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Climate-related Health Risks in School Age Children

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Today's Objectives

1. Articulate 3 climate-related health risks that may impact children and adolescents
2. Identify factors that place school age children at risk for climate-related health harms
3. Identify strategies to prevent or mitigate climate-related health impacts in school age children

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Climate Change, School Health, and School Nursing: A Call to Action

- Consider assessing environmental exposures during school physical exams
- Consider more frequent assessments of children at risk
- Consider starting an environmental/climate justice committee
- Food waste audit
- Limit school bus idling
- Sustainable utensils

Cowell, 2019, The Journal of School Nursing

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National Association of School Nurses

- 2020: Joined the Nursing Collaborative on Climate Change and Health, a partnership between the Alliance of Nurses for Healthy Environments (AHNE), Climate for Health, and other schools and national nursing organizations
- NASN School Nurse 2024 4-part series on the role of the school nurse addressing climate change

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Environmental Health

Position Statement

NASN POSITION
 It is the position of the National Association of School Nurses (NASN) that to protect and promote the health of all children, robust environmental health protections must be in place, and the inequities that lead to environmental injustice must be eliminated. The environment is a powerful social determinant of health and a critical factor in our children's development, academic performance, and future socioeconomic status. The registered professional school nurse (hereinafter referred to as school nurse) assesses for environmental health hazards, implements and coordinates individual health and social interventions, and addresses social determinants of health based on the National Association of School Nurses (NASN) Framework for 21st Century School Nursing™ (NASN, 2016), to positively influence children's environmental health (Campbell & Anderko, 2020).

NASN, 2021

National Association of School Nurses

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Climate Change Strategies

Mitigation: reducing and stabilizing the levels of heat-trapping greenhouse gases in the atmosphere

Adaptation: reducing our vulnerability to the existing impacts of climate change as well as making the most of inevitable changes (eg. increased growing seasons)

Resilience: the ability to prepare and plan for, absorb, recover from, and more successfully adapt to adverse events.

Note: there are health co-benefits to addressing climate change impacts (e.g. increased physical activity; decreased meat consumption)

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Climate change is an urgent global public health and health equity issue.

CHANGES IN CLIMATE

- Temperature increase
- Sea level rise
- Changes in land and sea ice
- Changes in precipitation
- Changes in extreme weather events

EFFECTS OF CLIMATE CHANGE

- Extreme heat
- Extreme cold
- Water scarcity
- Food and nutrition insecurity
- Displacement and migration
- Loss of biodiversity
- Loss of ecosystems
- Loss of cultural heritage
- Loss of livelihoods
- Loss of homes
- Loss of infrastructure
- Loss of services
- Loss of access to health care
- Loss of access to education
- Loss of access to justice
- Loss of access to information
- Loss of access to participation
- Loss of access to power
- Loss of access to resources
- Loss of access to opportunities
- Loss of access to choices
- Loss of access to freedom
- Loss of access to well-being
- Loss of access to dignity
- Loss of access to respect
- Loss of access to recognition
- Loss of access to rights
- Loss of access to justice
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- Loss of access to respect
- Loss of access to recognition
- Loss of access to rights

HEALTH IMPACTS

- Non-communicable diseases
- Infectious diseases
- Mental health
- Maternal and child health
- Antimicrobial resistance
- Health equity
- Health systems
- Health workforce
- Health financing
- Health governance
- Health research
- Health innovation
- Health leadership
- Health partnerships
- Health accountability
- Health transparency
- Health integrity
- Health ethics
- Health law
- Health policy
- Health strategy
- Health vision
- Health mission
- Health values
- Health culture
- Health identity
- Health reputation
- Health brand
- Health image
- Health perception
- Health belief
- Health attitude
- Health behavior
- Health habit
- Health lifestyle
- Health environment
- Health community
- Health society
- Health nation
- Health world

INTERVENTIONS STRATEGIES

- Climate-resilient health systems
- Health equity
- Health systems
- Health workforce
- Health financing
- Health governance
- Health research
- Health innovation
- Health leadership
- Health partnerships
- Health accountability
- Health transparency
- Health integrity
- Health ethics
- Health law
- Health policy
- Health strategy
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- Health lifestyle
- Health environment
- Health community
- Health society
- Health nation
- Health world

INEQUALITY-ADJUSTED HUMAN DEVELOPMENT INDEX, 2022

The Inequality-adjusted Human Development Index (IHDI) is a summary measure of the dimensions of human development: a long and healthy life, a good education, and a decent standard of living, adjusted for inequality in these dimensions. Higher values indicate higher and more equal human development.

Source: NH Climate Change and Health Initiative (<https://www.nhcc.gov/our-work/health>) October 2022

Source: UNDP Human Development Report 2024

Dr/Willi-Daewy/Innov-Development Index/CC BY

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Climate Justice

Those who contribute least to greenhouse gas emissions bear a disproportionate burden of negative health impacts...

“First and worst”

WORLD RESOURCES INSTITUTE

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On a global scale:

- 2 billion people lack safe drinking water
- 600 million experience foodborne illnesses
- 3.6 billion people are living in areas susceptible to climate impacts
- Between 2030 and 2050, 250,000 additional deaths/year are expected from undernutrition, malaria, diarrhea, and heat stress (World Health Organization, 2023)

Examples from the 2024 *Lancet* Countdown on Health and Climate Change (Beyeler et al., 2024):

- Infants and adults>65 experienced an average of 13.8 heatwave days per person
- 512 billion potential work hours lost; 63% in agriculture (higher in low Human Development Index [HDI] countries)
- 6% more hours of sleep lost than average during 1986-2005 period (new indicator)
- 31 countries experienced 100+ more days of extreme heat than expected without climate change-- more in low HDI countries
- Increased frequency of heatwaves & drought months in 2022 compared with 1981-2010 was associated with 151 million more people experiencing moderate or severe food insecurity across 124 countries subsistence farmers and Indigenous peoples (particularly Indigenous children) (Romanello et al., 2024)

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In the US:

- 2023 *Lancet* US Brief
 - Maricopa County had approximately 425 heat-related deaths
 - Severe drought in southern and midwestern US
 - Lahaina fire
 - Malaria: Arkansas, Texas, Maryland, and Florida
 - Dengue: Arizona, California, Florida, Texas
- 2024 *Lancet* US Brief Datasheet
 - In 2021, approx. 125,8000 deaths from air pollution (PM 2.5) in US = \$669 billion in monetized premature mortality
 - From 2014-2023, infants and adults >65 years were exposed to 9.3 & 8.4 heatwave days respectively (more than double from 1866-2005)
 - From 2014-2023, length of coast with conditions suitable for *Vibrio* was 50% great than in 2000-2004

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Who's most at risk?

- The very young; very old
- Women, pregnant people
- Children**
- Socioeconomically disadvantaged
- Indigenous Peoples
- Communities of Color
- Those living with disabilities
- Those with housing insecurity
- Those living with chronic physical and mental illness

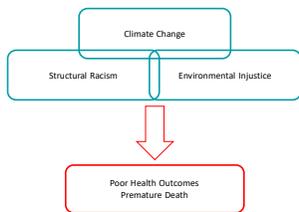
(Clayton et al., 2021)



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Emerging *Syndemic*:



- Co-occur in temporal or geographical contexts due to harmful social conditions
- Can occur at the population or individual level
- Leads to mutual enhancement of the negative effects of each condition

Berkower et al., 2022 (Eds.) National Academies of Science, Engineering, & Medicine

Singer et al., 2017

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Examples of Disparities in Child Health Outcomes

- Risk of ED visits for multiple causes associated with extreme heat days were higher among racially minoritized children than White children (47 children’s hospitals across the US)
- 7.2% of students grades 3-12 in all Puerto Rico public schools (n=6900) reported had clinically significant PTSD
- Latinx child farmworkers in North Carolina: roughly 50% experienced at least 1 heat-related illness over the preceding 12 months
- Children of color (particularly Blacks, Hispanic/Latinos) are at risk for poor birth outcomes

Berberian et al., 2022, *Current Environmental Health Reports*

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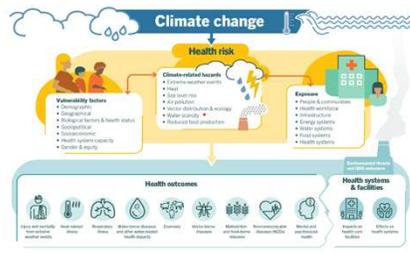


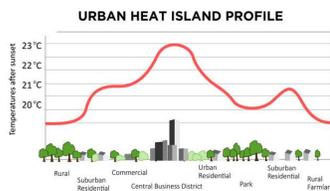
Figure: An overview of climate-sensitive health risks, their exposure pathways and vulnerability factors. Climate change impacts health both directly and indirectly, and is strongly mediated by environmental, social and public health determinants.

WHO Climate Change and Health <https://www.who.int/news-room/fact-sheets/detail/climate-change-and-health>

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Heat-related Morbidity and Mortality



<https://www.worldatlas.com/articles/urban-heat-island-causes-and-consequences.html>

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Extreme Weather Events

Individual

- Death
- Heat exhaustion/heat stroke
- Hypothermia/frostbite
- Trauma-related injury (including IPV and child maltreatment)
- New onset illness
- Mental health impacts
- Exacerbation of chronic illness due to lack of access to health care and medications

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Air Pollution

PRIMARY LINKAGE

WILDFIRE FEEDBACK LOOP

- In 2015, air pollution was responsible for 6.4 million deaths worldwide
- 2.8 million household
- 4.2 million ambient air pollution
- 5th highest risk factor for death behind HTN, smoking, increased fasting glucose, and high total cholesterol
- 15 % of Covid-19 deaths worldwide
- Under-appreciated cause of non-communicable diseases (heart attack, stroke are examples)

(Landrigan, *The Lancet*, 2017, [http://dx.doi.org/10.1016/S2468-2667\(16\)30023-8](http://dx.doi.org/10.1016/S2468-2667(16)30023-8))

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Particulate Matter

HUMAN HAIR
 50-70µm (microns) in diameter

FINE BEACH SAND
 90µm (microns) in diameter

PM₁₀
 Dust, pollen, mold, etc.
 <10µm (microns) in diameter

PM_{2.5}
 Combustion particles, organic compounds, metals, etc.
 <2.5µm (microns) in diameter

Source: EPA

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Ground Level Ozone

NOx + VOC + Heat & Sunlight = Ozone
 Ground-level or "bad" ozone is not emitted directly into the air, but is created by chemical reactions between NOx and VOCs in the presence of heat & sunlight.

Emitters from industrial facilities and electric utilities, motor vehicle exhaust, gasoline vapors, and chemical solvents are some of the major sources of oxides of nitrogen (NOx) and volatile organic compounds (VOC).

EPA.gov
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Impacts of Air Pollution on Health

- Lung development
- Increased and more severe respiratory disease
- **Increases in asthma prevalence and severity**
- Lung cancer
- Cardiovascular disease
- Stroke
- Ischemic heart disease
- Likely neurodegenerative disorders in adults; **neurodevelopmental disorders in children**
- **Poor pregnancy outcomes**

(Landrigan, *The Lancet*, 2017, [http://dx.doi.org/10.1016/S2468-2667\(16\)30023-8](http://dx.doi.org/10.1016/S2468-2667(16)30023-8))

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Five Major Pollutants

- EPA establishes an AQI for five major air pollutants regulated by the Clean Air Act.
- Each of these pollutants has a national air quality standard set by EPA to protect public health:
 - **ground-level ozone**
 - **particle pollution (also known as particulate matter, including PM2.5 and PM10)**
 - carbon monoxide
 - sulfur dioxide
 - nitrogen dioxide
- **Airnow**
 - <https://www.airnow.gov/>

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Climate-induced displacement

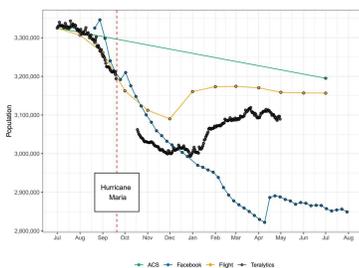
“The wave begins when individual perception of risk starts to shift, when the environmental threat reaches past the least fortunate and rattles the physical and financial security of broader, wealthier parts of the population. It begins when even places like California’s suburbs are no longer safe.” Abraham Lustgarten, *The Great Climate Migration, NYT*

- Within and between countries
- Rural to Urban

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Population in Puerto Rico After Hurricane Maria



- July 2017-Aug 2018
- American Community Survey 4% (129,848)
 - Disaster Maps from Facebook 17% (475,779)
 - Teralytics based on cell phone usage patterns 8% (235,375)
 - Airline Passenger Traffic data 5% (168,295)

Acosta et al., 2020, *PNAS*

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Climate-Induced Displacement: Impact on Children

- Risk for trafficking
- Interruptions in education
- Risk for child maltreatment
- Risk for poor mental health
- Loss of normal protective systems

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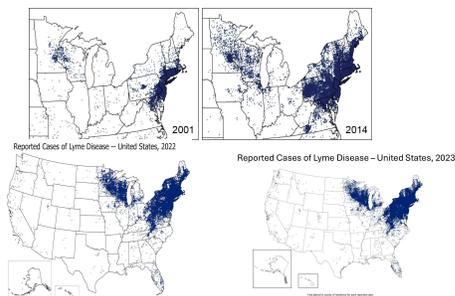
Vector-borne Diseases

- Mosquito-borne: ↑ temp, precipitation, frequency of extreme weather events = ↑ distribution and prevalence of infection (West Nile and others)
- In 2022, approx. 249 million cases of malaria globally
 - Flooding in Pakistan in 2022=5x increase in malaria cases
 - Climate change is likely increasing intensity in endemic areas and introducing malaria in areas where it has never been or has been eradicated
- Tick-borne: longer seasonal activity, expanding geographical exposure increase human tick exposure (Lyme disease and others)
- Emerging and Re-emerging of vector-borne diseases will result from climate change as well as other factors such as trade and travel (zika, dengue, chikungunya)

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Changes in Lyme Disease Case Report Distribution

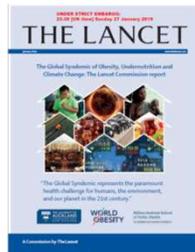


Centers for Disease Control and Prevention

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Malnutrition

- Malnutrition (obesity, undernutrition) and other dietary risks are the largest cause of ill-health globally
- The Global Syndemic: the synergy of 3 pandemics: climate change, obesity, and undernutrition
- Co-occur in time and place and interact with each other to create complex sequelae



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Mental Health and Well-being

Medical and Physical Health

- Changes in fitness and activity level
- Heat-related illness
- Allergies
- Increased exposure to waterborne and vector-borne illness

Mental Health

- Stress, anxiety, depression, grief, sense of loss
- Strains on social relationships
- Substance abuse
- Post-traumatic stress disorder

Community Health

- Increased interpersonal aggression
- Increased violence and crime
- Increased social instability
- Decreased community cohesion

US Global Change Research Program.(2016). Mental Health and Well Being. The Impacts of Climate Change on Human Health in the United States: A Scientific Assessment. (Adapted by Clayton et al., 2014)

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Chronic Impacts

Solastalgia

- A sense of loss of relationship to a place that is important
- Desolation and loss similar to those who experience forced migration
- "We are the people of sea ice. If there is no more sea ice, how can we be the people of sea ice?" Inuit community member

Ecoanxiety

- Anxiety related to watching slow, incremental impacts of climate change
- Worrying about the one's future, the future of one's family and future generations

(Clayton et al., 2021)

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CLIMATE PROTEST APR 12

"When I first found out about how climate change is progressing and how terrible the climate conditions are right now, I kind of felt powerless in an existential kind of way because we can't technically stop climate change and because our decision makers and policy makers are not taking it as seriously as they should. My anxiety went through the roof."

Mohamed et al., 2025, *Lancet Planetary Health*

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What do young people think?

- International survey of 10,000 young people (ages 16-24) across 10 countries
- 59% felt *very* or *extremely worried* about climate change
- Feelings reported: sad, anxious, angry, powerless, helpless, guilty
- >45% indicated their negative feelings impacted their daily lives and functioning
- 75% indicated the future is frightening
- Climate anxiety and distress were correlated with perceived inadequate government response and feelings of betrayal (*moral injury*)

Hickman et al., 2021, *Lancet Planetary Health*

- Younger generations worry that the world will end in their lifetime

Gislason et al., 2021, *International Journal of Environmental Research and Public Health*

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A framework for children & adolescent well-being

(adapted from the Nurturing Framework and WHO Adolescent well-being frameworks)

- Food security and nutrition
- Education and employment
- Displacement, immobility, and connectedness
- Socioeconomic distress
- Health
- Safety, conflict, violence, and exploitation
- Agency and resilience

Mohamed et al., 2025, *Lancet Planetary Health*

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Educators (and School Nurses) Guide to Climate Emotions

- Recognize common climate emotions (eco-anxiety, climate anxiety, fear, dread, anger)
 - Not signs of mental illness, but adaptive responses
- Listen, make space for feelings
 - Gently question all or nothing thinking
- Frame through an intersectional and equity lens
- Creative expression
- Integrate Indigenous perspectives
 - Seventh Generation Principle: decisions we make today should be sustainable for 7 generations into the future
- Teach and encourage climate action
 - Carbon footprint calculator
 - Implement solutions at the local level (school, town)

[A brave new way to teach kids about climate emotions](#)

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World Health Organisation (12 Oct 2023). Climate change: Key facts. <https://www.who.int/news-room/fact-sheets/detail/climate-change-and-health>

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Resources

- [Link to CDC and EPA environmental justice resources](#)
- [AirNow](#)
- [ClimateCheck](#)
- [Alliance of Nurses for Healthy Environments](#)
- [Climate for Health Ambassador's Training](#)
- [Planetary Health Alliance](#)

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