

Climate Change and Global Child Health

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Climate change threatens to reverse the gains in global child health and the reductions in global child mortality made over the past 25 years. There is broad recognition that greenhouse gases emitted by human activities are causing climate change.^{1,2} The problem of climate change transcends geopolitical boundaries and will have extensive impacts on child health and security (Fig 1).³ With implications for all of humanity, climate change will disproportionately affect children and the poor, magnifying existing disparities in social determinates of health.^{4,5}

GLOBAL TEMPERATURE CHANGES AND PROJECTIONS

Changes in temperature and weather patterns are already occurring. Global surface temperatures were the highest ever recorded in 2016, and 9 of the past 10 years were the warmest on record.⁶ Dramatic changes to the climate are expected to occur within the life span of current pediatric patients. The 2013 Intergovernmental Panel on Climate Change assessed that global temperatures will likely rise 2°C and may increase 4.8°C by 2100 if current trends in emissions continue (Fig 2).^{2,7} In the same scenario, the average global sea level rise will accelerate, and seas will likely rise 45 to 82 cm by 2100, relative to 1986–2005

levels.² Economic damage in the United States is predicted to be 1.2% of gross domestic product for every 1°C increase in temperature.⁸ Natural disasters will increase in frequency and intensity.² These climate-related threats are widely considered the most significant global health challenge of our lifetime.⁹

CLIMATE CHANGE AND CHILD HEALTH

Globally, children are estimated to bear 88% of the burden of disease due to climate change, with the poorest disproportionately affected.^{10,11} All children depend on the resources of caregivers and communities to buffer against environmental threats, including climate-related health threats. Children in communities with limited resources to adapt to climate change face an even higher risk of adverse environmental exposure. When exposure results in illness, disability, or death, the loss of potential healthy life is greater for the youngest, resulting in a greater burden of disease measured by disability-adjusted-life-years for children.¹⁰ Using projections of the distribution of mortality from climate-related health threats, researchers anticipate a disproportionate impact on the world's poorest citizens (Fig 3).¹¹

The evident geographic disparity in climate vulnerability likely

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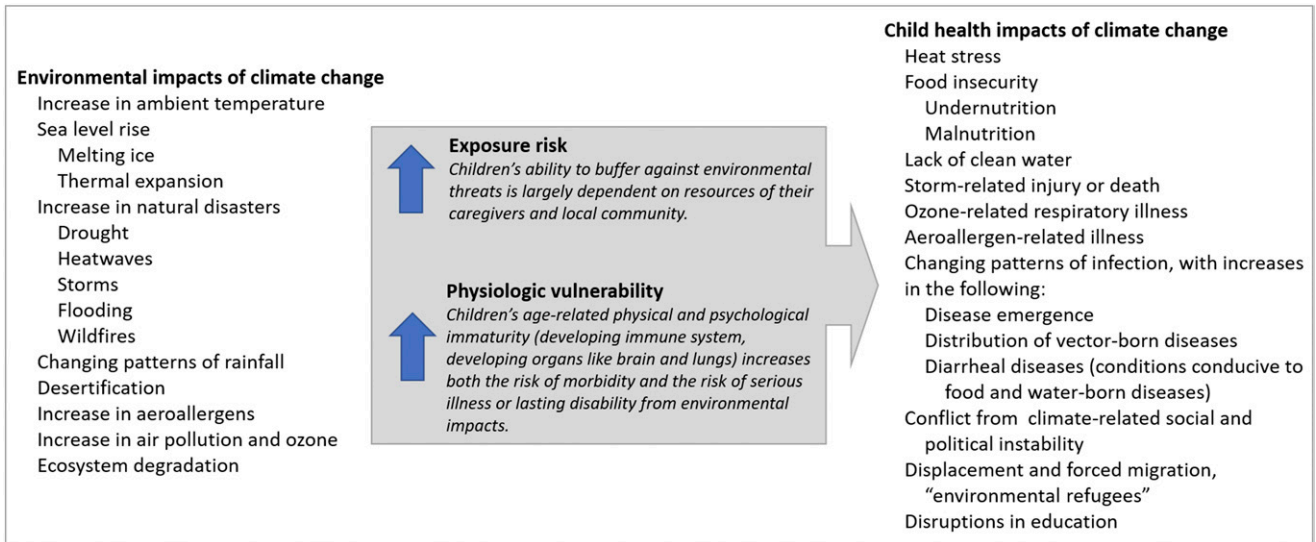


FIGURE 1
 Climate-related environmental health threats to children.

overlays a similar age-based disparity: deaths in young children account for a disproportionate share of total deaths due to climate-sensitive health threats. In 2015, deaths in children <5 years old accounted for 38%, 65%, and 48% of global deaths due to diarrhea, malaria, and nutritional deficiencies, respectively.¹² The projected increase in these diseases due to climate change corresponds to a considerable burden of preventable child deaths, particularly in low-income countries.

The attributable risk from specific exposures (like extreme heat and ozone) stems not only from the degree of increase but also from the ubiquity of the exposure.¹³ Researchers estimate that 74% of the world's population (up from 30% today) will be exposed to at least 20 days of lethal heat per year by 2100 if current emission trends continue.¹⁴ Children are particularly vulnerable to extreme heat: they have a high surface area to mass ratio and must divert more cardiac output to their skin to dissipate heat.¹⁵ Although variability exists in the literature on heat stress in children, Basagaña et al¹⁶ found that

infant mortality increased 25% on extremely hot days, with the first 7 days of life representing a period of critical vulnerability. High ambient temperature coupled with emissions have well-documented negative effects on pulmonary health in children.^{13,17} Air pollution decreases total lung volume and has negative impacts on lung function that may be lifelong.^{18,19} Increases in ambient temperature and ozone levels directly correlate with pediatric emergency department visits for asthma exacerbation.^{20,21} The research on climate and respiratory illness exemplifies the many-faceted implications of climate change on child health. Even in this well-studied realm, there is a dearth of data on children in resource-limited settings, and those children are the least able to modify their exposure risk.

These children are also most vulnerable to scarcity of basic natural resources (potable water and food) aggravated by droughts and flooding. Almost 160 million children live in high or extremely high drought zones and over 500 million inhabit areas with extremely high flood

occurrence.²² Increased amplitudes of drought and flood events are projected to stress agricultural systems, exacerbate food and water insecurity, and increase childhood undernutrition.^{23,24} The World Health Organization projects that there will be 77 000 to 131 000 additional deaths in children under 5 from climate-related undernutrition in 2030.²⁵ Contributing to 45% of total deaths in children <5 years old, undernutrition compromises the immune system and blunts long-term developmental potential.^{26,27} Scarcity of rainfall has been linked to environmental conflict.^{28,29} Conflict and migration, in turn, further stress the environment, agricultural system, and local populations in a vicious cycle that erodes basic social determinants of health.

Natural disasters also lead to displacement of families and children. Extreme weather events are increasing in frequency and intensity, undermining the stability of home and community for growing numbers of children, with risks to their security and physical and mental health.^{3,30} The Internal Displacement

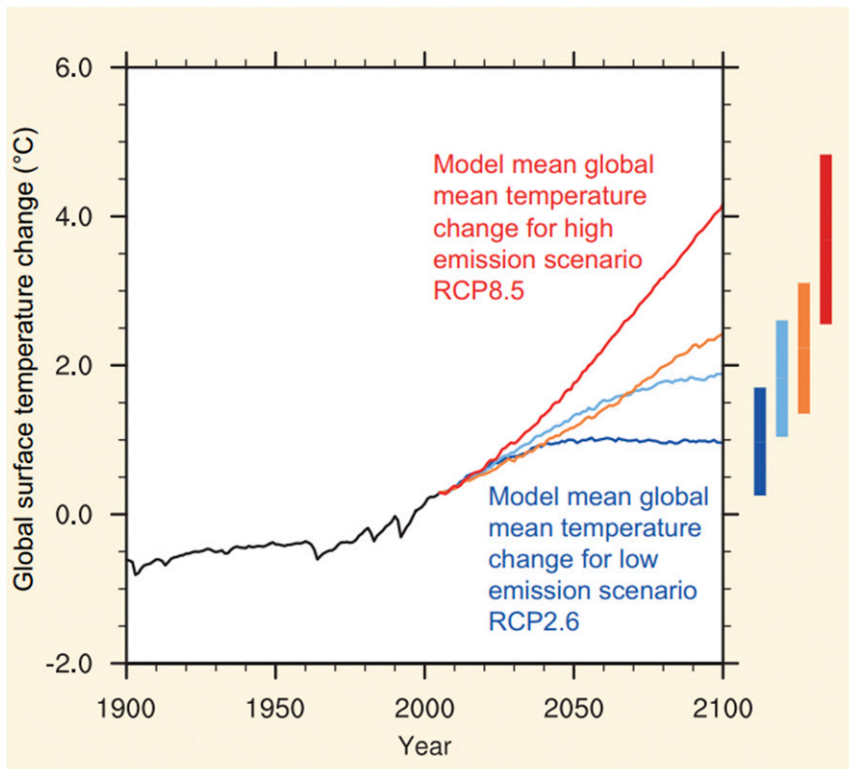


FIGURE 2

The Intergovernmental Panel on Climate Change projected range of temperature increases by 2100 under high-emission and low-emission scenarios. The graph shows predicted temperature increases by 2100 for various carbon scenarios (RCPs). The high-emission scenario (RCP8.5) represents no actions taken to curb carbon dioxide emissions, and the low-emission scenario (RCP2.6) represents a significant reduction in greenhouse gases worldwide. RCP2.6, representative concentration pathway 2.6; RCP8.5, representative concentration pathway 8.5. (Adapted with permission from FAQ 12.1, Figure 1, from Collins M, Knutti R, Arblaster J, Dufresne J-L, Fichefet T, Friedlingstein P, Gao X, Gutowski WJ, Johns T, Krinner G, Shongwe M, Tebaldi C, Weaver AJ and Wehner M. Long-term Climate Change: Projections, Commitments and Irreversibility. In: *Climate Change 2013: The Physical Science Basis. Contribution of Working Group I to the Fifth Assessment Report of the Intergovernmental Panel on Climate Change* [Stocker TF, Qin D, Plattner G-K, Tignor M, Allen SK, Boschung J, Nauels A, Xia Y, Bex V and Midgley PM (eds.)]. Cambridge, UK and New York, NY: Cambridge University Press; 2013:52.)

Monitoring Center estimates that more than 26 million people per year have left their homes because of natural disasters since 2008, a likelihood of displacement twice that of 1970.³¹ Over half of internationally displaced refugees were children.³² Displaced children face substantial health risks, including malnutrition, infection, traumatic stress, and physical or sexual abuse.³³ Disasters also disrupt the medical supply chain, compromising vaccination programs and the availability of medications. In 2017, Hurricane Maria disrupted the production of drugs and intravenous fluid manufactured in Puerto Rico, resulting in global shortages.³⁴ The

results of natural disasters are felt globally.

The potential for the rapid spread of infectious diseases in a world connected by global travel and commerce further illustrates the compass of climate change. Among its ecological impacts are anticipated increases in many infectious illnesses, alterations in vector-borne diseases, and more rapid disease emergence.³⁵ Increased temperatures are associated with an increased incidence of bacterial causes of diarrhea.³⁶ The World Health Organization estimates an

additional 48 000 deaths per year from diarrheal diseases in children <15 years old by 2030.³⁷ The re-emergence of Chikungunya (with its expansion into the western hemisphere) has been linked to changing climates in Southeast Asia.³⁸ Likewise, warmer climates are thought to have contributed to the Zika virus pandemic, with studies detailing the effect of warmer temperatures on the range, life cycle, and feeding patterns of *Aedes aegypti* mosquitoes.³⁵

OPPORTUNITIES FOR PEDIATRICIANS

These are select examples of research (and knowledge gaps) on the health impacts of climate change in children. Pediatricians are positioned to reframe this urgent debate from one of political interests to one of monumental global health importance. We must advocate for child-specific research on climate change and health as well as incorporation of child-specific needs in disaster preparedness plans and climate adaptation policies.³⁹ We must be prepared to respond to surges of child injury and illness in the aftermath of a disaster when health infrastructure itself is likely to be compromised. We can lead in adopting climate-friendly practices in our own personal and professional realms, taking stock of our energy, transportation, and food sources and choices.⁴⁰ Collective acts to prepare for and (most urgently) to limit the magnitude of climate change will help protect children around the globe from preventable illness and death. In the interim, our collective inaction may be to the detriment of those we dedicate our careers to protecting.

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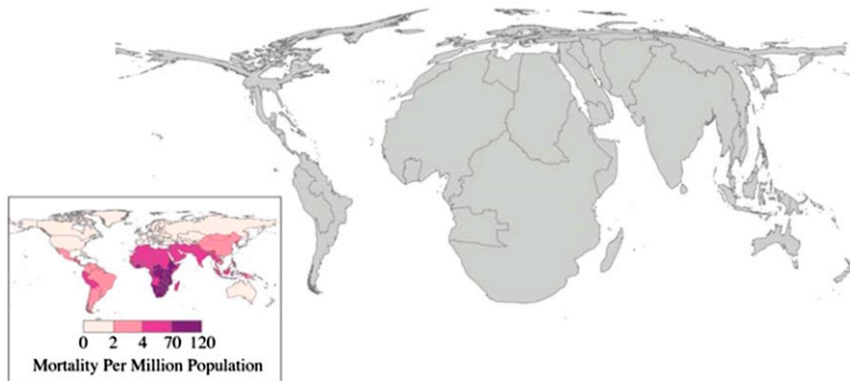


FIGURE 3

The estimated distribution of climate-related increase in mortality from diarrhea, malaria, inland and coastal flooding, and malnutrition from 2000 to 2030. The relative size of each region represents the increase in diarrhea, malaria, malnutrition, and inland flooding fatalities attributable to climate change that region will experience from 2000 to 2030. The map underscores the vulnerability of resource-limited settings to climate-sensitive health threats. (Reprinted with permission from Patz JA, Gibbs HK, Foley JA, Rogers JV, Smith KR. Climate change and global health: quantifying a growing ethical crisis. *EcoHealth*. 2007;4(4):400.)

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