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COVID-19

1. **COVID-19 Higher Mortality in Chinese Regions With Chronic Exposure to Lower Air Quality.**
Pansini R, Fornacca D. Front Public Health. 2021 Jan 22;8:597753. doi: 10.3389/fpubh.2020.597753. eCollection 2020.
https://www.ncbi.nlm.nih.gov/pmc/articles/PMC7874038/
We investigated the geographical character of the COVID-19 infection in China and correlated it with satellite- and ground-based measurements of air quality. Controlling for population density, we found more viral infections in those prefectures (U.S. county equivalent) afflicted by high Carbon Monoxide, Formaldehyde, PM 2.5, and Nitrogen Dioxide values. Higher mortality was also correlated with relatively poor air quality. When summarizing the results at a greater administrative level, we found that the 10 provinces (U.S. state equivalent) with the highest rate of mortality by COVID-19, were often the most polluted but not the most densely populated. Air pollution appears to be a risk factor for the incidence of this disease, despite the conventionally apprehended influence of human mobility on disease dynamics from the site of first appearance, Wuhan. The raw correlations reported here should be interpreted in a broader context, accounting for the growing evidence reported by several other studies. These findings warn communities and policymakers on the implications of long-term air pollution exposure as an ecological, multi-scale public health issue.

2. **Technological review on thermochemical conversion of COVID-19-related medical wastes.**
Purnomo CW, Kurniawan W, Aziz M. Resour Conserv Recycl. 2021 Apr;167:105429. doi: 10.1016/j.resconrec.2021.105429. Epub 2021 Jan 15.
https://europepmc.org/article/med/33519084
COVID-19 pandemic has brought tremendous environmental burden due to huge amount of medical wastes (about 54,000 t/d as of November 22, 2020), including face mask, gloves, clothes, goggles, and sanitizer/disinfectant containers. A proper waste management is urgently required to mitigate the spread of the disease, minimize the environmental impacts, and take

their potential advantages for further utilization. This work provides a prospective review on the possible thermochemical treatments for those COVID-19 related medical wastes (CMW), as well as their possible conversion to fuels. The characteristics of each waste are initially analyzed and described, especially their potential as energy source. It is clear that most of CMWs are dominated by plastic polymers. Thermochemical processes, including incineration, torrefaction, pyrolysis, and gasification, are reviewed in terms of applicability for CMW. In addition, the mechanical treatment of CMW into sanitized refuse-derived fuel (SRDF) is also discussed as the preliminary stage before thermochemical conversion. In terms of material flexibility, incineration is practically applicable for all types of CMW, although it has the highest potential to emit the largest amount of CO2 and other harmful gasses. Furthermore, gasification and pyrolysis are considered promising in terms of energy conversion efficiency and environmental impacts. On the other hand, carbonization faces several technical problems following thermal degradation due to insufficient operating temperature.

3. **Compromising situation of India's bio-medical waste incineration units during pandemic outbreak of COVID-19: Associated environmental-health impacts and mitigation measures.** Thind PS, Sareen A, Singh DD, Singh S, John S. Environ Pollut. 2021 Feb 8;276:116621. doi: 10.1016/j.envpol.2021.116621. Online ahead of print.
https://www.ncbi.nlm.nih.gov/pmc/articles/PMC7869633/
COVID-19 induced pandemic situations have put the bio-medical waste (BMW) management system, of the world, to test. Sudden influx, of COVID-infected patients, in health-care facilities, has increased the generation of yellow category BMW (Y-BMW) and put substantial burden on the BMW-incineration units of India. This study presents the compromising situation of the BMW-incineration units of India, in the wake of COVID-19 pandemic, from 21st March 2020 to 31st August 2020. This analysis revealed that on an average each COVID-infected patient in India generates approximately 3.41 kg/d of BMW and average proportion of Y-BMW in it is 50.44%. Further, it was observed that on 13th July 2020, the total Y-BMW, generated by both the normal and COVID-infected patients, fully utilized the BMW-incineration capacity of India. Also, it was made evident that, during the study period, BMW-incineration emitted several pollutants and their concentration was in the order: NOx > CO > SOx > PM > HCl > Cd > Pb > Hg > PCBs > Ni > Cr > Be > As. Subsequently, life time cancer risk assessment depicted that with hazard quotient >10-6, Cd may induce carcinogenic health impacts on both the adults and children of India. Therefore, to mitigate the environmental-health impacts associated with the incineration of BMW, evaluation of various options, viz., alternative technologies, substitution of raw materials and separate treatment of specific wastes, was also done. It is expected that the findings of this study may encourage the global auditory comprising scientific community and authorities to adopt alternate BMW-management strategies during the pandemic.

4. **Fuzzy-based multi-criteria decision analysis of environmental regulation and green economic efficiency in a post-COVID-19 scenario: the case of China.** Yao S. Environ Sci Pollut Res Int. 2021 Feb 16:1-27. doi: 10.1007/s11356-021-12647-w. Online ahead of print.
https://www.ncbi.nlm.nih.gov/pmc/articles/PMC7884973/
The COVID-19 pandemic outbreak posed serious threats not only to global health but also to the worldwide development regime. The experts, economists, policymakers, and the

governments expressed their pledges and determinations to adapt and mitigate climate change. Policymakers and governments have started adopting green growth and development strategies. The progress moves further to achieve green economic efficiency (GEE) to achieve economic, social, and environmental development. One of the major challenges has been promulgating and strictly implementing environmental regulations and policies vis-à-vis green growth and development. China, having the second largest economy, has started its voyage to achieve GEE. However, there are multiple challenges on the way to the green economy. The objective of the present stud is to analyze environmental regulation and GEE in China using fuzzy-based multi-criteria decision analysis. To serve this purpose, the study identifies 5 alternative strategies to achieve GEE while considering 10 criteria and 48 sub-criteria in the context of environmental regulations in China. The Fuzzy Analytical Hierarchy Process (AHP) has been employed to rank criteria and sub-criteria to the goal. The Fuzzy VIekriterijumsko KOmpromisno Rangiranje (VIKOR) method has been used to rank the alternative strategies of GEE. The proposed model unveiled resource efficiency and green purchasing as the best strategy to achieve GEE in the Chinese economy followed by local production. The study provides a comprehensive insight into the green development process to achieve GEE in the Chinese economy in the post-COVID-19 world.

Health Impacts of Climate Change

5. **Eight priorities for calculating the social cost of carbon.** Wagner G, Anthoff D, Cropper M, Dietz S, Gillingham KT, Groom B, Kelleher JP, Moore FC, Stock JH. Nature. 2021 Feb;590(7847):548-550. doi: 10.1038/d41586-021-00441-0.
https://www.nature.com/articles/d41586-021-00441-0
This month, the Biden administration is publishing an interim value of the SCC, which could be used immediately. Within a year, a newly reconstituted Interagency Working Group (IWG) will issue a review of the latest scientific and economic thinking, to inform what it calls a final number. The IWG will be co-led by the Council of Economic Advisers, the Office of Management and Budget and the Office of Science and Technology Policy. The group will also assess the social costs of methane, nitrous oxide and other greenhouse gases, and will provide recommendations for using and revising the SCC.

6. **Increasing impacts of temperature on hospital admissions, length of stay, and related healthcare costs in the context of climate change in Adelaide, South Australia.** Wondmagegn BY, Xiang J, Dear K, Williams S, Hansen A, Pisaniello D, Nitschke M, Nairn J, Scalley B, Xiao A, Jian L, Tong M, Bambrick H, Karnon J, Bi P. Sci Total Environ. 2021 Feb 6;773:145656. doi: 10.1016/j.scitotenv.2021.145656. Online ahead of print.
BACKGROUND: A growing number of studies have investigated the effect of increasing temperatures on morbidity and health service use. However, there is a lack of studies investigating the temperature-attributable cost burden.
OBJECTIVES: This study examines the relationship of daily mean temperature with hospital admissions, length of hospital stay (LoS), and costs; and estimates the baseline temperature-attributable hospital admissions, and costs and in relation to warmer climate scenarios in Adelaide, South Australia.

METHOD: A daily time series analysis using distributed lag non-linear models (DLNM) was used to explore exposure-response relationships and to estimate the aggregated burden of hospital admissions for conditions associated with temperatures (i.e. renal diseases, mental health, diabetes, ischaemic heart diseases and heat-related illnesses) as well as the associated LoS and costs, for the baseline period (2010-2015) and different future climate scenarios in Adelaide, South Australia.
RESULTS: During the six-year baseline period, the overall temperature-attributable hospital admissions, LoS, and associated costs were estimated to be 3915 cases (95% empirical confidence interval (eCI): 235, 7295), 99,766 days (95% eCI: 14,484, 168,457), and AU$159 million (95% eCI: 18.8, 269.0), respectively. A climate scenario consistent with RCP8.5 emissions, and including projected demographic change, is estimated to lead to increases in heat-attributable hospital admissions, LoS, and costs of 2.2% (95% eCI: 0.5, 3.9), 8.4% (95% eCI: 1.1, 14.3), and 7.7% (95% eCI: 0.3, 13.3), respectively by mid-century.
CONCLUSIONS: There is already a substantial temperature-attributable impact on hospital admissions, LoS, and costs which are estimated to increase due to climate change and an increasing aged population. Unless effective climate and public health interventions are put into action, the costs of treating temperature-related admissions will be high.

7. **Projecting heat-related excess mortality under climate change scenarios in China.** Yang J, Zhou M, Ren Z, Li M, Wang B, Liu L, Ou CQ, Yin P, Sun J, Tong S, Wang H, Zhang C, Wang J, Guo Y, Liu Q. Nat Commun. 2021 Feb 15;12(1):1039. doi: 10.1038/s41467-021-21305-1. https://www.nature.com/articles/s41467-021-21305-1
Recent studies have reported a variety of health consequences of climate change. However, the vulnerability of individuals and cities to climate change remains to be evaluated. We project the excess cause-, age-, region-, and education-specific mortality attributable to future high temperatures in 161 Chinese districts/counties using 28 global climate models (GCMs) under two representative concentration pathways (RCPs). To assess the influence of population ageing on the projection of future heat-related mortality, we further project the age-specific effect estimates under five shared socioeconomic pathways (SSPs). Heat-related excess mortality is projected to increase from 1.9% (95% eCI: 0.2-3.3%) in the 2010s to 2.4% (0.4-4.1%) in the 2030 s and 5.5% (0.5-9.9%) in the 2090 s under RCP8.5, with corresponding relative changes of 0.5% (0.0-1.2%) and 3.6% (-0.5-7.5%). The projected slopes are steeper in southern, eastern, central and northern China. People with cardiorespiratory diseases, females, the elderly and those with low educational attainment could be more affected. Population ageing amplifies future heat-related excess deaths 2.3- to 5.8-fold under different SSPs, particularly for the northeast region. Our findings can help guide public health responses to ameliorate the risk of climate change.

8. **Future air pollution related health burdens associated with RCP emission changes in the UK.** Fenech S, Doherty RM, O'Connor FM, Heaviside C, Macintyre HL, Vardoulakis S, Agnew P, Neal LS. Sci Total Environ. 2021 Feb 5;773:145635. doi: 10.1016/j.scitotenv.2021.145635. Online ahead of print.
Three Intergovernmental Panel on Climate Change (IPCC) Representative Concentration Pathways (RCPs) are used to simulate future ozone (O3), nitrogen dioxide (NO2), and fine

particulate matter (PM2.5) in the United Kingdom (UK) for the 2050s relative to the 2000s with an air quality model (AQUM) at a 12 km horizontal resolution. The present-day and future attributable fractions (AF) of mortality associated with long-term exposure to annual mean O3, NO2 and PM2.5 have accordingly been estimated for the first time for regions across England, Scotland and Wales. Across the three RCPs (RCP2.6, RCP6.0 and RCP8.5), simulated annual mean of the daily maximum 8-h mean (MDA8) O3 concentrations increase compared to present-day, likely due to decreases in NOx (nitrogen oxides) emissions, leading to less titration of O3 by NO. Annual mean NO2 and PM2.5 concentrations decrease under all RCPs for the 2050s, mostly driven by decreases in NOx and sulphur dioxide (SO2) emissions, respectively. The AF of mortality associated with long-term exposure to annual mean MDA8 O3 is estimated to increase in the future across all the regions and for all RCPs. Reductions in NO2 and PM2.5 concentrations lead to reductions in the AF estimated for future periods under all RCPs, for both pollutants. Total mortality burdens are also highly sensitive to future population projections. Accounting for population projections exacerbates differences in total UK-wide MDA8 O3-health burdens between present-day and future by up to a factor of ~3 but diminishes differences in NO2-health burdens. For PM2.5, accounting for future population projections results in additional UK-wide deaths brought forward compared to present-day under RCP2.6 and RCP6.0, even though the simulated PM2.5 concentrations for the 2050s are estimated to decrease. Thus, these results highlight the sensitivity of future health burdens in the UK to future trends in atmospheric emissions over the UK as well as future population projections.

WE ACT

9. **AMEE Consensus Statement: Planetary health and education for sustainable healthcare.** Shaw E, Walpole S, McLean M, Alvarez-Nieto C, Barna S, Bazin K, Behrens G, Chase H, Duane B, El Omrani O, Elf M, Faerron Guzmán CA, Falceto de Barros E, Gibbs TJ, Groome J, Hackett F, Harden J, Hothersall EJ, Hourihane M, Huss NM, Ikiugu M, Joury E, Leedham-Green K, MacKenzie-Shalders K, Madden DL, McKimm J, Nayna Schwerdtle P, Peters S, Redvers N, Sheffield P, Singleton J, Tun S, Woollard R. Med Teach. 2021 Feb 19:1-15. doi: 10.1080/0142159X.2020.1860207. Online ahead of print.
The purpose of this Consensus Statement is to provide a global, collaborative, representative and inclusive vision for educating an interprofessional healthcare workforce that can deliver sustainable healthcare and promote planetary health. It is intended to inform national and global accreditation standards, planning and action at the institutional level as well as highlight the role of individuals in transforming health professions education. Many countries have agreed to 'rapid, far-reaching and unprecedented changes' to reduce greenhouse gas emissions by 45% within 10 years and achieve carbon neutrality by 2050, including in healthcare. Currently, however, health professions graduates are not prepared for their roles in achieving these changes. Thus, to reduce emissions and meet the 2030 Sustainable Development Goals (SDGs), health professions education must equip undergraduates, and those already qualified, with the knowledge, skills, values, competence and confidence they need to sustainably promote the health, human rights and well-being of current and future generations, while protecting the health of the planet. The current imperative for action on environmental issues

such as climate change requires health professionals to mobilize politically as they have before, becoming strong advocates for major environmental, social and economic change. A truly ethical relationship with people and the planet that we inhabit so precariously, and to guarantee a future for the generations which follow, demands nothing less of all health professionals. This Consensus Statement outlines the changes required in health professions education, approaches to achieve these changes and a timeline for action linked to the internationally agreed SDGs. It represents the collective vision of health professionals, educators and students from various health professions, geographic locations and cultures. 'Consensus' implies broad agreement amongst all individuals engaged in discussion on a specific issue, which in this instance, is agreement by all signatories of this Statement developed under the auspices of the Association for Medical Education in Europe (AMEE). To ensure a shared understanding and to accurately convey information, we outline key terms in a glossary which accompanies this Consensus Statement (Supplementary Appendix 1). We acknowledge, however, that terms evolve and that different terms resonate variably depending on factors such as setting and audience. We define education for sustainable healthcare as the process of equipping current and future health professionals with the knowledge, values, confidence and capacity to provide environmentally sustainable services through health professions education. We define a health professional as a person who has gained a professional qualification for work in the health system, whether in healthcare delivery, public health or a management or supporting role and education as 'the system comprising structures, curricula, faculty and activities contributing to a learning process'. This Statement is relevant to the full continuum of training - from undergraduate to postgraduate and continuing professional development.

10. **Designing a sustainable closed-loop pharmaceutical supply chain in a competitive market considering demand uncertainty, manufacturer's brand and waste management.** Sazvar Z, Zokaee M, Tavakkoli-Moghaddam R, Salari SA, Nayeri S. Ann Oper Res. 2021 Feb 8:1-32. doi: 10.1007/s10479-021-03961-0. Online ahead of print.
https://link.springer.com/article/10.1007/s10479-021-03961-0
Pharmaceutical supply chain (PSC) is one of the most important healthcare supply chains and the recent pandemic (COVID-19) has completely proved it. Also, the environmental and social impacts of PSCs are undeniable due to the daily entrance of a large amount of pharmaceutical waste into the environment. However, studies on closed-loop PSCs (CLPSC) are rarely considered real-world requirements such as competition among diverse brands of manufacturers, the dependency of customers' demand on products' price and quality, and diverse reverse flows of end-of-life medicines. In this study, a scenario-based Multi-Objective Mixed-Integer Linear Programming model is developed to design a sustainable CLPSC, which investigates the reverse flows of expired medicines as three classes (must be disposed of, can be remanufactured and can be recycled). To study the competitive market and deal with demand uncertainty, a novel scenario-based game theory model is proposed. The demand function for each brand depends on the price and quality provided. Then, a hybrid solution approach is provided by combining the LP-metrics method with a heuristic algorithm. Furthermore, a real case study is investigated to evaluate the application of the model. Finally, sensitivity analysis and managerial insights are provided. The numerical results show that the proposed classification of reverse flows leads to proper waste management, making money,

and reducing both disposal costs and raw material usage. Moreover, competition increases PSCs performance and improves the supply of products to pharmacies.
SUPPLEMENTARY INFORMATION: The online version contains supplementary material available at 10.1007/s10479-021-03961-0.

11. **Curtailing Unnecessary Waste Among Operating Room Personnel: Evaluating the Cost Awareness of Commonly Used Surgical Items.** Heiman AJ, Camargo L, Bhat D, Desai V, Patel A, Ricci JA. Am Surg. 2021 Feb 17:3134821995079. doi: 10.1177/0003134821995079. Online ahead of print.
BACKGROUND: Operating rooms (ORs) generate 70% of hospital waste, leading to increased costs for the hospital, patient, and the environment. The lack of cost awareness among physicians has been well documented; however, there is little information on anesthesiologists or ancillary OR staff. This study aimed to evaluate the cost awareness of commonly used items at an academic medical center among OR personnel.
METHODS: Anonymous surveys were distributed to OR personnel (nurses, surgical technicians (STs), nurse anesthetists, anesthesiologists, surgeons, and residents), asking for the estimated costs of ten commonly used items. These costs were then compared against actual costs to evaluate the accuracy of participants' estimates. Responders were clustered by job, highest level of education, and years of experience for comparison.
RESULTS: 167 surveys were collected, and overall only 16.4% of estimates were accurate within 50% of actual price. No significant differences in accuracy between groups were identified overall (P = .2), but both surgical and anesthesia attendings had significantly higher rates of correct responses than their respective residents. No difference was seen in accuracy when all attendings (surgeons and anesthesiologists) were compared with either nurses or STs. Linear regression demonstrated no correlation between number of years at current position or years at institution and number of correct responses (R2 = .0025 and R2 = .005, respectively).
DISCUSSION: Addressing the knowledge deficit around item costs via global education of all OR personnel (surgeons, anesthesia providers, and ancillary staff) could be a viable pathway to reduce waste, and thus cost, for our healthcare system.

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