International Journal of Contemporary Pediatrics
Chamarthi VS et al. Int J Contemp Pediatr. 2025 Nov;12(11):1892-1897
http://www.ij paediatrics.com
pISSN 2349-3283 | eISSN 2349-3291

DOI: https://dx.doi.org/10.18203/2349-3291.ijcp20253385

Review Article

Climate change and paediatric health outcomes: implications for primary care practice

Venkata S. Chamarthi[1]*, Vignesh Gunasekaran[2], Sastry Chamarthi[3]

[1]Department of Paediatrics, Valley Children's Healthcare, Madera, CA, USA
[2]West Virginia University School of Medicine, Morgantown, West Virginia, USA
[3]Clinica Sierra Vista Elm Community Health Center, Fresno, CA, USA

Received: 20 September 2025
Accepted: 14 October 2025

***Correspondence:**
Dr. Venkata S. Chamarthi,
E-mail: Vchamarthi1@valleychildrens.org

ABSTRACT

Climate change is increasingly recognized as a significant determinant of child health worldwide, affecting nearly every aspect of paediatric well-being through both direct and indirect mechanisms. Children are vulnerable due to their developing physiology, higher metabolic demands, and limited capacity to adapt to environmental stressors. Rising global temperatures, worsening air quality, extreme weather events, and disruptions in food and water systems contribute to an expanding spectrum of paediatric health consequences. These include heat-related illnesses, respiratory and allergic disorders, vector-borne infections, nutritional deficiencies, and psychosocial effects such as climate anxiety. In addition to physical health risks, displacement, food insecurity, and community disruption exacerbate disparities in child health outcomes. Paediatricians and primary care providers occupy a critical frontline role in recognizing climate-sensitive health conditions, integrating anticipatory guidance into routine visits, and advocating for family-centered adaptation and mitigation strategies. This review synthesizes current evidence on the health impacts of climate change in children, outlines the clinical and public-health implications for primary care, and identifies research priorities and practice recommendations to strengthen resilience within paediatric systems of care. Addressing climate change as a child health crisis requires collaboration among clinicians, researchers, educators, and policymakers to safeguard the well-being of future generations.

Keywords: Climate change, Paediatric health, Environmental health, Primary care, Child vulnerability, Public health adaptation

INTRODUCTION

The accelerating pace of climate change represents one of the most pressing global threats to child health in the twenty-first century. Global surface temperatures have increased markedly above pre-industrial levels, accompanied by rising sea levels, altered precipitation patterns, and a concerning escalation in extreme weather events that disrupt ecological and socioeconomic systems.[1] These changes have profound implications for paediatric populations, whose physiological immaturity, developmental stage, and social dependence render them uniquely and particularly vulnerable.

Children possess higher surface-area-to-body-mass ratios, higher metabolic rates, and immature thermoregulatory and immune systems, limiting their capacity to adapt to temperature extremes and environmental insults.[2,3] Their behavioral patterns—greater time outdoors, higher ventilation per kilogram, and dependence on adult decision-making—further amplify exposure to environmental hazards. Many professional organizations have emphasized that climate change is a fundamental child health crisis that requires an urgent, multisectoral response, meaning a coordinated effort involving specific sectors such as healthcare, education, and environmental protection.[1] This review synthesizes evidence on the impact of climate change on paediatric health outcomes,

with a focus on conditions most relevant to primary care.[4] These conditions include specific examples, such as increased incidence of asthma due to air pollution or heat-related illnesses. It also highlights practice challenges, emerging mitigation opportunities, and the role of paediatricians as advocates for environmental health and climate resilience. The pathways through which climate change affects paediatric health are multifactorial, involving direct environmental exposures and indirect socioeconomic effects (Figure 1).

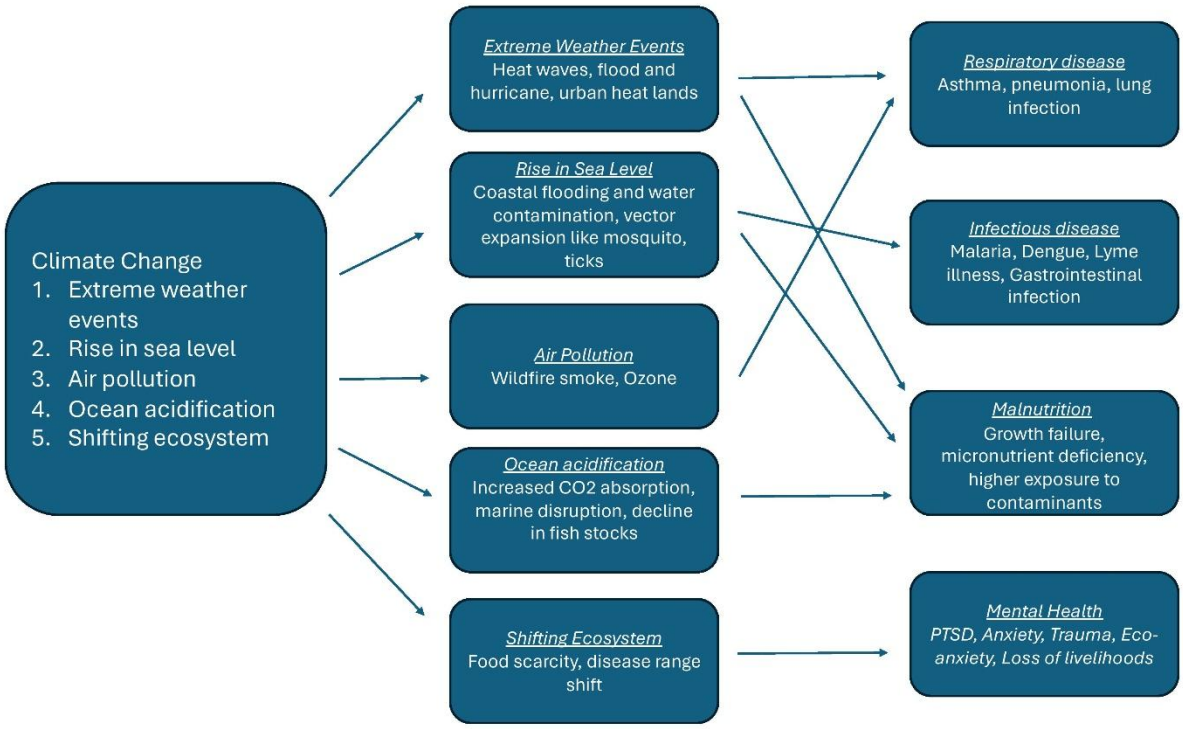

Figure 1: Conceptual pathways linking climate change to paediatric health outcomes.

Major environmental drivers—extreme weather events, rising sea levels, air pollution, ocean acidification, and shifting ecosystems—interact to influence multiple domains of child health. Resulting impacts include respiratory and infectious diseases, malnutrition, and mental-health consequences such as anxiety and trauma. Paediatric vulnerability is amplified by physiological immaturity, developmental dependence, and inequities in adaptive capacity

HEAT-RELATED ILLNESS IN CHILDREN

The steady increase in global temperatures and the growing frequency of heatwaves have led to a marked rise in paediatric heat-related morbidity. Studies from diverse climatic regions have shown significant increases in emergency visits and hospitalizations among children during heat extremes, with the youngest age groups being most affected.[5] Young children, especially infants and toddlers, are highly susceptible due to immature thermoregulation, high metabolic demands, and dependence on caregivers for hydration and environmental protection.[3] Heat exposure during pregnancy links preterm birth and low birth weight, with greater impacts observed among marginalized populations where socioeconomic constraints limit adaptive capacity.[1]

Among school-aged children and adolescents, exertional heat illness is a growing concern, especially in outdoor sports and physically demanding activities. In severe instances, heat exhaustion may progress to rhabdomyolysis and acute kidney injury.[5] Urban heat islands and communities with inadequate infrastructure face elevated risks due to poor access to shade and cooling resources. As global warming continues, projections indicate that paediatric heat-related illnesses will rise further, emphasizing the need for anticipatory guidance, equitable urban planning, and early warning systems tailored to protect children from extreme heat events.[6]

RESPIRATORY HEALTH AND AIR QUALITY

Air quality deterioration remains one of the most significant pathways through which climate change affects child health. Elevated ground-level ozone and delicate particulate matter ($PM_{2.5}$) produced by fossil-fuel combustion and biomass burning exacerbate asthma, reduce lung function, and increase respiratory infections.[7,8] Children's developing lungs, higher minute ventilation, and increased outdoor activity levels amplify exposure to pollutants, particularly during heat and drought conditions that promote smog formation. Wildfire smoke, increasingly common across continents, introduces complex mixtures of particulates and toxins that penetrate deep into the airways, causing inflammation and oxidative stress.[8]

Longer pollen seasons, increased allergenicity, and overlapping exposures to pollutants and allergens further intensify respiratory symptoms.[7] Warmer temperatures and elevated CO_2 concentrations prolong pollen duration, exacerbating allergic rhinitis and asthma symptoms. Indoors, flood damage, mold growth, and inadequate ventilation exacerbate respiratory risks, particularly in densely populated or resource-constrained settings. Together, these exposures threaten to increase the global burden of paediatric asthma and allergic diseases, underscoring the importance of improved air-quality monitoring, urban greening, and public health interventions targeting cleaner energy and transportation systems.

VECTOR-BORNE DISEASES

Climate-driven ecological shifts are expanding the geographical range and seasonality of many vector-borne diseases affecting children. Warmer temperatures, altered rainfall patterns, and increased humidity favor the proliferation of mosquitoes and ticks, while human migration and land-use changes further facilitate the transmission of pathogens.[9,10]

The Intergovernmental Panel on Climate Change (IPCC) projects a rising incidence of malaria, dengue, chikungunya, and other arboviral infections without strong adaptation measures. Dengue, now endemic in more than 120 countries, has experienced record increases globally, driven by the expansion of *Aedes* mosquito habitats and prolonged transmission seasons.[11] Children remain at particular risk of severe dengue manifestations, including hemorrhagic fever and shock syndrome.

Tick-borne diseases, such as Lyme disease, are expanding into higher latitudes and altitudes as temperate regions warm.[12] Similarly, outbreaks of West Nile and other arboviruses correlate with seasonal variations in temperature and precipitation. These infections disproportionately affect children due to behavioral exposure and immunologic naivety. Strengthening vector surveillance, implementing vaccination programs where applicable, and implementing community-level control measures are critical to reducing disease transmission.[13] Climate-informed health systems that integrate environmental monitoring with paediatric care can help mitigate the growing global threat of vector-borne infections in children.

FOOD SECURITY AND NUTRITIONAL IMPACTS

Climate change has a profound impact on food security, threatening both the quantity and nutritional quality of food available to children. Increased frequency of droughts, floods, and extreme weather events disrupts agricultural yields and food supply chains, while elevated CO_2 levels reduce the protein and micronutrient content of staple crops.[14] By 2050, climate-related disruptions are projected to increase global hunger and undernutrition by up to 20%, with the most significant burden borne by children in low-income regions.[15] In 2023, more than 730 million people faced hunger worldwide, and climate stressors were a major contributing factor.[16]

For children, food insecurity manifests as a dual burden of malnutrition — persistent undernutrition alongside rising obesity. Poor dietary diversity and reliance on calorie-dense, nutrient-poor foods increase risks of stunting, wasting, and micronutrient deficiencies.[14]

Displacement caused by climate disasters disrupts breastfeeding, food assistance, and access to health services; nearly 10 million children were displaced by weather-related disasters in 2020.[2] These intersecting factors highlight the urgent need for resilient food systems, equitable nutrition programs, and policies that prioritize maternal–child nutrition within national climate adaptation strategies.

MENTAL HEALTH AND PSYCHOLOGICAL EFFECTS

The psychological and developmental consequences of climate change are increasingly recognized as significant dimensions of child health. Children and adolescents experience high levels of climate anxiety — feelings of fear, sadness, and helplessness about environmental degradation and future uncertainty.[17]

A multinational survey found that more than two-thirds of young people expressed distress about the climate crisis, with many reporting a diminished trust in institutions to address it.[18] Exposure to weather events such as floods, cyclones, and wildfires can lead to post-traumatic stress, depression, and prolonged anxiety, often persisting for years after the event.

Beyond direct trauma, indirect stressors such as displacement, family financial strain, and community instability exacerbate mental-health risks. Heat exposure itself has been associated with higher emergency visits for paediatric behavioral and psychiatric concerns, suggesting both physiological and psychosocial pathways. Paediatricians should screen for early indicators of distress, normalize emotional discussions around environmental issues, and connect families with supportive resources.[18] Promoting youth engagement in environmental and community action can help transform anxiety into agency, fostering resilience and hope across generations. The spectrum of climate-related paediatric health effects varies by developmental stage, with unique vulnerabilities and risk profiles across age groups (Table 1).

Table 1: Climate-related health impacts by paediatric age group.

Age group	Primary health impacts	Mechanisms of vulnerability	High-risk populations
Infants (0–12 months)	Heat-related morbidity and mortality; diarrheal diseases; malnutrition and stunting; respiratory infections	Immature thermoregulation; high surface-area-to-mass ratio; dependence on caregivers; developing immune system	Low-birth-weight and formula-fed infants; infants in homes without cooling; flood-prone or water-insecure areas
Preschool (1–5 years)	Acute respiratory infections; asthma exacerbations; vector-borne infections; heat illness; developmental delays	Greater outdoor activity; higher ventilation per body weight; limited hydration awareness	Children with asthma; residents of urban heat islands; malaria-endemic or food-insecure regions
School-age (6–12 years)	Asthma and allergic rhinitis; exertional heat illness; tick-borne disease; impaired cognitive performance; emerging climate anxiety	Extended outdoor play and sports; poor school air quality; developing emotional awareness	Children with chronic respiratory disease; young athletes; wildfire-exposed communities; low-resource schools
Adolescents (13–18 years)	Depression, anxiety, and PTSD; rhabdomyolysis from exertional heat; expanding vector-borne infections; food insecurity effects	Increased autonomy and physical exertion; heightened climate awareness; ongoing neurologic plasticity	Adolescents with mental-health disorders; competitive athletes; displaced or migrant youth; conflict-affected areas

*PTSD=Post-traumatic stress disorder

CHALLENGES IN ADDRESSING CLIMATE-RELATED PAEDIATRIC HEALTH

Addressing the impact of climate change on children's health is complicated by multiple interrelated challenges. Climate–health relationships are inherently multifactorial and often confounded by socioeconomic conditions, making direct causal attribution difficult.[4] Low-income and minority populations bear disproportionate exposure due to substandard housing, limited access to cooling, and proximity to pollution sources. Knowledge gaps within clinical practice further compound these disparities, as surveys reveal limited climate-health literacy among healthcare providers and a lack of evidence-based resources or time to integrate counselling on environmental risks into routine care.[19]

Surveillance systems capable of monitoring paediatric climate-sensitive outcomes in real-time are scarce, particularly in low- and middle-income countries, hindering early warning and targeted interventions. Communication of long-term risks also poses difficulties, since today's emissions translate into health burdens for future generations, creating ethical and motivational barriers to immediate action.

Finally, the regions most affected by climate change frequently possess the least capacity and financial resources for adaptation. This inequity is compounded by the fact that healthcare delivery itself contributes approximately 5% of global greenhouse-gas emissions, generating tension between the need to provide essential medical services and the imperative to operate sustainably.[20]

FUTURE DIRECTIONS

Integrating climate considerations into paediatric clinical practice is an essential step toward safeguarding children's health in a changing environment. Primary-care paediatricians should incorporate region-specific guidance into routine visits, educating families on hydration, heat safety, air quality monitoring, and vector avoidance strategies.[21] Promoting active transportation and plant-forward diets benefits both paediatric health and emission reduction. To strengthen clinical preparedness, climate-health education must be embedded across all levels of medical training. Competency frameworks should equip providers to recognize climate-sensitive conditions, communicate effectively with families, and engage in advocacy that prioritizes environmental determinants of child health. In parallel, robust surveillance systems and longitudinal cohort studies are needed to clarify long-term outcomes of early-life climate exposures.[4] Implementation research should assess the effectiveness of adaptation strategies—such as school-based cooling programs and telehealth-enabled early warning systems—to ensure equitable protection for vulnerable paediatric populations.

Building climate resilience within healthcare systems is equally critical. Hospitals and clinics must establish resilience plans to maintain paediatric services during extreme weather events, including reliable vaccine cold chains, backup power supplies, and emergency surge capacity. Decarbonization initiatives focused on energy efficiency, sustainable procurement, and waste reduction can reduce institutional greenhouse-gas emissions without compromising care quality. Policy and advocacy also remain central; professional societies, such as the American Academy of Pediatrics (AAP), have issued clear

recommendations for paediatricians to participate in policy reform and public health planning.[19] Digital health technologies, including artificial intelligence and remote monitoring tools, hold promise for enhancing the early detection of climate-sensitive illnesses and supporting data-driven interventions.[2] However, these innovations must address equity, privacy, and ethical governance. Finally, empowering children through climate education and participatory community initiatives can transform eco-anxiety into constructive engagement. Youth-led projects and school-based sustainability programs foster resilience, agency, and optimism for a healthier planetary future.[22]

CONCLUSION

Climate change is an escalating paediatric health emergency affecting every organ system and developmental stage. Evidence demonstrates clear links to heat-related illness, respiratory disorders, vector-borne infections, nutritional insecurity, and psychosocial distress. Children's inherent physiological and social vulnerabilities amplify these risks, while inequities in exposure and adaptation widen existing health gaps. Paediatricians are uniquely positioned to identify climate-sensitive conditions, counsel families, and advocate for preventive policies. Integrating climate awareness into routine care, education, research, and system planning can strengthen resilience and protect children's right to a healthy future. Climate action, at its core, is an investment in child health and equity for generations to come.

Funding: No funding sources
Conflict of interest: None declared
Ethical approval: Not required

REFERENCES

1. Ahdoot S, Baum CR, Cataletto MB, Hogan P, Wu CB, Bernstein A, et al. Climate Change and Children's Health: Building a Healthy Future for Every Child. Pediatrics. 2024;153(3):e2023065505.
2. Campbell EA, Holl F, Marwah HK, Fraser HS, Craig SS. The impact of climate change on vulnerable populations in pediatrics: opportunities for AI, digital health, and beyond-a scoping review and selected case studies. Pediatr Res. 2025;29.
3. Smith CJ. Pediatric thermoregulation: considerations in the face of global climate change. Nutrients. 2019;11(9):2010.
4. Weeda LJZ, Bradshaw CJA, Judge MA, Saraswati CM, Le Souëf PN. How climate change degrades child health: a systematic review and meta-analysis. Sci Total Environ. 2024;920:170944.
5. Merritt TA, Bhatia S, Solomon C, Yu A. Heat-related illness trends at a pediatric health care system, 2012 to 2023. Acad Pediatr. 2025;25(6):102855.
6. Apiratwarakul K, Cheung LW, Pearkao C, Ienghong K. The impact of global warming on the rise in heat-related illnesses in emergency medical services. J Multidiscip Healthc. 2024;17:5211-6.
7. Biagioni B, Cecchi L, D'Amato G, Annesi-Maesano I. Environmental influences on childhood asthma: climate change. Pediatr Allergy Immunol. 2023;34(5):e13961.
8. Domingo KN, Gabaldon KL, Hussari MN, Yap JM, Valmadrid LC, Robinson K, et al. Impact of climate change on paediatric respiratory health: pollutants and aeroallergens. Eur Respir Rev. 2024;33(172):230249.
9. Paz S. Climate change: a driver of increasing vector-borne disease transmission in non-endemic areas. PLoS Med. 2024;21(4):e1004382.
10. Gage KL, Burkot TR, Eisen RJ, Hayes EB. Climate and vectorborne diseases. Am J Prev Med. 2008;35(5):436-50.
11. Zhang WX, Zhao TY, Wang CC, He Y, Lu HZ, Zhang HT, et al. Assessing the global dengue burden: Incidence, mortality, and disability trends over three decades. PLoS Negl Trop Dis. 2025;19(3):e0012932.
12. Couper LI, MacDonald AJ, Mordecai EA. Impact of prior and projected climate change on US Lyme disease incidence. Glob Chang Biol. 2021;27(4):738-54.
13. Thomson MC, Stanberry LR. Climate change and vectorborne diseases. N Engl J Med. 2022;387(21):1969-78.
14. Agostoni C, Baglioni M, La Vecchia A, Molari G, Berti C. Interlinkages between climate change and food systems: the impact on child malnutrition—narrative review. Nutrients. 2023;15(2):416.
15. United Nations International Children's Emergency Fund (UNICEF). The global climate crisis is a child nutrition crisis. Published October 8, 2025. Available at: https://www.unicef.org/documents/ global-climate-crisis-child-nutrition-crisis. Accessed on 21 August 2025.
16. Food and Agriculture Organization (FAO). FAO Knowledge Repository. 2025. Available at: https://openknowledge.fao.org/items/ebe19244-9611-443c-a2a6-25cec697b361. Accessed on 21 August 2025.
17. Hickman C, Marks E, Pihkala P, Clayton S, Lewandowski RE, Mayall EE, et al. Climate anxiety in children and young people and their beliefs about government responses to climate change: a global survey. Lancet Planet Health. 2021;5(12):e863-73.
18. Van Nieuwenhuizen A, Hudson K, Chen X, Hwong AR. The effects of climate change on child and adolescent mental health: clinical considerations. Curr Psychiatry Rep. 2021;23(12):88.
19. American Academy of Pediatrics (AAP). Climate change: the impact on children's health. 2025. Available at: https://www.aap.org/en/patient-care/environmental-health/promoting-healthy-environments-for-children/climate-change/. Accessed on 21 August 2025.
20. Rodríguez-Jiménez L, Romero-Martín M, Spruell T, Steley Z, Gómez-Salgado J. The carbon footprint of healthcare settings: a systematic review. J Adv Nurs. 2023;79(8):2830-44.

21. Philipsborn RP, Cowenhoven J, Bole A, Balk SJ, Bernstein A. A pediatrician's guide to climate change-informed primary care. Curr Probl Pediatr Adolesc Health Care. 2021;51(6):101027.
22. Clayton S, Manning C, Hill AN, Speiser M. Mental Health and Our Changing Climate: Children and Youth Report 2023. 2023. Available at: https://www.apa.org/pubs/reports/climate-change-mental-health-children-2023. Accessed on 10 July 2025.

Cite this article as: Chamarthi VS, Gunasekaran V, Chamarthi S. Climate change and paediatric health outcomes: implications for primary care practice. Int J Contemp Pediatr 2025;12:1892-7.