

## Environmental Stewardship Resource Desk

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### New Research

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#### COVID-19

- 1. Analysis of medical waste management and impact analysis of COVID-19 on its generation in Taiwan.** Tsai WT. Waste Manag Res. 2021 Mar 5:734242X21996803. doi: 10.1177/0734242X21996803. Online ahead of print.  
[https://journals.sagepub.com/doi/10.1177/0734242X21996803?url\\_ver=Z39.88-2003](https://journals.sagepub.com/doi/10.1177/0734242X21996803?url_ver=Z39.88-2003)  
Medical waste management in Taiwan is a crucial issue due to its highly environmental and human health risks. The main objectives of this paper were to analyse the status of medical waste generation and treatment in recent years, and also address the discussions on the impacts of coronavirus disease 2019 (COVID-19) on its generation in the first half of 2020. It showed that the reported quantities have slightly increased from 35,747 metric tonnes (Mt) in 2016 to 40,407 Mt in 2019, showing an average increase by 4.17%. This rate of increase was consistent with the hospital services. When classified by the reported codes, the C-type waste (infectious waste) accounted for about 89% of the reported quantities, which indicated an annual increase by 4.14% during the same period. In addition, the medical waste treatment in 2019 was mainly dependent on the commissioned treatment (80.18%), followed by the recycling (18.53%) and the self-treatment (1.29%). Furthermore, the impact of COVID-19 on the medical waste generation in Taiwan was not significant in the first half of 2020 compared to the data during the years of 2016-2019. It was indicated that the consistent trend was observed at the daily confirmed COVID-19 cases in Taiwan during this period. Obviously, the reduction in the hospital medical services during the COVID-19 outbreak should be offset by the increase in medical waste generation from the medical services. In order to try to ensure safe and complete destruction of the COVID-19 virus, all the waste generated from the healthcare facilities should be treated in the incineration plants.
- 2. Examining the status of improved air quality in world cities due to COVID-19 led temporary reduction in anthropogenic emissions.** Sannigrahi S, Kumar P, Molter A, Zhang Q, Basu B, Basu AS, Pilla F. Environ Res. 2021 Mar 3:110927. doi: 10.1016/j.envres.2021.110927. Online ahead of print.

<https://www.sciencedirect.com/science/article/pii/S0013935121002218>

Clean air is a fundamental necessity for human health and well-being. Anthropogenic emissions that are harmful to human health have been reduced substantially under COVID-19 lockdown. Satellite remote sensing for air pollution assessments can be highly effective in public health research because of the possibility of estimating air pollution levels over large scales. In this study, we utilized both satellite and surface measurements to estimate air pollution levels in 20 cities across the world. Google Earth Engine (GEE) and Sentinel-5 Precursor TROPOspheric Monitoring Instrument (TROPOMI) application were used for both spatial and time-series assessment of tropospheric Nitrogen Dioxide (NO<sub>2</sub>) and Carbon Monoxide (CO) statuses during the study period (1 February to 11 May 2019 and the corresponding period in 2020). We also measured Population-Weighted Average Concentration (PWAC) of particulate matter (PM<sub>2.5</sub> and PM<sub>10</sub>) and NO<sub>2</sub> using gridded population data and in-situ air pollution estimates. We estimated the economic benefit of reduced anthropogenic emissions using two valuation approaches: (1) the median externality value coefficient approach, applied for satellite data, and (2) the public health burden approach, applied for in-situ data. Satellite data have shown that ~ 28 tons (sum of 20 cities) of NO<sub>2</sub> and ~ 184 tons (sum of 20 cities) of CO have been reduced during the study period. PM<sub>2.5</sub>, PM<sub>10</sub>, and NO<sub>2</sub> are reduced by ~37 (µg/m<sup>3</sup>), 62 (µg/m<sup>3</sup>), and 145 (µg/m<sup>3</sup>), respectively. A total of ~1310, ~401, and ~430 premature cause-specific deaths were estimated to be avoided with the reduction of NO<sub>2</sub>, PM<sub>2.5</sub>, and PM<sub>10</sub>. The total economic benefits (Billion US\$) (sum of 20 cities) of the avoided mortality are measured as ~10, ~3.1, and ~3.3 for NO<sub>2</sub>, PM<sub>2.5</sub>, and PM<sub>10</sub>, respectively. In many cases, ground monitored data was found inadequate for detail spatial assessment. This problem can be better addressed by incorporating satellite data into the evaluation if proper quality assurance is achieved, and the data processing burden can be alleviated or even removed. Both satellite and ground-based estimates suggest the positive effect of the limited human interference on natural environments. Further research in this direction is needed to explore this synergistic association more explicitly.

3. **Emerging from COVID-19: Lessons for Action on Climate Change and Health in Cities.** Milner J, Davies M, Haines A, Huxley R, Michie S, Robertson L, Siri J, Wilkinson P. *J Urban Health*. 2021 Mar 1:1-5. doi: 10.1007/s11524-020-00501-2. Online ahead of print.

<https://www.ncbi.nlm.nih.gov/pmc/articles/PMC7920547/>

The COVID-19 pandemic has required health protection responses with far-reaching consequences for society, livelihoods, and the wider economy. Future enquiries will in time evaluate the success of responses at all scales. But emerging lessons highlight immediate implications for addressing the growing climate crisis through a recovery from COVID-19 that advances population health, economic regeneration and climate action [1].

Cities are where many of the most critical actions for health, greenhouse gas (GHG) emissions reduction, resilience and risk reduction must be taken, supported by national governments, multi-lateral agencies and other stakeholders [2]. Rapid decarbonisation across all sectors of society is needed over this decade—further delay will seriously reduce the possibility of achieving the targets set out in the Paris Agreement [3]. Now is therefore an especially important juncture for cities to act for both the near-term imperatives of the post-COVID recovery and the long-term welfare of their residents and the planet.

4. **Transformation of the Food Sector: Security and Resilience during the COVID-19 Pandemic.** Boyacı-Gündüz CP, Ibrahim SA, Wei OC, Galanakis CM. *Foods*. 2021 Feb 25;10(3):497. doi: 10.3390/foods10030497.

<https://www.mdpi.com/2304-8158/10/3/497>

The ongoing COVID-19 pandemic has resulted in a new era in the efficacy of the food supply chain, while the consequences of this new era on humanity, the economy, and the food sector are still under examination. For example, food security is one vital aspect of food systems which is directly affected. This review summarizes food security during epidemics and pandemics before moving on to panic buying, food shortages, and price spikes observed during the current crisis. The importance of food resilience, together with the need for addressing issues related to food loss and food waste, is underlined in the review towards food security and sustainable development. As a result, the pandemic has shown that our food systems are fragile. Since the global population and urbanization will grow in the coming decades, pandemics will likely occur more often, and climate change will intensify. Consequently, there is a need to ensure that our food systems become more sustainable and resilient. To that end, we have highlighted the need to develop contingency plans and mitigation strategies that would allow a more rapid response to extreme events (e.g., disasters from climate change) and transform the food sector by making it more resilient.

5. **COVID-19 Pandemic and Environmental Health: Effects and the Immediate Need for a Concise Risk Analysis.** Maipas S, Panayiotides IG, Tsiodras S, Kavantzias N. *Environ Health Insights*. 2021 Feb 17;15:1178630221996352. doi: 10.1177/1178630221996352. eCollection 2021.

<https://journals.sagepub.com/doi/full/10.1177/1178630221996352>

COVID-19 pandemic, as another disease emerging in the interface between animals and humans, has revealed the importance of interdisciplinary collaborations such as the One Health initiative. Environmental Health, whose role in the One Health concept is well established, has been associated with COVID-19 pandemic via various direct and indirect pathways. Modern lifestyle, climate change, environmental degradation, exposure to chemicals such as endocrine disruptors, and exposure to psychological stress factors impact human health negatively. As a result, many people are in the disadvantageous position to face the pandemic with an already impaired immune system due to their exposure to environmental health hazards. Moreover, the ongoing pandemic has been associated with outdoor and indoor air pollution, water and noise pollution, food security, and plastic pollution issues. Also, the inadequate infrastructure, the lack of proper waste and wastewater management, and the unequal social vulnerability reveal more linkages between Environmental Health and COVID-19 pandemic. The significant emerging ecological risk and its subsequent health implications require immediate risk analysis and risk communication strategies.

6. **Research Agenda of Climate Change during and after the Coronavirus Disease 2019 (COVID-19) Pandemic.** Nishiura H, Mimura N. *J Clin Med*. 2021 Feb 15;10(4):770. doi: 10.3390/jcm10040770.

<https://www.ncbi.nlm.nih.gov/pmc/articles/PMC7918948/>

The global pandemic of coronavirus disease 2019 (COVID-19) rapidly spread worldwide during the first few months of 2020. Most industrialized countries had to adopt so-called “suppression strategies” against COVID-19, aiming to greatly reduce virus transmission and to limit deaths and the demand for critical care services. These suppression strategies have required substantial reductions in the rate of human-to-human contact, sometimes via legally binding countermeasures including “lockdown” policies in urban areas [1]. Once such countermeasures were in place, levels of human mobility decreased dramatically, resulting in an enormous reduction in commuting owing to work-from-home policies (i.e., remote or telework). Domestic and international travel as well as other means of transportation declined drastically. It is expected that widespread use of specific methods of COVID-19 prevention (e.g., vaccination) and treatment (e.g., combination therapy using antivirals and steroids) will begin soon; however, the virus that causes COVID-19, severe acute respiratory syndrome coronavirus 2 (SARS-CoV-2), is likely to continue circulating widely at least during the 2020/2021 winter season in the Northern Hemisphere.

Such drastic and artificial changes in societies around the world have provided an unprecedented opportunity for the scientific community to study climate change. Global air pollution and carbon dioxide (CO<sub>2</sub>) emissions were instantaneously reduced for a certain duration of time [2], offering a very important chance for the general public to experience improved air quality and reduced CO<sub>2</sub> emissions levels. Nevertheless, the impact of COVID-19 on climate change comprises both positive and negative elements because many COVID-19 countermeasures have had severely negative economic impacts. Moreover, plans for mitigation as well as adaptation are also considerably affected by the “new normal” lifestyles. Under the direction of the Ministry of the Environment, Japan, the Environmental Restoration and Conservation Agency of Japan (ERCA) has launched a strategic financial support program, the Environment Research and Technology Development Fund, to support “Integrated Research on Climate Change Impact Assessment and Adaptation Plans” (S-18; project leader: Nobuo Mimura), beginning in the fiscal year 2020. The project aims to provide up-to-date scientific evidence to assist decision-making regarding governmental policies for adaptation planning that also address climate change. As life under the new normal conditions progresses worldwide, our strategic research program should also be flexibly set to measure the scientific features of the relationship between COVID-19 and climate change. In this editorial, we aim to discuss the research agenda regarding this particular relationship.

#### **7. Challenges and practices on waste management and disposal during COVID-19 pandemic.**

Hantoko D, Li X, Pariatamby A, Yoshikawa K, Horttanainen M, Yan M. *J Environ Manage*. 2021 Feb 8;286:112140. doi: 10.1016/j.jenvman.2021.112140. Online ahead of print.

<https://www.sciencedirect.com/science/article/pii/S0301479721002024>

The COVID-19 pandemic has imposed a global emergency and also has raised issues with waste management practices. This study emphasized the challenges of increased waste disposal during the COVID-19 crisis and its response practices. Data obtained from the scientific research papers, publications from the governments and multilateral organizations, and media reports were used to quantify the effect of the pandemic towards waste generation. A huge increase in the amount of used personal protective equipments (facemasks, gloves, and other protective stuffs) and wide distribution of infectious wastes from hospitals, health care facilities, and

quarantined households was found. The amount of food and plastic waste also increased during the pandemic. These factors caused waste treatment facilities to be overwhelmed, forcing emergency treatment and disposals (e.g., co-disposal in a municipal solid waste incinerator, cement kilns, industrial furnaces, and deep burial) to ramp up processing capacity. This paper discussed the ways the operation of those facilities must be improved to cope with the challenge of handling medical waste, as well as working around the restrictions imposed due to COVID-19. The study also highlights the need for short, mid, and longer-term responses towards waste management during the pandemic. Furthermore, the practices discussed in this paper may provide an option for alternative approaches and development of sustainable strategies for mitigating similar pandemics in the future.

8. **Climate risk, culture and the Covid-19 mortality: A cross-country analysis.** Ozkan A, Ozkan G, Yalaman A, Yildiz Y. *World Dev.* 2021 May;141:105412. doi: 10.1016/j.worlddev.2021.105412. Epub 2021 Jan 19.

<https://www.ncbi.nlm.nih.gov/pmc/articles/PMC7817474/>

Why have some countries done significantly better than others in fighting the Covid-19 pandemic? Had some countries been better prepared than others? This paper attempts to shed light on these questions by examining the role of climate risk and culture in explaining the cross-country variation in the Covid-19 mortality, while controlling for other potential drivers. In our analysis, we consider climate risk, readiness to climate change and individualism as main indicators reflecting the climate and culture status of individual countries. Using data from 110 countries, we find that the greater the climate risk; the lower the readiness to climate change and the more individualistic the society, the higher the pandemic mortality rate. We also present a series of sensitivity checks and show that our findings are robust to different specifications, alternative definitions of the mortality rate; and different estimation methods. One policy implication arising from our results is that countries that were better prepared for the climate emergency were also better placed to fight the pandemic. Overall, countries in which individuals look after each other and the environment, creating sustainable societies, are better able to cope with climate and public health emergencies.

### Health Impacts of Climate Change

9. **An advanced empirical model for quantifying the impact of heat and climate change on human physical work capacity.** Foster J, Smallcombe JW, Hodder S, Jay O, Flouris AD, Nybo L, Havenith G.

*Int J Biometeorol.* 2021 Mar 5. doi: 10.1007/s00484-021-02105-0. Online ahead of print.

<https://link.springer.com/article/10.1007/s00484-021-02105-0>

Occupational heat stress directly hampers physical work capacity (PWC), with large economic consequences for industries and regions vulnerable to global warming. Accurately quantifying PWC is essential for forecasting impacts of different climate change scenarios, but the current state of knowledge is limited, leading to potential underestimations in mild heat, and overestimations in extreme heat. We therefore developed advanced empirical equations for PWC based on 338 work sessions in climatic chambers (low air movement, no solar radiation) spanning mild to extreme heat stress. Equations for PWC are available based on air

temperature and humidity, for a suite of heat stress assessment metrics, and mean skin temperature. Our models are highly sensitive to mild heat and to our knowledge are the first to include empirical data across the full range of warm and hot environments possible with future climate change across the world. Using wet bulb globe temperature (WBGT) as an example, we noted 10% reductions in PWC at mild heat stress (WBGT = 18°C) and reductions of 78% in the most extreme conditions (WBGT = 40°C). Of the different heat stress indices available, the heat index was the best predictor of group level PWC ( $R^2 = 0.96$ ) but can only be applied in shaded conditions. The skin temperature, but not internal/core temperature, was a strong predictor of PWC ( $R^2 = 0.88$ ), thermal sensation ( $R^2 = 0.84$ ), and thermal comfort ( $R^2 = 0.73$ ). The models presented apply to occupational workloads and can be used in climate projection models to predict economic and social consequences of climate change.

10. **Climate Change, Human Health, and Academic Medicine.** Roberts LW. Acad Med. 2021 Mar 1;96(3):315-316. doi: 10.1097/ACM.0000000000003900.  
[https://journals.lww.com/academicmedicine/Fulltext/2021/03000/Climate\\_Change,\\_Human\\_Health,\\_and\\_Academic.1.aspx](https://journals.lww.com/academicmedicine/Fulltext/2021/03000/Climate_Change,_Human_Health,_and_Academic.1.aspx)

People in every country have begun to experience the health repercussions of rapid climate change. Extreme heat, poor air quality, reduced availability of food and safe water, and infectious diseases will continue to lead to displacements of populations, physical illness, mental health disorders, disability, and death. 13–17The health of humanity and the state of our planet are linked—and it is for this reason that the field of academic medicine must concern itself with climate change.

11. **Projecting Health Impacts of Future Temperature: A Comparison of Quantile-Mapping Bias-Correction Methods.** Qian W, Chang HH. Int J Environ Res Public Health. 2021 Feb 18;18(4):1992. doi: 10.3390/ijerph18041992.  
<https://www.ncbi.nlm.nih.gov/pmc/articles/PMC7922393/>

Health impact assessments of future environmental exposures are routinely conducted to quantify population burdens associated with the changing climate. It is well-recognized that simulations from climate models need to be bias-corrected against observations to estimate future exposures. Quantile mapping (QM) is a technique that has gained popularity in climate science because of its focus on bias-correcting the entire exposure distribution. Even though improved bias-correction at the extreme tails of exposure may be particularly important for estimating health burdens, the application of QM in health impact projection has been limited. In this paper we describe and apply five QM methods to estimate excess emergency department (ED) visits due to projected changes in warm-season minimum temperature in Atlanta, USA. We utilized temperature projections from an ensemble of regional climate models in the North American-Coordinated Regional Climate Downscaling Experiment (NA-CORDEX). Across QM methods, we estimated consistent increase in ED visits across climate model ensemble under RCP 8.5 during the period 2050 to 2099. We found that QM methods can significantly reduce between-model variation in health impact projections (50-70% decreases in between-model standard deviation). Particularly, the quantile delta mapping approach had the largest reduction and is recommended also because of its ability to preserve model-projected absolute temporal changes in quantiles.

## WE ACT

12. **Evaluation of Drug Wastage in the Operating Rooms and Intensive Care Units of a Regional Health Service.** Barbariol F, Deana C, Lucchese F, Cataldi G, Bassi F, Bove T, Vetrugno L, De Monte A. *Anesth Analg.* 2021 Mar 5. doi: 10.1213/ANE.0000000000005457. Online ahead of print.

<https://journals.lww.com/anesthesia->

[analgesia/Fulltext/9900/Evaluation\\_of\\_Drug\\_Wastage\\_in\\_the\\_Operating\\_Rooms.97.aspx](https://journals.lww.com/anesthesia-analgesia/Fulltext/9900/Evaluation_of_Drug_Wastage_in_the_Operating_Rooms.97.aspx)

**BACKGROUND:** Pharmacological treatments for critical processes in patients need to be initiated as rapidly as possible; for this reason, it is a standard of care to prepare the main anesthesia and emergency drugs in advance. As a result, 20%-50% of the prepared drugs remain unused and are then discarded. Decreasing waste by optimizing drug use is an attractive strategy for meeting both cost containment and environmental sustainability. The primary end point of this study was to measure the actual amount of drug wastage in the operating rooms (ORs) and intensive care units (ICUs) of a Regional Health Service (RHS). The secondary end point was to analyze and estimate the economic implications of this waste for the Health Service and to suggest possible measures to reduce it.

**METHODS:** This prospective observational multicenter study was conducted across 12 hospitals, all of which belong to the same RHS in the north-east of Italy. Data collection took place in March 2018 and included patients admitted to ICUs, emergency areas, and ORs of the participating hospitals. Data concerning drug preparation and administration were collected for all consecutive patients, independent of case types and of whether operations were scheduled or unscheduled. Drug wastage was defined as follows: drugs prepared in ready-to-use syringes but not administered at all and discarded untouched. We then estimated the costs of wasted drugs for a 1-year period using the data from this study and the yearly regional pharmacy orders of drugs provided to the ORs and ICUs. We also performed a sensitivity analysis to validate the robustness of our assumptions and qualitative conclusions.

**RESULTS:** We collected data for a total of 13,078 prepared drug syringes. Drug wastage varied from 7.8% (Urapidil, an alpha-1 antagonist antihypertensive) to 85.7% (epinephrine) of prepared syringes, with an overall mean wastage rate of 38%. The estimated yearly waste was 139,531 syringes, for a total estimated financial cost of €78,060 (\$92,569), and an additional quantity of medical waste amounting to 4968 kg per year. The total provider time dedicated to the preparation of unused drugs was predicted to be 1512 working hours per year.

**CONCLUSIONS:** The overall extent of drug wastage in ORs and ICUs is concerning. Interventions aimed at minimizing waste-related costs and improving the environmental sustainability of our practice are paramount. Effort should be put into designing a more efficient workflow that reduces this waste while providing for the emergency availability of these medications in the OR and ICU.

13. **The Promotion of Sustainable Diets in the Healthcare System and Implications for Health Professionals: A Scoping Review.** Alberdi G, Begiristain-Zubillaga M. *Nutrients.* 2021 Feb 26;13(3):747. doi: 10.3390/nu13030747.

<https://www.mdpi.com/2072-6643/13/3/747>

The impacts of the current global food system are already visible in the environment and in the health of the population. The promotion of sustainable diets is key to counter the negative consequences. The healthcare system could be a powerful tool to educate patients by guiding their diets towards sustainability. This study aimed to assess the size and scope of the available literature regarding the promotion of sustainable diets in the healthcare system and to obtain a reliable approximation of the processes and roles related to sustainable diet promotion within healthcare systems. A scoping review where online databases were used to identify English written scientific and grey literature published between 2000-2019 was carried out. The analytical-synthetic approach was used for data charting. Twelve studies were included that were published between 2007-2020. The data highlight education, community and clinical health services, community engagement and policy advocacy, and governance as main action areas along with two transversal aspects, social support, and gender. A systemic approach to the food system is emphasized. Evidence suggests that health professionals have the potential to drive a paradigm shift in food-health environments. Currently, however, their role and potential impact is underestimated within healthcare systems. This review has identified a framework with key areas where processes need to be developed to guarantee sustainable diet promotion in healthcare services.

14. **Medical education and the COVID-19 pandemic - a dress rehearsal for the "climate pandemic"?** Nikendei C, Cranz A, Bugaj TJ. *GMS J Med Educ.* 2021 Jan 28;38(1):Doc29. doi: 10.3205/zma001425. eCollection 2021.

<https://www.ncbi.nlm.nih.gov/pmc/articles/PMC7899110/>

In the present commentary, we raise the question whether the COVID-19 pandemic should be seen as just the dress rehearsal for what awaits us in the impending climate crisis. Many factors have helped us navigate the challenge of this coronavirus pandemic and continue to do so. These include: recognizing scientific expertise, medical education, and digitalization as important driving forces, providing us with key information about the SARS-CoV-2 virus, as well as integrating it into our curricula and promoting action-oriented research. However, the "premiere of the climate pandemic" will, in all likelihood, confront us with even greater challenges, difficulties, and threats. Adhering to scientific findings, promoting medical education about the effects of global warming and using the power of digitalization, as well as consciously engaging in our role as medical caregivers and leaders will make a decisive contribution to providing impetus for climate action.

15. **Health Care Waste Management Improvement Interventions Specifications and Results: A Systematic Review and Meta-Analysis.** Ashtari A, Sadegh Tabrizi J, Rezapour R, Rashidian Maleki M, Azami-Aghdash S. *Iran J Public Health.* 2020 Sep;49(9):1611-1621. doi: 10.18502/ijph.v49i9.4074.

<https://www.ncbi.nlm.nih.gov/pmc/articles/PMC7898106/>

BACKGROUND: Given the importance of proper management of Health Care Waste Management (HCWM), comprehensive information on interventions in this field is necessary. Therefore, we aimed to systematically review and meta-analysis of characteristics and results of interventions in the field of HCWM.

**METHODS:** The required data were gathered through searching the keywords such as waste management, biomedical waste, hospitals waste, health care waste, infectious waste, medical waste, Waste Disposal Facilities, Garbage, Waste Disposal Facilities, Hazardous Waste Sites in PubMed, Scopus, EMBASE, Google scholar, Cochrane library, Science Direct, web of knowledge, SID and MagIran and hand searching in journals, reference by reference, and search in Gray literatures between 2000 and 2019. CMA software: 2 (Comprehensive Meta-Analysis) was used to perform the meta-analysis.

**RESULTS:** Twenty-seven interventions were evaluated. Most of the studies were conducted after 2010, in the form of pre and post study, without control group, and in hospital. Interventions were divided into two categories: educational interventions (19 studies) and multifaceted managerial interventions (8 studies). The most studied outcome (in 11 studies) was KAP (knowledge, attitude and practice). The mean standard difference of interventions on KAP was estimated 3.04 (2.54-3.54) which was significant statistically ( $P < 0.05$ ). Also, interventions were considerably effective in improving the indicators of waste production amount, waste management costs and overall waste management performance.

**CONCLUSION:** Despite positive effect of interventions, due to the methodological deficiencies of published studies and high heterogeneity in results of studies, caution should be exercised in interpreting and using the results of the studies.

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