Climate Change and Children's Health and Well-Being in the United States

EXECUTIVE SUMMARY

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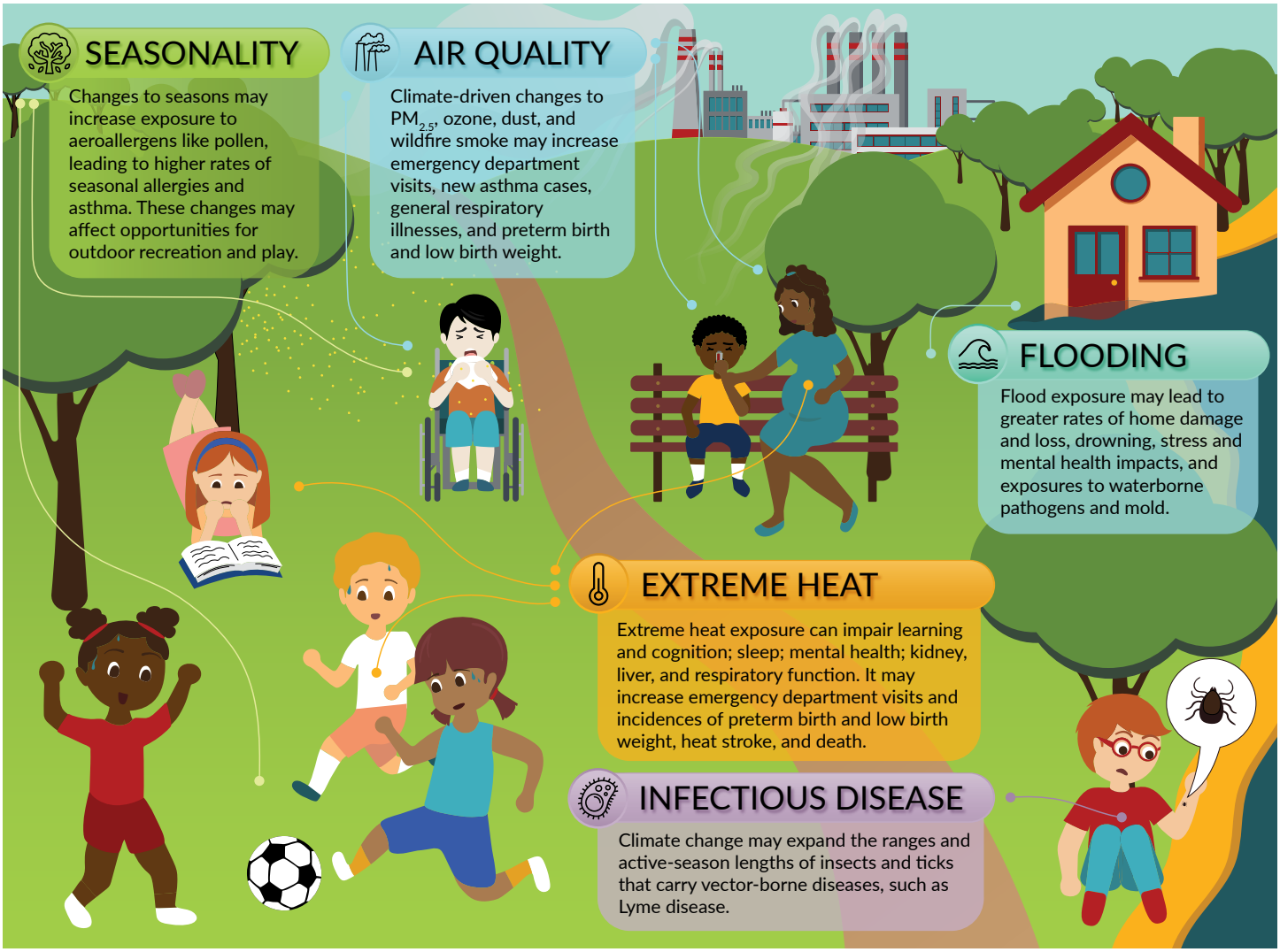
EXECUTIVE SUMMARY

Introduction

Our climate is changing, and the health and well-being of children will continue to be affected in many ways. Children are uniquely vulnerable to climate change in part because of the natural physiology of developing and growing bodies. Exposures to climate-related stressors can occur in a variety of ways, some of which are distinctive to children, including through outdoor play and at school. Children, and young children especially, have less control over their physical environments, less knowledge about health effects from climate change, and less ability to remove themselves from harm. Climate impacts experienced during childhood can have lifelong consequences stemming from effects on learning, physical development, chronic disease, or other complications.

This report investigates five climate-related environmental hazards associated with children's health and well-being in the contiguous United States (U.S.): extreme heat, poor air quality, changes in seasonality, flooding, and different types of infectious diseases. It provides national-scale quantification of risks to children for a subset of key impacts, in addition to reviewing a broad set of pathways in which climate stressors affect children's health. The analyses presented in this report are part of the EPA's Climate Change Impacts and Risk Analysis (CIRA) project, a framework using consistent inputs to enable comparison of impacts across time and space. The infographic below shows some examples of ways children can be exposed to harmful conditions in a changing climate.



EXECUTIVE SUMMARY

Analysis Approach

The analyses in this report rely on existing evidence establishing links between environmental conditions and impacts on children to project what our changing climate may mean for future generations. Results are summarized by degree of global warming relative to recent conditions. Each detailed analysis follows three main steps:

1 **Establish current risks to children:** Existing literature and data are used to document or model conditions for children during a baseline period of 1986-2005.

2 **Project future environmental conditions:** The rich array of climate data provided in general circulation models (GCMs), or climate models, are employed to project future climate hazards.

3 **Estimate future impacts on children:** Statistical relationships from peer-reviewed, relevant literature are leveraged to project impacts on children's health resulting from exposures to climate change-associated hazards.

Risks are documented for all children in the contiguous U.S., with additional consideration for effects at local and regional scales. The analyses also examine the extent to which certain groups of overburdened children (Black, Indigenous, and people of color, or BIPOC; low income; limited English speaking; and children without health insurance) may be disproportionately exposed to the most severe impacts.

The report also highlights recent literature documenting other pathways in which the five climate stressors of interest may affect children, including potential future magnitudes of each outcome. Finally, some health outcomes from climate change can be prevented or reduced through well-timed and appropriate action; see Chapter 8 of this report for more information on ways to minimize health impacts to children.

FIVE DETAILED ANALYSES

Heat and learning: Heat negatively impacts children through learning, among other pathways. This analysis quantifies how heat experienced during the school year reduces learning, values those learning losses in terms of lost future income, and demonstrates the important role of air conditioning (A/C) in schools and homes in facilitating effective learning.

Air quality and children's health: Existing evidence clearly links poor air quality with various adverse health effects in children, including asthma. This analysis considers how a warming climate will change childhood exposures to particulate matter ($PM_{2.5}$) and ozone (O_3), and then quantifies the related effects on respiratory diseases and related outcomes.

Pollen and children's health: Climate change can increase children's pollen exposures as seasons lengthen and temperatures warm. This analysis examines how changes in oak, birch, and grass pollen may lead to more visits to healthcare facilities, prescriptions filled for allergy medications, and emergency department (ED) visits for asthma among children.

Coastal flooding and children's homes: During flooding events, children experience safety risks, psychological stress associated with displacement and loss, as well as health risks from water-borne pathogens and mold in flooded structures. This analysis estimates the number of children who may experience temporary or permanent displacement from their homes because of coastal flooding.

Lyme disease: Varying temperature and precipitation patterns are likely to alter the habitat, range, and density of pathogens, vectors, and hosts that can cause disease among children. Lyme disease, carried by blacklegged (deer) ticks, is one such disease. This analysis projects the number of new Lyme disease cases in parts of the country.

EXECUTIVE SUMMARY

Key Findings

Results of the detailed analyses are presented for increases in global average temperature of 2°C and 4°C above levels observed in 1986-2005. For the flooding analysis, analogous results for 50 cm and 100 cm of global sea level rise are described. Average impacts across climate models are highlighted, in addition to the minimum and maximum estimates projected by the models. In situations where overburdened children may be disproportionally exposed to the most severe impacts, those findings are provided as well. The summary below also discusses other key pathways through which children are likely to be affected by climate change in the future.

EXTREME HEAT

David L. Ryan / The Boston Globe via Getty Images

Temperature increases of 2°C and 4°C of global warming are associated with, on average, 4% and 7% reductions in academic achievement per child, respectively, relative to average learning gains experienced each school year. Across each cohort of graduating students, the total lost future income attributable to these learning losses may reach $6.9 billion ($1.9 to $12.7 billion) at 2°C and $13.4 billion ($8.9 to $18.3 billion) at 4°C. In contrast, installing A/C in schools is less costly, although this action only partially mitigates these effects, and may further induce GHG emissions that contribute to climate impacts. Black, Hispanic or Latino, and low income students report the lowest rates of current A/C in schools, and therefore are likely to experience these impacts disproportionately.

Another way to measure the magnitude of heat's effects on children's health is the number of ED visits associated with high temperature days. Existing evidence suggests the number of ED visits among children are expected to increase between May and September each year as summer temperatures continue to rise.

EXECUTIVE SUMMARY

Key Findings

AIR QUALITY

New diagnoses of asthma associated with $PM_{2.5}$ and O_3 exposure are estimated to increase by 34,500 (27,900 to 42,800) per year at 2°C of global warming up to 89,600 (74,100 to 108,000) at 4°C. On average, this represents a 4% and 11% increase relative to baseline incidence. ED visits and hospital admissions due to general respiratory conditions are projected to increase, as are school days lost because of these effects. The analysis further projects additional premature deaths among newborns. Most impacts stem from climate-induced changes in weather conditions that worsen concentrations of $PM_{2.5}$ and O_3, although wildfires and ground-level dust in the arid Southwest also play a role. BIPOC children are more likely to experience new asthma diagnoses associated with $PM_{2.5}$ exposure, specifically.

Wildfire smoke is comprised of numerous air pollutants that pose significant human health impacts, including adverse birth outcomes. New research documents the association between exposure to wildfire smoke and risk of preterm birth, suggesting a dramatic potential increase in this outcome as wildfire activity continues to increase.

At 2°C of global warming, an additional 5,800 (4,800 to 8,000) asthma-related ED visits in children are anticipated annually from exposures to oak, birch, and grass pollen, increasing to approximately 10,000 (9,500 to 11,000) additional visits annually at 4°C of warming. Less severe outcomes, like visits to healthcare facilities for seasonal allergies (allergic rhinitis) and prescriptions for allergy medications for children, may increase by 41,000 (34,000 to 57,000) visits and 121,000 (101,000 to 167,000) prescriptions annually at 2°C of warming. On average, the health impacts associated with pollen exposure increase 17% and 30% at 2°C and 4°C, respectively. Limited English-speaking, BIPOC, and uninsured children are more likely to experience these impacts stemming from oak pollen exposure, specifically.

Changing seasonality also will alter the ways children play or recreate outside. Overall, new evidence suggests that lengthening warm seasons are expected to result in more time spent on outdoor recreation, especially boating and water sports. On the other hand, the number of trips associated with some recreation types, like skiing and cold-water fishing, is projected to decrease under climate change.

CHANGING SEASONS

EXECUTIVE SUMMARY

Key Findings

If no additional adaptation actions are taken, approximately 185,000 (159,000 to 437,000) children are estimated to experience complete home loss from coastal flooding at 50 cm of global sea level rise increasing to 1.13 million (477,000 to 3 million) at 100 cm. More than 1 million additional children living in coastal areas may be temporarily displaced from their homes annually due to flooding at both 50 cm and 100 cm. Well-timed adaptation measures, including building sea walls, could delay or prevent many of these impacts; however, they themselves are costly. Children in each of the overburdened groups considered in this report are disproportionally affected by temporary home displacement at 50 cm and complete loss of home at 100 cm.

Inland flooding, also known as riverine flooding, could increase in the future due to climate change. Existing research suggests children will experience damage to their homes from flooding in these areas.

INFECTIOUS DISEASES

In 21 Eastern states and the District of Columbia, an additional 2,600 (-7,500 to 20,200) new Lyme disease cases per year are projected among children under 2°C of global warming. At 4°C of global warming, the increase is much more extreme: 23,400 (7,800 to 47,000) additional cases per year. These additional cases represent a 31% to 272% increase above baseline infection levels, respectively. States in the northernmost areas of the Northeast and Midwest regions are expected to see most of new cases among children. Research demonstrates that Lyme disease may be under-reported and undertreated among some overburdened populations, increasing the likelihood of more severe outcomes in these communities.

West Nile Virus (WNV) carried by mosquitos is likely to see a change in new cases as temperatures increase, including among children. While existing evidence suggests the estimated increase in new cases of West Nile Neuroinvasive Disease (WNND), a severe outcome associated with WNV, is anticipated to be small in magnitude, growing numbers of cases could be indicative of greater rates of other types of mosquito-borne diseases.

EXECUTIVE SUMMARY

Regional Highlights

Finally, this report documents where climate-induced impacts on children are projected to be most acute. Among the impacts considered, this section identifies the states and regions that are likely to experience the greatest impacts, including emerging areas of interest. The map below summarizes the findings for 2°C of global warning and 50 cm of global sea level rise. By synthesizing results across regions, the map demonstrates how children can experience multiple climate stressors simultaneously. However, the map does not convey the geographic distribution of all climate change impacts on children, or where baseline impacts are high.

NORTHWEST

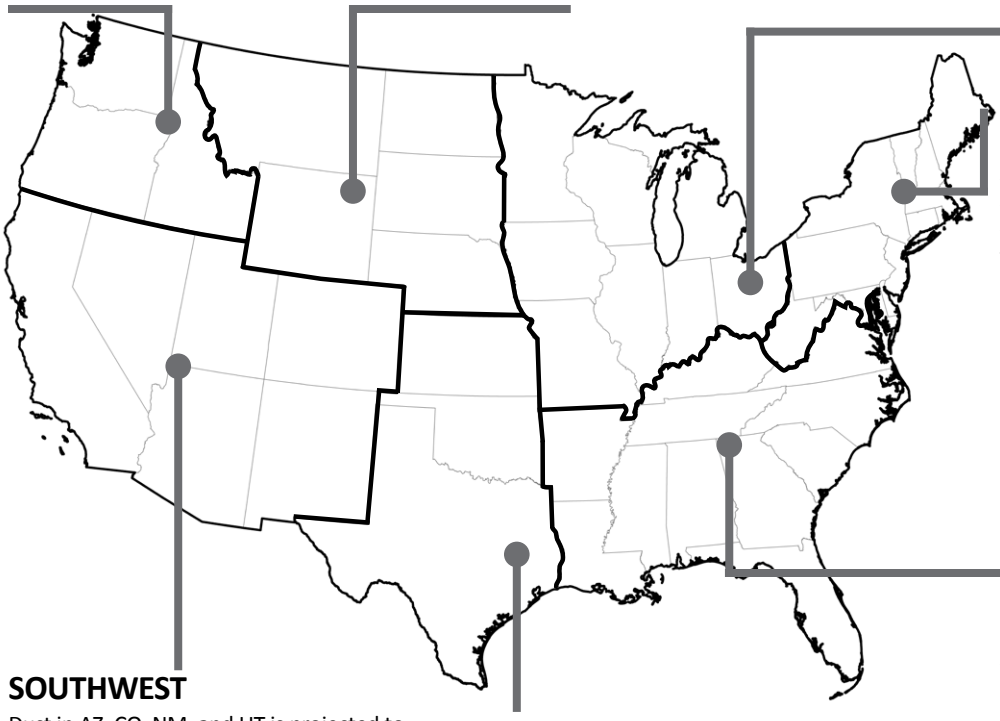
ID and OR are projected to have high concentrations of wildfire smoke, while some of the highest rates of respiratory health impacts among children nationally are projected in WA due to degrading air quality from the climate-induced sources in this analysis. Additionally, increased grass pollen is projected to result in high adverse health effects per capita in OR. Inland flooding effects are among the greatest in the country.

NORTHERN GREAT PLAINS

WY is among the states with the highest projected learning losses per child nationally given high warming and low current A/C coverage. WNND incidence rates may be greatest in ND, NE, and SD, compared to national rates. MT and WY are projected to experience some of the highest rates of health effects to children from wildfire smoke. Inland flooding effects are among the greatest in the country.

MIDWEST

Increasing climate-driven concentrations of O_3 in IL, IN, and OH may contribute to some of the highest rates of air quality health effects on children nationally. MI is projected to experience some of the most considerable learning losses per student due to heat exposure, while MI and MN experience the most extreme per capita increases in Lyme disease cases. IN and OH are projected to see the greatest impacts on children's health of across all included pollen types.



NORTHEAST

ME, NH, and VT are among the states with the highest projected learning losses per child from high temperatures during the school year, as well as low current A/C coverage. These states may also experience the greatest increase in Lyme disease rates. Children in WV and VT are most likely to experience health impacts associated with oak and birch pollen exposures. MD and DC may have some of the highest rates of climate-driven air quality impacts per child, where O_3 is the primary exposure.

SOUTHWEST

Dust in AZ, CO, NM, and UT is projected to adversely impact respiratory health among children. Wildfire smoke stemming from future fire activity in CA is projected to lead to high rates of poor health outcomes, such as asthma. WNND incidence rates are projected to be among the highest in AZ and CO. Inland flooding effects are high in this region.

SOUTHERN GREAT PLAINS

Increases in exposures to grass pollens may lead KS and OK to have some of the highest rates of ED visits for asthma among children. Children in central TX are expected to see considerable per capita health impacts from exposures to oak and grass pollen.

SOUTHEAST

Children in coastal areas of GA, LA, NC, SC, and VA are the most likely to be affected by the impacts of coastal flooding on their homes, assuming no additional protective measures are taken. Inland flooding effects also are high in this region. Climate-driven changes to $PM_{2.5}$ exposure may lead to significant air quality health impacts in AL, GA, NC, and SC. KY may experience among the greatest rates of pollen-related and combined air quality-induced impacts on children nationally.