts linked to electronic health records of Kaiser Permanente (KP) beneficiaries in the metropolitan Washington DC area for 2013-2014. **Results** The proportion of KP beneficiaries with respiratory-related healthcare utilization was significantly greater (for  $p \leq 0.05$ ) given a 1 standard deviation increase in same-day pollen exposure. For tree pollen, a 1 standard deviation increase in same day pollen exposure was associated with relative increases in utilization ranging from 1.77% (95% CI: 0.07-4.17) for urgent and emergent care visits to 12.84% (95% CI: 11.02-14.65) for provider calls/e-mails. For grass pollen exposure, a 1 standard deviation increase in same day pollen exposure was associated with relative increases in utilization ranging from 1.42% (95% CI: 0.39-2.46) for provider face-to-face visits to 11.09% (95% CI: 9.26-12.92) for provider calls/e-

mails. Conclusions Increased pollen exposure was associated with increases in healthcare utilization across a range of services, with relatively higher increases in provider calls/e-mails and lower increases in emergent or acute care. If climate change increases intensity and geographic scope of pollen exposure as predicted and if this study's estimates of association of peak pollen exposure on healthcare utilization are generalizable, then the impact of climate change on healthcare utilization may be significant.

6. **Is there an association between hot weather and poor mental health outcomes? A systematic review and meta-analysis.** Liu J, Varghese BM, Hansen A, Xiang J, Zhang Y, Dear K, Gourley M, Driscoll T, Morgan G, Capon A, Bi P. *Environ Int.* 2021 Mar 30;153:106533. doi: 10.1016/j.envint.2021.106533. Online ahead of print.

<https://www.sciencedirect.com/science/article/pii/S0160412021001586>

**BACKGROUND:** Mental health is an important public health issue globally. A potential link between heat exposure and mental health outcomes has been recognised in the scientific literature; however, the associations between heat exposure (both high ambient temperatures and heatwaves) and mental health-related mortality and morbidity vary between studies and locations.

**OBJECTIVE:** To fill gaps in knowledge, this systematic review aims to summarize the epidemiological evidence and investigate the quantitative effects of high ambient temperatures and heatwaves on mental health-related mortality and morbidity outcomes, while exploring sources of heterogeneity.

**METHODS:** A systematic search of peer-reviewed epidemiological studies on heat exposure and mental health outcomes published between January 1990 and November 2020 was conducted using five databases (PubMed, Embase, Scopus, Web of Science and PsycINFO). We included studies that examined the association between high ambient temperatures and/or heatwaves and mental health-related mortality and morbidity (e.g. hospital admissions and emergency department visits) in the general population. A range of mental health conditions were defined using ICD-10 classifications. We performed random effects meta-analysis to summarize the relative risks (RRs) in mental health outcomes per 1 °C increase in temperature, and under different heatwaves definitions. We further evaluated whether variables such as age, sex, socioeconomic status, and climate zone may explain the observed heterogeneity.

**RESULTS:** The keyword search yielded 4560 citations from which we identified 53 high temperatures/heatwaves studies that comprised over 1.7 million mental health-related mortality and 1.9 million morbidity cases in total. Our findings suggest associations between heat exposures and a range of mental health-related outcomes. Regarding high temperatures, our meta-analysis of study findings showed that for each 1 °C increase in temperature, the mental health-related mortality and morbidity increased with a RR of 1.022 (95%CI: 1.015-1.029) and 1.009 (95%CI: 1.007-1.015), respectively. The greatest mortality risk was attributed to substance-related mental disorders (RR, 1.046; 95%CI: 0.991-1.101), followed by organic mental disorders (RR, 1.033; 95%CI: 1.020-1.046). A 1 °C temperature rise was also associated with a significant increase in morbidity such as mood disorders, organic mental disorders, schizophrenia, neurotic and anxiety disorders. Findings suggest evidence of vulnerability for populations living in tropical and subtropical climate zones, and for people aged more than 65 years. There were significant moderate and high heterogeneities between effect estimates in

overall mortality and morbidity categories, respectively. Lower heterogeneity was noted in some subgroups. The magnitude of the effect estimates for heatwaves varied depending on definitions used. The highest effect estimates for mental health-related morbidity was observed when heatwaves were defined as "mean temperature  $\geq$ 90th percentile for  $\geq$ 3 days" (RR, 1.753; 95%CI: 0.567-5.421), and a significant effect was also observed when the definition was "mean temperature  $\geq$ 95th percentile for  $\geq$ 3 days", with a RR of 1.064 (95%CI: 1.006-1.123).

**CONCLUSIONS:** Our findings support the hypothesis of a positive association between elevated ambient temperatures and/or heatwaves and adverse mental health outcomes. This problem will likely increase with a warming climate, especially in the context of climate change. Further high-quality studies are needed to identify modifying factors of heat impacts.

- 7. Public perceptions of Lyme disease and climate change in southern Manitoba, Canada: making a case for strategic decoupling of climate and health messages.** Cameron L, Rocque R, Penner K, Mauro I. BMC Public Health. 2021 Mar 30;21(1):617. doi: 10.1186/s12889-021-10614-1.

<https://bmcpublichealth.biomedcentral.com/articles/10.1186/s12889-021-10614-1>

**BACKGROUND:** Despite scientific evidence that climate change has profound and far reaching implications for public health, translating this knowledge in a manner that supports citizen engagement, applied decision-making, and behavioural change can be challenging. This is especially true for complex vector-borne zoonotic diseases such as Lyme disease, a tick-borne disease which is increasing in range and impact across Canada and internationally in large part due to climate change. This exploratory research aims to better understand public risk perceptions of climate change and Lyme disease in order to increase engagement and motivate behavioural change.

**METHODS:** A focus group study involving 61 participants was conducted in three communities in the Canadian Prairie province of Manitoba in 2019. Focus groups were segmented by urban, rural, and urban-rural geographies, and between participants with high and low levels of self-reported concern regarding climate change.

**RESULTS:** Findings indicate a broad range of knowledge and risk perceptions on both climate change and Lyme disease, which seem to reflect the controversy and complexity of both issues in the larger public discourse. Participants in high climate concern groups were found to have greater climate change knowledge, higher perception of risk, and less skepticism than those in low concern groups. Participants outside of the urban centre were found to have more familiarity with ticks, Lyme disease, and preventative behaviours, identifying differential sources of resilience and vulnerability. Risk perceptions of climate change and Lyme disease were found to vary independently rather than correlate, meaning that high climate change risk perception did not necessarily indicate high Lyme disease risk perception and vice versa.

**CONCLUSIONS:** This research contributes to the growing literature framing climate change as a public health issue, and suggests that in certain cases climate and health messages might be framed in a way that strategically decouples the issue when addressing climate skeptical audiences. A model showing the potential relationship between Lyme disease and climate change perceptions is proposed, and implications for engagement on climate change health impacts are discussed.

8. **Multi-decade changes in pollen season onset, duration, and intensity: A concern for public health?** Glick S, Gehrig R, Eeftens M. *Sci Total Environ.* 2021 Mar 16;781:146382. doi: 10.1016/j.scitotenv.2021.146382. Online ahead of print.

<https://www.sciencedirect.com/science/article/pii/S0048969721014509>

Longitudinal shifts in pollen onset, duration, and intensity are public health concerns for the growing number of individuals with pollen sensitization. National analyses of long-term pollen changes are influenced by how a plant's main pollen season (MPS) is defined. Prior Swiss studies have inconsistently applied MPS definitions, leading to heterogeneous conclusions regarding the magnitude, directionality, and significance of multi-decade pollen trends. We examined national pollen data in Switzerland between 1990 and 2020, applying six MPS definitions (2 percentage-based and 4 threshold-based) to twelve relevant allergenic plants. We analyzed changes in pollen season using both linear regression and locally estimated scatterplot smoothing (LOESS). For 4 of the 12 plant species, there is unanimity between definitions regarding earlier onset of pollen season ( $p < 0.05$ ), with magnitude of 31-year change dependent on specific MPS definition (hazel: 9-18 days; oak: 5-13 days; grasses: 8-25 days; and nettle/hemp: 6-25 days). There is also consensus ( $p < 0.05$ ) for modified MPS duration among hazel (21-104% longer), nettle/hemp (8-52% longer), and ash (18-38% shorter). Between-definition agreement is highest for MPS intensity analysis, with consensus for significant increases in seasonal pollen quantity ( $p < 0.05$ ) among hazel, birch, oak, beech, and nettle/hemp. The largest relative intensification is noted for hazel (110-146%) and beech (162-237%). LOESS analysis indicates that these multi-decade pollen changes are typically nonlinear. The robustness of MPS definitions is highly dependent on annual pollen accumulation, with definition choice particularly influential for long-term analysis of low-pollen plants such as ragweed. We identify systematic differences between MPS definitions and suggest future aerobiologic studies apply multiple definitions to minimize bias. In summary, national pollen onset, duration, and intensity have shifted for some plants in Switzerland, with MPS definition choice affecting magnitude and significance of these variations. Future public health research can determine whether these temporal and quantitative pollen changes correlate with longitudinal differences in population pollen sensitization.

9. **Leishmaniasis in the United States: Emerging Issues in a Region of Low Endemicity.** Curtin JM, Aronson NE. *Microorganisms.* 2021 Mar 11;9(3):578. doi: 10.3390/microorganisms9030578. <https://www.mdpi.com/2076-2607/9/3/578>

Leishmaniasis, a chronic and persistent intracellular protozoal infection caused by many different species within the genus *Leishmania*, is an unfamiliar disease to most North American providers. Clinical presentations may include asymptomatic and symptomatic visceral leishmaniasis (so-called Kala-azar), as well as cutaneous or mucosal disease. Although cutaneous leishmaniasis (caused by *Leishmania mexicana* in the United States) is endemic in some southwest states, other causes for concern include reactivation of imported visceral leishmaniasis remotely in time from the initial infection, and the possible long-term complications of chronic inflammation from asymptomatic infection. Climate change, the identification of competent vectors and reservoirs, a highly mobile populace, significant population groups with proven exposure history, HIV, and widespread use of immunosuppressive medications and organ transplant all create the potential for increased

frequency of leishmaniasis in the U.S. Together, these factors could contribute to leishmaniasis emerging as a health threat in the U.S., including the possibility of sustained autochthonous spread of newly introduced visceral disease. We summarize recent data examining the epidemiology and major risk factors for acquisition of cutaneous and visceral leishmaniasis, with a special focus on implications for the United States, as well as discuss key emerging issues affecting the management of visceral leishmaniasis.

10. **One Health Approach to Zoonotic Parasites: Molecular Detection of Intestinal Protozoans in an Urban Population of Norway Rats, *Rattus norvegicus*, in Barcelona, Spain.** Galán-Puchades MT, Trelis M, Sáez-Durán S, Cifre S, Gosálvez C, Sanxis-Furió J, Pascual J, Bueno-Marí R, Franco S, Peracho V, Montalvo T, Fuentes MV. *Pathogens*. 2021 Mar 7;10(3):311. doi: 10.3390/pathogens10030311.

<https://www.mdpi.com/2076-0817/10/3/311>

*Rattus norvegicus*, the brown or Norway rat, is the most abundant mammal after humans in urban areas, where they live in close proximity to people. Among rodent-borne diseases, the reservoir role of Norway rats of zoonotic parasites in cities has practically been ignored. Considering the parasitic diseases in the One Health approach, we intended to identify and quantify the zoonotic intestinal protozoans (ZIP) in an urban population of *R. norvegicus* in the city of Barcelona, Spain. We studied the presence of ZIP in 100 rats trapped in parks (n = 15) as well as in the city's sewage system (n = 85) in the winter of 2016/17. The protozoans were molecularly identified by means of a multiplex PCR (Allplex™ Gastrointestinal Panel-Parasite Assay). We also investigated the presence of co-infections among the species found. Four ZIP were identified, presenting significant prevalences in sewers, specifically *Blastocystis* (83.5%), *Giardia duodenalis* (37.7%), *Cryptosporidium* spp. (34.1%), and *Dientamoeba fragilis* (14.1%). Several co-infections among the detected ZIP were also detected. The reservoir role of ZIP that Norway rats play in cities as well as the role rats may play as sentinels of zoonotic parasites affecting humans in urban areas are strongly backed up by our findings. The increasing worldwide urbanization, climate change, and the COVID-19 pandemic are factors that are producing an increase in human-rat interactions. Our results should be considered a warning to the authorities to intensify rat control and surveillance in public health interventions.

11. **A Risk Exchange: Health and Mobility in the Context of Climate and Environmental Change in Bangladesh-A Qualitative Study.** Nayna Schwerdtle P, Baernighausen K, Karim S, Raihan TS, Selim S, Baernighausen T, Danquah I. *Int J Environ Res Public Health*. 2021 Mar 5;18(5):2629. doi: 10.3390/ijerph18052629.

<https://www.ncbi.nlm.nih.gov/pmc/articles/PMC7967404/>

BACKGROUND: Climate change influences patterns of human mobility and health outcomes. While much of the climate change and migration discourse is invested in quantitative predictions and debates about whether migration is adaptive or maladaptive, less attention has been paid to the voices of the people moving in the context of climate change with a focus on their health and wellbeing. This qualitative research aims to amplify the voices of migrants themselves to add nuance to dominant migration narratives and to shed light on the real-life challenges migrants face in meeting their health needs in the context of climate change.

**METHODS:** We conducted 58 semi-structured in-depth interviews with migrants purposefully selected for having moved from rural Bhola, southern Bangladesh to an urban slum in Dhaka, Bangladesh. Transcripts were analysed using thematic analysis under the philosophical underpinnings of phenomenology. Coding was conducted using NVivo Pro 12.

**FINDINGS:** We identified two overarching themes in the thematic analysis: Firstly, we identified the theme "A risk exchange: Exchanging climate change and health risks at origin and destination". Rather than describing a "net positive" or "net negative" outcome in terms of migration in the context of climate change, migrants described an exchange of hazards, exposures, and vulnerabilities at origin with those at destination, which challenged their capacity to adapt. This theme included several sub-themes-income and employment factors, changing food environment, shelter and water sanitation and hygiene (WaSH) conditions, and social capital. The second overarching theme was "A changing health and healthcare environment". This theme also included several sub-themes-changing physical and mental health status and a changing healthcare environment encompassing quality of care and barriers to accessing healthcare. Migrants described physical and mental health concerns and connected these experiences with their new environment. These two overarching themes were prevalent across the dataset, although each participant experienced and expressed them uniquely.

**CONCLUSION:** Migrants who move in the context of climate change face a range of diverse health risks at the origin, en route, and at the destination. Migrating individuals, households, and communities undertake a risk exchange when they decide to move, which has diverse positive and negative consequences for their health and wellbeing. Along with changing health determinants is a changing healthcare environment where migrants face different choices, barriers, and quality of care. A more migrant-centric perspective as described in this paper could strengthen migration, climate, and health governance. Policymakers, urban planners, city corporations, and health practitioners should integrate the risk exchange into practice and policies.

12. **Assessing Environmental Factors within the One Health Approach.** Humboldt-Dachroeden S, Mantovani A. *Medicina (Kaunas)*. 2021 Mar 5;57(3):240. doi: 10.3390/medicina57030240. <https://www.mdpi.com/1648-9144/57/3/240>

**Background:** One Health is a comprehensive and multisectoral approach to assess and examine the health of animals, humans and the environment. However, while the One Health approach gains increasing momentum, its practical application meets hindrances. This paper investigates the environmental pillar of the One Health approach, using two case studies to highlight the integration of environmental considerations. The first case study pertains to the Danish monitoring and surveillance programme for antimicrobial resistance, DANMAP. The second case illustrates the occurrence of aflatoxin M1 (AFM1) in milk in dairy-producing ruminants in Italian regions. **Method:** A scientific literature search was conducted in PubMed and Web of Science to locate articles informing the two cases. Grey literature was gathered to describe the cases as well as their contexts. **Results:** 19 articles and 10 reports were reviewed and informed the two cases. The cases show how the environmental component influences the apparent impacts for human and animal health. The DANMAP highlights the two approaches One Health and farm to fork. The literature provides information on the comprehensiveness of the



DANMAP, but highlights some shortcomings in terms of environmental considerations. The AFM1 case, the milk metabolite of the carcinogenic mycotoxin aflatoxin B1, shows that dairy products are heavily impacted by changes of the climate as well as by economic drivers. Conclusions: The two cases show that environmental conditions directly influence the onset and diffusion of hazardous factors. Climate change, treatment of soils, water and standards in slaughterhouses as well as farms can have a great impact on the health of animals, humans and the environment. Hence, it is important to include environmental considerations, for example, via engaging environmental experts and sharing data. Further case studies will help to better define the roles of environment in One Health scenarios.

13. **Positive Externalities of Climate Change Mitigation and Adaptation for Human Health: A Review and Conceptual Framework for Public Health Research.** Bikomeye JC, Rublee CS, Beyer KMM. *Int J Environ Res Public Health*. 2021 Mar 3;18(5):2481. doi: 10.3390/ijerph18052481. [https://www.mdpi.com/1660-4601/18/5/2481?type=check\\_update&version=1](https://www.mdpi.com/1660-4601/18/5/2481?type=check_update&version=1)

Anthropogenic climate change is adversely impacting people and contributing to suffering and increased costs from climate-related diseases and injuries. In responding to this urgent and growing public health crisis, mitigation strategies are in place to reduce future greenhouse gas emissions (GHGE) while adaptation strategies exist to reduce and/or alleviate the adverse effects of climate change by increasing systems' resilience to future impacts. While these strategies have numerous positive benefits on climate change itself, they also often have other positive externalities or health co-benefits. This knowledge can be harnessed to promote and improve global public health, particularly for the most vulnerable populations. Previous conceptual models in mitigation and adaptation studies such as the shared socioeconomic pathways (SSPs) considered health in the thinking, but health outcomes were not their primary intention. Additionally, existing guidance documents such as the World Health Organization (WHO) Guidance for Climate Resilient and Environmentally Sustainable Health Care Facilities is designed primarily for public health professionals or healthcare managers in hospital settings with a primary focus on resilience. However, a detailed cross sectoral and multidisciplinary conceptual framework, which links mitigation and adaptation strategies with health outcomes as a primary end point, has not yet been developed to guide research in this area. In this paper, we briefly summarize the burden of climate change on global public health, describe important mitigation and adaptation strategies, and present key health benefits by giving context specific examples from high, middle, and low-income settings. We then provide a conceptual framework to inform future global public health research and preparedness across sectors and disciplines and outline key stakeholders recommendations in promoting climate resilient systems and advancing health equity.

14. **Impact of Extreme Weather on Healthcare Utilization by People with HIV in Metropolitan Miami.** Samano D, Saha S, Kot TC, Potter JE, Duthely LM. *Int J Environ Res Public Health*. 2021 Mar 2;18(5):2442. doi: 10.3390/ijerph18052442. <https://www.mdpi.com/1660-4601/18/5/2442>

Extreme weather events (EWE) are expected to increase as climate change intensifies, leaving coastal regions exposed to higher risks. South Florida has the highest HIV infection rate in the United States, and disruptions in clinic utilization due to extreme weather conditions could

affect adherence to treatment and increase community transmission. The objective of this study was to identify the association between EWE and HIV-clinic attendance rates at a large academic medical system serving the Miami-Dade communities. The following methods were utilized: (1) Extreme heat index (EHI) and extreme precipitation (EP) were identified using daily observations from 1990-2019 that were collected at the Miami International Airport weather station located 3.6 miles from the studied HIV clinics. Data on hurricanes, coastal storms and flooding were collected from the National Oceanic and Atmospheric Administration Storms Database (NOAA) for Miami-Dade County. (2) An all-HIV clinic registry identified scheduled daily visits during the study period (hurricane seasons from 2017-2019). (3) Daily weather data were linked to the all-HIV clinic registry, where patients' 'no-show' status was the variable of interest. (4) A time-stratified, case crossover model was used to estimate the relative risk of no-show on days with a high heat index, precipitation, and/or an extreme natural event. A total of 26,444 scheduled visits were analyzed during the 383-day study period. A steady increase in the relative risk of 'no-show' was observed in successive categories, with a 14% increase observed on days when the heat index was extreme compared to days with a relatively low EHI, 13% on days with EP compared to days with no EP, and 10% higher on days with a reported extreme weather event compared to days without such incident. This study represents a novel approach to improving local understanding of the impacts of EWE on the HIV-population's utilization of healthcare, particularly when the frequency and intensity of EWE is expected to increase and disproportionately affect vulnerable populations. More studies are needed to understand the impact of EWE on routine outpatient settings.

15. **A Systems Understanding Underpins Actions at the Climate and Health Nexus.** Pongsiri MJ, Bassi AM. *Int J Environ Res Public Health*. 2021 Mar 1;18(5):2398. doi: 10.3390/ijerph18052398. <https://www.mdpi.com/1660-4601/18/5/2398>

Multiple sectors-health and non-health-can determine the health and well-being of people and the condition of the socio-ecological environment on which it depends. At the climate and human health nexus, a systems-based understanding of climate change and health should inform all stages of the policy process from problem conceptualization to design, implementation, and evaluation. Such an understanding should guide countries, their partners, and donors to incorporate health in strategic climate actions based on how health is affected by, and plays a role in, the dynamic interactions across economic, environmental, and societal domains. A systems-based approach to sustainable development has been widely promoted but operationalizing it for project level and policy development and implementation has not been well articulated. Such an approach is especially valuable for informing how to address climate change and health together through policy actions which can achieve multiple, mutually reinforcing goals. This commentary article describes strategic steps including the complementary use of health impact assessment, quantification of health impacts, and linking climate and health actions to national and global policy processes to apply a systems-based approach for developing climate mitigation and adaptation actions with human health benefits.

**WE ACT**

16. **Net-zero carbon pledges must be meaningful to avert climate disaster.** Nature. 2021 Apr;592(7852):8. doi: 10.1038/d41586-021-00864-9.

<https://www.nature.com/articles/d41586-021-00864-9>

The administration of US President Joe Biden has pledged 2050 as its deadline for net-zero greenhouse-gas emissions. Earlier, China declared 2060 for its own net-zero date. A debate is under way in India, too, as in much of the rest of the world. In all, some 124 nations out of 202 surveyed in a report published last week have made net-zero pledges ahead of November's world climate summit in Glasgow, UK (see [go.nature.com/2puuzmh](https://go.nature.com/2puuzmh)). Activities leading up to the United Nations summit include a 'race to zero' campaign to get the remaining countries on board by then.

But what does net zero actually mean? In a 2018 special report, the Intergovernmental Panel on Climate Change said that countries must bring carbon dioxide emissions to "net zero" by 2050 to keep global warming to within 1.5 °C of pre-industrial levels. But beyond that, there's less agreement on which substances net zero applies to. This creates serious ambiguity, and countries and organizations are defining the phrase according to their own criteria. Agreeing on a definition is important for accountability but, most importantly of all, without it, the 2015 Paris climate agreement's aim to limit warming to between 1.5 °C and 2 °C by mid-century might not be achieved.

17. **People of faith are allies to stall climate change.** Müller T. Nature. 2021 Apr;592(7852):9. doi: 10.1038/d41586-021-00808-3.

<https://www.nature.com/articles/d41586-021-00808-3>

I am used to sceptical looks when I talk to scientists about my work with religious communities. They have reason to see science as under threat from zealots: examples abound, from the treatment of Galileo Galilei to vaccine aversion. But faith communities can feel the same way about scientists. Even if they disagree on important topics, it's both possible and essential to collaborate on urgent issues, such as the fact that large parts of Earth are becoming uninhabitable. In my view, this Easter, Passover or Ramadan is the perfect time to start.

18. **The environmental impact of interventional radiology: An evaluation of greenhouse gas emissions from an academic interventional radiology practice.** Chua A, Amin R, Zhang J, Thiel CL, Gross JS. J Vasc Interv Radiol. 2021 Mar 29:S1051-0443(21)00935-0. doi: 10.1016/j.jvir.2021.03.531. Online ahead of print.

[https://www.jvir.org/article/S1051-0443\(21\)00935-0/fulltext](https://www.jvir.org/article/S1051-0443(21)00935-0/fulltext)

PURPOSE: To calculate the volume of greenhouse gases (GHG) generated by a hospital-based interventional radiology department.

MATERIALS AND METHODS: Life cycle assessment (LCA) was used to calculate GHG emitted by an IR department at a tertiary care academic medical center during a single workweek. The volume of waste generated, the amount of disposable supplies and linens used, and the operating time of electrical equipment were recorded for each procedure performed between 7:00AM-7:00PM on five consecutive weekdays. LCA was then performed using purchasing data, plug loads for electrical hardware, data from temperature control units, and estimates of emissions related to travel in the area surrounding the medical center.

RESULTS: 98 procedures were performed on 97 patients. The most commonly performed procedures were drainages (30 procedures), placement and removal of venous access (21 procedures), and CT guided biopsy (13 procedures). Approximately 23,500 kg CO<sub>2</sub>e were emitted during the study. Sources of CO<sub>2</sub> emissions in descending order were those related to indoor climate control (11,600 kg CO<sub>2</sub>e), production and transportation of disposable surgical items (9640 kg CO<sub>2</sub>e), electricity plug load for imaging, non-imaging, and lighting equipment (1060 kg CO<sub>2</sub>e), staff transportation (524 kg CO<sub>2</sub>e), waste disposal (426 kg CO<sub>2</sub>e), production and laundering of linens (279 kg CO<sub>2</sub>e), and gas anesthetics (19.3 kg CO<sub>2</sub>e).

CONCLUSION: The practice of interventional radiology generates substantial volumes of greenhouse gases, a majority of which come from energy used to power climate control followed by emissions related to the production and transportation of single use supplies. Efforts to reduce energy consumption and the use of disposable supplies may decrease GHG emissions and IR's contribution to climate change.

19. **Inhaled Anesthetics: Environmental Role, Occupational Risk, and Clinical Use.** Gaya da Costa M, Kalmar AF, Struys MMRF. *J Clin Med.* 2021 Mar 22;10(6):1306. doi: 10.3390/jcm10061306. <https://www.ncbi.nlm.nih.gov/pmc/articles/PMC8004846/>

Inhaled anesthetics have been in clinical use for over 150 years and are still commonly used in daily practice. The initial view of inhaled anesthetics as indispensable for general anesthesia has evolved during the years and, currently, its general use has even been questioned. Beyond the traditional risks inherent to any drug in use, inhaled anesthetics are exceptionally strong greenhouse gases (GHG) and may pose considerable occupational risks. This emphasizes the importance of evaluating and considering its use in clinical practices. Despite the overwhelming scientific evidence of worsening climate changes, control measures are very slowly implemented. Therefore, it is the responsibility of all society sectors, including the health sector to maximally decrease GHG emissions where possible. Within the field of anesthesia, the potential to reduce GHG emissions can be briefly summarized as follows: Stop or avoid the use of nitrous oxide (N<sub>2</sub>O) and desflurane, consider the use of total intravenous or local-regional anesthesia, invest in the development of new technologies to minimize volatile anesthetics consumption, scavenging systems, and destruction of waste gas. The improved and sustained awareness of the medical community regarding the climate impact of inhaled anesthetics is mandatory to bring change in the current practice.

20. **Role of Health Professionals Regarding the Impact of Climate Change on Health-An Exploratory Review.** Dupraz J, Burnand B. *Int J Environ Res Public Health.* 2021 Mar 20;18(6):3222. doi: 10.3390/ijerph18063222.

<https://www.mdpi.com/1660-4601/18/6/3222>

Health professionals are increasingly urged to act to protect individuals and populations against the negative effects of climate and environment change on health. However, the amount of evidence supporting initiatives to that end is unknown. We explored the literature examining the awareness, preparedness, and role of healthcare professionals to inform about the impact of climate change on health on the one hand, and literature about the effectiveness of interventions mediated by health professionals aiming at reducing the environmental impact of human activities on the other hand. We included 137 articles published between 2000 and

2020, mostly in general medical and nursing journals. The typical article was a perspective, commentary, or other special article aimed at alerting readers about the impact of climate and environment change on health. We identified 22 studies, of which only two reported interventions. Despite increasing efforts of health professionals to address climate and environment change and related health risks, health literature supporting such efforts remains scarce, and studies assessing the effectiveness of interventions are lacking. We need appropriate evidence to indicate which interventions should be prioritized, considering that the association of health issues with climate and environment change could constitute an effective lever for change.

**21. Understanding Public Health Adaptation to Climate Change: An Explorative Study on the Development of Adaptation Strategies Relating to the Oak Processionary Moth in The Netherlands.**

Buist Y, Bekker M, Vaandrager L, Koelen M. *Int J Environ Res Public Health*. 2021 Mar 17;18(6):3080. doi: 10.3390/ijerph18063080.

<https://www.ncbi.nlm.nih.gov/pmc/articles/PMC8002434/>

Understanding of public health adaptation (PHA) to climate change and implementation is limited. This study therefore focuses on one specific PHA issue: adaptation to the oak processionary moth (OPM). The aim is to examine the development of OPM adaptation in order to offer a problem description of the complexities involved in OPM adaptation. In this explorative case study, we investigate adaptation strategies based on semi-structured interviews with 26 actors involved in OPM adaptation in The Netherlands. The results indicate that the context of OPM adaptation is relatively complex, given the involvement of many interdependent actors. OPM adaptation was developed with limited knowledge and strategies were based on ad hoc approaches in which there was ambiguity about tasks and expertise. In addition, different actors have different perceptions and values concerning health, sustainability, risks and responsibilities influencing decision-making processes, while also posing a challenge to collaboration and the development of a coordinated approach. The generation of knowledge and its translation into practical strategies calls for interdisciplinary cooperation in knowledge development. PHA adaptation involves more than technical and organisational solutions alone. It also entails the development of a shared problem perception and solution space in which citizens are also engaged.

**22. How I See Me-A Meta-Analysis Investigating the Association Between Identities and Pro-environmental Behaviour.**

Udall AM, de Groot JIM, De Jong SB, Shankar A. *Front Psychol*. 2021 Mar 16;12:582421. doi: 10.3389/fpsyg.2021.582421. eCollection 2021.

<https://www.frontiersin.org/articles/10.3389/fpsyg.2021.582421/full>

Prolific research suggests identity associates with pro-environmental behaviours (PEBs) that are individual and/or group focused. Individual PEB is personally driven, self-reliant, and are conducted on one's own (e.g., home recycling). Group focused PEB is other people-reliant and completed as part of a group (e.g., attending meetings of an environmental organisation). A wide range of identities have been related to PEBs. For example, a recent systematic qualitative review revealed 99 different types of identities studied in a PEB context. Most studies were correlational, few had an experimental design. However, the relationships between all these identities and PEBs have so far not been tested quantitatively with meta-analytical techniques.

As such, a clear overview of this field is currently lacking. Due to the diverse nature of the field, a priori hypotheses were not possible and relatively broad definitions of identity had to be used to encompass all types of identities and the diverse meanings of identity that have been included in PEB research. What prior theory did allow for was to assess the distinction between two main types of identity, namely how people label, describe, and recognise oneself individually (individual identity), or as part of a group (group identity). Our overall goal was thus to assess the current state of knowledge on identities and PEBs. In 104 studies using a meta-regression following the preferred reporting items for systematic reviews and meta-analyses guidelines, our random-effects meta-analysis showed that the overall concept of identity associated with PEB with a medium Pearson's  $r$  (Aim 1). Furthermore, we found that individual identities associated more strongly with PEBs than group identities (Aim 2). The associations between individual and group identities were stronger when the identity and PEB were from the same category (e.g., when both were group-focused; Aim 3). Methodologically, the findings revealed that group identities and group PEBs were most strongly associated for self-reported rather than observed PEBs (Aim 4). Overall identity associated most strongly with group PEBs in the field rather than in the lab (Aim 5) and in student- rather than non-student samples (Aim 6). We discuss the theoretical and practical implications.

23. **Implementing Anti-Racism Interventions in Healthcare Settings: A Scoping Review.** Hassen N, Lofters A, Michael S, Mall A, Pinto AD, Rackal J. *Int J Environ Res Public Health*. 2021 Mar 15;18(6):2993. doi: 10.3390/ijerph18062993.

<https://www.mdpi.com/1660-4601/18/6/2993/htm>

Racism towards Black, Indigenous and people of colour continues to exist in the healthcare system. This leads to profound harm for people who use and work within these settings. This is a scoping review to identify anti-racism interventions in outpatient healthcare settings. Searching the peer-reviewed and grey literature, articles were screened for inclusion by at least two independent reviewers. Synthesizing the socio-ecological levels of interventions with inductively identifying themes, a conceptual model for implementing anti-racism interventions in healthcare settings is presented. In total, 37 peer-reviewed articles were included in the review, with 12 empirical studies and 25 theoretical or conceptual papers. Six grey literature documents were also included. Healthcare institutions need to incorporate an explicit, shared language of anti-racism. Anti-racism action should incorporate leadership buy-in and commitment with dedicated resources, support and funding; a multi-level approach beginning with policy and organizational interventions; transparent accountability mechanisms for sustainable change; long-term meaningful partnerships with Black, Indigenous, and people of colour (i.e., racialized communities); and ongoing, mandatory, tailored staff education and training. Decision-makers and staff in healthcare settings have a responsibility to take anti-racism action and may improve the success and sustainability of their efforts by incorporating the foundational principles and strategies identified in this paper.

24. **Review of Current Healthcare Waste Management Methods and Their Effect on Global Health.** Kenny C, Priyadarshini A. *Healthcare (Basel)*. 2021 Mar 5;9(3):284. doi: 10.3390/healthcare9030284.

<https://www.mdpi.com/2227-9032/9/3/284>

Healthcare is a rapidly growing industry as medical treatments become more sophisticated, more in demand due to increasing incidence of chronic disease and more widely available worldwide. This booming industry is also creating more waste than ever before and, as such, there is a growing need to treat and dispose of this waste. Healthcare waste (HCW) disposal includes a multitude of disposal methods, including incineration, landfilling and chemical treatments. These rudimentary methods and their growing use present their own problems that negatively impact both the environment and, in turn, damage public health, thus contributing to a global healthcare crisis. The aim of this review was to examine the current HCW disposal methods in place and the harmful effects they have on the environment and on public health. The findings accumulated in this review demonstrate a heavy reliance on basic, low tech HCW disposal techniques and uncovered the negative impacts of these methods. There is a notable lack of employment of "greener" HCW disposal methods on a largescale due to cost, access and feasibility. Despite innovations in HCW disposal, there is no scalable, global green solution at present. Further, the review highlights that global health consequences of HCW disposal methods often differ depending on how developed the country is.

25. **Tools and Methods to Include Health in Climate Change Adaptation and Mitigation Strategies and Policies: A Scoping Review.** Delpla I, Diallo TA, Keeling M, Bellefleur O. *Int J Environ Res Public Health*. 2021 Mar 4;18(5):2547. doi: 10.3390/ijerph18052547.

<https://www.mdpi.com/1660-4601/18/5/2547>

Climate change represents a serious threat to the health and well-being of populations. Today, many countries, regions, and cities around the world are implementing policies and strategies to adapt to climate change and mitigate its effects. A scoping review was performed to identify tools and methods that help integrate health into climate change adaptation and mitigation policies and strategies. The literature search includes scientific and grey literature. The scientific literature was conducted using PubMed, Elsevier Embase, and Web of Science databases. A grey literature web search was performed to complement the results. A total of 35 studies (28 from the scientific literature and 7 from the grey literature) were finally included. A large majority of research articles (24/28) and almost all reports (6/7) from the grey literature were published after 2010. Results show that the tools that were found most frequently are the nested models (12/35), health impact assessment (6/35), vulnerability and adaptation assessment (3/35), conceptual frameworks (3/35), and mixed methods (3/35). This review shows an increasing interest in the topic of developing tools to better manage health issues in adaptation and mitigation strategies, with a recent increase in the number of publications. Additional analyses of tools' effectiveness should be conducted in further studies.

26. **Poised for Change: University Students Are Positively Disposed toward Food Waste Diversion and Decrease Individual Food Waste after Programming.** Alattar MA, Morse JL. *Foods*. 2021 Mar 1;10(3):510. doi: 10.3390/foods10030510.

<https://www.ncbi.nlm.nih.gov/pmc/articles/PMC7998915/>

Eaters (consumers of food) are responsible for 60% of waste along the food cycle in developed countries. Programs that target individual and household food waste behavior change are essential to addressing such waste. School cafeterias worldwide offer an opportune microcosm in which to educate on food and nutrition skills and change related behavior. No Scrap Left

Behind, a cafeteria food waste diversion program, was developed, piloted, and assessed based on measures of both direct and indirect food waste behavior, and attitudes, knowledge, and emotions related to food waste. Participants had positive attitudes towards food waste reduction, engaged in food waste diversion actions, had some knowledge of the impacts of wasted food, and considered their actions important to waste reduction generally. Food waste per student was decreased by 28% over the course of the first year of programming ( $p = 0.000967$ ), and by 26% in the following year when measured a week before and a week after programming occurred ( $p = 0.0218$ ). Results indicate that students were poised for food behavior change and that related programming did impact behavior in the short term. Programming may, therefore, help improve student attitudes and skills to develop long-term change as well, although future research should explore this specifically. In comparison with other research on cafeteria programming, results suggest that food waste diversion programming can positively impact students' dispositions and behaviors, and may be more effective when tailored to the specific population.

27. **Does telemedicine reduce the carbon footprint of healthcare? A systematic review.** Purohit A, Smith J, Hibble A. *Future Healthc J.* 2021 Mar;8(1):e85-e91. doi: 10.7861/fhj.2020-0080.

<https://www.ncbi.nlm.nih.gov/pmc/articles/PMC8004323/>

In the rapidly progressing field of telemedicine, there is a multitude of evidence assessing the effectiveness and financial costs of telemedicine projects; however, there is very little assessing the environmental impact despite the increasing threat of the climate emergency. This report provides a systematic review of the evidence on the carbon footprint of telemedicine. The identified papers unanimously report that telemedicine does reduce the carbon footprint of healthcare, primarily by reduction in transport-associated emissions. The carbon footprint savings range between 0.70-372 kg CO<sub>2</sub>e per consultation. However, these values are highly context specific. The carbon emissions produced from the use of the telemedicine systems themselves were found to be very low in comparison to emissions saved from travel reductions. This could have wide implications in reducing the carbon footprint of healthcare services globally. In order for telemedicine services to be successfully implemented, further research is necessary to determine context-specific considerations and potential rebound effects.

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