Bridging the evidence gap to achieve a healthy, net zero carbon future

The urgent challenge of achieving net zero carbon emissions by 2050 at the latest presents an opportunity to drive transformative changes in all sectors of society. Well designed actions to cut greenhouse gas (GHG) emissions could bring major benefits for health, both reducing the health risks of climate change and delivering multiple co-benefits to human health and development.[1,2] Modelling studies estimate that many millions of premature deaths could be prevented and GHG emissions greatly reduced by phasing out fossil fuels, thereby reducing air pollution,[3] and by encouraging active travel, increasing use of public transport, and shifting to sustainable and healthy diets.[1,4,5] Further benefits could accrue from efficient, well ventilated housing[6] and from efforts to develop net zero health-care systems.[7,8] There is also great potential to achieve climate and health benefits from nature-based solutions, including green space in cities, reforestation, and reduced deforestation and agroforestry.[9,10] However, these potential benefits will only be realised by addressing key barriers and challenges.

First, standard approaches are inadequate to assess and quantify the health and GHG impacts of climate actions, including the use of different timescales.[11] This means the results of different studies, even in the same sector, are difficult to compare. The design of research is often limited by the absence of data on baseline health status and GHG emission levels. Second, many of the published studies model estimates of effect sizes that indicate the potential magnitude of benefits, but do not quantify the impacts of implemented actions. Additionally, few studies document synergies and trade-offs between policies. Projected benefits may not be fully realised in implemented projects without rigorous evaluation. More consideration needs to be given to the unintended adverse consequences for health and equity that result from poorly designed policies and from an absence of comprehensive policy packages to effectively transform systems. For example, higher carbon prices could increase poverty if issues around equity and distribution are not addressed[12] and planting more crops for biofuels that compete for land with food crops could reduce food security.[13]

Third, the political economy of climate action impedes progress towards net zero carbon emissions.[14] Vested commercial and political interests, such as from within fossil fuel industries, often oppose the rapid phase out of high emitting sources of energy, the withdrawal of subsidies, and effective carbon pricing. The economic valuation of health co-benefits shows that such co-benefits can offset wholly or partly the costs of mitigation.[15] But policy making typically focuses on the maximisation of gross domestic product growth, which does not account for the costs of damaging externalities such as air pollution and climate change.[16] Despite public backing for post-COVID-19 economic stimulus packages that support progress towards net zero carbon emissions,[17] in 15 of the G20 countries and in five of ten other countries analysed, the announced stimulus of US$17·2 trillion could have a net negative environmental

impacts.[18] Fourth, the potential to integrate adaptation and mitigation actions is often overlooked, therefore some adaptation actions could increase the challenges for mitigation. For example, dependence on air conditioning can result in increased energy use and GHG emissions, leading to grid failures during heatwaves, as well as displacing heat outdoors, thereby increasing the urban heat island effect.

Nevertheless, there is now an opportunity to take action and overcome these barriers to change and to capitalise on growing awareness of the need to achieve net zero carbon emissions by 2050. The COVID-19 pandemic has resulted in support for public health action in many countries. Further, health professionals have become mobilised to support climate action.[19] To build on this momentum, the research community should harmonise approaches to assessing and modelling the health benefits, co-benefits, and trade-offs of climate action—eg, use of consistent time scales and metrics so that research is more useful for policy and practice.[11,20] All nations should include health in their Nationally Determined Contributions under the Paris Agreement, including quantitative estimates of the health benefits of climate action.[21] More emphasis should be given to the evaluation of implemented actions to understand the levers and barriers to change and the magnitude of impacts, as well as potential synergies and trade-offs. Such research can use approaches that build on the UK Medical Research Council guidance for the evaluation of complex interventions[22] to include GHG emissions and relevant health and equity outcomes. Increasingly adaptation, resilience, and mitigation should be addressed through integrated strategies that aim to minimise the effects of climate change on vulnerable populations and accelerate progress towards net zero carbon emissions.

Established to catalyse action and aid transformational change, the Pathfinder Initiative[23] aims to increase the utility of research on the benefits and co-benefits of mitigation actions by collecting and making widely available evidence of the effects of mitigation actions across all sectors. A review of published and submitted studies of implemented actions by the Pathfinder Initiative as of August, 2021, found only ten studies that reported quantitative data on both health and mitigation.[24] This situation shines a light on the insufficient information available with which to capture the lessons from the implementation of climate actions. The Pathfinder Initiative is now inviting further submissions of implemented actions that describe the health and climate impacts of mitigation actions in a range of socioeconomic, sectoral, and geographical settings to be submitted as case studies through the Pathfinder Initiative's website. Reframing climate change as a health issue and capitalising on the potential to address health and climate priorities is a powerful lever for action towards a healthy, net zero carbon future.

SW, RG, and AH reports grants from Wellcome Trust and the Oak Foundation. The Pathfinder Initiative is funded by the Wellcome Trust with support from the Oak Foundation. The other authors declare no competing interests.

We acknowledge with thanks the contributions of the *Lancet* Pathfinder Commission's research team Syreen Hassan, Kristine Belesova, Peninah Murage, Romain Clercq-Roques, Roberto Picetti, Kris Murray, Soledad Cuevas, and Commissioners María Cortés-Puch, Lorraine Whitmarsh, Kristie L Ebi, Johan Rockström, Leena Srivastava, Aimée Aguilar Jaber, Tolullah Oni, Robert B Zougmoré, Diarmid Campbell-Lendrum, Aromar Revi, Nicole de Paula, and Rachel Huxley to the ongoing work of the Commission.

**Sarah Whitmee, Rosemary Green, Joy Phumaphi, Helen Clark, Andy Haines*

sarah.whitmee@lshtm.ac.uk

Centre on Climate Change and Planetary Health, London School of Hygiene & Tropical Medicine, London WC1H 9SH, UK (SW, RG, AH); African Leaders Malaria Alliance, Dar Es Salaam, Tanzania (JP); The Helen Clark Foundation, Auckland, New Zealand (HC)

1 Haines A, McMichael AJ, Smith KR, et al. Public health benefits of strategies to reduce greenhouse-gas emissions: overview and implications for policy makers. *Lancet* 2009; **374:** 2104–14.

2 Haines A. Health co-benefits of climate action. *Lancet Planet Health* 2017; **1:** e4–5.

3 Lelieveld J, Klingmüller K, Pozzer A, Burnett RT, Haines A, Ramanathan V. Effects of fossil fuel and total anthropogenic emission removal on public health and climate. *Proc Natl Acad Sci USA* 2019; **116**: 7192–97.

4 Willett W, Rockström J, Loken B, et al. Food in the Anthropocene: the EAT–*Lancet* Commission on healthy diets from sustainable food systems. *Lancet* 2019; **393:** 447–92.

5 Aleksandrowicz L, Green R, Joy EJM, Smith P, Haines A. The impacts of dietary change on greenhouse gas emissions, land use, water use, and health: a systematic review. *PLoS One* 2016; **11:** e0165797.

6 Wilkinson P, Smith KR, Davies M, et al. Public health benefits of strategies to reduce greenhouse-gas emissions: household energy. *Lancet* 2009; **374:** 1917–29.

7 Lenzen M, Malik A, Li M, et al. The environmental footprint of health care: a global assessment. *Lancet Planet Health* 2020; **4:** e271–79.

8 Pencheon D, Wight J. Making healthcare and health systems net zero. *BMJ* 2020; **368:** m970.

9 Seddon N, Smith A, Smith P, et al. Getting the message right on nature-based solutions to climate change. *Glob Chang Biol* 2021; **27:** 1518–46.

10 Cohen-Shacham E, Walters G, Janzen C, Maginnis S, eds. Nature-based solutions to address global societal challenges. Gland, Switzerland: International Union for Conservation of Nature, 2016.

11 Hess JJ, Ranadive N, Boyer C, et al. Guidelines for modeling and reporting health effects of climate change mitigation actions. *Environ Health Perspect* 2020; **128:** 115001.

12 Dorband II, Jakob M, Kalkuhl M, Steckel JC. Poverty and distributional effects of carbon pricing in low- and middle-income countries—a global comparative analysis. *World Dev* 2019; **115:** 246–57.

13 Muscat A, de Olde EM, de Boer IJM, Ripoll-Bosch R. The battle for biomass: a systematic review of food-feed-fuel competition. *Glob Food Sec* 2020; **25:** 100330.

14 Workman A, Blashki G, Bowen KJ, Karoly DJ, Wiseman J. The political economy of health co-benefits: Embedding health in the climate change agenda. *Int J Environ Res Public Health* 2018; **15:** 674.

15 Markandya A, Sampedro J, Smith SJ, et al. Health co-benefits from air pollution and mitigation costs of the Paris Agreement: a modelling study. *Lancet Planet Health* 2018; **2**: e126–33.

16 Stiglitz JE, Sen A, Fitoussi J-P. Report by the Commission on the Measurement of Economic Performance and Social Progress. 2009. https://ec.europa.eu/eurostat/documents/8131721/8131772/Stiglitz-Sen-Fitoussi-Commission-report.pdf (accessed Oct 8, 2021).

17 Ipsos MORI. Majority of people expect government to make environment a priority in post COVID-19 recovery. June 5, 2020. https://www.ipsos.com/ipsos-mori/en-uk/majority-people-expect-government-make-environment-priority-post-covid-19-recovery (accessed Oct 8, 2021).

18 Vivid Economics, Finance for Biodiversity Initiative. Greenness of Stimulus Index. 2021. https://www.vivideconomics.com/wp-content/uploads/2020/10/201028-GSI-report_October-release.pdf (accessed Oct 8, 2021).

19 Harvey F. World health leaders urge green recovery from coronavirus crisis. *The Guardian*, May 26, 2020.

20 Remais J V, Hess JJ, Ebi KL, et al. Estimating the health effects of greenhouse gas mitigation strategies: addressing parametric, model, and valuation challenges. *Environ Health Perspect* 2014; **122:** 447–55.

21 Dasandi N, Graham H, Lampard P, Jankin Mikhaylov S. Engagement with health in national climate change commitments under the Paris Agreement: a global mixed-methods analysis of the nationally determined contributions. *Lancet Planet Health* 2021; **5:** e93–101.

22 Craig P, Dieppe P, Macintyre S, Mitchie S, Nazareth I, Petticrew M. Developing and evaluating complex interventions: the new Medical Research Council guidance. *BMJ* 2008; **337:** 979–83.

23 Haines A, Clark H, Phumaphi J, Whitmee S, Green R. The *Lancet* Pathfinder Commission: pathways to a healthy, zero-carbon future—a call for evidence. *Lancet* 2021; **397:** 779.

24 Hassan S, Cuevas Garcia-Dorado S, Belesova K, et al. A protocol for analysing the effects on health and greenhouse gas emissions of implemented climate change mitigation actions. *Wellcome Open Res* 2021; **6:** 111.