

► SPECIAL REPORT

From Exposure to Action: Climate Change, Children's Health, and the Role of Environmental Health Professionals

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Abstract Climate change represents a major emerging threat to children's health and well-being, with negative effects extending far beyond environmental concerns to encompass physical, mental, and developmental consequences that can persist throughout a child's lifetime. In comparison with adults, children are uniquely vulnerable due to physiological, physical, and behavioral differences. Their developing bodies, higher metabolic rates, and faster breathing rates increase susceptibility to environmental hazards, while critical windows of brain and organ development make them particularly vulnerable to long-term effects of climate exposures.

These vulnerabilities compound with intensifying climate impacts to create substantial projected health effects, including heat-related illnesses, respiratory complications from wildfire smoke and extended pollen seasons, water-related diseases, expanded vectorborne disease transmission, and mental health consequences. The convergence of children's unique vulnerabilities with climate change presents a public health issue that urges immediate, coordinated action across healthcare, public health, education, and policy sectors. The purpose of this special report is to inform environmental public health professionals about climate change impacts on children's health and provide strategies for adaptation.

Keywords: climate change, children's health, environmental health, climate adaptation, health-related illness, health equity

Introduction

The devastating headlines tell a story that should alarm every parent, educator, and public health professional: "27 Dead in Texas Flash Flood at Children's Camp," "Hurricane Helene Overwhelms Childcare Centers in North Carolina," "Child Dies From Brain-Eating Amoeba After Swimming in South Carolina Lake." These headlines do not represent isolated tragedies but are symptoms of a rapidly changing climate that

is fundamentally altering the health risks children face every day.

Climate change is a defining health challenge of the 21st century, and children bear a disproportionate burden of its negative impacts (Hayden et al., 2023). Climate change affects children's health via direct effects from extreme weather, indirect effects from disrupted systems, and psychological consequences of climate awareness (van Nieuwenhuizen et al., 2021). These negative impacts occur during

critical developmental windows when children are most vulnerable to environmental influences, which can create lifelong health consequences (Sheffield & Landrigan, 2011).

Summer 2025 demonstrated climate change's deadly reach into children's lives. In July, flash flooding along the Guadalupe River in Texas rose more than 25 ft in under one hour, killing 27 campers and counselors at Camp Mystic. Just months earlier, Hurricane Helene brought unprecedented flooding to Western North Carolina, where stormwater runoff alone affected thousands of children and families when the runoff overwhelmed private wells and childcare centers. These events represent more than weather disasters—they exemplify how climate change is creating new and intensified threats that specifically endanger children's health and survival.

Children's Unique Vulnerabilities

Children are more vulnerable to climate change than adults for three key reasons: 1) physiological differences, 2) behavioral patterns, and 3) developmental factors. Physiologically and developmentally, the structure and functionality of children's bodies increase

their risk. Children have higher surface area-to-body weight ratios, making them more vulnerable to temperature extremes. They also breathe faster than adults, inhaling more air pollutants per unit of body weight (Hayden et al., 2023). Additionally, children consume 2.5 times more water and 3–4 times more food per unit of body weight compared with adults, which increases children's exposure to contaminants (Sheffield & Landrigan, 2011). Their immature metabolic and immune systems are also less effective at eliminating contaminants from the body and fighting infectious diseases (Sampson et al., 2024).

Behaviorally, children spend more time outdoors than adults, which increases interactions with climate-related hazards (Hayden et al., 2023). Moreover, children play in parks, swim, and participate in sports outdoors, which increases their exposure to extreme heat, poor air quality, contaminated water, and vectorborne diseases.

Scope of the Problem

Children born today will live through decades of continued climate change, facing cumulative health risks that previous generations have not experienced. Without immediate intervention, this generation could experience worse health outcomes than their parents, reversing decades of progress in child health and development (Sheffield & Landrigan, 2011). Every delay in action means more children will experience preventable illness, developmental delays, and psychological distress. The negative impacts are unbalanced: children in low-income communities, communities of color, and developing nations face the highest risks due to increased environmental risk from concentrated pollution sources and climate exposure in already disadvantaged communities (Gamble et al., 2016).

Key Climate-Related Health Impacts

Climate change creates multiple pathways by which environmental hazards affect children. Understanding these exposure pathways is crucial for developing effective interventions (Sheffield & Landrigan, 2011). Children encounter climate-related health threats through the air they breathe, the water they drink and play in, the food they consume, direct contact with extreme weather, and vectors that carry disease (Hayden et al., 2023).

These pathways often interact and amplify each other. For example, extreme heat can worsen air quality while also increasing children's time spent in potentially contaminated water as they seek relief from the heat (Gamble et al., 2016). The following sections examine how these exposure pathways translate into specific negative health impacts.

Heat-Related Illnesses

Extreme heat impacts children's health in various ways, ranging from mild to severe complications. Symptoms range from headaches and muscle cramps to vomiting and dehydration, which can progress to confusion, unconsciousness, or death in severe cases (Kerr et al., 2013). Research has documented that extreme heat exposure increases rates of emergency department visits, asthma exacerbations, heat illness, and impaired school performance among children (Bernstein et al., 2022). These impacts extend beyond direct heat illness to include secondary effects such as reduced cognitive function and academic performance during periods of hot weather (Kerr et al., 2013).

Researchers have studied increased risks associated with outdoor activities. One study conducted in 2024 evaluated 165 children ages 10–17 years who were working on farms in North Carolina and found that the most commonly reported symptoms were dizziness, headaches, and feeling like they were going to pass out (Schapiro et al., 2024). In addition to young workers, youth athletes are also at increased risk of these symptoms (Kerr et al., 2013).

Exertional heat illness affects an estimated 9,000 youth athletes per year, with rates peaking in August during practices lasting >2 hr (Kerr et al., 2013). Football players experience exertional heat illness at a rate >11 times that of other sports combined (Kerr et al., 2013). While having a medical professional on-site can help, it is imperative that athletes, parents, coaches, and school staff are trained to recognize symptoms of exertional heat illness.

Clinical data reveal increases in pediatric heat-related emergency department visits as temperatures rise. One national study found that temperatures above the minimum morbidity temperature—the temperature associated with the fewest heat-related visits—accounted for nearly 12% of all warm-season visits and 31% of heat-related illness visits,

demonstrating the substantial healthcare burden associated with elevated temperatures (Bernstein et al., 2022). As climate change continues to drive more frequent and intense heat events and without effective measures to adapt to a warming world, children will experience worsening health impacts, including a potential increase in heat-related emergency department visits.

Respiratory Health

Climate change poses significant and escalating threats to children's respiratory health via multiple pathways. Ground-level ozone traps particulate matter (PM), which is associated with increases in asthma and other respiratory conditions in children, while rising temperatures extend pollen seasons and increase allergen exposure (Ebi et al., 2018). Extreme weather events, such as dust storms and wildfires, can also negatively impact respiratory health.

Wildfires are increasing in number and severity as a part of the evolving climate crisis, creating dangerous air quality conditions that especially affect children with preexisting respiratory conditions (Moore et al., 2023). Wildfire smoke is an increasing health threat to which children are particularly vulnerable, as their developing respiratory systems and higher breathing rates make them more susceptible to airborne pollutants (Holm et al., 2021). Exposure to poor air quality can have long-term effects on developing lungs through oxidative stress, local and systemic inflammation, airway epithelium compromise, and increased vulnerability to infection (Wilgus & Merchant, 2024).

Water-Related Health Illnesses

Children are vulnerable to water-related health impacts due to their physiology and behavior. Their developing bodies and immature immune systems make them more sensitive to environmental hazards, while activities such as playing outdoors and swimming increase their exposure to potentially contaminated water. Waterborne diseases and recreational water illnesses are among the most immediate threats.

The increasing frequency and intensity of heavy rainfall events can lead to combined sewer overflows and stormwater runoff, contaminating recreational and drinking water sources. Children often encounter contami-

nated water while swimming or playing, which increases their risk of exposure to pathogens. Additionally, the maturing immune system in children makes it harder for them to fight off infections, with younger children particularly prone to dehydration and complications from diarrhea (Gamble et al., 2016).

Climate change is creating favorable conditions for three water-related pathogens that pose serious risks to children. Legionnaires' disease incidence has quadrupled in the U.S. over the past 20 years, with warming temperatures and precipitation surplus likely responsible for the elevated density of *Legionella* bacteria in the environment (Guzman-Herrador et al., 2015). Climate change could lead to temporary or longer-term increases in the incidence of legionellosis due to a combination of warm and wet weather (Dupke et al., 2023). Children are especially vulnerable because *Legionella* bacteria can colonize in building water systems, such as schools and childcare facilities, and children's developing respiratory systems are more susceptible to severe pneumonia.

Vibrio bacteria, which thrive in warming coastal waters, represent another emerging threat. Non-cholera *Vibrio* occur naturally in seawater, but they can proliferate in shallow waters that have higher temperatures (Dupke et al., 2023). In the Eastern U.S., *Vibrio vulnificus* wound infections increased 8-fold between 1988 and 2018 (Archer et al., 2023). Children playing in coastal waters, particularly children with cuts or compromised immune systems, face increased risk of severe skin and soft tissue infections that can progress rapidly to life-threatening conditions, with wound infection mortality rates reported as high as 18% (Archer et al., 2023).

Perhaps most alarming is *Naegleria fowleri*, the "brain-eating amoeba" (Centers for Disease Control and Prevention, 2025). As air temperatures increase, warmer water temperatures in lakes, ponds, and other freshwater sources result. These conditions provide a more favorable environment for *N. fowleri* to grow (Siddiqui & Khan, 2014). Climate change likely is facilitating *N. fowleri*'s spread into areas that would have otherwise been unfavorable to the amoeba. Scientists are concerned that climate change could cause *N. fowleri* and other pathogenic amoebae to expand their range (Maciver et al., 2020).

In addition to these three threats, harmful algal blooms (HABs) caused by warming

water temperatures and nutrient pollution produce neurotoxins that pose serious risks to developing brains and nervous systems. Children playing in or near contaminated water could accidentally ingest or inhale aerosolized toxins, which can lead to rashes, respiratory symptoms, gastrointestinal distress, and potentially more severe neurological effects during key developmental windows (Gamble et al., 2016).

Contamination of drinking water also is a pressing concern as extreme weather strains aging infrastructure. Flooding and system failures can introduce lead, nitrates, and microbial contaminants into drinking water. Children absorb lead more easily than adults do and are particularly vulnerable to lead's negative effects on cognitive development, behavior, and long-term health (Bellinger, 2008). Similarly, high nitrate levels in water can interfere with oxygen delivery in infants, while microbial contamination can cause severe illness (Richard et al., 2014).

Flooding risks bring a cascade of health and social challenges. Displacement, injuries, and disruption of healthcare and education services affect children more severely than adults. Recent examples include Hurricane Helene's unprecedented flooding in Western North Carolina in 2024, where storm runoff overwhelmed private wells and childcare centers, and the 2025 flash flooding along the Guadalupe River in Texas that killed 27 young campers and camp counselors. Trauma related to extreme weather events can have lasting mental health consequences, especially when compounded by a lack of access to care. Projections suggest that with a 4 °C rise in global temperatures, up to 1 million children could be at risk from coastal flooding, with another 560,000 children facing threats from inland flooding (UNICEF, 2021).

Vectorborne Diseases

Vectorborne diseases can affect children at higher rates because children play outside more, which potentially increases exposure to family pets that can harbor vectors such as ticks. Climate change is reshaping the ecology of vectorborne diseases, shifting where and when disease-carrying ticks and mosquitoes thrive.

Warmer temperatures and disrupted ecosystems are increasing the range and length of active seasons for ticks and mosquitoes

(Gamble et al., 2016). Children, especially those ages 5–9 years, are disproportionately affected by Lyme disease, partly because they are more likely to engage in outdoor activities in wooded or grassy areas without consistently wearing protective clothing, using repellents, or performing tick checks. Their smaller body size means a tick bite can transmit a higher relative dose of pathogens, and delays in diagnosis are common, as symptoms mimic other illnesses (Gamble et al., 2016).

Similarly, the risk of West Nile virus is rising due to more frequent heat waves and standing water from intense storms, creating ideal breeding and harboring conditions. While most cases are mild, children—especially children with chronic conditions or compromised immune systems—face a higher risk of complications such as encephalitis (Sheffield & Landrigan, 2011). Early-life infections affecting the brain or central nervous system can have long-term implications for learning, behavior, and mental health.

Prevention effectiveness depends on comprehensive community-level strategies, including mosquito control, public education, and environmental planning that considers where and how children play. As climate change pushes vectorborne diseases into new regions, these protective systems often lag, leaving children vulnerable.

Mental Health Effects

Climate change is emerging as a major threat to children's mental health via both direct and indirect pathways. Climate change affects child and adolescent mental health in intersecting ways, including as a social and ecological determinant of health, a threat amplifier, and a source of trauma and distress (van Nieuwenhuizen et al., 2021). Direct exposure to extreme weather events is linked to long-term psychological effects, with studies finding increased risk of poor mental health and anxiety among adults who experienced climate-related events before age 5 years (Proulx et al., 2024). These early traumatic experiences can have lasting effects into adulthood, highlighting childhood as a particularly vulnerable time.

Beyond direct exposure to climate disasters, children are experiencing significant psychological distress simply from an awareness of climate change itself. This phenomenon, often termed "eco-anxiety" or "climate anxiety," rep-

resents a new category of mental health concern that does not require direct experience of climate events. A study by Martin et al. (2022) showed that children experience negative emotional responses stemming from an overarching awareness of the imminent threats to the planet due to climate change. Children's emotional responses to climate change awareness include worry, guilt, and hopelessness, which can significantly affect daily functioning and overall well-being.

The scope of climate anxiety among young people appears to be substantial and global in nature. Young people globally report high levels of climate anxiety as well as frustration with governmental climate action, which affects their everyday lives (Hickman et al., 2021). Research indicates that young people might bear a greater share of the mental health consequences associated with climate change, underscoring their particular susceptibility to climate-related psychological effects (Ma et al., 2022). When young people perceive that governments are not adequately addressing climate change, their levels of distress tend to increase (Hickman et al., 2021), which suggests that children's climate-related mental health concerns are not only about environmental threats but also about feelings of powerlessness and abandonment by adult institutions.

Overlapping Vulnerabilities

Climate change can disproportionately affect children's health when compounded with existing inequities. Children from low-income families and communities of color face heightened risks from respiratory illnesses, heat exposure, and contaminated water sources due to historical segregation patterns that concentrated disadvantaged populations in areas with poor air quality, inadequate infrastructure, and limited green spaces. These communities often lack the financial resources to combat exposure to environmental hazards (e.g., lack of air conditioning during extreme heat events, inability to relocate away from pollution sources), while simultaneously experiencing higher baseline rates of asthma and other chronic conditions that climate-related environmental hazards can exacerbate.

Geographic factors further intensify these disparities, because rural and urban underserved areas frequently have limited health-care infrastructure, fewer pediatric special-

ists, and reduced access to mental health services needed to address climate-related trauma and anxiety (Proulx et al., 2024). Children in these communities might also face nutritional challenges when extreme weather events disrupt food supply chains or damage local agricultural systems, while inadequate community resources (e.g., cooling centers, emergency shelters, after-school programs) leave families without critical support systems during climate-related emergencies. The cumulative effect creates a cycle where the most vulnerable children bear the greatest burden of climate impacts while having the least access to protective resources and healthcare interventions.

Call to Action

The mounting evidence of climate change's disproportionate impact on children's health demands immediate, coordinated action across multiple sectors. Children cannot protect themselves from these environmental threats—they depend on adults and institutions to create safe, healthy environments that support their development and well-being. Our call to action focuses on adaptation and mitigation strategies to address the need to protect children from the impacts of climate change. The time for action is now, before irreversible damage occurs to an entire generation's health and future.

Environmental Public Health Officials

As environmental public health professionals, we stand at a moment when our expertise becomes essential for protecting children's futures. Changes within our environment compel us to transform how we practice public health. We need to move beyond traditional approaches to embrace comprehensive, climate-informed strategies—such as children's environmental health competencies and performance indicators—which can continue to guide environmental public health professionals on how to address climate-related challenges (Del Rio et al., 2023, 2024).

Surveillance Infrastructure

We can begin by building the surveillance infrastructure our communities desperately need, which necessitates establishing tracking networks to monitor and initiate early warning systems that activate before extreme weather strikes. Surveillance systems should

track climate-sensitive health outcomes in children, including heat-related illness, respiratory conditions, vectorborne diseases, and mental health impacts. For example, a tracking network could monitor air and water quality with specific attention to effects on children's health and development.

Prevention and Preparedness Programs

Next, we need to implement comprehensive prevention and preparedness programs. Heat action plans should coordinate seamlessly with schools, childcare centers, and youth sports programs. Emergency preparedness planning requires comprehensive approaches (such as for evacuation procedures and mental health support) that address children's specific vulnerabilities during climate disasters. While also increasing communication in communities about prevention strategies, vector control programs should focus strategically on areas where children spend their time.

Our technical expertise means little without strong community connections. We can launch public awareness campaigns that translate complex science into actionable prevention strategies, but there needs to be a method in place to ensure families can implement the strategies. Building partnerships with schools, childcare facilities, and community organizations increases the local capacity needed for climate resilience. Educational materials developed in partnership with trusted community leaders who understand local values and priorities can reach diverse populations through culturally appropriate messaging.

Policy and Systems Change

We believe that the most powerful impact, however, comes through policy and systems change. Advocacy for building codes and urban planning policies that protect children from heat exposure and improve air quality is important for building sustainable infrastructure. Supporting policies that reduce emissions of greenhouse gases addresses climate change at its source. The decisions enacted by politicians today could determine children's health outcomes for decades, making it essential that we ensure that these investments prioritize pediatric health protection while integrating climate considerations into all public health planning.

Conclusion

The urgency of this call to action cannot be overstated. Climate change is not a distant threat—it is negatively affecting children's health today, and these impacts will intensify without immediate intervention. Every healthcare professional, environmental and public health official, and educator has a role to play in protecting children from climate-related health risks. The actions we take today will determine whether we safeguard children's health and give them the opportunity to thrive in a changing climate, or whether we allow preventable harm to compromise their development and future.

Every surveillance system we establish, every prevention program we launch, every community partnership we build, and every policy we champion directly shapes the health landscape that children will inherit. Our professional knowledge uniquely positions us to lead this transformation, particularly if we act with the urgency that this moment demands.

Success will require unprecedented coordination across sectors, sustained political will, and recognition that protecting children's health from climate change is both a moral imperative and a practical necessity for building resilient communities. The children counting on us cannot wait. The time for comprehensive action is now. 🌱

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