A Research Agenda to Protect Human Health & Build Resilience in the Face of a Changing Climate

Zulfiqar Bhutta, Darryl Zeldin, Celynne Balatbat, and Shaneah M. Taylor, *Editors*

DRAFT

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A RESEARCH AGENDA TO PROTECT HUMAN HEALTH & BUILD RESILIENCE IN THE FACE OF A CHANGING CLIMATE

Contributors

Ismayil Amit, National Institute on Aging
Zulfiqar Bhutta, Hospital for Sick Children, Colorado
Vic Gomez Betancourt, Cultivando
Lindsey Criswell, National Institutes of Health
Jim Crooks, National Jewish Health
Elizabeth DeVilbiss, National Institutes of Health
Ann-Christine Duhaime, Massachusetts General Hospital Center for the Environment and Health
Shasta Gaughen, Pala Environmental Network
Lynn Goldman, Milken Institute School of Public Health, The George Washington University
Jagteshwar (Una) Grewal, National Institutes of Health
Tracey Holloway, University of Wisconsin, Madison
Anne Marie Jukic, National Institutes of Environmental Health Sciences and Yale School of Public Health
Edward Lakatta, National Institute on Aging
Jay Lemery, University of Colorado
Gabriela Lemus, Maryland Latinos Unidos
Ed Maibach, George Mason Center for Climate Communication
Tulsi Modi, Johns Hopkins University
Chris Murray, Institute for Health Metrics and Evaluation
Jonathan Patz, University of Wisconsin, Madison
Caitlin Rublee, University of Colorado
Renee Salas, Harvard School of Public Health
Dale Sandler, National Institute of Environmental Health Sciences
Chinmoy Sarkar, University of Hong Kong
Elizabeth Schenk, Providence
Michael Skinner, Washington State University
Guadalupe Solis, Cultivando
Raymond Sweet, Hollygrove Dixon Neighborhood Association
Adrianne Teherani, University of California, San Francisco, Center for Climate, Health, and Equity
Sapna Thottathil, University of California, San Francisco, Center for Climate, Health, and Equity
Sheri Weiser, University of California, San Francisco, Center for Climate, Health, and Equity
Joshua Wortzel, Brown University
Darryl Zeldin, National Institute of Environmental Health Sciences

NAM Staff

Shaneah M. Taylor, Deputy Director of Programs
Emma Lower-McSherry, Research Associate

Christopher Hanley, Director, Grand Challenge on Climate Change, Human Health, & Equity
Kimber Bogard, Deputy Executive Officer and Jonathan B. Perlin, MD, and Donna J. Perlin, MD, Director of NAM Programs

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INTRODUCTION

Background and Context

Climate change is among the most significant health challenges of the 21st century. Extensive evidence supports the scientific consensus that human health and well-being are profoundly impacted by climate change.

Climate change affects human health through a variety of pathways, both direct and indirect. Direct impacts include extreme weather events like heatwaves, hurricanes, and floods, which can cause immediate injury, death, and mental health issues. Indirect impacts involve changes in environmental conditions that affect health, such as shifts in the patterns of vector-borne diseases (e.g., malaria and dengue fever), worsening air quality leading to respiratory and cardiovascular problems, and threats to food and water security that can result in malnutrition and waterborne diseases. These effects are further complicated by social drivers of health, including economic status, access to healthcare, and pre-existing health conditions. As the impacts of climate change intensify, they exacerbate existing health disparities, disproportionately affecting marginalized communities and threatening the well-being of populations worldwide. Addressing these intersections between climate change, human health, and equity are crucial to promoting resilience and well-being for all.

Research on the health impacts of climate change has significantly increased in the past decade. However, gaps in evidence and a shortage of applied research impede the knowledge necessary to implement effective solutions. Furthermore, the protection of human health has only recently become a primary consideration in global climate change policy discussions. The heightened awareness of health issues is prompting decision-makers to demand robust scientific data for knowledge synthesis and policy guidance on health and healthcare, including evidence on effect attribution and the quantification of adaptation and mitigation solutions.

There is a need for a research agenda for climate change and human health to advance understanding, guide policy and practice, and ultimately protect and improve human health in the face of a changing climate. A research agenda for climate change and human health is crucial for understanding the complex interactions between climate factors and health outcomes. Climate change affects human health through direct impacts like heatwaves and extreme weather events, and indirect effects such as changes in vector-borne diseases, air quality, and food and water security. By comprehensively studying these interactions, we can develop evidence-based information that informs effective mitigation and adaptation strategies. This is essential for policymakers and practitioners to make informed decisions that protect public health

and allocate resources efficiently to address the most pressing health challenges posed by climate change.

Additionally, a research agenda enhances community resilience and preparedness by identifying targeted interventions and designing healthcare systems capable of responding to climate-related health threats. It ensures that populations living in vulnerable conditions, such as low-income communities, the elderly, and those with pre-existing health conditions, are specifically addressed in climate and health strategies. By identifying research gaps and promoting innovation, we can develop new technologies and policies to mitigate and adapt to health impacts. Furthermore, a structured agenda provides a framework for monitoring and evaluating the effectiveness of interventions, facilitating global coordination and collaboration to share knowledge, data, and best practices in tackling the global health impacts of climate change.

To this end, the National Academy of Medicine (NAM) and Kaiser Permanente, collaborated to develop a research agenda for climate change and human health. Importantly, the NAM collaborated with stakeholders from various sectors and communities, integrating diverse perspectives to shape the research priorities. This inclusive approach ensures that the research agenda reflects the concerns and priorities of those most affected by climate change. By co-developing the research agenda, we acknowledge the complex and interconnected nature of the challenges posed by climate change, health disparities, and social inequities. This process fosters transparency, accountability, and shared ownership among all stakeholders, enhancing the relevance, validity, and impact of the research outcomes.

Research Agenda Methodology

The development of this research agenda involved a multi-phase process (see Figure 1) designed to ensure inclusivity and comprehensiveness.

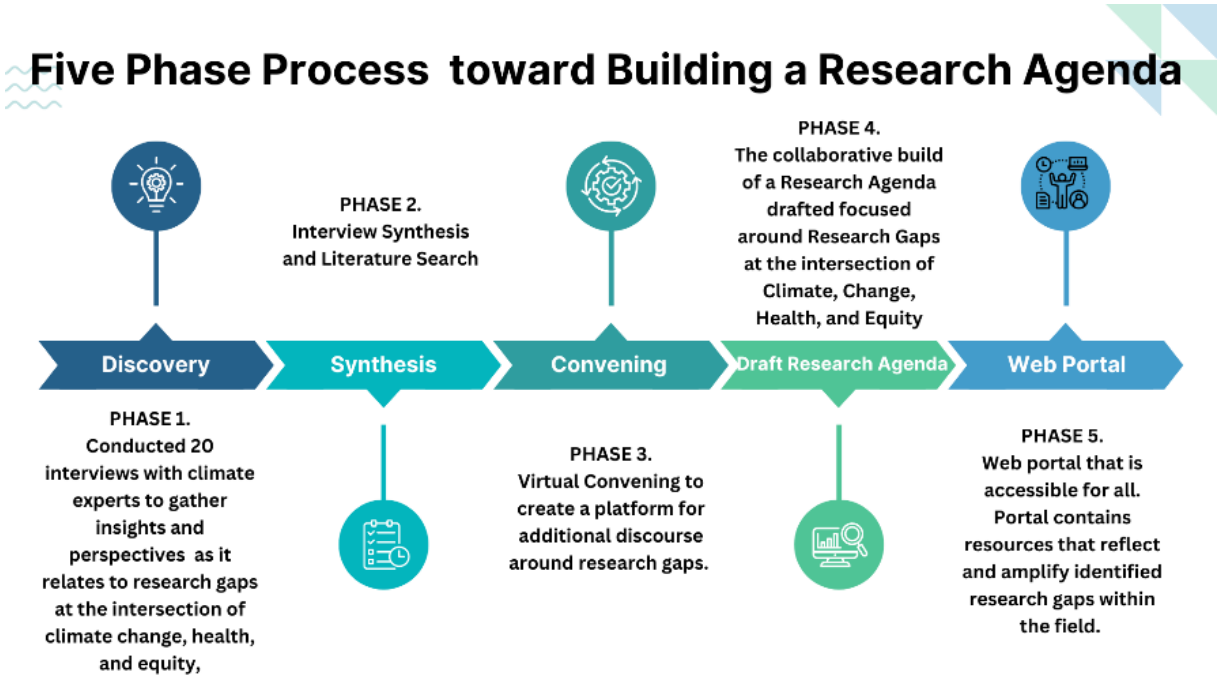

Figure 1. Multi-phase process for developing a research agenda

The methodology included informational interviews, a review of existing literature, and public feedback through a survey of meeting attendees:

- **Phase 1: Discovery**
  The NAM's Grand Challenge on Climate Change, Human Health, and Equity collaborated with the National Academies of Science, Engineering, and Medicine Climate Crossroads initiative to conduct 20 informational interviews across all workstreams. Half of the interviewees were researchers across disciplines such as climate change and health, environmental health, epidemiology, public health, geriatrics, and reproductive health. The remaining interviewees included community representatives, sustainability practitioners, policymakers, philanthropists, and members of the Climate Communities Network with lived experience. Appendix A [[not included in partial review draft]] is a semi structured interview protocol that was modified depending on respondent's expertise. Key words that were derived from the interviews to inform the literature search are included in Appendix B [[not included in partial review draft]].
- **Phase 2: Literature Search**
  Information from Phase 1 was synthesized to inform a literature search to explore the intersections of climate change, health, and equity. Keywords included both information from Phase 1 as well as guidance from the National Academies library staff. Tailored search strategies with relevant keywords (Appendix B) were developed, focusing on US-based publications from the past decade. Databases that were selected included Embase, Medline (PubMed), and Scopus for their comprehensive coverage. The results were analyzed to identify gaps, particularly regarding disparities, biases, and structural inequities. To supplement the scholarly search, governmental resources, such as those from the U.S. Environmental Protection Agency and Department of Health and Human Services, were consulted. Research gaps identified across phases 1 and 2 are listed in Appendix C [[not included in partial review draft]].
- **Phase 3: Convening and Feedback**
  NAM convened a full-day online meeting with climate and health experts, including those with lived experience, to discuss gaps in knowledge. A survey was distributed to meeting attendees to gather feedback from interested stakeholders for the research agenda. Appendix D [[not included in partial review draft]] contains the survey questions. We targeted a subset of respondents from the meeting to identify additional research gaps. Thirty-seven individuals responded. Respondents included professionals from diverse fields focused on climate, health, and equity. Their expertise spans areas such as environmental health, epidemiology, urban development, socioeconomic inequalities, mental health impacts, and public policy (Appendix E [[not included in partial review draft]]).
- **Phase 4: Draft and Validate Research Agenda**
  Following analysis and synthesis of the informational interviews, literature search results, online convening discussions, and survey results, a proposed research agenda was drafted to address evidence gaps in climate-based health impacts and intervention strategies in the United States (US).

- **Phase 5: Evidence and Tools Portal**
  A searchable database will be created to support researchers, the general community, and policy advisors, focusing on health equity. This publicly accessible, community-oriented portal aims to inform action beyond academic circles.

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Climate and Health Research Gaps

The multi-phase process (informational interviews, review of existing literature, and feedback from interested stakeholders through a survey of meeting attendees) generated a wide range of topics related to the intersection of environmental factors, climate change, and human health. These topics were categorized into four overarching domains. In developing these domains, existing frameworks on climate change and health were reviewed including the Lancet Countdown's monitoring framework on health impacts of climate change, WHO's operational framework for building climate resilient health systems, the United States Global Change Research Program's primary exposure pathways by which climate change affects health, and the Interacademy Partnership's Global Synthesis Report.

The four domains include:

- **Domain 1: Climate Impacts on Health Supporting Infrastructures and Health Outcomes:** This domain explores the effects of climate change on critical infrastructures that support human health, including water and sanitation systems, food systems, agriculture, and air quality. It examines the direct and indirect health outcomes, such as the spread of water-borne diseases, food insecurity, malnutrition, and respiratory illnesses. Additionally, it considers the broader implications for health systems, the cross-generational impacts of climate change, and the heightened vulnerability of high-risk populations. Moreover, this domain highlights the need for studying disease mechanisms at the molecular, cellular, and epigenetic levels, as well as adopting a One Health approach to understand the interconnected impacts of climate change on human, animal, and environmental health.
- **Domain 2: Mitigation and Adaptation Research:** This domain focuses on the strategies for mitigating and adapting to the health impacts of climate change. It includes research on reducing greenhouse gas emissions, developing adaptive health infrastructure, and fostering collaboration and community engagement to build resilience. Special attention is given to Indigenous health and the integration of traditional knowledge, as well as the role of policy and governance in driving effective climate action. It also emphasizes the importance of addressing the needs of vulnerable populations—such as the elderly, children, and women—by incorporating health equity considerations and addressing the social drivers that exacerbate climate-related health disparities.
- **Domain 3: Research and Technology Infrastructure and Capacity Building**: This domain addresses the essential research and technological needs required to support climate and health initiatives. It highlights the importance of robust data systems, the development of new technologies, and the expansion of workforce capacity to address climate-related health challenges. The domain also emphasizes the need for sustained

funding to ensure the long-term success of research efforts and the implementation of innovative solutions.

- **Domain 4: Public and Policy Engagement and Education:** This domain emphasizes the critical role of public engagement and education in addressing climate and health challenges. Education is envisioned as a bi-directional process, where researchers not only disseminate knowledge but also learn from the lived experiences, insights, and concerns of the public. This collaborative approach fosters a deeper understanding of science and strengthens community resilience. By valuing and incorporating public input, this domain aims to create more effective, inclusive, and culturally relevant climate and health interventions. This domain also emphasizes the importance of policy research and developing effective methods for communicating with and educating policymakers at local, state, national, and international levels to ensure that climate and health research informs actionable and equitable policy decisions.

Table 1. Overarching Domains and Research Gaps

Domain	Topics
Domain 1: Climate Impacts on Health Supporting Infrastructures and Health Outcomes	1. Heat-related illness and mortality 2. Extreme weather events 3. Water and sanitation systems & water-borne disease 4. Air quality and health 5. Vector-borne diseases 6. Food security and nutrition 7. One Health 8. Mental health and well-being 9. Cross-generational impacts of climate change on health 10. High-risk populations
Domain 2: Mitigation and Adaptation Research	1. Adaptation and mitigation 2. Mitigation technologies 3. Implementation science 4. Policy and governance 5. Collaboration and community engagement 6. Community resilience and adaptation 7. Vulnerable populations and health equity 8. Indigenous health and traditional knowledge
Domain 3: Research and Technology Infrastructure and Capacity Building	1. Data gaps and capacity building 2. New technologies 3. Climate savvy workforce 4. Funding

Domain 4: Public and Policy Engagement and Education	1. Public engagement and education as a bidirectional process 2. Engage and influence policy