



Short communication

Building a comprehensive approach in CDC's National Center for Environmental Health to address the health effects of climate change



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ABSTRACT

Background: Climate change has direct impacts on human health, and these impacts are projected to grow. The National Center for Environmental Health (NCEH) at the Centers for Disease Control and Prevention (CDC) has implemented climate and health activities for more than a decade. CDC's Climate and Health Program, within NCEH, is the national leader in preparing communities for the health impacts of climate change. Recent efforts by NCEH's Division of Environmental Health Science and Practice (DEHSP) seek to expand climate work, foster collaboration, and create an updated strategy to protect human health from the impacts of climate change.

Objectives: Here we outline a proposed strategy focusing on climate and health data, science, and action. The strategy expands NCEH's current climate and health activities while integrating with other programs and partners, to increase capacity across the nation to prepare for and respond to the health impacts of climate change.

Methods: DEHSP developed a climate and health strategy through a planning process including division leadership, all branch chiefs within the division, and subject matter experts from across NCEH. The process began in January 2021 and is ongoing to continue to refine an adaptive and iterative strategy. This strategy, while led by DEHSP, aligns with NCEH and CDC's overall climate and health priorities and goals.

Discussion: Implementation of this strategy will ensure coordination of CDC climate and health activities to create healthy climate resilient communities, while building local capacity to implement adaptations to protect health. Expanding collaborations and partnerships to support each strategy will be critical for success. The three-pronged strategy serves to increase our understanding of the impacts of climate change and the effectiveness of adaptation strategies, foster locally led response actions, and ensure accurate data to inform, track, and evaluate these actions. Government entities at all levels (from local to federal) can consider adopting similar strategies to ensure a coordinated and integrated effort. The intended outcome is healthier communities that are prepared for the impacts of climate change.

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1. Introduction

1.1. Climate change and human health

We are currently living in the warmest period in the history of modern civilization. Climate change has caused temperature extremes, sea level rise, and severe weather events, resulting in major societal impacts [1]. There is extensive evidence that human activities are the dominant cause of observed warming since the mid-20th century [2]. The global effects of climate change are expected to intensify [3,4].

Climate change is already impacting human health through air pollution, allergens and pollen, diseases carried by vectors, food- and water-borne disease, precipitation extremes, temperature extremes, and wildfires, and these health impacts are expected to increase [5–9]. While anyone can be affected by climate change, some people and communities are disproportionately affected. This includes communities of color, indigenous people, older adults, people with disabilities and chronic illnesses, those who are socially and economically disadvantaged, pregnant persons, and children [10]. These disproportionate effects are the result of climate-related hazards intersecting with systemic policies, practices, and conditions that have placed some people and communities at greater disadvantage. Climate adaptation activities must address these disproportionate impacts.

1.2. Background and prioritization

The Biden administration recognizes climate change as an existential threat to humankind and an emergency that must be addressed quickly and effectively [11]. Many climate change initiatives focus on the mitigation of greenhouse gases. Human health considerations are often left out of these initiatives or are secondary. The health impact of heat waves and increasing incidence of tick-borne disease are just two examples that demonstrate the urgency of directly addressing health [12,13]. Coordinating across the Centers for Disease Control and Prevention (CDC) to bring a public health approach to broader climate change initiatives can unite a diverse group of stakeholders, potentially “uniting all actors behind a common cause,” as the concept of health is more personal and tangible than concepts such as tons of atmospheric carbon dioxide [14].

CDC proposes adopting a comprehensive public health approach to address climate change with three core components – **data, science, and action**. Environmental justice and health equity will be the cornerstones for all activities, ensuring the voices of those most impacted by climate change are the foundation of adaptation activities. The approach will help to protect health, prevent deaths, reduce healthcare costs, and empower communities that are disproportionately affected. It is designed to be widely adoptable, including by health departments and the healthcare sector.

1.3. Planning and preparing for the health impacts of climate change

Despite the urgent threat of climate change, many communities are not adequately prepared. Most health departments in the United States lack consistent funding and relevant subject matter expertise – in one study only 5.1% of health departments said they “strongly agree” that they had “expertise to assess the potential public health impacts associated with climate change” [15]. Similarly, a survey by the National Association of County and City Health Officials found that 76% of county health directors believed their health department lacked the expertise to assess potential climate impacts, 80% lacked the expertise to create effective plans to protect residents, and 87% indicated they did not have sufficient resources to effectively protect residents from the health impacts of climate change [16]. A 2020 Trust for America’s Health (TFAH) report assessed all 50 states and

found that states with the highest levels of climate vulnerability—predominantly located in the Southeast—were among the least prepared [17]. Most states have not moved beyond initial identification of potential climate threats and have not examined them in depth or planned for specific impacts. Unless urgent action is taken, the health impacts of climate change will bring further disruption and threaten lives and livelihoods [14].

CDC has existing strategies that prepare communities. TFAH’s report found that states that received funding from CDC’s Climate-Ready States and Cities Initiative were furthest along assessing specific vulnerabilities and preparing to adapt, scoring highest in the assessment. All but one of the 16 CDC-funded states earned a perfect score [17]. Growth and expansion of these strategies, and development of new innovative strategies, can ensure more communities are prepared for climate change.

1.4. Current climate and health portfolio in the National Center for Environmental Health

CDC’s Climate and Health Program was established in 2009. The program is the national leader in empowering communities to protect human health from a changing climate through epidemiologic studies to build the scientific evidence base, provision of technical assistance and cooperative agreements, and implementation of a communication strategy. CDC directly funds health departments to implement the Building Resilience Against Climate Effects (BRACE) framework and works with partners to provide funding to Tribes and Territories [18,19]. CDC is working with the American Public Health Association to develop guidance to support health departments embedding justice, equity, diversity and inclusion into their programs. This will help to ensure equity is a cornerstone in BRACE implementation.

1.5. Current policy and legislative landscape

One way of addressing climate-related health effects is through policy. Of the 130 climate-related bills introduced in the 117th Congress as of April 2021, only twenty have health-related provisions. Many of the bills focus on interagency cooperation and coordination by the establishment of interagency advisory councils. President Biden also signed an Executive Order on Tackling the Climate Crisis at Home and Abroad in January 2021, establishing a National Climate Task Force to facilitate a government-wide approach to “address the disproportionately high and adverse human health... impacts on disadvantaged communities, as well as the accompanying economic challenges of such impacts” [20].

2. Methods

CDC’s Division of Environmental Health Science and Practice (DEHSP) began developing a climate and health strategy in January 2021. The goal was to create a strategy to strengthen and develop climate-ready public health systems nationally – expanding to 3000 communities, 500 tribes, and 14 territories without continued dependency on funding from the CDC. Utilizing evaluation of previous CDC efforts, and with input from leadership and subject matter experts, the group identified specific focus areas, with environmental justice and health equity serving as the cornerstone for all activities. This strategy was designed to align with the Agency’s overall climate and health priorities and goals, and to be broadly applicable to other governments and jurisdictions.

3. Discussion

NCEH’s comprehensive public health approach to climate change focuses on **data, science, and action**, amplified by policy,

partnerships, communication, and evaluation to create maximum impact – with integration of environmental justice and equity in each area. For each focus area, a problem statement and proposed actions are outlined. The strategy will be reassessed and updated on a recurring basis. CDC's partners, and local, state, tribal, and territorial governments, can consider implementing similar strategies focusing on data, science, and action.

3.1. Data

3.1.1. Problem statement

Data relevant to climate and health are not collected at consistent geographic and temporal scales. There is no existing integrated system to track health outcomes and inform climate and health assessments and adaptations. Some data, such as airborne pollen, are not collected nationally or in a coordinated way. Health data is not always available at small geographic scales or for recent time periods (syndromic surveillance) and access may be restricted. Temperature and precipitation data are often on a grid scale (e.g., a 5 km grid), while health data is often at county-level. CDC has begun to address this gap by transforming climatologic variables and pairing them with health data, but many gaps remain. There is also an indicator gap. Indicators help to track climate-related trends and inform resource allocation and policy decisions. While there has been some work on individual climate and health indicators, there is no national indicator system. Finally, there is a lack of behavioral health data. Understanding how climate change interacts with mental health will be important for improving health in disproportionately impacted communities and climate refugees.

3.1.2. Proposed actions

Establish a national climate and health surveillance strategy and develop a suite of climate and health indicators to improve understanding of the human health impacts of climate change and of the people and communities disproportionately affected. This action would leverage and expand the National Environmental Public Health Tracking Program (Tracking Program) that houses CDC's only comprehensive environmental health surveillance system, the Environmental Public Health Tracking Network (Tracking Network). The Tracking Network is a web-based system that collects and shares data. Over 500 data measures currently delivered via the Tracking Network are validated, standardized, visualized, and shareable, although only a fraction of these measures are climate-related. The Data Explorer tool supports maps, charts, and tables, giving users the ability to identify demographic factors, environmental burdens, and socioeconomic conditions directly related to climate change and environmental justice.

CDC's Tracking Network includes a number of climate-relevant datasets across eight categories, including historic and projected temperatures, heat-related hospitalizations, wildfire smoke, and drought [21]. Expansion would position health departments to prepare for and respond to climate change and aid researchers studying health impacts. Adding equity data and indicators, including the social vulnerability index (SVI), and pairing these data directly with climate data, would allow our partners to identify disproportionate impacts on racial and ethnic groups, linguistic minority groups, and under-resourced communities. Effective elements of this strategy could be scaled across CDC and externally.

Expand syndromic surveillance for climate and health. Syndromic surveillance allows real-time identification of climate-related health impacts like heat-related morbidity, carbon monoxide deaths after a severe storm, and water-borne illnesses following flooding events. It can identify the populations that are most impacted, to inform tailored interventions. CDC's existing syndromic surveillance efforts are spread across multiple systems and climate-relevant health data

(such as heat-related deaths) are not available in a timely manner. Expanding national capacity for syndromic surveillance would allow for rapid action and communication to save lives. This could be integrated into existing CDC surveillance efforts, creating a coordinated system for detecting, tracking, and responding to the health impacts of climate change. While national syndromic surveillance is needed, initial efforts can focus on the most disproportionately impacted communities.

3.2. Science

3.2.1. Problem statement

The health impact of climate change is an emerging field. How current health impacts will change, emergence of novel health impacts, and populations most impacted are still being explored. A lack of national-level data in many topic areas, for example on airborne aeroallergens, hinders the ability to set a baseline and track changes. Effectiveness of adaptations and interventions is not fully known, particularly how interventions can be tailored for disproportionately impacted communities, and potential health impacts of mitigation activities. There have been several efforts to summarize available information [5,22], but gaps remain in knowledge, data, surveillance, and assessment. The scope of potential interventions is vast; a system of categorizing and evaluating them is needed.

3.2.2. Proposed actions

Expand the science base to characterize the health impacts of climate change and the effectiveness of interventions and adaptations to protect health. We propose development of a CDC-wide climate and health research agenda that integrates the mission of each center into one collaborative and coherent strategy, prioritizes and guides CDC's climate research efforts, and informs interagency collaboration. The agenda would leverage cross-sector funding opportunities, incorporating health considerations into climate change research. Development of this strategy builds upon previous efforts [22,23], including NCEH's current research priorities, drawing in expertise on topics such as vector-borne disease, injury, and global health.

Increase knowledge on effectiveness of adaptations and interventions. Literature reviews, new research, direct involvement of affected community members, and evaluation would serve to characterize the effectiveness of adaptation strategies and inform public health action on the ground with a focus on disproportionately impacted populations. This is in alignment with step three of CDC's Building Resilience Against Climate Effects (BRACE) framework. Research to guide tailoring adaptations to local climate hazards (e.g. wildfires or drought) can directly connect the proposed science and action strategies.

Investigate health impacts of greenhouse gas mitigation strategies. Strategies to reduce greenhouse gas emissions ("mitigation") could have intentional or unintentional health impacts. For example, planting trees as a "carbon sink" could have a positive health impact by providing shade to reduce temperatures, thus reducing heat-related illness, but could increase airborne pollen that can trigger respiratory health impacts. This action would implement a cross-sector approach to climate change mitigation, expanding research on the co-benefits and mal-adaptations of mitigation efforts. This action could reduce pollution exposure in fence-line communities.

3.3. Action

3.3.1. Problem statement

Climate-related health impacts are inherently local and depend on sociodemographic factors and climate hazards specific to a geographic area. Actions informed by local data are needed to protect

health. However, many jurisdictions do not have the knowledge or capacity to design and implement adaptations. CDC's BRACE framework was initially designed to support state and local health departments and can be adapted to apply more broadly to protect health and build lasting capacity.

3.3.2. Proposed actions

Utilize the BRACE framework to support tailored interventions that are accessible to all communities. We propose new BRACE technical assistance for a broader array of jurisdictions. This includes under-resourced jurisdictions, smaller health departments, and tribal governments. BRACE is already designed as an adaptable framework that can be implemented in novel ways to enhance resilience in groups at higher risk from climate impacts. CDC can build upon previous utilizations of BRACE, for example the Swinomish "indigenization" of the BRACE framework [24] and NACCHO's guide [25], and develop funding opportunities for communities disproportionately affected by climate change. NCEH can promote adaptive management strategies [26] and include the BRACE framework within Notice of Funding Opportunities (NOFOs) across CDC.

Expand to a fully national program to reach states, localities, territories, and tribes. Currently, health departments have limited capacity to address the health impacts of climate change. CDC's Climate and Health Program directly funds states and cities, but most Americans live in states that do not have funding. NCEH can use funding strategies to expand the Climate-Ready States and Cities Initiative and Climate-Ready Tribes and Territories Initiative. Promoting policies that support healthy lifestyles will be critical, for example supporting policies like development of energy efficient building stock, ease of low-cost active transportation, and increased access to green spaces.

Build environmental health workforce capacity and expertise on climate change. Climate change adaptation presents new challenges to the environmental public health workforce. NCEH will build workforce capacity and expertise through training, provision of technical assistance, capacity building in disproportionately impacted communities, and, potentially, implementation of new fellowship programs focusing on diversity and inclusion. This will help to build resilient communities without continued dependency on funding from the CDC. An online toolkit can provide training and resources to health professionals and students. NCEH can work to boost climate and health knowledge in epidemiologists and enhance expertise within the Climate and Health Program.

3.4. Leveraging partnerships

NCEH has coordinated with dozens of partners across multiple sectors on climate and health [27]. The proposed data, science, and action strategies will require continuation and expansion of these partnerships. CDC worked directly with the National Oceanic and Atmospheric Administration to transform the geographic scale of climatological and meteorological data to be more useful to health departments, for example on the Heat and Health Tracker [28]. Other federal climate data collaborators may include FEMA and EPA. Expanded partnerships, including with non-Federal partners, and leveraging of citizen science, could increase the utility of CDC's surveillance networks. NCEH can partner with academic institutions, non-profits, and governmental agencies to enhance the climate and health science base. An investment in research efforts would advance the state of the science. Investigation of the health impacts of greenhouse gas mitigation strategies is a new topic area for NCEH that would necessitate collaboration with external experts. NCEH can explore funding opportunities with major philanthropy organizations or private partners. All action strategy activities will involve continued

direct collaboration with state, local, tribal, and territorial health staff and community organizations representing the underserved.

3.5. Summary

As the national leader in climate and health adaptation, CDC's NCEH has worked for over a decade to prepare communities for climate change. We propose a new, expanded climate and health strategy based on data, science, and action. This strategy is one layer of a comprehensive federal approach. Other Centers, Institutes, and Offices across CDC have climate-relevant activities, and coordination will help to maximize impact. As climate change affects the mission of all parts of CDC, an agency-wide plan will be needed to help foster coordination and collaboration on relevant activities, particularly on topics such as vector-borne disease, disaster response, flood injuries, and mental health. NCEH's strategy will also be incorporated into planning activities of the US Global Change Research Program. More broadly, governments at all levels, from local to international, can consider implementing aspects of this strategy to ensure a coordinated and collaborative effort to protect health from climate hazards. This strategy can be adapted to fit local needs, for example those of a Tribe or a city. Ongoing monitoring and evaluation will ensure this is an adaptive strategy that is continually improved.

Climate change not only affects every aspect of public health, it also involves cross-sectoral action. For example, the transportation and energy sectors will be impacted by climate change, with associated health impacts. A multi-layered cross-government approach that integrates into larger climate change adaptation and mitigation plans nationally would ensure effective collaboration. Leveraging partnerships will help to accomplish this.

By implementing and evaluating this strategy, coordinating with other parts of CDC and external partners, and expanding our work in data, science, and action, CDC's NCEH can save lives and enable communities to prepare for the health effects of climate change.

Declaration of Competing Interest

The authors have no actual or potential competing financial interests. The authors would like to acknowledge Claudia Brown for her assistance.

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