



A Threat to Progress

Confronting the effects of climate change
on child health and well-being

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Pakistan, 2023

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Acknowledgements

Authors

Karolinska Institutet: Daniel Helldén, PhD and Tobias Alfvén (Professor, Global Child Health)

UNICEF: Swathi Manchikanti (Consultant, Climate and Health) and Abheet Solomon (Senior Adviser, Environment).

Editorial and production

UNICEF: Yasmine Hage (Communications Specialist), Katelyn Greer (Consultant, Advocacy and Communications), Charlotte Rutsch (English Editor), Jeremy Sprigge (Advocacy Manager), Samantha Wauchope (Head of Publishing), Eric Zuehlke (Head of Editorial), Ahmed Al Izzi Alnaqshbandi (Arabic Editor), Maud Combier-Perben (French Editor) and Elena Munoz-Vico (Spanish Editor).

Green Ink: Jessica Money

Arabic translation by SEDC Translations, French translation by Dorothée Altimira and Anouk Pardo, and Spanish translation by Tradumodi.

Design and layout by Blossom

Overall guidance and direction

George Laryea-Adjei (Director, Programme Group) and Helga Fogstad (Director, Health) from UNICEF.

UNICEF contributors and reviewers

Victor Aguayo, Ida-Marie Ameda, Maaïke Arts, Maria Brown, Gunter Boussey, Mauro Brero, Marije Broekhuijsen, Samantha Cocco-Klein, Erinna Dia, Sophie De Fries, Lindsay Denny, Larissa Demel, Jan Eijkenaar, Emma Ferguson, Zeinab Hijazi, Sowmya Kadandale, Karin Kallander, Nupur Kukrety, Niina Johanna Kylliäinen, Sophie Lee, Ken Limwame, Malvikha Manoj, James McQueen Patterson, Sebastian John Meaney, Anthea Moore, Desiree Raquel Narvaez, Rory Nefdt, Tamara Plush, Chemba Raghavan, Gwyther Rees, Nicholas Rees, Julia Sandberg, Benjamin Schreiber, Cecilia Sharp, Tom Slaymaker, Jen Stephens, Rie Takesue, Farai Tunhuma, Dee Wang, Madeline West.

External contributors and reviewers

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Mapatano Mala Ali, Kinshasa School of Public Health; Zulfiqar Bhutta, SickKids Centre for Global Child Health; Kai Chen, Yale University; Bernadette Daelsman, World Health Organization; Sarah DalGLISH, CAP2030; Jai Das, Aga Khan University; Kristi L. Ebi, University of Washington; Ruth Etzel, International Pediatric Association; Arthy Hartwell, Wellcome Trust; Salman Khan, International Federation of Medical Students Associations; Kari Christine Nadeau, Harvard University; Christophe Ngendahay, Royal Society of Tropical Medicine and Hygiene; Stefan Peterson, Karolinska Institutet; Revati Phalkey, Save the Children; Elizabeth Pleuss, USAID; Tamer Samah Rabie, World Bank; Dr. Sreevatsan Raghavan, Translational Health Science and Technology Institute Marina Romanello, Lancet Countdown; Grace Rubiou, US EPA; Mauricio Agustín Scarpello, Argentine Society of Pediatrics; Rhoda Wanyenze, Makerere University; Arthur Wyns, Senior Advisor, Climate and Health, COP28 Presidency.

Contents

Acronyms	2
Executive summary	3
Introduction	7
Chapter 1. What's at stake for child health: Strategic overview and framework	11
Chapter 2. Climate-related hazards with the greatest burden on children	21
Chapter 3. Multipliers: Factors made worse by climate change	44
Chapter 4. Recommendations	53
Key resources for protecting children from climate impacts	64
Annex: Approach to methodology and evidence gaps	70
Citations	75

Acronyms

ADHD	Attention deficit hyperactivity disorder
CCRI	Children's Climate Risk Index
DALYS	Disability-adjusted life years
DHS	Demographic and Health Surveys
ECMWF	European Centre for Medium-Range Forecasts
EU	European Union
IPCC	Intergovernmental Panel on Climate Change
ITN	Insecticide-treated net
MICS	Multiple Indicator Cluster Surveys
PM	Particulate matter
PTSD	Post-traumatic stress disorder
SIDS	Sudden infant death syndrome
UNICEF	United Nations Children's Fund
WASH	Water, sanitation and hygiene
WHO	World Health Organization

Executive summary

In recent decades, the world has seen remarkable progress in reducing the number of deaths in children under 5, from 93 per 1,000 live births in 1990 to 37 per 1,000 live births in 2022. Despite this progress, however, many of today's children – and their chance to enjoy good health and well-being throughout their lives – is at risk from the impacts of climate change.

Children are disproportionately affected because they are uniquely vulnerable to environmental hazards compared to adults. The interplay of physiological, psychosocial, and behavioural factors and dependence on caregivers renders children more susceptible to the detrimental health impacts of climate change.

This report aims to provide a comprehensive 'stocktake' of the impacts of climate change on children across six major hazards that impact their health and well-being: extreme heat, droughts, wildfires, floods and storms, air pollution and ecosystem changes.

While the evidence on the impact of climate change on children's health and well-being is growing, research often focuses on the effects of individual hazards. This report therefore aims to provide a comprehensive 'stocktake' of the impacts of climate change on children across six major hazards that impact their health and well-being: extreme heat, droughts, wildfires, floods and storms, air pollution and ecosystem changes.

The report finds that climate change is impacting almost every aspect of child health and well-being from pregnancy to adolescence. The health impacts compound as children face climate-related hazards that often overlap. Of great concern is the risk of adverse birth outcomes, including pre-term birth and low birth weight, increasing across most climate-related hazards. Neonates and infants have a higher risk of death due to air pollution and extreme heat. Killer infectious diseases for children, like malaria, are expected to intensify with climate change. Malnutrition, underlying half of all under-five deaths globally, is set to increase due to extreme weather events, in addition to injuries. Beyond contributing significantly to the major causes of child mortality, non-communicable diseases like asthma impacted by changing ecosystems will have a detrimental lifelong effect. Finally, the mental health of children and adolescents is impacted, both due to experiencing extreme weather events and the overarching climate change being witnessed.

The health impact is worsened by the impact of climate-related hazards on the five multipliers: water scarcity and contamination, food insecurity and contamination, infrastructural damage, service disruption and displacement. **The severity of impact is determined by the inequities and vulnerability factors children face** based on socio-economic status, gender, location, existing health status, country context and capacity, together with children's unique vulnerabilities across their life-course.

Nearly half of all children live in countries that are extremely vulnerable to the impacts of climate change. [The world is at a crossroads, as climate change threatens to reverse the hard-won progress on child health and the world becomes a more dangerous place for children.](#) Even now, despite this threat, we do not yet have an estimate of the current impact of climate change on child mortality and morbidity or the projected burden. Unless mitigation efforts are accelerated and adaptation efforts are scaled up urgently, current and future generations of children will continue to bear the brunt as climate change affects their survival, lifelong health and well-being.

In response, we make three recommendations with specific actions:

Reduce emissions to meet 1.5°C degree threshold ensuring the best interest of the child:

Urgent ambitious mitigation actions are needed from high-income countries to reduce emissions and provide support to low- and-middle-income countries in their energy transition. Actions to accelerate climate mitigation must: prioritize child health co-benefits; afford universal access to modern fuels and technologies for cooking to reduce emissions and child deaths attributable to household air pollution; transition to sustainable energy in sectors that provide essential services to children and to green infrastructure; develop a climate education programme that promotes active mobility and sustainable diets; and integrate decarbonization technologies with detoxification strategies.

Pakistan, 2024

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Protect children from the impact of climate change:

Adaptation actions should: urgently equip caregivers and service providers with the information and skills they need to protect children; strengthen climate-resilient primary health care; safeguard access to nutritious food and safe water; improve preparedness and response to environmental hazards; and implement child-sensitive social protection measures. The report outlines specific asks in each of these areas.

Prioritize child health and well-being in climate policy, investment and action:

Climate action must centre on the impact on child health and well-being, ensuring targeted strategies are implemented to protect children's health, safety and future. Specific actions and investments are needed to generate local data, prioritizing child-focused vulnerability assessments, addressing gaps in research, and fostering multistakeholder collaboration to bridge knowledge-to-action gaps on children's environmental health, including with the participation of children and youth.

The burden of passing on a more perilous world to children falls heavily on the shoulders of adults, whose actions and inactions have contributed significantly to the escalating climate crisis. Focusing climate action on protecting children's health holds the key to a brighter and more sustainable future for humanity. Therefore, these recommendations speak to what climate mitigation and adaptation must deliver upon and be held accountable for. After all, the true measure of success or failure in addressing climate change lies not solely in temperature metrics, but rather in the tangible reduction of child mortality and morbidity attributable to its impacts.

Chad, 2023

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Somalia, 2024

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We suffer the most. Children have dreams about the future, but they are losing their hope because of climate change...It is absolutely important to take into account children's health when tackling these issues because the climate crisis is also a health public crisis.

— Francisco, 14, UNICEF Child Advocate

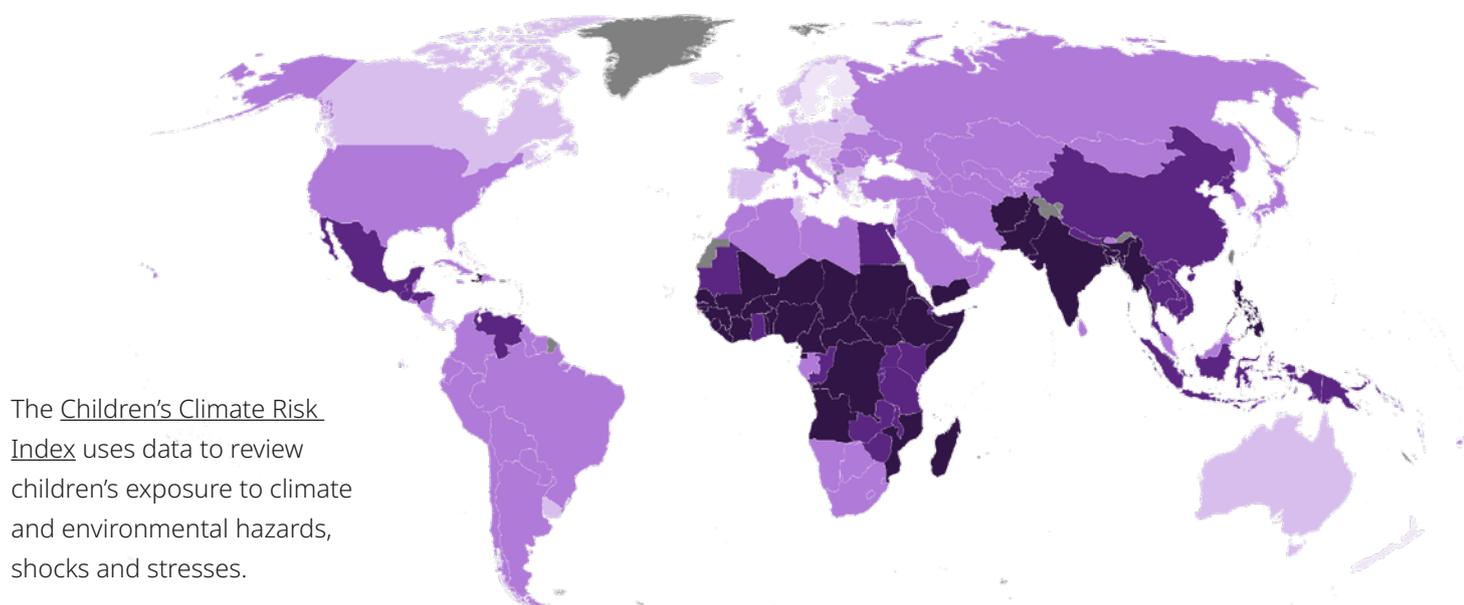


Introduction

The world has made remarkable progress in reducing the number of deaths in children under age 5 from 93 per 1,000 live births in 1990 to 37 per 1,000 live births in 2022. Yet, the annual number of child deaths remains unacceptably high – an estimated 4.9 million children under the age of 5 died in 2022. Conditions related to neonatal mortality and infectious diseases are the cause of most under-five deaths around the world. Nearly half of deaths among children under 5 years of age are linked to undernutrition¹ and a quarter linked to unhealthy environments.²

Children endure unequal chances of survival based on where they live, their socio-economic group and if they live in a fragile and conflict-affected setting. The risk of death among children younger than 5 years of age in the highest-mortality country is 80 times that of the lowest-mortality country. If progress is not prioritized and accelerated, many low- and lower-middle income countries, primarily in sub-Saharan Africa and South Asia, will not reach the Sustainable Development Goals (SDGs) targets for newborn and under-five mortality.³

Climate change threatens the progress to date on child health and well-being. In 2021, UNICEF's Children's Climate Risk Index (CCRI) reported that 1 billion children are at extremely high risk of the impacts of the climate crisis, threatening their ability to survive, grow and thrive and deepening existing inequities.⁴ Currently, 559 million children are exposed to high heatwave frequency, rising to over 2 billion children globally by 2050.⁵ Worldwide, 953 million children are exposed to high or extremely high-water stress.⁶ Over the last six years, 43.1 million internal displacements of children were linked to weather-related disasters – the equivalent to approximately 20,000 child displacements per day.⁷



The [Children's Climate Risk Index](#) uses data to review children's exposure to climate and environmental hazards, shocks and stresses.

In 2022

**182
MILLION
PEOPLE**

in 108 countries
were affected by
climate-related
disasters.

Climate change intertwines with these existing vulnerabilities to place children at greater risk of death and disease, and adverse lifelong outcomes than ever before. The extraction and use of natural resources, combined with widespread contamination through pollution and waste, have fuelled climate change; intensified the toxic pollution of water, air and soil; caused ocean acidification; and devastated biodiversity and the very ecosystems that sustain all life. The extent and magnitude of the triple planetary crisis, comprising the climate emergency, the collapse of biodiversity and pervasive pollution, profoundly imperils children's health on a global scale.

Many children live in areas that experience multiple, overlapping climate and environmental hazards. Droughts, floods and severe weather, coupled with other environmental stresses, compound one another. These hazards not only exacerbate each other, but also marginalize pockets of society and increase inequality. Children in low-income countries and poor, marginalized communities – including the 300–500 million in rapidly growing urban slums – are at heightened risk of harm from these impacts.⁸

In 2022, 182 million people, or 2.5 per cent of the world's population, in 108 countries were affected by climate-related disasters. UNICEF estimates that its response to climate-related disasters may have reached around 28 million people in 2022, with at least one life-saving intervention in 32 low-and-middle-income countries, benefitting, in various ways, about 15 per cent of the world's population affected by climate-related disasters in 2022. UNICEF's estimated response to climate-related disasters was less than 3 per cent of its overall humanitarian response in 2022 – only half of which was funded – a challenge shared across partners working to respond to the growing humanitarian challenge.

With children facing a historic confluence of crises,⁹ from conflict and displacement to infectious disease outbreaks, the impact of climate change represents a grim scenario for child health that the world must now confront.

Every child's right to a healthy environment

In August 2023, the United Nations Committee on the Rights of the Child explicitly affirmed children's right to a clean, healthy and sustainable environment.¹⁰ With this statement, **the Committee amplified calls for action from children and young people worldwide to protect their future by urgently addressing the climate crisis.**

The 28th Conference of Parties (COP28) declaration on climate and health acknowledges the urgency to protect communities and prepare health care systems to cope with climate-related health impacts such as extreme heat,

air pollution and changing patterns of diseases.¹¹ The Parties also agreed on targets for the Global Goal on Adaptation, specifically including the aspiration to attain resilience against climate change-related health impacts and reduce climate-related morbidity and mortality.

As countries strengthen their efforts towards climate action, placing children's needs and rights at the forefront of the response to the climate crisis is about current and future generations having the opportunity to survive and thrive.

The growing evidence on the impacts of the climate crisis on children often presents the effects of individual hazards, but rarely on the unique vulnerabilities of children, and often lacks strong and actionable policy recommendations. This report addresses these challenges by bringing together existing evidence in a comprehensive 'stocktake' of the existing evidence for the impacts of the climate crisis on children and making specific recommendations to address these challenges.

Iraq, 2024

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Malawi, 2023

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Chapter 1.

What's at stake for child health: Strategic overview and framework

Climate change impacts health, especially for the most vulnerable.

Climate change manifests in concrete environmental changes that significantly impact human health and well-being across the globe. Climate change exacerbates inequalities both between and within countries, creating a complex web of challenges that disproportionately affect already vulnerable populations. Over the last few decades, it has become increasingly clear that climate change and its associated impacts will be the largest health threat of the twenty-first century.^{12, 13} However, climate change will not affect everyone equally, and children born today, particularly in low- and middle-income countries – who are the least responsible for climate change – will bear the heaviest health burden from its impacts.^{14, 15}

High-income countries, historically responsible for most greenhouse gas emissions, often possess the financial means and technological advancements to mitigate and adapt to climate change. In contrast, low-income countries face heightened vulnerability due to limited resources, inadequate infrastructure, and socio-economic disparities perpetuating a cycle of inequality.¹⁶ Within countries, climate change deepens existing inequalities, disproportionately impacting marginalized and poverty-stricken communities.

Madagascar, 2023

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Children are uniquely vulnerable to the impacts of climate change

Children are uniquely vulnerable to climate change, facing health challenges that set them apart from adults. The interplay of physiological, psychosocial and behavioural factors and dependence on caregivers renders children more susceptible to the detrimental health impacts of climate change (see Figure 1).

Physiological

Physiological changes during pregnancy make mothers particularly vulnerable to the health impacts of climate change. During pregnancy, in-utero exposure to climate-related hazards can significantly impact perinatal and childhood development. One of the primary reasons children are more vulnerable to climate change is their early stage of physiological and cognitive development. Developing organs and immune systems make children less equipped to handle the stressors induced by climate-related events. Children often lack immunity to certain diseases due to their limited exposure or incomplete vaccination schedules. Their developing respiratory and cardiovascular systems also render them more susceptible to the impact of climate change, exacerbating respiratory diseases and compromising overall health. Exposure to climate and environmental hazards during the key developmental stages can lead to greater risk of developing chronic health issues that last a lifetime. The long-term consequences, both physical and psychological, underscore the importance of acting early and addressing children's vulnerabilities throughout the life-course to ensure good health and well-being for all.

Behavioural

Children's behavioural patterns, characterized by higher levels of outdoor activity, identity formation and exploratory behaviour, expose them to environmental risks. These risks are intertwined with mental health outcomes, as the stress of experiencing or even understanding these environmental hazards can lead to anxiety, severe levels of distress or other psychological impacts. Additionally, children's limited understanding of environmental hazards and their potential consequences, and adolescents' higher likelihood of taking risks, can lead to unintended prolonged exposure to hazards, further compromising their health.

FIGURE 1.

The unique vulnerabilities of children across the life-course

	PREGNANCY	INFANCY AND CHILDHOOD	ADOLESCENCE
PHYSIOLOGICAL	<ul style="list-style-type: none"> • Weakened immune system and reduced lung capacity • Hormonal changes • Eating and drinking more due to foetal development and increased metabolism • Increased susceptibility to heat • Fetuses can be exposed in utero to physical, biological, and chemical agents • Mental health impacts due to physiological and lifestyle changes 	<ul style="list-style-type: none"> • Rapidly developing immune system and organs • Rapid period of brain growth and maturation, with windows of higher vulnerability • Breathing more air per unit of weight • Eating and drinking more per unit of weight, due to higher metabolism • Increased internal heat and compromised thermal regulation in infancy • Higher surface area to mass ratio compared to adults (i.e., Affects heat regulation and absorption) • Thinner and more permeable skin 	<ul style="list-style-type: none"> • Continued physical and hormonal changes, including due to puberty • Eating and drinking more, due to higher metabolism • Developing brain structure and function (i.e. impulse control, emotional regulation, decision making) • Mental stress due to peer, academic, and other social pressures • Experiencing identity formation
BEHAVIOURAL	<ul style="list-style-type: none"> • Possibly restricted physical activity • Higher risk of exposure while working outdoors and indoor air pollution 	<ul style="list-style-type: none"> • More likely to put their hands in their mouth and eat non-food items • More likely to spend time closer to the ground • More likely to spend time outdoors • Less able to communicate needs or understand guidance 	<ul style="list-style-type: none"> • More likely to spend time outdoors • More likely to take risks
DEPENDENCE	<ul style="list-style-type: none"> • May require support to access nutritious food, clean water and other physical and mental health needs 	<ul style="list-style-type: none"> • Dependent on others for their survival • At risk of exposures based on caregiver lifestyle e.g., using poor cooking technologies indoors without ventilation • Increased vulnerability when separated from caregivers e.g., during a disaster • Dependence on peer and community networks 	<ul style="list-style-type: none"> • Dependent on caregivers in early adolescence for care, guidance and survival • Dependence on peer and community networks



Sources: See endnotes 18–37.

Dependence

Children rely heavily on caregivers for their health and well-being and disruptions caused by climate change can have profound impacts on their health. Specifically, the health and well-being of the mother and child are heavily interconnected. Additionally, climate change hazards can severely compromise the ability of caregivers to provide consistent and effective nurturing care. These disruptions not only threaten the physical safety and health of infants but also their psychological and emotional development. Disruptions to food and water sources, loss of a home or displacement can have serious and broad implications to a child's development. Adolescents also often need support from caregivers and peers for care and guidance. The physical and psychological toll of climate-related hazards on caregivers and society at large can indirectly affect children and adolescents, influencing their mental health and psychosocial well-being.



The health impacts of climate change on children

Climate change poses unique threats to the health and well-being of children. However, the pathways of impact are not yet well understood, which can lead to an underestimation of the full extent of the impacts of climate change and hamper work to understand how child-specific climate change mitigation and adaptation efforts can limit the impacts. As a response to this, a framework (see *Figure 2*) based on the current evidence on the impact of climate change on child health is proposed, incorporating considerations of mental health, psychosocial well-being and development.

Climate-related hazards with implications for child health are linked to the increased frequency and intensification of extreme weather events such as flooding and storms, droughts and extreme heat.¹⁷ In addition, climate change leads to an ecosystem disruption: the release, volatilization and long-range transport of toxic chemicals into water, soil and the atmosphere;¹⁸ longer and more intense allergic seasons; and changing patterns of infectious diseases. Air pollution and climate change are distinct but interconnected hazards that share underlying drivers and often act synergistically.

The direct impacts of climate change follow the established inequities within and between countries, with the most disadvantaged children being at most risk. Indeed, the impacts of climate change on child health multiply through the damage caused by climate-related hazards on existing supporting systems. This includes food insecurity and resulting devastating effects on the nutritional status of the child due to crop failure, nutrient deficiencies, and disruptions in supply chains. Damage to essential water and sanitation services, changed precipitation patterns and sea level rise can lead to water scarcity and contamination of water and food sources. Direct damage to households, schools, community facilities and other critical infrastructure further exacerbates existing vulnerabilities in addition to environmental contamination from toxic chemicals from industrial facilities, agricultural areas and hazardous waste disposal.¹⁹ Beyond direct damage, climate change can lead to health care, education, child protection and social protection service disruptions that can severely compromise child health. Displacement due to climate change is perhaps the most severe risk amplifier as it exacerbates all existing vulnerabilities and disrupts virtually all social determinants of health.

Climate change and the resulting climate-related hazards, interacting with the multipliers, can lead to a range of immediate and long-term impacts on child health and well-being. Contextual vulnerabilities that include many of

FIGURE 2.

Impact of climate change on child survival, health and well-being

HAZARDS

Climate-related hazards with significant impact on children:

- Extreme heat
- Droughts
- Wildfires
- Floods and storms
- Ecosystem changes
- Air pollution

MULTIPLIERS

Factors made worse by climate change:

- Water scarcity and contamination
- Food insecurity and contamination
- Infrastructural damage
- Service disruption
- Displacement

VULNERABILITIES

Inequities and factors that determine the severity of the impact:

- Socio-economic status
- Gender
- Location
- Existing health status
- Country context and capacity
- Unique vulnerabilities across the life-course

IMPACTS

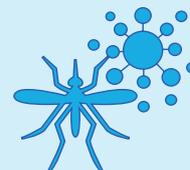
Health outcomes contributing to child mortality and morbidity



Pregnancy complications and adverse birth outcomes



Malnutrition



Infectious diseases



Injuries



Non-communicable diseases



Impacts on neurodevelopment and mental health



Effects on well-being

MANY CLIMATE-RELATED HAZARDS

can lead to pregnancy complications and adverse pregnancy outcomes, including preterm birth

the social determinants of health, from the health status of the child, socio-economic status of the family, to the geographic location of household, health systems, and country context and capacity. Moreover, the children are often exposed to multiple climate hazards simultaneously, which can compound and increase the severity of the associated health impact.

Child health impacts of exposure to climate-related hazards, when looking across their life stages, are varied but there are many impacts that are common across types of hazards (see Figure 3). There is a particular interconnection between the health and well-being of the mother and the child that needs to be considered.

Many climate-related hazards, including floods and storms, extreme heat and wildfires, can lead to pregnancy complications and adverse pregnancy outcomes, including preterm birth. All extreme weather events can have severe implications for children's mental health.

Flooding can lead to increased spread of infectious diseases and exposure to chemicals (lead, mercury, pesticides) causing neurodevelopmental impacts. Droughts have multiple health impacts and can increase all-cause rates of mortality and morbidity among children, and to increased rates of undernutrition and spread of infectious diseases due to water scarcity and food insecurity.

Extreme heat is associated with increases in all-cause mortality rates among infants and among older children and adolescents, extreme heat can lead to poorer cognitive and physical development, including lower educational attainment. In addition to causing direct physical harm to children, exposure to wildfire smoke can interact negatively with neurodevelopment and lead to respiratory diseases and increased susceptibility to respiratory infections.

Climate change will lead to changing patterns of disease. In particular, malaria, dengue fever, Zika virus and Lyme disease have been shown to be increasing in geographical spread with climate change, challenging progress made in reducing the impact of these infectious diseases on children. The burden of other infectious disease pathogens causing respiratory infections and diarrhoeal diseases are also set to increase with climate change, with implications for antimicrobial resistance patterns.

Particulate matter air pollution and other chemicals related to burning of fossil fuels and dust storms are linked to worsened respiratory capacity in children, including the development of asthma. Allergic and atopic diseases are set to become more prevalent with increased spread of allergens due to climate change.

FIGURE 3.

Key health impacts of selected climate hazards on children



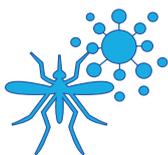
Pregnancy complications and adverse birth outcomes

- Still birth
- Low birth weight
- Preterm birth
- Congenital defects
- Preeclampsia
- Gestational diabetes
- Gestational hypertension



Malnutrition

- Stunting
- Wasting
- Underweight
- Overweight and obesity
- Micronutrient deficiencies



Infectious diseases

- Pneumonia and other respiratory infections
- Diarrhoeal diseases such as cholera
- Malaria, dengue, Zika and chikungunya
- Lyme disease
- Other neglected tropical diseases



Injuries

- Drowning
- Burns
- Poisoning



Non- communicable diseases

- Heat-related illnesses such as heat stroke
- Asthma
- Allergies
- Sudden Infant Death Syndrome
- Chronic metabolic and cardiovascular diseases



Impacts on neurodevelopment and mental health

- Cognitive dysfunction
- Developmental delays
- Anxiety
- Depression
- Post-traumatic stress disorder



Effects on well-being

- Learning loss
- Loss of caregiver, peers and community
- Violence, abuse and exploitation such as gender-based violence
- Sleep quality

While climate change hazards impact a broad set of child diseases and disorders, it is important to emphasize that many of the health impacts of climate change are among the most common global causes of child mortality and morbidity. This report describes each climate hazard and how it impacts children's health and well-being in detail and provides an overview of the risk multipliers. Additionally, the importance of considering health impacts on pregnant women and a life-course perspective on child health is emphasized. Although some research gaps persist, there is overwhelming evidence of the health impacts of climate change on children – and that these impacts will accelerate over the coming decades.

There is overwhelming evidence of the health impacts of climate change on children -

**AND THAT
THESE
IMPACTS WILL
ACCELERATE**

This report provides recommendations to safeguard children from the health impacts of climate change, which necessitates a holistic approach that considers their distinctive vulnerabilities. Mitigation and adaptationⁱ strategies must be tailored to address the specific physiological, psychosocial, behavioural and socio-economic factors that render children more susceptible.

The general burden of climate change on children and adolescents can lead to climate anxiety, a normal and adaptive response that can present daily challenges and more severe concerns if it remains unaddressed or ignored. The anxiety also stems from dissatisfaction with the response of governments and stakeholders.²⁰ By prioritizing the health and well-being of children in climate change policies and interventions, we can not only protect a vulnerable population but also lay the foundation for a more resilient and sustainable future. It is our collective responsibility to ensure that the world's youngest members are shielded from the health consequences of a changing climate while recognizing the agency and ability of children and adolescents in driving such action. In producing this report, UNICEF aims to ensure that the survival, health and well-being of children is the topline priority on the climate agenda.

ⁱ According to the Intergovernmental Panel on Climate Change, mitigation is “a human intervention to reduce emissions or enhance the sinks of greenhouse gases” and adaptation is “the process of adjustment to actual or expected climate and its effects, in order to moderate harm or exploit beneficial opportunities” within human systems.

Ethiopia, 2023

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Chapter 2.

Climate-related hazards with the greatest burdens on children

This chapter describes the climate and climate-related hazards that have been found to place the greatest burdens on children, based on a global evidence review: floods and storms, droughts, extreme heat, wildfires, air pollution and ecosystem change. For each hazard, this chapter presents currently available exposure data and attempts to understand the likely impacts on children because of this exposure. This chapter also considers, where available, forecasts that assess the likely implications of some of these climate hazards for children in the future.

(see Annex for detailed methodology)

2.1 Extreme heat

In 2021 alone,
approximately

**442,000
DEATHS**

were attributable
to exposure to high
temperatures



Exposure data

Global warming has exacerbated extreme shocks such as hurricanes and floods, and increased the duration, frequency and intensity of extreme heatwaves around the world.

According to the Institute of Health Metrics and Evaluation, in 2021 alone, approximately 442,000 deaths were attributable to exposure to high temperatures, with 45,000 deaths among children and 31,000 of those occurring among children under age 5.²¹ According to the UNICEF report *The Coldest Year of the Rest of Their Lives*, approximately 559 million children are already exposed to high heatwave frequency and around 624 million children are exposed to one of the three other high-heat measures: high heatwave duration, high heatwave severity or extreme high temperatures.²²



Impacts on children

Pregnant women and foetuses are particularly vulnerable to the effects of extreme heat.²³ A meta-analysis showed associations between temperature exposure during pregnancy and stillbirth, preterm birth and low birth weight, with odds of stillbirth rising by 5 per cent per 1°C increase in temperature.²⁴ Women who give birth during extreme heat periods may be more likely to have newborns with illnesses. In Bangladesh, women were 14 per cent more likely to have newborns with neonatal illnesses when giving birth on hot days, compared to those giving birth on cooler days.²⁵ Heat stress can increase the risk of foetal tachycardia, development of congenital defects, and foetal distress during development.²⁶ Dehydration, which is more likely to occur during high-heat periods, can lead to serious complications during pregnancy and the postpartum period, including reduction of the levels of amniotic fluid and poor production of breast milk.²⁷ Dehydration may also represent a trigger for preterm birth, and exposure to extreme heat during the first half of pregnancy has been associated with greater risk of pre-eclampsia and gestational hypertension,^{28, 29} as well as gestational diabetes.³⁰



Heat stress can

**INCREASE
THE RISK OF**

foetal tachycardia,
development of congenital
defects, and foetal distress
during development.

Young children and infants in particular are also uniquely affected by heat stress, leaving them more vulnerable than the general adult population to its short-term and long-term effects.ⁱⁱ This is due to their greater body surface area, which makes them more receptive to absorbing heat from the environment, depending on their fitness levels; their lower levels of sweat production, compared to adults per unit of sweat gland; underdeveloped immune systems, which leave infants in particular less capable of fighting infections exacerbated by heat in the

environment; and their general slower adjustment to weather changes, in part due to less efficient blood circulation and lower proportional cardiac output.³¹ Some studies have suggested links between high temperature exposure and increased risk of sudden infant death syndrome (SIDS).³² Generally, heat-related mortality is detected at higher threshold temperatures in warmer climates.³³ However, children (especially under the age of 1) have a higher risk of mortality due to lower thermoregulatory capabilities when compared to adults.^{34,35,36} One study using data from 170 countries found that a 1°C increase in temperature in low-income countries leads to an additional 16.6 children per 1,000 live births dying before 1 year of age.³⁷

While older children and adolescents have developed bodily systems that are comparative to those of adults, they can still be impacted by heat stress. Adolescents do not have less effective thermoregulatory ability or insufficient cardiovascular capacity compared with adults. However, in part because of poor hydration practices, adolescents who exercise in the heat can experience reduced performance and increased risk of heat-related illnesses, as well as muscular and kidney dysfunction.³⁸

Extreme heat can affect sleep quality for children and adolescents, which subsequently impacts mental health, and contributes to poorer cognitive and physical development, as well as elevated levels of stress.^{39,40} In particular, humid heat is reported to affect slow wave sleep in the earlier phase of sleep.⁴¹ When it comes to educational outcomes, according to a 58-country assessment, each additional day above 26.7°C during the three years preceding an exam lowered scores by 0.18 per cent of a standard deviation, with the effect larger for lower-income populations.⁴² Another study found that, without air conditioning, for each 0.56°C increase in school-year temperature, student achievement declined by the equivalent of 1 per cent of a year's learning.⁴³ This suggests a critical need for climate regulation in educational settings to support academic performance. Early exposure to extreme heat can have even longer-term consequences. Every additional day with mean temperatures above 32°C in utero and in the first year after birth is associated with a 0.1 per cent reduction in adult annual earnings at age 30,⁴⁴ highlighting the long-term economic implications of early exposure to extreme heat.

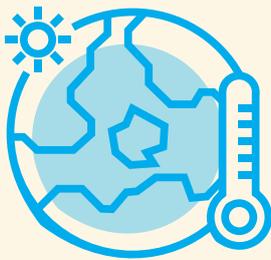
The brain detects extreme heat as a threat to well-being, which activates the stress response system.^{45,46} Excessive activation of the stress response system during pregnancy and in young children can disrupt the development of healthy emotional regulation circuits in the developing brain of a child.⁴⁷ Children and adolescents are especially vulnerable to the mental health impacts of extreme heat, due to their developmental needs and sensitivities. At least one study of individuals in New York City found an increase in mental

According to a 58-country assessment each additional day above 26.7°C during the three years preceding an exam **LOWERED SCORES** by 0.18 per cent of a standard deviation.

ⁱⁱ The following list of characteristics making infants and children uniquely vulnerable has been sourced from the literature review by Ishimine, Paul, 'Heat Stroke in Children', 15 November 2022, <www.uptodate.com/contents/heat-stroke-in-children/print>, accessed 21 March 2023.

health emergency department visits by children and adolescents during periods of elevated temperatures.⁴⁸ Recent research shows that temperature rises can be associated with increases in suicides and suicidal behaviour; rises in hospital admission for mental health conditions; and poor overall community health and well-being.⁴⁹ More robust and global research on associated mental health outcomes is required.

Finally, several studies reported overlapping and synergistic effects of heat and air pollution on perinatal health, and most studied an increased risk of preterm birth.^{50, 51, 52} The biological mechanism behind this synergistic effect is not fully understood, but studies have indicated that particulate matter (PM_{2.5}) and ground-level ozone could cause placental inflammation, resulting in altered vascular function and perfusion leading to preterm birth, where concurrent high temperature may intensify this effect.⁵³ However, evidence on this pathway is still limited.



Future scenarios for children

The UNICEF report *The Coldest Year of the Rest of Their Lives* found that by 2050 almost every child in the world – over 2 billion – will be exposed to high heatwave frequency, up from only 24 per cent of children in 2020.⁵⁴



2.2 Droughts

In 2022,

**470 MILLION
CHILDREN**

faced high or extremely high levels of exposure to drought



Exposure data

Droughts are affecting children and their families across the world. About 160 million children are exposed to severe and prolonged droughts leading to detrimental short- and long-term health impacts.⁵⁵ In 2022, 470 million children faced high or extremely high levels of exposure to drought. Overall, 436 million children were exposed to high or extremely high water vulnerability – the lowest levels of drinking water service and highest levels of physical water scarcity,⁵⁶ which is further exacerbated by drought events.



Impacts on children

A lack of precipitation over time, along with other factors such as evaporation from the environment associated with increased temperatures, can lead to drought. Droughts generally have a longer onset and duration compared to many other extreme weather events.⁵⁷ The relative attribution of long-term climate change to drought has become more evident in recent years.⁵⁸ For example, the risk of an event similar to the unprecedented 2022 drought in the Horn of Africa, which affected more than 20 million children⁵⁹ and led to at least 15,800 excess deaths of children under 5 years old,⁶⁰ has been estimated to have become 100 times more probable due to human-made climate change.⁶¹ Drought events that would previously have been considered exceptional are becoming the new normal.

Droughts cause multiple health impacts to children that begin in pregnancy and can lead to increased mortality and morbidity rates. A study from rural India found a higher probability of children being underweight when exposed to a drought in utero and a higher probability of infant death.⁶² In rural South Africa, a study found higher rates of disabilities, especially in males, after early-life drought exposure.⁶³ Mothers in Uganda have described how more drought-prone weather changes negatively impacted food security, which in turn had negative effects on both maternal and infant health.⁶⁴ A study of sub-Saharan Africa found that women who experienced drought conditions in their own childhood were more likely to have children born at low birth weights, and another in Nepal found that droughts during a pregnant woman's first trimester are associated with lower birth weight in children.^{65,66} Long-term changes in rainfall patterns, particularly a lower annual volume, have been suggested as negatively affecting child mortality rates in the Sahel region.⁶⁷ Overall, minor to severe droughts were associated with worse child nutrition, as measured by Z-score, a common indicator assessing stunting.⁶⁸



Mali, 2024

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The health impacts of drought on children primarily arise from the resulting food insecurity and water scarcity. Droughts undermine ecosystems and are often detrimental to crop production and livestock management, causing household incomes to fall and families to become more vulnerable to food price increases, with ensuing food insecurity and risk of undernutrition.^{69, 70} For example, in a study from Burkina Faso, droughts were linked to increased rates of child stunting, particularly when the drought occurred during a crop season.⁷¹ Perhaps unsurprisingly, younger children seem to be more vulnerable to drought-related undernutrition.⁷²

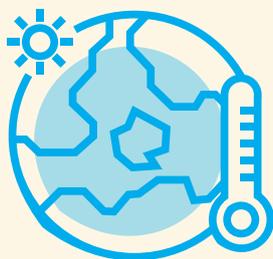
Reduced access to clean water due to drought limits the possibility for proper hygiene and sanitation practices, which in combination with undernutrition can lead to increased risk of infectious diseases.^{73, 74, 75} For example, during the 2022 drought in the Horn of Africa, Ethiopia, Kenya and Somalia experienced surges in cases of cholera. Infectious diseases, in particular diarrhoeal diseases, in children who do not have access to clean water and sanitation can lead to substantial mortality and morbidity. The triple threat of climate change, WASH-related diseases among children under 5 and limited access to WASH services affects at least 190 million children, primarily in sub-Saharan Africa.⁷⁶

The pressure of food insecurity and water scarcity on families can force

DISPLACEMENT AND EVEN LONG-TERM MIGRATION

The pressure of food insecurity and water scarcity on families can force displacement and even long-term migration,⁷⁷ leading to lasting impacts on the health of children. Evidence from the United Republic of Tanzania and Australia indicates that drought-associated food insecurity and water scarcity can also lead to mental health challenges among adolescents and young people, including a higher degree of general mental distress, and in some cases can lead to more severe symptoms of mental health conditions such as depression, post-traumatic stress disorder and anxiety.^{78, 79, 80, 81}

There is evidence that children and adolescents can experience grief and loss, acute stress, and adverse reactions including sleep disturbance and behaviour change as a result of extreme weather events like drought and flooding.⁸² Droughts in particular, which are 'slow-creeping' events, are more strongly associated with mood disorders⁸³ and at least one study has found a link between exposure to a prolonged drought and worsening mental health in young people, including an elevated risk of suicide.⁸⁴ Parents and caregivers can themselves experience grief and loss reactions, depression, anxiety, post-traumatic stress disorder (PTSD), anger, helplessness and hopelessness, and suicidality. This in turn can lead to increased aggression, domestic discord or challenges for parents when caring for their children, serving as a risk factor for child mental health and well-being.^{85,86}



Future scenarios for children

Climate change will lead to increases in temperature extremes, with droughts becoming more frequent and severe, especially if global warming reaches 2°C or above.⁸⁷ One model has predicted that the risk of drought will increase, with the largest increases in South Asia, the Mediterranean, East Asia, Southeast Asia and Central America. Mortality and malnutrition among children have been projected to be the largest health impacts from droughts in 2050.⁸⁸ Simultaneously, as the demand for clean water grows, the number of children experiencing high or extremely high water stress is set to increase from the already high level of 953 million children in 2022, to 988 million in 2050.⁸⁹ Five billion people, or around two thirds of the world's population, will face at least one month of water shortages by 2050, according to the first in a series of United Nations reports on how climate change is affecting the world's water resources.⁹⁰

2.3 Wildfires

Between 2010 and 2019

2.18 BILLION PEOPLE

were exposed to at least 1 day of substantial air pollution generated by landscape fire.



Exposure data

Whilst ambient air pollution – pollution found daily in the air – poses a persistent, year-round health risk in many urban and industrialized areas, wildfire smoke tends to have more immediate and localized impacts. In addition, exposure to wildfire smoke can be more hazardous than ambient air pollution alone.⁹¹ Between 2010 and 2019, 2.18 billion people globally were exposure to at least 1 day of substantial air pollution generated by landscape fireⁱⁱⁱ, an almost 7 per cent increase compared to the decade prior.⁹² For instance, as of 2023, in the United States, an estimated annual average showed an increase between 2011 and 2021 of approximately 1 billion person-days^{iv} of exposure to heavy smoke and medium smoke, and more than 2.5 billion person-days for light smoke.⁹³



Impacts on children

Wildfire smoke consists of a complex mixture of particles and chemicals from varying sources and the smoke composition influences its toxicity.^{94,95} An increasing body of research is indicating that wildfire smoke is especially dangerous to pregnant women, because it affects both the woman and foetal development. Hormonal and physical changes during pregnancy can affect the respiratory tract, reducing lung capacity while simultaneously leading to an increase in the volume of air breathed in and out.⁹⁶ This means that pregnant women are more likely than the general population to experience shortness of breath,⁹⁷ which can be exacerbated by exposure to wildfire smoke. Pregnant women are also at a higher risk of developing gestational hypertension and gestational diabetes if exposed.⁹⁸

Fire-sourced PM exposure is associated with an increased risk of child mortality. Compared to PM_{2.5} from other sources, PM_{2.5} released from wildfires has been found to be approximately 10 times more harmful to children's respiratory health, particularly for children 5 years of age and younger.⁹⁹ Each 1 microgram per cubic metre of air (mg/m³) increment of PM_{2.5} emanating from fires was associated with a 2.3 per cent increase in the risk of child mortality; exposure was found to be 'super-linear', meaning that the per-unit exposure to larger fires led to increased toxicity.¹⁰⁰

ⁱⁱⁱ The term "landscape fire" refers to any fire that burns across a landscape, including agricultural lands. Landscape fires become wildfires when they are unplanned or unmanaged.

^{iv} A 'person-day' measure is an accounting approach to estimating the overall reach of an event (e.g., if 100 people are each exposed for five days, that would yield 500 person-days).



Tuvalu, 2023

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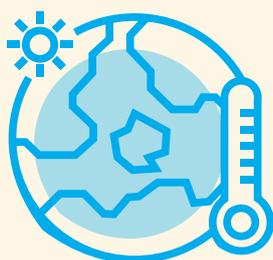
A study based in Colorado, a state in the western United States prone to wildfires, found that over the second trimester of pregnancy, each 1 mg/m^3 increase in $\text{PM}_{2.5}$ from wildfire smoke across a trimester was associated with a 13.2 per cent increase in the odds of preterm birth.¹⁰¹ Studies of wildfire smoke exposure in 2022 in Brazil, which is prone to wildfires and has a high rate of preterm births, also found that wildfire smoke exposure may increase the risk of preterm birth and low birth weight.¹⁰² Another study looking at births in California, United States, between 2007 and 2010, found a 28 per cent increased risk, with first-trimester exposure to wildfires, of foetal gastroschisis, a defect that can restrict foetal growth and increase the risk of stillbirth.¹⁰³ Children exposed to wildfire smoke in utero are also likely to be more vulnerable to infections and disease after birth, as well as at higher risk of any health consequences resulting from being born with congenital defects.¹⁰⁴

Children have less nasal deposition of particles, meaning that a higher proportion of smoke particles can penetrate deeply into the lungs.¹⁰⁵ A growing body of literature has connected exposure to PM to lower lung function in children, stunted physical growth,¹⁰⁶ and neurological and metabolic dysfunction.¹⁰⁷ A combination of genetic and environmental

Some children are born with **HIGHER SUSCEPTIBILITY TO ASTHMA** after a mother's exposure to air pollution during pregnancy or due to smoke exposure during postnatal periods.

factors can result in some children being born with higher susceptibility to specific health effects, such as asthma, after a mother's exposure to air pollution during pregnancy or due to smoke exposure during postnatal periods.¹⁰⁸ In terms of morbidity, a 2023 study of over 36,000 children under the age of 5 in 48 low- and middle-income countries found that PM_{2.5} from fires was more strongly associated with acute respiratory infection than PM_{2.5} from non-fire sources.¹⁰⁹ Some studies have also found positive associations between air pollution levels, influenced by wildfires, and the risk of children developing metabolic disorders such as diabetes and hypertension.¹¹⁰

Studies are also finding that exposure to particulate matter from wildfires may have neurophysiological effects in children, and could contribute to higher risk of developing attention deficit hyperactivity disorder (ADHD), autism and impaired memory.¹¹¹ In Canada, a study conducted 18 months after a wildfire found that 27–37 per cent of children and adolescents exhibited symptoms of psychological distress, including PTSD, with those experiencing the greatest impacts (losing their home, for example) being significantly more distressed.¹¹² Physical injuries and deaths have been documented over the past few decades, but the range of effect continues to vary drastically. For instance, the EM-DAT^v suggests that 73 people were killed by wildfires between 2012–2014, while data collected by the Global Fire Monitoring Centre indicate that approximately nine times more people were killed in the same period.¹¹³ In the United States, the majority of fire-related deaths are caused by smoke inhalation of the toxic gases produced by fires. Actual flames and burns only account for about 30 per cent of fire-related deaths and injuries.¹¹⁴



Future scenarios for children

The United Nations Environment Programme projects that there will be a global increase in extreme fires of up to 14 per cent by 2030, and over 50 per cent by the end of the century.¹¹⁵ A 2017 study predicts that the current rate of population exposure to wildfire smoke will cause a 138 per cent increase in deaths due to all related causes by 2100.¹¹⁶ In addition, a study from the United States estimates that wildfire smoke-related deaths could increase from approximately 15,000 currently to 40,000 annually by 2100 as well.¹¹⁷

^v EM-DAT is the international disaster database maintained by the Centre for Research on the Epidemiology of Disasters.

2.4 Floods and storms

In 2021, approximately
330 MILLION CHILDREN
were living in areas
highly exposure to riverine
flooding and 240 million
to coastal flooding.



Exposure data

As of 2021, around 400 million children were highly exposed to tropical cyclones. As of the same year, approximately 330 million children were living in areas highly exposed to riverine flooding and 240 million were living in coastal areas prone to flooding (there is overlap between the two groups, as some children are exposed to both). Riverine flooding is increasing as a result of higher levels of precipitation but also, more frequent and intense storms, and melting snow and glaciers, combined with changes in land cover such as deforestation that further expose children and their families to flash floods and landslides. Coastal flooding can be caused by sea level rise and increasing frequency and intensity of tropical cyclones and storms, while erosion and man-made changes to coastlines put children living in low-level areas at significant risk.¹¹⁸



Impacts on children

Children are vulnerable to storms and flooding due to their developing physiology and physically limited ability to withstand high wind speeds and large water masses. During floods, particularly flash floods, direct mortality from drowning is particularly prevalent, while children also suffer morbidity from flood-associated injuries.^{119, 120, 121} One of the most recent devastating floods occurred in Pakistan in 2022, when an extended and intensified monsoon season led to extensive flooding that affected more than 33 million people, and destroyed households, schools and health facilities, leading to more than 350 child deaths and lasting adverse health outcomes.¹²² The floods were caused by extreme precipitation, with climate change estimated to have intensified the precipitation by up to 50 per cent.¹²³ Over more long-term trajectories, a study found that infants living in flood-prone areas in Bangladesh had an 8 per cent higher chance of dying compared with their counterparts who were not exposed to floods, leading to more than 150,000 excess infant deaths over a 30-year period.¹²⁴ This is likely partly due to the intersection of exposure to floods and child vulnerability, where the most vulnerable children tend to live in flood-prone areas; low- and middle-income countries are home to 89 per cent of the world's flood-exposed population.¹²⁵ In general, it seems that increased precipitation over the long term, particularly in low-income settings, is associated with overall higher mortality rates among children,^{126, 127, 128} while the increased short-term mortality and morbidity impacts from tropical storms are clear.¹²⁹

Gestational flood exposure is associated with an

8 PER CENT INCREASED RISK

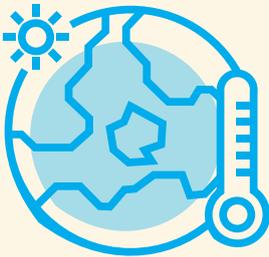
of pregnancy loss,
including stillbirths.

Flooding during pregnancy has implications for maternal and child health. High-intensity precipitation and flood events seem to be associated with an increased risk of adverse birth outcomes such as preterm birth and low birth weight.^{130, 131, 132, 133} Pregnancy complications may also occur. Gestational flood exposure is associated with an 8 per cent increased risk of pregnancy loss, including stillbirths, with greater effects on women younger than 21 or older than 35 years of age, as well as those dependent on surface water and with lower income or education levels.¹³⁴ There was also an upward trend in annual pregnancy losses from 2010 to 2020.¹³⁵ A 2022 review found that the risk of gestational hypertension, preeclampsia and eclampsia increased slightly after a flood.¹³⁶ Severe flood exposure has been shown to be associated with greater maternal depression during the perinatal period.¹³⁷ More long-term impacts of in utero exposure to floods have been found, including lower educational attainment.^{138, 139, 140}

Flooding and storms are associated with an increased spread of infectious diseases through the destruction or overflow of existing sewage systems, leading to the contamination of drinking water. A 43-country study found a slight increase in diarrhoeal prevalence in children under 5 years old when exposed to flooding; children who were exposed to droughts prior to floods were at even higher risk of diarrhoeal incidence.¹⁴¹ There is evidence of an increased spread of water-related infectious diseases during and after flooding events.^{142, 143, 144, 145, 146} Other infectious diseases, such as malaria and various respiratory infections, can also become more prevalent.^{147, 148} Flooding can also lead to toxicants contaminating water and sanitation systems, while the growth of indoor mould in flood-damaged households can impact respiratory health in children.¹⁴⁹

Extreme weather events such as floods and storms can often cause families to be displaced, which can increase the risk of infections in children, among other exacerbated health risks of displacement. Similarly, floods and storms can lead to the breakdown of local infrastructure, severely hampering health and social services for children, and affecting community resilience and social connectedness.¹⁵⁰ Severe and recurrent floods impact undernutrition, mainly in the forms of stunting, wasting and underweight in children under 5 in low- and middle-income countries.¹⁵¹ This is often the result of a decrease in food supply following flood-related destruction of crops.¹⁵² In more high-income settings, however, an increase in total body fat and greater weight among infants and children whose mothers experienced prenatal maternal stress during floods have been documented.^{153, 154}

Floods and storms can be traumatic events for children but their impacts are often worsened due to the displacement or loss of a safe environment, leading to subsequent mental health challenges. For example, during the 2022 flooding in Pakistan, an estimated 50 per cent of affected children and their caregivers reported signs of distress.¹⁵⁵ More long-term mental health challenges from flooding include PTSD and depression, both in low- and high-income settings.^{156, 157} Extreme weather events like floods can also impact some of the social and economic determinants of mental health by leading to unemployment, homelessness, or food and water insecurity.¹⁵⁸ This can, in turn, detrimentally affect the mental health and psychosocial well-being of children, adolescents and their caregivers.¹⁵⁹



Future scenarios for children

Heavy precipitation and storms will become even more prevalent while sea levels continue to rise, leading to more frequent and intensified flooding events in most world regions. With global temperatures likely to continue to rise beyond 1.5°C (the target set by the Paris Agreement), this pattern is set to escalate further.¹⁶⁰ Indeed, over the next 30 years, almost 96 million children could be displaced due to riverine floods;¹⁶¹ without adaptation and with accelerated climate change, there will be an increase of 52 per cent of the world's population exposed to flooding by the end of the century, with low-level regions at greatest risk.¹⁶²

2.5 Air pollution

Around

**630 MILLION
CHILDREN**

under 5 years of age are exposed to air pollution that exceeds international guidelines.



Exposure data

Around 630 million children under 5 years of age are exposed to particulate matter air pollution that exceeds the World Health's Organization (WHO) air quality guidelines.¹⁶³ There is a bidirectional relationship between climate change and air pollution, consisting of particular matter, chemicals and allergens. For instance, particulate matter air pollution is a direct by-product of fossil fuel combustion, a major driver of greenhouse gas emission. On the other hand, a significant amount of air pollution comes from climate change related droughts, wildfires and dust storms that are set to increase.^{164, 165, 166, 167} Therefore, air pollution and climate change have similar underlying drivers – often, the impacts of one will exacerbate the other.



Impacts on children

Exposure to air pollution, in the form of particular matter, chemicals such as nitric oxide, ozone and allergens, affects the developing child, from in utero exposure to infancy, childhood and adolescence, with long-lasting health impacts.^{168, 169} Air pollution is associated with increased risk of infant death and adverse birth outcomes, with nearly 2 million preterm births annually being attributed to ambient particulate matter exposure.¹⁷⁰ Air pollution and high-temperature exposure also likely have a synergetic effect on the risk of preterm birth.¹⁷¹ Additionally, air pollution exposure during the later stages of pregnancy and the neonatal period has been associated with cognitive disabilities and dysfunctional neurodevelopment in children.¹⁷² According to one study, in 2021, more than 700,000 deaths in children under age 5 were linked to air pollution (approximately 15 per cent of all global deaths in children under age 5), with the majority being in children under 1 year of age; most of these occurred in Asia and Africa.¹⁷³ Studies looking at the associations between exposure to air pollution and mental health outcomes have shown links to psychosocial and behavioural deficits; in contrast, exposure to green spaces being associated with improved well-being.^{174, 175}

Exposure to air pollution can harm the health of pregnant women and children, particularly by affecting their respiratory systems.^{176, 177} Exposure to particulate matter adversely affects lung function in children, lowering peak expiratory flow and forced expiratory volume.¹⁷⁸ Exposure, particularly in early life, also leads to increased risk of asthma and susceptibility to respiratory infections.¹⁷⁹



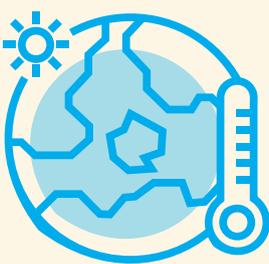
Viet Nam, 2024

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Overall higher exposure to particulate matter air pollution, particularly for children with asthma, increases the number of emergency department visits, hospitalizations and deaths in children.^{180, 181, 182} Particulate matter from dust storms has been linked to increases in hospitalizations and overall mortality in children, while some studies have indicated long-term impacts including lower cognitive function from prenatal exposure.^{183, 184} There is evidence that high temperatures and low humidity exacerbate the impacts of particulate matter air pollution, leading to a slightly higher risk of child mortality and morbidity,^{185, 186, 187} but the relationship between air pollution and other climatic variables is more complex.¹⁸⁸ There is some evidence for an interaction between air pollution and mental health in older children and adolescents, with higher exposure to air pollution leading to increased risk of depression and other mental disorders.^{189, 190}

Increased levels of ozone, likely given rising temperatures and continued fossil fuel combustion, will exacerbate child respiratory disorders such as asthma,¹⁹¹ and other conditions such as atopic dermatitis^{192, 193} and allergic conjunctivitis.¹⁹⁴ A study from South Korea showed that ozone pollution is projected to cause the majority of the burden of disease from climate change in children under 15 years of age during this century.¹⁹⁵ Other air pollutants from fossil fuel sources, including carbon monoxide, sulphur oxides and nitrogen dioxide, can similarly harm respiratory function in children, particularly those suffering from asthma or other chronic respiratory diseases.^{196, 197} Exposure to particulate matter is also being found to be associated with rising incidence of metabolic diseases in children, such as diabetes, and greater risks of developing cardiovascular diseases in adulthood.¹⁹⁸ For instance, children exposed to traffic-related air pollutants were found to have greater insulin resistance¹⁹⁹ and long-term exposure to ambient pollution was associated with increased blood pressure and prevalence of hypertension in children and adolescents.²⁰⁰

Due to climate change and higher carbon dioxide concentrations, mean temperatures and precipitation are likely to increase in many parts of the world, which can prolong and intensify the allergenic pollen season and increase the severity of allergic rhinitis, allergic conjunctivitis, atopic dermatitis and asthma.^{201, 202, 203, 204} Understanding the burden of allergenic diseases on children due to climate change is difficult due to multifaceted causal pathways and interlinked systems.^{205, 206, 207} However, epigenetic and genomic analysis holds some promise to an increase understanding of the links between climate change and allergenic diseases.²⁰⁸



Future scenarios for children

Climate change and global warming have been identified as contributing to both recent increases in the prevalence and severity of allergic diseases and are expected to contribute to ongoing increases in the future.²⁰⁹ For instance, if climate change continues without mitigation or adaptation efforts, there could be a 14 per cent increase in emergency department visits due to allergic asthma in the United States by 2090.²¹⁰

2.6 Ecosystem changes

Every year, more than

700,000 PEOPLE

die from vector-borne diseases; children account for the majority of these deaths.



Exposure data

In 2022, 4.9 million children under 5 years of age died globally.²¹¹ Infectious diseases, including pneumonia, diarrhoea and malaria, remain a leading cause, along with preterm birth and intrapartum-related complications.²¹² Vector-borne diseases are human illnesses caused by parasites, viruses and bacteria that are transmitted by vectors.²¹³ Every year more than 700,000 people die from vector-borne diseases such as malaria, dengue, schistosomiasis, human African trypanosomiasis, leishmaniasis, Chagas disease, yellow fever, Japanese encephalitis and onchocerciasis; children account for the majority of these deaths²¹⁴ the vast majority resulting from malaria alone, with a disproportionately high share in Africa.²¹⁵ There are also large morbidities associated with infectious diseases. From 2000 to 2019, WHO documented a 10-fold surge in reported cases of dengue worldwide, with cases increasing from 500,000 to 5.2 million.²¹⁶ Studies have found that the highest incidence of cases occur in children and adolescents, who are also prone to experience more severe symptoms.^{217, 218, 219}



Impacts on children

A changing climate threatens to disrupt the delicate balance of the world's ecosystems, leading to changes that impact all living things. This can create numerous serious consequences for children's health, arising from altered vector ecology, changing patterns of infectious diseases – including food- and water-borne diseases, and respiratory diseases – and increased risk from zoonotic diseases.

Vector-borne diseases: Malaria, dengue fever, Zika virus and Lyme disease

Climate change affects a range of vector-borne diseases and is likely to have a substantial impact on almost all neglected tropical diseases. Although estimates differ, the *World Malaria Report 2023* indicates that there were 249 million malaria cases and 608,000 deaths in 2022, with approximately three quarters (76 per cent) being among children under 5 years old.²²⁰ The percentage of total malaria deaths in children aged under 5 years decreased from 87 per cent in 2000 to 76 per cent in 2015.

Since then, there has been no change.²²¹ Despite recent progress in increasing insecticide-treated net (ITN) usage, only 56 per cent of children under 5 years in malaria-endemic countries slept under ITNs in 2023.²²² The relationship between local or regional weather trends (as well as other factors affecting mosquito habitats) and the geographic range, seasonality and prevalence of malaria is well understood.^{223, 224} With warming climates, the geographical spread of malaria will likely increase, including the reintroduction of malaria in locations that have eliminated malaria or are close to elimination, with a heightened or reduced transmission intensity depending on geography.²²⁵ However, there remain uncertainties around the degree to which climate change will affect the spread and prevalence of malaria, as well as its impacts on child mortality and morbidity,^{226, 227, 228, 229} especially in newly infected communities.

Malawi, 2024

© UNICEF/UNI585036/Chikondi



Malaria in pregnancy is associated with a higher risk of severe malaria, maternal anaemia and maternal mortality, as well as perinatal mortality, preterm birth, low birth weight and neurocognitive impairments.^{230, 231} In children, malaria can lead to cerebral malaria or severe malarial anaemia, which is associated with significant risks of mortality and long-term impacts on neurodevelopment, school performance and learning capacities.²³² There is some preliminary evidence that short-term weather trend changes, plausibly due to climate change, linked to high temperatures and increased flooding have led to more favourable conditions for malaria transmission in countries such as Mali, Uganda and Zambia.^{233, 234, 235, 236, 237} Intensified malaria transmission across sub-Saharan Africa could increase malaria-related under-five mortality by 10–15 per cent if no measures are taken to mitigate or adapt to climate change.^{238, 239} With accelerated climate change, the areas with the highest malaria prevalence will likely shift from West Africa towards eastern and southern rural Africa during this century.²⁴⁰ In recent years, studies have also explored internalizing and externalizing mental health conditions among children with severe malaria, especially cerebral malaria. Research over the last 15 years has demonstrated that many survivors of cerebral malaria sustain brain injury and/or experience long-term cognitive and neurological impairment.^{241, 242, 243, 244}

Intensified malaria transmission across sub-Saharan Africa could increase malaria-related under-5 mortality by 10–15 % if no measures are taken to mitigate or adapt to climate change.

Cases of dengue fever, which is caused by an arbovirus, have been rapidly increasing over recent decades. Climate variability, particularly average temperature change, is associated with a change in the geographic distribution of dengue fever.^{245, 246, 247} Infection with dengue during pregnancy is associated with more severe disease, post-partum haemorrhage and higher mortality, as well as adverse pregnancy outcomes, including stillbirth.^{248, 249} Infants with dengue antibodies from their mothers are particularly vulnerable because, unlike older children, adults who experience symptoms during a secondary infection, they can develop severe disease during a primary infection.²⁵⁰ Moreover, dengue fever, either from the infection itself or from the experience of the infection and potential hospitalization, might lead to depressive and anxiety symptoms among children.²⁵¹

Zika virus, another arbovirus, has high rate of vertical transmission during pregnancy and can lead to foetal loss or congenital Zika syndrome, with microcephaly and neurodevelopmental abnormalities.^{252, 253} Warmer temperatures are expected to extend the habitat of *Aedes* mosquitos and accelerate their development cycles; since 2015, the spread of Zika virus has increased rapidly in the Americas, particularly South America.²⁵⁴

Lyme disease, caused by *Borrelia burgdorferi* bacteria, is transmitted by ticks, with children often being at most risk.²⁵⁵ The disease has multisystemic effects and can cause cardiac, neurological, musculoskeletal, psychosocial and rheumatological symptoms, with implications for the mental and physical health of children and adolescents exposed to the disease, as well

as their caregivers' mental well-being.^{256, 257, 258} The lifecycles of the bacteria and tick are dependent on temperature and humidity, among other factors. Rising temperatures due to climate change have expanded the geographic areas of transmission of Lyme disease into more northern parts of North America and Europe, and increased the risk of transmission in endemic areas.^{259, 260} Moreover, there is sufficient literature linking exposure to infectious agents playing a role in neurologic and psychosocial impairments, although the exact nature of these associations are still emerging.²⁶¹

Water- and food-borne infectious diseases

Diarrhoea in children is a dangerous health threat that can lead to swift dehydration and other deadly health impacts. Worldwide, diarrhoea was estimated to cause 444,000 deaths in children under age 5 in 2021.²⁶² Water, sanitation and hygiene (WASH)-attributable diarrhoea deaths in children under age 5 was estimated to be around 273,000 deaths in 2019.²⁶³ The multifactorial aetiology of diarrhoea and its interaction with other determinants of child health make it difficult to attribute water- and food-borne child infection cases to climate change. However, a recent systematic review suggested that changes in temperature due to climate change could be responsible for a significant portion of all diarrhoea cases.²⁶⁴ Specifically, the prevalence of bacteria (such as *Escherichia coli*²⁶⁵ and *Cryptosporidium spp.*²⁶⁶), gastrointestinal viruses including rotavirus,²⁶⁷ and parasites such as *Giardia* and *Toxoplasma gondii*^{268, 269} has been shown to increase with higher temperatures.

In addition, rural areas experiencing lower amounts of rainfall experience higher diarrhoea incidence rates among children,^{270, 271} while higher precipitation levels in urban areas may increase diarrhoea incidence due to a lack of quality water and sanitation systems.^{272, 273}

Evidence from short-term weather changes possibly linked to climate change indicates that a warmer and drier climate, with longer dry seasons, could increase the intensity of rainfall during the wet season in some sub-Saharan countries that already have a high prevalence of diarrhoeal diseases and limited water and sanitation systems.^{274, 275, 276, 277, 278, 279} Similarly, increased precipitation in India may be linked to an increased prevalence of diarrhoeal diseases in children.^{280, 281} Increasing incidences of heavy rainfall and floods in Cambodia and China have shown that these events put children at risk for diarrhoea.^{282, 283} Evidence from other Asian countries suggests that, overall, temperature is the most important weather variable associated with diarrhoea, although this differs between geographic areas.^{284, 285, 286, 287, 288}

Respiratory pathogens and other infectious diseases

Children are more likely to contract bacterial or viral lower respiratory tract infections when precipitation and humidity levels increase.^{289, 290, 291} Changes in local weather, due either to extreme weather events or to long-term climate change, in the form of heatwaves, temperature variability and heavy precipitation, could make children more vulnerable to respiratory pathogens.^{292, 293, 294, 295, 296} A changing climate could also affect the geographical range and prevalence of other infectious diseases, such as mumps,^{297, 298} hand-foot-and-mouth disease,^{299, 300, 301} bacterial meningitis,³⁰² varicella viruses³⁰³ and parasitic diseases.³⁰⁴

There is also evidence that acute respiratory infections are attributable to unsafe WASH, with an estimated 112,000 WASH-attributable acute respiratory infection deaths in children under the age of 5 in 2019.³⁰⁵



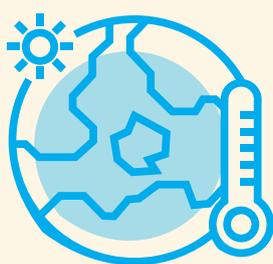
An estimated
240,000
CHILDREN
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Changing ecosystems, zoonotic diseases and antimicrobial resistance

Climate change leads to concrete changes in ecosystems and local environments, which can increase the touchpoints between children and animals, potentially leading to increased transmission and risk of outbreaks of zoonotic diseases.³⁰⁶ The links between climate change, infectious diseases including zoonoses, and antimicrobial resistance development are complex and multidimensional, requiring a One Health approach.^{307, 308}

For instance, while antimicrobial resistance is driven by several factors (including the use of antibiotics in farmed animals), higher temperatures can lead to greater antimicrobial resistance by increasing both bacterial growth rates and the incidence of horizontal gene transfer. Pressure on water and sanitation systems from extreme weather events can cause increased release of antimicrobial compounds into the environment and the spread of resistant microbes, while climate change-associated biodiversity loss can reduce natural defences against antimicrobial resistance development by, for example, reducing competition from other microbes.^{309, 310}

An estimated 240,000 children died in 2019 as a consequence of antimicrobial resistance,³¹¹ the overwhelming majority in low- and middle-income countries. Beyond direct mortality, antimicrobial resistance leads to longer recovery and hospital stays, incurring significant health-care costs for families and health systems and morbidity burden on children.³¹² While health interventions that embrace environmental aspects are being explored, knowledge of the intersection between antimicrobial resistance, climate change and children is limited.



Future scenarios for children

According to *The Lancet*, an additional 4.7 billion people may be at risk of the vector-borne diseases malaria and dengue by 2070.³¹³ One study estimated that almost half of the world's population could be at risk for dengue fever by the end of the century. Another estimate based on modelling predicts that in the worst-case scenario, over 1.3 billion new people could face 'suitable transmission temperatures' for Zika by 2050, a concern to large naïve populations in North America and Europe.³¹⁴ In the United States, the incidence of Lyme disease is estimated to increase by 20 per cent in the coming decades.^{315, 316} Resistance to microbial infections, according to the Review on Antimicrobial Resistance commissioned by the Government of the United Kingdom, could potentially kill 10 million people per year by 2050.³¹⁷

South Sudan, 2023

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Chapter 3.

Multipliers: Factors made worse by climate change

While all children will be impacted by a changing climate, the world's most vulnerable children are most at risk from the damaging effects of climate-related events, which can cause or exacerbate existing challenges with water scarcity and contamination; food security and contamination; damage to infrastructure; disruptions to services; and displacement of populations impacted. Their impacts are modulated by existing vulnerabilities that affect a child's ability to cope with the shocks, then lead to the overall decreased resilience of a community. For instance, children in low- and middle-income countries are likely to be more impacted by climate change and will have fewer resources to adapt or mitigate the effects of these multipliers, than high-income countries.

Water scarcity and contamination

Climate change-induced variations in the frequency and magnitude of extreme water-related events, such as flooding, are already making it more difficult for poor countries to maintain existing WASH services and to extend services to the underserved.³¹⁸ Flooding damages WASH infrastructure, contaminating water supplies and leading to unsafe discharges of faecal waste into the environment, which increases the spread of water-borne diseases. Droughts reduce the availability of water for drinking, cooking and personal hygiene, and increase reliance on alternative supplies that may be unsafe. In addition, drastic changes in precipitation and temperatures – contributing to floods or droughts – can degrade water quality at the source, with contamination from increased run-off of pollutants, saltwater intrusion, and presence of harmful microbes.³¹⁹

In 2022, 739 million children – almost one in three children globally – were exposed to high or extremely high-water scarcity.³²⁰ An estimated 594 million children globally still lack even basic drinking water, sanitation and hygiene services. Access to safe water and sanitation services is a universal human right. Ensuring this right would significantly reduce the burden of disease and death among children: inadequate WASH accounts for 69 per cent of diarrhoeal cases, 14 per cent of acute respiratory infections and 10 per cent of cases of malnutrition. Among children under 5 years of age, the total WASH-attributable burden of disease amounts to 395,000 deaths and 37 million disability-adjusted life years (DALYS), representing around 8 per cent of all deaths and DALYS in this age group.³²¹ Inadequate WASH can also have lifelong impacts on children's education and well-being, as children, particularly girls, are more likely to drop out of schools lacking basic WASH facilities. Extending coverage of WASH services in households, schools and health-care facilities and increasing their resilience to climate hazards are essential to mitigating the impacts on child health.³²²

Food insecurity and malnutrition

The impacts of climate change – including extreme heat, droughts and floods, and long-term damage to the quality of air, soil and water – are dramatically reducing the diversity, quality and quantity of food available to vulnerable children and their families.³²³ Currently, an estimated 200 million children under 5 years of age live in severe food poverty, 149 million children suffer from stunted growth and development, 45 million suffer from wasting and 37 million from overweight or obesity.³²⁴ A disproportionate number of these children live in countries at high risk of climate shocks.

Food insecurity and malnutrition are associated with various mental health outcomes among children and their caregivers.^{325,326} For instance, a systematic review of 108 studies showed a significant association between food insecurity and parental symptoms of depression, anxiety and stress, and between food insecurity and symptoms of depression, externalizing and internalizing behaviours, and hyperactivity.³²⁷

The world's food systems contribute one third of global greenhouse gas emissions, both from agriculture and from the carbon impacts of processing, packaging and transporting food. Ultra-processed foods contribute more to greenhouse gas emissions, as well as to biodiversity loss and plastic pollution.³²⁸ Worldwide, the massive growth in cheap, nutrient-poor and ultra-processed foods is an increasing threat to child nutrition and health.³²⁹ Climate change with increased average temperatures can lead to increased risk of obesity and overweight in children possibly due to lower physical activity and the displacement of health diets by making them less available and affordable.³³⁰

Projected future climate change will increasingly affect food security, with low-income consumers, particularly women and children, most at risk.³³¹ Children will continue to face a double burden of malnutrition, whereby undernutrition and micronutrient deficiencies coexist with overweight, obesity and other diet-related non-communicable diseases.³³² However, the bidirectional relationship between child nutrition and climate change presents an opportunity: to prevent child malnutrition while contributing to climate change mitigation through programming that enables children to access nutritious, safe, affordable and sustainable diets.³³³

Bangladesh, 2023

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Structural damage

The impacts of extreme weather are potentially worsened when these events disrupt or damage critical infrastructure such as

DRINKING AND WASTEWATER SERVICES, ROADS OR HEALTH-CARE FACILITIES

The impacts of extreme weather are potentially worsened when these events disrupt or damage critical infrastructure such as drinking and wastewater services, roads or health-care facilities.³³⁴ Damage to transportation infrastructure, which is essential to the efficient delivery of food and energy as well as access to jobs and markets, can cause significant human and economic losses.³³⁵ Flooding can lead to damage to and contamination of water supplies, with potentially devastating consequences for health. Droughts can reduce the performance of irrigation and hydroelectric systems, with consequent impacts on food supply.³³⁶ And damage to schools from extreme weather can disrupt the education of millions of children and young people, a situation that is often worsened by poor school design or construction.³³⁷ In the longer term, sea level rise as a result of climate change is likely to impact infrastructure and services, influence migration (particularly in small island developing states) and affect the agricultural viability of low-lying regions.

Increased frequency and intensity of extreme weather events such as floods, hurricanes and wildfires can lead to the release of toxic chemicals stored in industrial facilities, agricultural areas and waste disposal sites that are affected and/or damaged by the event.³³⁸ Mine sites, tailings dams and other infrastructure can be disrupted, leading to the release of hazardous chemicals.³³⁹ More frequent and intense flooding can increase chemical releases from waste disposal sites, leading to more extensive contamination of natural resources with harmful chemicals such as lead, cadmium and mercury.³⁴⁰ Intense flooding in agricultural areas may leach toxic pesticides into the environment.³⁴¹

To date, there has been little attention on the role of physical infrastructure in the relationship between climate-related hazards and risks to human health and well-being, and therefore understanding of how infrastructure can help to prevent these risks is limited.³⁴² Buildings, including community centres and schools, can be designed to mitigate the impacts of climate stresses and shocks: for example, by limiting the ingress of polluted air or disease vectors (such as mosquitoes), or by ensuring that electricity supplies and air conditioning systems continue to function during extreme heatwaves. Infrastructure that is specifically intended to mitigate the impacts of extreme events, such as flood defences, can also be constructed.

Service disruption

Close to
**1 BILLION
PEOPLE**
in low- and lower-middle
income countries are already
being served by health-care
facilities with unreliable or
no electricity supply. Climate
hazards can exacerbate this.

Climate change and extreme weather events can disrupt access to essential services for children, such as education, health care, and social care, as well as other services vital to their well-being, including water and electricity supplies. Disruptions in accessing these services, especially in regions where inequities in service access and delivery already exist, can lead to long-term impacts on the physical and mental health and psychosocial well-being of children;³⁴³ for instance, close to 1 billion people in low- and lower-middle income countries are already being served by health-care facilities with unreliable or no electricity supply, and climate hazards can exacerbate this.³⁴⁴ Another example is HIV, with climate change presenting significant challenges to improve access to prevention and other necessary services especially in hard to reach areas. The mental health implications are significant, as disruptions in routine and accessibility to essential services can increase stress, anxiety, and feelings of instability among children. Prolonged disruptions can lead to chronic stress disorders, affecting children's emotional regulation and developmental outcomes. Disruption to services can also lead to loss of livelihoods and resources, affecting families' abilities to ensure a safe and stable home for their children.³⁴⁵

Every year, nearly 40 million children have their education disrupted by natural hazards and disease outbreaks.³⁴⁶ Some disasters lead to schools being closed, rendered inaccessible, or unable to provide regular lessons. A lack of consistent, quality education limits the potential of children and young people, and harms their long-term learning and skills development. It can also have implications for mental health and psychosocial well-being. The disruption of educational routines can exacerbate feelings of anxiety and loss of control, leading to decreased self-esteem and increased risk of psychological distress.

Climate change and extreme weather events can have varying and often unpredictable consequences for electricity supplies. While extreme events can lead to temporary blackouts, changes in demand, degrading grid conditions and uncertainty around renewable energy sources can all affect the performance of energy systems over the longer term.³⁴⁷ Some forms of energy generation can be directly affected by climate change; for example, hydropower generation depends directly on the availability of water resources and, therefore, on rainfall.³⁴⁸

Key community services such as social protection schemes are often affected by extreme weather events. Those who depend on social protection are already more vulnerable to climate-related impacts such as food price increases; often more exposed to hazards; and likely to lose relatively more in the event of a disaster. Climate change has already increased poverty and this is expected to worsen as temperatures and exposure to climate-related risks continue to rise.³⁴⁹ The World Bank estimates that an additional 68 to 135 million people could be pushed into poverty by 2030 because of climate change, as well.³⁵⁰

These climate-related disruptions to services necessary to protect children – such as psychosocial services and education access – can also intensify competition over land and water resources, thereby putting already vulnerable children at an increased risk of experiencing violence, neglect and mistreatment.³⁵¹

South Sudan, 2023

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Displacement

Already, millions of children have experienced displacement due to extreme weather events exacerbated by climate change. Between 2016 and 2021, there were 43.1 million internal displacements of children linked to weather-related disasters – equivalent to around 20,000 child displacements per day. Nearly all (95 per cent) of these were due to floods or storms.³⁵² South Sudan and Somalia experienced the most child displacements from floods relative to the size of their child populations.

Even short-term displacement can multiply climate risks faced by children and their families. In the immediate aftermath of a disaster, children can be separated from their families, increasing their risk from abuse and exploitation. Displacement can also disrupt access to education and health care, exposing children to disease, malnutrition and inadequate immunization.³⁵³ Young children are particularly vulnerable to the effects of this disruption given their early stage of physiological and cognitive development and reliance on adults for their well-being and security.³⁵⁴ Other children at particular risk include those with existing or complex health-care needs, and those living in communities that are marginalized or have fewer resources.

Between 2016 and 2021,
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Children displaced by climate and ecological crises face increased exposure to severely distressing or adverse events and risks to their safety, compounded by poor or precarious living conditions and lack of access to basic services. Children and caregivers with pre-existing mental health conditions are especially at risk of relapse or deterioration. They can face stigma and discrimination and need continued access to care. These are considerable risk factors for the mental health and psychosocial well-being of children and their caregivers. The potential mental health impacts of displacement for children are wide-ranging, but include symptoms of depression, anxiety, and other stress related disorders such as post-traumatic stress disorder (PTSD) and school behavioural problems. Symptoms of PTSD in children are relatively common after disasters (estimates vary from 29 per cent to 71 per cent).³⁵⁵

Adolescent girls are disproportionately impacted by violence and exploitation during times of crisis and through displacement, and young children with disabilities are also among the most marginalized and at-risk people in communities affected by humanitarian crises, being more vulnerable to higher rates of mental health issues.³⁵⁶

Indonesia, 2020

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Chapter 4. Recommendations

Every child has the right to a clean, healthy and sustainable environment.

To this end, in 2023, the United Nations Committee on the Rights of the Child outlined the obligations of the state and noted that, as environmental decisions generally concern children, the *best interest of the child* shall be a primary consideration in the adoption and implementation of environmental decisions, including laws, regulations, policies, standards, guidelines, plans, strategies, budgets, international agreements and the provision of development assistance.³⁵⁷

The recommendations, following the evidence presented in this report, focus on what is needed to protect the survival, health and well-being of children from climate-related hazards. Unless mitigation efforts are accelerated and adaptation efforts are scaled up urgently, current and future generations of children will continue to bear the brunt as climate change affects their survival, and lifelong health and well-being.

Belize, 2024

© UNICEF/UNI594468/Dejongh

To this end, the world must work together to:



#1: Reduce emissions to meet 1.5°C degree threshold ensuring the best interest of the child ^{358, 359, 360, 361}

The window of opportunity to prevent a more dangerous world for children and future generations is fast closing. As of November 2023, 145 countries have either adopted, announced or are discussing net zero greenhouse gas or net zero carbon emissions commitments. However, according to the IPCC, given the current global greenhouse gas emissions trajectory, the global temperature increase is likely to exceed the 1.5°C threshold committed to under the 2015 Paris Agreement, and limiting warming to 2°C will be challenging. Commitments, therefore, must translate into action that ensure rapid, deep and – in most cases – immediate greenhouse gas emission reductions.

To effectively prioritize child health, co-benefits in climate mitigation efforts, governments should focus on targeted interventions that address multiple challenges simultaneously. Investing in cleaner energy sources is vital to reducing household air pollution, which significantly impacts children's respiratory health and is a leading risk factor contributing to child mortality. Advancing access to clean cooking and sustainable energy, and delivering on the Paris Climate Agreement are inextricably linked. Every effort must be made to ensure that places where children are born, live, learn and play are prioritized first.

Integrating climate education into school curricula can promote the early adoption of healthy lifestyles, such as active mobility, and instil awareness about the importance of sustainable diets and food practices. By building green infrastructure that improves children's health and empowering children with knowledge and skills to mitigate climate change's health impacts, governments can foster a generation of environmentally conscious individuals capable of making informed decisions that both benefit them individually and contribute to lowered global emissions levels.

Finally, some climate technologies also risk contributing to the toxic burden borne by children, particularly in low- and middle-income countries. Circular economy practices, relevant environmental governance and sustainable approaches to extraction should always be implemented in the best interest of the child.

Specific actions and investments are needed to ensure:

- Countries with greater capacity and responsibility for emissions – particularly high-income and high-emitting countries among the G20 – take more ambitious and rapid action, and provide financial and technical support to developing nations.
- Energy transitions in low- and middle-income countries that provide universal access to energy lift millions out of poverty and expand strategic industries.
- The elimination of cooking poverty by 2030, thereby enabling the world's poor to cook with modern fuels and technologies, and reduce child deaths attributable to household air pollution.
- The transition to sustainable energy in health, education and water sectors in low- and middle-income countries increasing access to critical services that build human capital whilst reducing emissions.
- The scale-up of climate education programmes in schools to improve the uptake of active mobility, sustainable diets and food practices.
- A swift transition to green infrastructure that ensures cleaner air, road safety, mental health and opportunities for physical activity, whilst supporting skills development in furthering a just transition.
- Decarbonization technologies are integrated with detoxification strategies to minimize the toxic burden on children and the planet.



#2: Protect children from the impact of climate change:

With the growing intensity and frequency of the climate shocks and stresses being felt by children, adaptation efforts must be urgently prioritized in national agendas and must focus on protecting children from climate change-related hazards. Key climate policies and commitments such as Nationally Determined Contributions, National Adaptation Plans and the plans of health and health-determining sectors must meet the basic needs of children by prioritizing the following actions and investments.

Provide caregivers with information and skills to protect children^{362, 363, 364}

Caregivers and providers need to have the right information at the right time, as well as the right capacities to protect children in their communities. To enable this,:

- a) Governments should invest in early warning and alert systems that can trigger the necessary actions on the frontlines, initiating state-supported community and household measures that protect children from climate-related impacts.
- b) Risk communication campaigns should raise awareness on the unique vulnerabilities of children and actions caregivers and providers can take to protect children.
- c) Government should support building the capacities of health workers including through pre-service and in-service trainings critical for the prevention and management of climate-related health impacts.

Specific actions and investments are needed to ensure:

- Multi-hazard early warning systems reach caregivers and providers with early warnings and risk communication including the relevant vulnerability of children.
- Caregivers and teachers are oriented on the unique vulnerabilities of children and actions they can take to protect them from climate and environment related hazards.
- Health workers have the skills to recognize, prevent, diagnose and manage children's physical and mental conditions related to climate and environmental hazards.
- Health services, parent-teacher associations, peer groups, digital and other community platforms engage caregivers on the impact of climate change on children's health and well-being across the life course and how to protect them.

Ensure a focus on primary health care towards climate-resilient and low-carbon health systems ^{365, 366, 367, 368, 369, 370, 371}

Primary health care is the cornerstone of a resilient health system, as it delivers on basic health services and addresses broader determinants of health equitably and acts as a foundation for achieving future universal health coverage. A reorientation of health systems towards ensuring climate-resilient primary health care will ensure maximum coverage on the frontlines to protect children from the impacts while also reducing its own contributions to it. Additionally, such a reorientation will also improve health equity and community ownership, and subsequently support better preparedness for the shocks ahead.

A focus on climate-resilient primary health care will ensure that children always have access to essential maternal, newborn, child and adolescent health and nutrition services that are responsive to ongoing and emerging climate-related hazards and fully mainstream the children's environmental health.

Specific actions and investments are needed to ensure:

- A community health workforce that is sufficiently trained, paid, protected, supervised and equipped to deliver the highest quality of care to protect children from climate and environment related hazards.
- Health facilities and workers at the primary health-care level are able to operate through emergencies and disasters, taking into account climate change scenarios, and capable of managing the additional patient burden during the response.
- The health facility infrastructure at the primary health-care level is climate-resilient and environmentally sustainable, providing electricity, water, waste management and sanitation services, technology and products including connectivity.
- The essential supplies to deliver maternal, newborn, child and adolescent health services in the face of climate-related hazards remain accessible.
- Monitoring and surveillance systems that continuously assess the impact on child health outcomes from climate change.

Safeguard access to food and water while establishing climate-resilient water and sanitation infrastructure ^{372, 373, 374, 375}

The bidirectional relationship between child nutrition and climate change provides the opportunity to prevent child malnutrition while contributing to climate change mitigation through programming that enables children, adolescents and women to access nutritious, safe, affordable and sustainable diets, essential nutrition and care services, and healthy food environments and nutrition practices. Adaptation efforts must guarantee food security by combining supply-side actions such as efficient production, transport and processing of healthy nutritious foods with demand-side interventions such as improved food practices, and reduction of food loss and waste.

Water supply and sanitation systems that are climate-resilient from the start and prioritize retrofitting existing infrastructure to improve resilience of operational and maintenance activities will be critical. Scaling-up of sustainable WASH services should start in the household and community, educational centres and health-care facilities – all spaces vital for children’s survival. Improved water resource management practices in agriculture and other industries can help reduce demand on freshwater supplies. In parallel, nature-based and innovative water storage and management systems can help mitigate water scarcity during prolonged dry spells.

Specific actions and investments are needed to ensure:

- Nutrition services are climate-resilient and can ensure community-based early prevention, detection and treatment of child malnutrition.
- Food security is guaranteed by combining supply-side actions such as efficient production, transport, and processing of healthy nutritious foods with demand-side interventions such as improved food practices, and reduction of food loss and waste.
- An integrated water resource management approach to secure water availability and quality.
- Access to safe water and sanitation systems that can withstand climate hazards.

Ensure better preparedness and response to the triple planetary crises ^{376, 377, 378}

The extent and magnitude of the triple planetary crisis, comprising the climate emergency, the collapse of biodiversity and pervasive pollution, is an urgent and systemic threat to children's rights globally.

Disaster risk reduction strategies can help local governments and communities to effectively prepare for, cope with and respond to the range of outcomes associated with climate hazards. This entails:

- a) designing policies to operate under a range of risk scenarios;
- b) scaling up comprehensive disaster and climate risk management; and
- c) investing in sustainable and resilient infrastructure systems and utilizing traditional and indigenous knowledge.

Humanitarian responses during extreme weather events must ensure access to safe shelter or evacuation from vulnerable areas. Responses must afford access to health and nutrition services, safe water and sanitation, mental health and psychosocial support, continuity in education whilst ensuring community resilience and building long-term resilience.

The world must build preparedness and resilience to pandemics and other global health emergencies. This includes supporting the prevention, detection and responses to health-related outbreaks with pandemic potential and ensuring equitable access to countermeasures.

Finally, an integrated, unifying One Health approach that aims to sustainably balance and optimize the health of people, animals and ecosystems must be promoted. This will ensure holistic solutions that protect children from polluted air, water and soil, combat antimicrobial resistance, promote access to nutritious foods, identify and mitigate the risk of zoonotic disease transmission, preserve natural habitats and promote outdoor activities that can support children's mental well-being.

Specific actions and investments are needed to ensure:

- Proactive steps are taken to prepare communities, childcare centres, schools, health facilities and households for climate-related hazards, responsive to children's needs across their life stages as well as their vulnerabilities (e.g., supporting children with disabilities). This includes disseminating information about evacuation routes, shelter locations, emergency contacts, and household and institutional preparedness kits.
- Humanitarian action delivers life-saving interventions, including mental health and psychosocial support, family reunification and ensure the protection of children from violence, exploitable and abuse.
- A prompt and effective response to the first signs of a disease outbreak and the protection of children and their communities from exposure to and the impacts of public health emergencies.
- The adoption and scale-up of a holistic One Health approach to building integrated systems and capacity to better prevent, predict, detect and respond to child health threats collectively.



Prioritize child-sensitive and shock-responsive social protection services ^{379, 380, 381}

Climate risk for children is critically influenced by the extent to which children and their families can access social protection and basic services such as health and education. Comprehensive and integrated policy approaches to shock-responsive social protection systems can effectively identify vulnerabilities and enhance resilience for the most disadvantaged children and their families, as well as enable their recovery after a climate shock.

Displacement is a multiplier for climate-related hazards for children and their families. It is critical to ensure that migration is safe and empowering, and that children and young people are in the best possible position to integrate and thrive in their host communities, as well as reintegrate upon return.

Specific actions and investments are needed to ensure:

- Universal child benefits that can quickly be scaled up or adjusted in times of emergency, given their wide coverage complemented with anticipatory cash transfers in countries with recurring extreme weather events.
- Disability benefits, unemployment benefits, pensions, which can protect from income loss due to climate shocks focusing on women and girls, and children with disabilities.
- Insurance and credit options that allow for funding access during or immediately after climate-related emergencies to enable mitigation and recovery, focusing on protecting households with children in poverty or those vulnerable.
- Child-critical services for children displaced – including education, health, social protection and child protection – that are shock responsive, portable and inclusive.

#3: Prioritize child health and well-being in climate policy, investment and action

Climate action should always be taken based on the impact on child health and well-being. By considering the specific risks and challenges faced by children, decision makers can implement targeted strategies to protect their health, ensure their safety, and secure their future. Additionally, focusing on children's well-being can serve as a moral imperative, as they are the ones who will bear the long-term consequences of today's climate actions or inactions. Prioritizing children in climate decisions not only safeguards their health and well-being but also fosters resilience and sustainability for future generations.

This report underscores significant gaps in evidence, notably the absence of global or country-level estimates of child mortality or morbidity related to climate change. Locally generated data through national health information systems or household surveys are critical to helping establish these estimates.

Studies on climate impacts rarely centre on children, especially in low-income or fragile settings, with limited analyses disaggregated by age group or sex. Furthermore, understanding of how climate change intersects with other determinants of child health and well-being, such as pollution and loss of biodiversity, remains limited.

Finally, multistakeholder collaborative approaches that bridge the knowledge to action gap and catalyse the much-needed action on children's environmental health are critical. These include the sharing of data, resources, best practices, tools and educational materials for evidence-based action.

Specific actions and investments are needed to ensure:

- Vulnerability and adaptation assessments prioritize the impact of climate change on child health and well-being across the life course.
- Generating evidence to establish global or country-level estimates of child mortality or morbidity related to climate change are available.
- National household surveys, such as DHS and MICS, and health information systems incorporate indicators to assess the impact of climate change on child health and well-being.
- Research focuses on the impact of climate change on children across the life course to support comprehensive local and national action including using implementation research and participatory action.
- Knowledge to action gaps at the local and global levels are bridged through multistakeholder collaborative action on children's environmental health.

Nigeria, 2023

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Thailand, 2023

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**Key resources
for protecting
children from
climate impacts**

B. The Children's Environmental Health Collaborative

UNICEF, in collaboration with the United Nations Environment Programme and the World Bank, has founded a multi-stakeholder initiative uniting partner efforts around a common vision – that all children deserve to grow up in a clean, healthy, and sustainable environment. Governments and international civil society partners and the private sector are invited to join this effort to inspire, motivate, equip and mobilize efforts through advocacy, brokering knowledge and catalysing action.

In addition to the CEH country profiles, the collaborative hosts technical and guidance notes specific to protecting children from a range of climate and environmental hazards, such as extreme heat, wildfire smoke and air pollution. It also features easy-to-use communication materials such as expert videos, communication assets and key messages to spread the message and mobilize action.

The collaborative hosts the first of its kind e-course on children's environmental health, aimed at equipping health workers globally with the skills they need to recognize, prevent, diagnose and manage children's conditions related to an array of environmental threats.

Rwanda, 2020

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Visit www.ceh.unicef.org to find these resources and more.



C. Resources on climate and children

- **The world's children need urgent action on climate change:** A call to action with specific recommendations on how to protect children as part of larger climate adaptation efforts by governments. Read at <https://www.unicef.org/documents/children-need-urgent-action-climate-change>
- **Nationally Determined Contributions for Every Child platform:** When policies are child-sensitive, their potential to lower child vulnerability to climate change increases, and also position children and young people to be more aware, educated, empowered and resilient. This platform showcases 48 indicators providing context for understanding child-sensitivity of available Nationally Determined Contributions (NDCs). Go to <https://ndcsforeverychild.unicef.org> (English) and <https://ndcsparacadainfancia.unicef.org> (Spanish).
- **Loss and Damage Finance for Children:** This report explores losses and damages that relate directly to children's rights and well-being. It identifies opportunities for the Loss and Damage Fund, together with other loss and damage financing, to address the negative impacts of loss and damage on present and future generations of children. Read at <https://www.unicef.org/globalinsight/media/3276/file/UNICEF-Innocenti-Loss-Damage-Finance-2023.pdf>
- **The Climate-Changed Child:** This report builds on 2021's Children's Climate Risk Index and examines water scarcity and water vulnerability along with the critical actions the international community must take at COP28 to protect children against climate change. Read at: <https://www.unicef.org/reports/climate-changed-child>
- **Words into Action: Engaging children and youth on the frontline of disaster risk reduction and resilience:** This guide offers access to global expertise, communities of practice and networks of practitioners with specific advice on how to support and engage children and youth, with a section on health. Read at: <https://www.undrr.org/words-into-action/engaging-children-and-youth-disaster-risk-reduction-and-resilience-building>
- **Global Learning4ClimateAction Platform:** A collection of engaging and interactive modules to help understand how the triple planetary crisis is affecting our planet. Learn at <https://climateaction.learningpassport.org>

- ***Engaged and Heard! Guidelines on adolescent participation and civic engagement:*** These guidelines provide information on the 'why', 'what' and 'how-to' of adolescent participation and civic engagement, including sector-specific recommendations related to health programming. Read at <https://www.unicef.org/documents/engaged-and-heard-guidelines-adolescent-participation-and-civic-engagement>
- ***Air quality: It's time to act!:*** This is a youth air pollution guide to understanding the key tools for making progress towards the global climate action goals and the Sustainable Development Goals, including the Paris Agreement, Nationally Determined Contributions and other tools. Read in English and Spanish at <https://www.unicef.org/lac/en/reports/air-quality-its-time-act>

D. Additional resources

- **Alliance for Transformative Action on Climate and Health (ATACH):** An alliance that works to realize the ambition set at COP26 to build climate-resilient and sustainable health systems, using the collective power of WHO Member states ('Member states') and other stakeholders to drive this agenda forward at pace and scale; and promote the integration of climate change and health nexus into respective national, regional and global plans. Learn more and join at <https://www.who.int/initiatives/alliance-for-transformative-action-on-climate-and-health>
- **ClimaHealth.info:** A global open-access platform to serve as a technical reference point for users of interdisciplinary health, environmental, and climate science. It seeks to explain the climate and health nexus, provide capacity building resources and solutions, and a resource library. Visit at www.climahealth.info
- **Clim-HEALTH Africa:** Supported by the International Network for Climate and Health for Africa, it acts as a coordination platform and a knowledge repository for the latest briefs and reports on climate issues affecting the region. Visit at <https://climhealthafrica.org/>
- **Global Heat Health Information Network:** An independent, voluntary, and member-driven forum of scientists, practitioners, and policymakers focused on improving capacity to protect populations from the avoidable health risks of extreme heat in our changing climate. It hosts resources and trainings related to addressing heat health. Visit at <https://ghhin.org/>
- **The Global Climate and Health Alliance:** A global community of health and development organizations advocating for climate solutions that prioritize health co-benefits for all. Visit at <https://climateandhealthalliance.org/>
- **Harvard C-Change Resources:** a compilation of climate and health resources for caregivers and health providers working to protect children's health. Visit at <https://www.hsph.harvard.edu/c-change/news/climate-and-health-resources/>
- **Columbia's Global Consortium on Climate and Health Education:** The consortium provides resources for a range of health professionals, from medical providers to social workers, on climate and health issues, as well as training events. Visit at <https://www.publichealth.columbia.edu/research/programs/global-consortium-climate-health-education/>

Ethiopia, 2023

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Annex: Approach to methodology and evidence gaps

Methodological considerations

Although the evidence provided in this report was collected and synthesized through a structured approach, it is not intended to serve as a systematic review of the academic field. First, existing peer-reviewed literature on how climate change impacts child health was considered to develop the conceptual framework and outline key climate hazards. To ensure that the most recent data and developments were covered, a focused literature search comprising three broad search blocks (definition of children, health and/or well-being and the related climate hazard) was conducted in the MEDLINE database. Only English language articles and those published after the year 2000 were considered. It was beyond the scope of this work to provide a comprehensive literature search for each climate hazard and its impact on children's health; rather, the aim of the literature search was to ensure that the most up-to-date evidence was included for each chapter. From the review papers and the literature search, key articles were compiled for each climate change hazard. Additionally, data from key sources including non-peer reviewed grey literature were included where relevant. A formal quality assessment of the included articles or documents was not carried out due to the broad range of literature and high number of relevant articles. However, the climate change hazards that were most described in the literature or where a higher number of studies provided evidence of the impact on child health and well-being were given more emphasis. We may have missed evidence from other sources. Finally, extensive external consultations with leading researchers within the field were carried out to provide additional key references and input to the scientific quality and rigor of the report. The stocktake serves as a narrative review of the ever-expanding and diverse literature on how children are confronted by climate change.

Evidence gaps

This stocktake presents evidence on the most important climate change hazards and how they impact child health throughout the life-course. However, there are many evidence gaps when it comes to climate change and child health. The most pertinent of these is the lack of global or country-level estimates of climate change-related child mortality or morbidity. Children are rarely the sole focus of climate change impact studies and the studies conducted are still predominantly concerned with higher or middle-income settings. A life-course and multisectoral approach to children within climate research is still emerging and analyses disaggregated by age-group or sex are scarce. Additionally, many health impact studies have various definitions of

climate change or climate hazard, which makes it difficult to conduct rigorous systematic or meta-analyses of impacts across different studies. This needs to be strengthened while national risk assessments and national strategic plans for children and adolescents with regards to climate change should be developed. Moreover, the understanding of how climate change relates to other important social, political and commercial determinants of child health, survival and well-being is limited. Indeed, data and evidence on how climate change shape and is shaped by inequities must be strengthened. We have a limited understanding of how multiple overlapping climate change hazards interact to impact child health. Rejuvenating research action to overcome these evidence gaps will be critical to designing impactful adaptation and mitigation strategies.

Financing of innovative and locally relevant research to close the knowledge-to-implementation gap, such as participatory action research, implementation research, and health systems and policy research, which fosters on the approach of turning evidence and policy into action systematically, is also critical for realizing which solutions have practical applications and potential for scale-up in various cultural, socio-economic and geographic contexts.

Key overarching child health and climate change review papers

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- A future for the world's children? A WHO–UNICEF–Lancet Commission report ([www.thelancet.com/article/S0140-6736\(19\)32540-1/fulltext](http://www.thelancet.com/article/S0140-6736(19)32540-1/fulltext))
- Children in all policies 2030 initiative (<https://cap-2030.org>)
- The Intergovernmental Panel on Climate Change (www.ipcc.ch)

Côte d'Ivoire, 2023

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