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Effect of climate related flooding on health and healthcare worldwide

Continuing lack of preparation is a serious cause for concern

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The negative effects of the climate crisis—including flooding, heatwaves, crop failures, and climate related conflict—are already a reality in many parts of the world.¹ As politicians and other leaders drag their feet over climate mitigation strategies, these and other crises such as drought and biodiversity collapse will only get worse over time, with cascading risks and increasing uncertainty.¹⁻³

Healthcare delivery

The climate crisis also poses a substantial risk to the delivery of healthcare. As well as damage to health infrastructure caused by heatwaves, flooding, wildfires, or conflicts, demand will increase because of extreme weather events and the expanding ranges of vectorborne diseases.¹⁴ The resilience of healthcare systems worldwide is an increasing concern. Flooding is one of the big risks to health and healthcare and will become more important as the crisis deepens⁵ and extreme weather events become more frequent.^{6,7} Also of concern are deliberate flooding incidents, as recently seen in southern Ukraine with the destruction of the Kakhovka dam.

Health relevant infrastructure in its wider sense includes not only hospitals but also urgent care centres and triage services (such as NHS 111 in the UK), primary care facilities, laboratories, and roads, railways, and other transport links. Learning from previous flooding events and understanding their effects on health and healthcare delivery will be vital to increase resilience and shift decision makers from a disaster response approach to prevention and long term risk management.^{5,7}

Vulnerability

The vulnerability of a population to the health effects of flooding depends on numerous factors. These include the baseline health of a population; the severity and frequency of flooding; the location of housing, workplaces, and critical infrastructure; the use of flood warning systems and evacuation; and the speed of response measures and access to healthcare.^{6,8}

Most deaths linked to flooding are the result of drowning or injuries; 7398 such deaths were recorded internationally in 2022.⁹ Other health effects include infections and mental health conditions such as stress and anxiety, which can be followed by chronic anxiety, depression, and post-traumatic stress disorder.¹⁰ In the longer term, population displacement and ongoing problems with water supply and sanitation will lead to further health consequences such as waterborne diseases, including cholera and other diarrhoeal diseases.⁸ Demand for healthcare increases after substantial flooding events in both the short and the longer term, although

evidence on the long term effect on healthcare is limited.^{5,6}

When healthcare facilities or other critical infrastructure are affected by flooding directly, providing emergency and routine healthcare becomes a challenge. Populations at greatest risk include those in resource poor settings where health infrastructure is already fragile and access to healthcare limited.^{11,12} One recent example is the devastating flooding in Pakistan in 2022. More than three million people and 900 health facilities were affected, and over 1100 people died.¹³ Although Pakistan contributes only 1% of all global carbon emissions, it is already disproportionately affected by climate change because of its high exposure to natural hazards as well as social vulnerability from poverty.^{14,15}

Internationally, the vulnerability of healthcare systems to flooding has been recognised repeatedly.^{8,13,16-18} Although detailed data are not available for many countries, most are likely to be underprepared for the effects of the climate crisis, including clear risks to healthcare systems.^{5,18}

A qualitative study interviewing people involved in preparing for, responding to, and recovering from a flooding event in England found that levels of preparedness and awareness of the implications of flooding were inconsistent across the health system.¹⁹ Subsequent publications in the UK have recognised an ongoing lack of preparation for the effects of climate change on health and healthcare systems.²⁰ This scenario is likely to be similar internationally. Other climate sensitive risks to healthcare include the roads, bridges, and train tracks that are vulnerable to damage from extreme heat, with clear implications for the delivery of healthcare, patient transportation, and supply chains.^{4,5}

Governments worldwide should prioritise collecting data on health and healthcare outcomes linked to flooding and improving vulnerability assessments of critical infrastructure. They should have policies in place to ensure that all flooding events are used as learning exercises to inform effective prevention and mitigation strategies. Lastly, they should routinely conduct planning exercises with stakeholders to prepare health systems for the immediate management of healthcare crises caused by flooding and the subsequent disruption to healthcare delivery. Disaster planning would also help authorities put in place the measures needed for timely recovery of infrastructure and services. It would also ensure that they have effective business continuity plans so healthcare is less disrupted.

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- 1 Romanello M, Di Napoli C, Drummond P, et al. The 2022 report of the Lancet Countdown on health and climate change: health at the mercy of fossil fuels. *Lancet* 2022;400:54. doi: 10.1016/S0140-6736(22)01540-9 pmid: 36306815
- 2 Intergovernmental Panel on Climate Change. Summary for policymakers. In: Global warming of 1.5°C. An IPCC special report on the impacts of global warming of 1.5°C above pre-industrial levels and related global greenhouse gas emission pathways, in the context of strengthening the global response to the threat of climate change, sustainable development, and efforts to eradicate poverty. 2018. <https://www.ipcc.ch/sr15/>
- 3 Lenton TM, Rockström J, Gaffney O, et al. Climate tipping points—too risky to bet against. *Nature* 2019;575:5. doi: 10.1038/d41586-019-03595-0 pmid: 31776487
- 4 Sherman JD, MacNeill AJ, Biddinger PD, Ergun O, Salas RN, Eckelman MJ. Sustainable and resilient health care in the face of a changing climate. *Annu Rev Public Health* 2023;44:77. doi: 10.1146/annurev-publhealth-071421-051937 pmid: 36626833
- 5 Ebi KL, Vanos J, Baldwin JW, et al. Extreme weather and climate change: population health and health system implications. *Annu Rev Public Health* 2021;42:315. doi: 10.1146/annurev-publhealth-012420-105026 pmid: 33406378
- 6 Bo-Tao ZH, Jin QI. Changes of weather and climate extremes in the IPCC AR6. *Clim Change Responses* 2021;17:18.
- 7 Pörtner H-O, Roberts DC, Tignor M, et al. Climate change 2022: impacts, adaptation and vulnerability working group II contribution to the sixth assessment report of the Intergovernmental Panel on Climate Change. 2022. https://report.ipcc.ch/ar6/wg2/IPCC_AR6_WGII_FullReport.pdf.
- 8 Menne B, Murray V World Health Organization. *Floods in the WHO European Region: health effects and their prevention*. WHO Regional Office for Europe, 2013.
- 9 Ritchie H, Rosado P, Roser M. *Natural disasters*. 2022. <https://ourworldindata.org/natural-disasters>
- 10 Stanke C, Murray V, Amlöt R, Nurse J, Williams R. The effects of flooding on mental health: Outcomes and recommendations from a review of the literature. *PLoS Curr* 2012;4. doi: 10.1371/4f91fa9c3cae pmid: 23066515
- 11 Smith GS, Anjum E, Francis C, Deanes L, Acey C. Climate change, environmental disasters, and health inequities: the underlying role of structural inequalities. *Curr Environ Health Rep* 2022;9:9. doi: 10.1007/s40572-022-00336-w pmid: 35338470
- 12 Cappelli F, Costantini V, Consoli D. The trap of climate change-induced “natural” disasters and inequality. *Glob Environ Change* 2021;70:102329doi: 10.1016/j.gloenvcha.2021.102329
- 13 WHO. Major health risks unfolding amid floods in Pakistan. 2022. <http://www.emro.who.int/pak/pakistan-news/major-health-risks-unfolding-amid-floods-in-pakistan.html>
- 14 World Bank. Climate change knowledge portal. Pakistan—vulnerability. 2023. <https://climate-knowledgeportal.worldbank.org/country/pakistan/vulnerability>
- 15 Deivanayagam TA, English S, Hickel J, et al. *Envisioning environmental equity: climate change, health, and racial justice*. Lancet Health Policy, 2023.
- 16 Pitt M. *Learning lessons from the 2007 floods*. 2008. https://webarchive.nationalarchives.gov.uk/ukgwa/20100807034701/http://archive.cabinetoffice.gov.uk/pittreview/_/media/assets/www.cabinetoffice.gov.uk/flooding_review/pitt_review_full%20pdf.pdf.
- 17 Runkle J, Svendsen ER, Hamann M, Kwok RK, Pearce J. Population health adaptation approaches to the increasing severity and frequency of weather-related disasters resulting from our changing climate: a literature review and application to Charleston, South Carolina. *Curr Environ Health Rep* 2018;5:52. doi: 10.1007/s40572-018-0223-y pmid: 30406894
- 18 United Nations Development Programme. Vulnerability and adaptation of health care providers and lessons learned from COVID-19 crisis. 2022. UNDP, 2022. <https://www.undp.org/lebanon/publications/vulnerability-and-adaptation-health-care-providers-and-lessons-learned-covid-19-crisis>
- 19 Landeg O, Whitman G, Walker-Springett K, Butler C, Bone A, Kovats S. Coastal flooding and frontline health care services: challenges for flood risk resilience in the English health care system. *J Health Serv Res Policy* 2019;24:28. doi: 10.1177/1355819619840672 pmid: 31333054
- 20 Climate Change Committee. Progress in adapting to climate change. 2023. <https://www.thecc.org.uk/wp-content/uploads/2023/03/WEB-Progress-in-adapting-to-climate-change-2023-Report-to-Parliament.pdf>