



Review Article

Impact of Climate Change on Physical Health and Health Care System. A Scoping Review

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Abstract

Climate change is an escalating global threat to physical health and the resilience of healthcare systems. This scoping review synthesizes current evidence on both the direct and indirect effects of climate change on physical health, with implications for healthcare infrastructure, service delivery, and workforce capacity. Direct effects include heat-related disorders and cardiovascular and respiratory conditions, while indirect effects encompass vector- and water-borne diseases, nutritional deficiencies, and occupational health hazards. Vulnerable populations—including children, older adults, and socioeconomically disadvantaged groups—experience disproportionate impacts, worsening existing health inequities. The review further identifies significant strains on healthcare systems, including infrastructure weaknesses, increased disease burden, supply chain disruptions, workforce shortages, and economic consequences. Adaptation and mitigation strategies such as climate-resilient infrastructure, early warning systems, public awareness initiatives, and policy integration are critical to enhancing system preparedness. Despite increasing recognition of these issues, research gaps—especially in low- and middle-income countries—persist. This review underscores the pressing need for integrated, equity-focused, and interdisciplinary approaches to safeguard physical health and enhance healthcare systems in the face of a changing climate.

Keywords: Climate change, Health resilience, Diseases, Health systems, Vulnerability, Adaptation.

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Introduction

Climate change has emerged as one of the most pressing global health concerns of the 21st century (Campbell-Lendrum et al., 2023). While its environmental consequences are widely acknowledged, mounting scientific evidence shows its profound and multifaceted impact on human physical health (Byg & Shah, 2023) and the functionality of healthcare systems (Gkouliaveras et al., 2025). The increasing frequency and intensity of heatwaves, floods, droughts, air pollution, and other climate-related hazards not only threaten ecosystems but also directly and indirectly compromise human health (Drake et al., 2022). These effects are evident in low- and middle-income countries (Grigoroudis et al., 2023), where healthcare infrastructure often lacks the resilience and resources necessary to respond to escalating climate-related pressures (Bianco et al., 2024). Climate change contributes to deteriorating physical health through various pathways, including exposure to extreme temperatures, the spread of vector-borne diseases, declining air and water quality, and increasing food insecurity (Liu et al., 2023; Singh et al., 2024). Vulnerable populations—including children, the elderly, individuals with chronic conditions, and those from low-income backgrounds—are disproportionately affected (White et al., 2023).

Simultaneously, global health systems are increasingly strained. Many lack the capacity, flexibility, or

preparedness to respond effectively to these emerging challenges (Braithwaite et al., 2024; Naser et al., 2024). Forecasts suggest that the Arctic has a 5% likelihood of reaching a temperature increase of 16°C by 2100, while North Africa, West Asia, and most of Europe are expected to experience increases of at least 2°C (Chen et al., 2023). These changes are expected to raise global mortality from infectious diseases, emphasizing the critical need for mitigation, surveillance, and adaptation strategies (Chen et al., 2023; Greene et al., 2006).

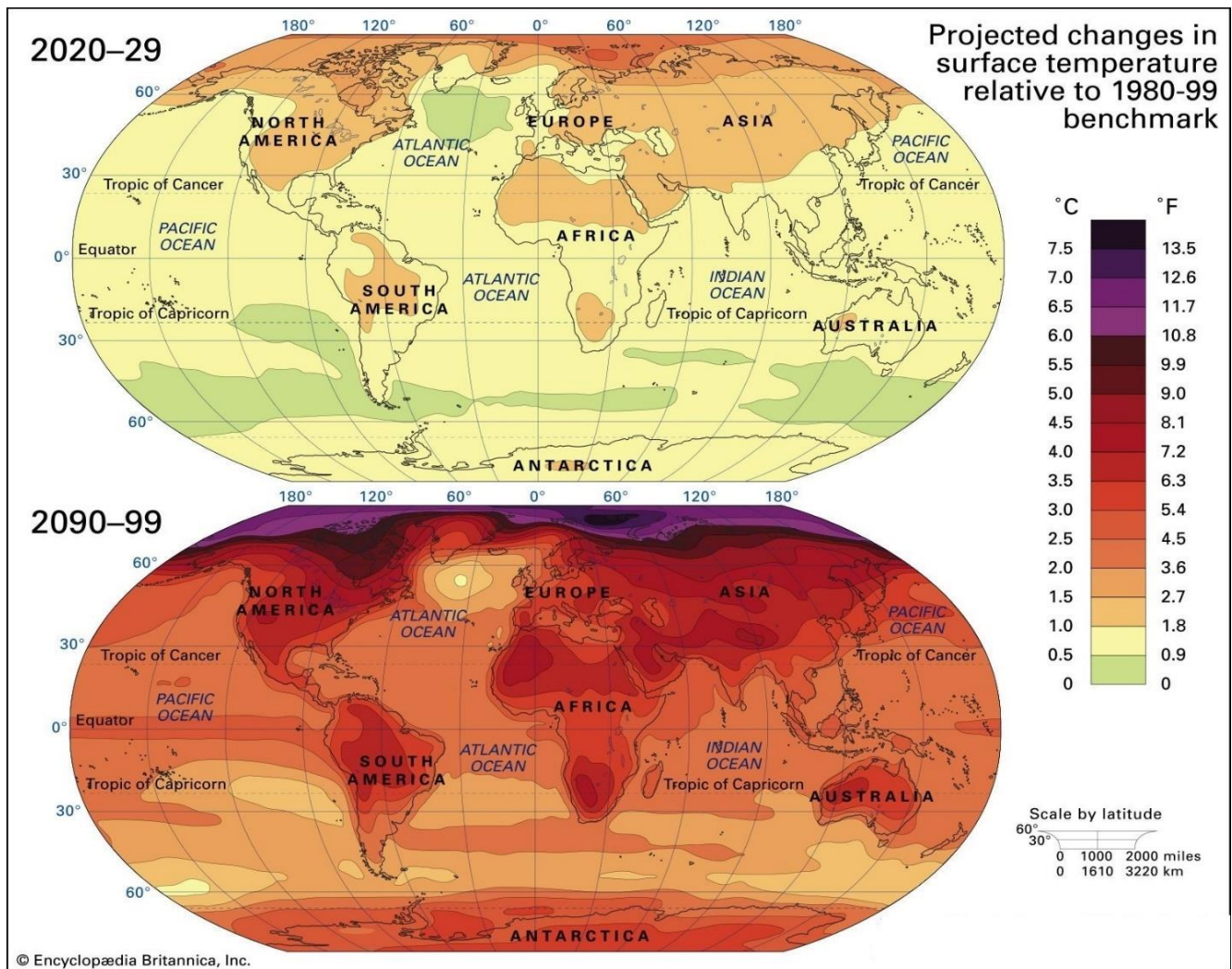


Figure 1. Climate change prediction 2020–2099; Source: Climate Change 2007. The Physical Science Basis. Summary for Policymakers, IPCC.

Objectives of the Scoping Review

This scoping review aims to comprehensively examine and consolidate the existing literature on the impacts of climate change on physical health and healthcare systems. Unlike systematic reviews that address narrowly defined questions, scoping reviews provide a broad synthesis of available evidence, identify dominant themes, uncover knowledge gaps, and offer an overview of the research landscape (Dodgson, 2023; Sobieraj & Baker, 2021). This review aims to serve as a foundational resource for researchers, policymakers, and healthcare practitioners seeking to understand the complex interplay between climate change, health outcomes, and system-level responses.

Methodology and Scope of Review

This review follows the methodological framework proposed by Arksey and O'Malley (Arksey & O'Malley, 2005) and refined by Levac et al. (Levac et al., 2010). A systematic search of peer-reviewed articles, reports, and grey literature was conducted across major databases including PubMed, Scopus, Web of Science, and Google Scholar, focusing on publications from the past 20 years. Search terms included combinations of “climate change,” “global warming,” “physical health,” “healthcare system,” “heatwaves,” “vector-borne diseases,”

“health infrastructure,” and related topics.

Inclusion criteria encompassed studies examining direct or indirect impacts of climate change on physical health or health systems. Studies focusing solely on mental health or environmental issues without a health component were excluded. The scope focuses on physical health outcomes and system vulnerabilities, providing a global perspective with a particular emphasis on climate-sensitive diseases and healthcare adaptation.

Climate Change and Physical Health: An Overview

Climate change affects physical health through both direct and indirect pathways. Globally, shifting weather patterns, rising temperatures, and environmental disturbances are creating increasingly hazardous conditions for human health (Alamgir & Shan, 2023; Bianco et al., 2024). This section outlines these mechanisms, with a particular focus on their disproportionate impacts on vulnerable populations.

Direct Impacts

Direct health effects of climate change are primarily linked to increased exposure to extreme environmental conditions (Agache et al., 2022). For instance, in the United States, the average number of heatwaves per year has increased by a factor of three since the 1960s. By the end of the century, some cities may experience two to four times as many annual heatwave days, with certain regions facing persistent night-time heatwaves lasting over half the year under high-emission scenarios (Bhattarai et al., 2025).

Regional evidence from China and Australia indicates that both the frequency and severity of heatwaves are increasing, with some areas experiencing remarkably rapid increases in duration and geographical spread. The intensity of heatwaves—measured by deviations from average temperatures—is also projected to grow by 0.5–1.5°C or more above global warming thresholds, especially in tropical and Mediterranean zones (Perkins-Kirkpatrick & Gibson, 2017). As a result, rates of heat-related illnesses such as heat exhaustion (Mahajan & Kothari, 2019), heatstroke (Khan & Mubeen, 2025), dehydration (Oh et al., 2022), and cardiovascular complications (Khraishah et al., 2022) are increasing, particularly among individuals with chronic illnesses, outdoor workers, the elderly, and infants (Benevolenza & DeRigne, 2018; Hopp et al., 2018).

For every 1°C rise in temperature, morbidity and mortality due to heat-related illnesses are estimated to increase by 18% and 35%, respectively, with subtropical regions and older adults being affected most severely (Faurie et al., 2022). Air pollution, often exacerbated by climate-induced events such as wildfires and dust storms, is a significant contributor to respiratory and cardiovascular conditions, including asthma and COPD (Grigorieva & Lukyanets, 2021; Moreira et al., 2024). Severe heatwaves, such as recent episodes in Europe and Australia, have led to spikes in emergency calls, hospitalizations, and mortality, often exceeding public health response capacities (Li et al., 2024; Nitschke et al., 2011).

In addition to thermal stress, climate-driven events such as floods, hurricanes, and wildfires cause a range of direct injuries, including drowning, trauma, smoke-related respiratory distress, and increased exposure to infectious diseases through displacement and overcrowding (Parker, Mo, & Goodman, 2022; Weilhhammer et al., 2021).

Indirect Impacts

Beyond immediate physical exposure, climate change also threatens health indirectly by disrupting ecosystems, agriculture, water systems, and disease transmission patterns (Ebi et al., 2017; Singh et al., 2024). Shifting temperatures and precipitation cycles are expanding the geographic and seasonal range of vector-borne diseases such as malaria, dengue, chikungunya, and Lyme disease (Abbasi, 2025; Fillinger et al., 2009). Similarly, waterborne diseases such as cholera, typhoid, and diarrheal infections are increasing in response to deteriorating water quality and availability (Nichols et al., 2018).

Food insecurity, driven by reduced agricultural productivity, altered crop cycles, and livestock stress, leads to undernutrition, micronutrient deficiencies, and increased vulnerability to infections (Paudel et al., 2023).

Volatile food prices and disruptions in global supply chains further limit access to nutritious food among low-income populations (Munialo & Mellor, 2023; Rojas-Reyes et al., 2024).

These indirect pathways are rooted in climate-induced disruptions to social and natural systems, rather than in direct exposure to hazards. For example, insect-borne disease vectors are thriving in new environments due to rising temperatures and shifting rainfall patterns, which are increasing the spread of malaria and dengue (Agache et al., 2022; Neira et al., 2023). Simultaneously, degraded air quality contributes to both respiratory and cardiovascular illnesses, compounding pre-existing conditions (Ioannou et al., 2022).

Displacement from extreme weather events often leads to overcrowding, unsanitary conditions, and weakened disease prevention efforts, thereby amplifying the risk of disease outbreaks (Jurgilevich et al., 2023). Mental health consequences—including trauma, anxiety, and stress—are also increasingly reported due to economic instability, migration, and environmental uncertainty (Ramadan & Ataallah, 2021).

Vulnerable populations—including children, the elderly, chronically ill individuals, and those living in poverty—face the most significant risk from these indirect effects (Leal Filho et al., 2024; Neira et al., 2023). Moreover, climate change intensifies existing social inequities, as marginalized communities typically have fewer resources to adapt (Agache et al., 2022). These complex, overlapping risks call for comprehensive public health and policy interventions to mitigate the health consequences of climate change (Leal Filho et al., 2024; McMichael et al., 2006).

Vulnerable Populations

Certain groups face heightened vulnerability to climate-related health risks due to biological, social, and economic factors. Pregnant women (Conway et al., 2024), the elderly (Mannucci, Harari, Martinelli, & Franchini, 2015), children (Dondi et al., 2023), and individuals with chronic conditions (Hooper & Kaufman, 2018) are biologically more susceptible to the effects of heat, air pollution, and infections. Socioeconomically disadvantaged populations—particularly in low-income countries—often lack access to clean water, adequate nutrition, safe housing, and healthcare services, increasing their exposure to climate-sensitive diseases (Durstmueller et al., 2024).

Rural and indigenous communities face additional risks, as well as displaced populations, due to geographic isolation, inadequate infrastructure, and weak health systems (Zant, Schlingmann, Reyes-García, & García-del-Amo, 2023). Recognizing these disparities is essential for designing targeted, equitable interventions and adaptable strategies to protect public health in the context of climate change.

Impact of Climate Change on Specific Physical Health Outcomes

Climate change impacts a wide range of physical health outcomes through complex and interrelated pathways. A combination of biological vulnerability, socioeconomic status, and environmental conditions shapes these outcomes. This section systematically reviews the major physical health effects most frequently documented in the literature.

Cardiovascular and Respiratory Disorders

Cardiovascular and respiratory diseases are among the most sensitive to climate-related stressors (De Vita et al., 2024; Xu, Su, Liu, Nie, & Cui, 2025). Rising temperatures, air pollution, and extreme weather events significantly increase the incidence and severity of these conditions. For example, heatwaves are associated with increased hospital admissions for heart attacks, arrhythmias, strokes, and congestive heart failure, particularly in older adults and individuals with pre-existing conditions (PoshtMashhadi, Ijadi Maghsoodi, & Wood, 2025).

High temperatures also intensify the formation of ground-level ozone and particulate matter, which aggravate respiratory conditions such as asthma and COPD (Schnell & Prather, 2017; Yildizhan, Udriștioiu, Pekdogan, & Ameen, 2024). Wildfires, which are becoming more frequent due to prolonged droughts and rising temperatures, release large volumes of delicate particulate matter, creating both immediate and long-term

respiratory hazards (Cedeño Laurent et al., 2024).

Heat-Related Deaths and Illnesses

Heat-related illness is among the most direct health outcomes of climate change (Faurie et al., 2022). Prolonged exposure to high temperatures can result in heat exhaustion (S.Mahajan & Kothari, 2019), heatstroke (Khan & Mubeen, 2025), dehydration (Kriebel-Gasparro, 2024), electrolyte imbalances (Heidari et al., 2016), renal damage (Hajat et al., 2024), and, in severe cases, mortality (Zafeiratou et al., 2025). Outdoor workers—such as those in agriculture, construction, and manual labor—are especially vulnerable to chronic heat exposure (Nerbass et al., 2017).

The “urban heat island effect,” where urban environments retain more heat than rural areas, compounds this risk for city dwellers (Wiszniewski, 2021). According to the World Health Organization (WHO), without appropriate adaptation strategies, heat-related mortality is expected to rise sharply in the coming decades (Ebi et al., 2021).

Infectious Diseases (Vector-Borne and Water-Borne)

Climate change alters the transmission dynamics of vector-borne diseases by shifting the geographic range, seasonal duration, and intensity of disease outbreaks (Fillinger et al., 2009). Warmer temperatures, increased rainfall, and fluctuating humidity levels facilitate the spread of diseases such as dengue, chikungunya, Zika virus, Lyme disease, and malaria via vectors like mosquitoes and ticks (de Souza & Weaver, 2024; Kraemer et al., 2019).

For instance, dengue fever is now being reported in regions and elevations where it was previously non-endemic (Zahir, Ullah, Shah, & Mussawar, 2018). Similarly, disruptions to water supply and sanitation—often following floods or droughts—increase the risk of waterborne diseases, including cholera, typhoid, and diarrheal infections (Ahmad et al., 2021). These threats are magnified among populations with inadequate sanitation and limited access to clean drinking water.

Malaria alone accounted for approximately 229 million infections and 409,000 deaths in 87 endemic countries in 2019 (WHO, 2023). The disease remains especially deadly in Africa, where the *Anopheles* mosquito, whose habitat is highly climate-dependent, is responsible for 92% of malaria-related deaths (Ayong, Guewo Fokeng, & Makoge, 2019). Dengue, transmitted by *Aedes aegypti*, has exhibited increasing case fatality rates in Asia, currently standing at 0.22 (Haider, Hasan, Onyango, & Asaduzzaman, 2024). As climate change expands mosquito habitats, the global burden of these diseases is expected to grow significantly.

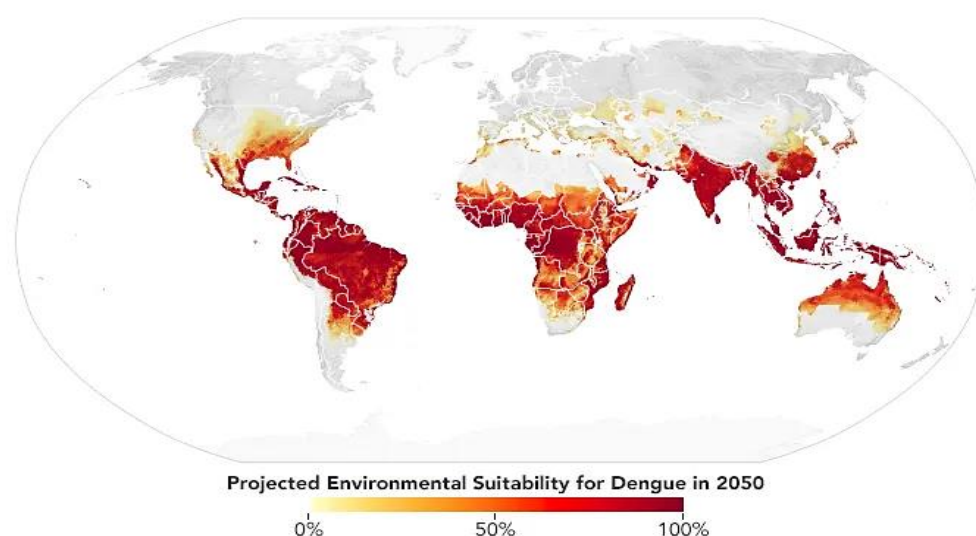


Figure 2. Projected environmental suitability for dengue in 2050; Source: NASA Earth Observatory map by Lauren Dauphin, based on data from Janey Messina, University of Oxford.

Projected 2050 habitat for the *Aedes aegypti* mosquito, responsible for transmitting dengue fever. As the climate warms, large parts of the southeastern U.S., central Mexico, central and southern Africa, coastal China, and Japan could become favorable environments for dengue fever.

Malnutrition and Nutritional Deficiencies

Climate change exacerbates malnutrition and nutrient deficiencies through multiple interconnected mechanisms. Droughts and floods disrupt food production, reducing crop yields and leading to food shortages—particularly among children and vulnerable populations (Fanzo et al., 2025; Lieber, Chin-Hong, Kelly, Dandu, & Weiser, 2022; Mirzabaev et al., 2023). Drought conditions are especially associated with increased rates of underweight and wasting due to constrained access to both food and clean water.

Erratic rainfall and rising temperatures also degrade the nutritional quality of crops, lowering levels of essential micronutrients such as iron and zinc (Fanzo et al., 2025; Nelson et al., 2018). These impacts are most severe in low-income regions that rely on subsistence agriculture and have limited adaptive capacity (Mirzabaev et al., 2023; van der Merwe, Clance, & Yitbarek, 2022).

Furthermore, climate change disrupts food systems, increases prices, and reduces dietary diversity, thereby worsening malnutrition and deficiencies (Agostoni, Baglioni, La Vecchia, Molari, & Berti, 2023; Nelson et al., 2018). Children are particularly affected, with increasing rates of stunting, wasting, and anaemia in highly vulnerable areas (Mahapatra, Walia, Rao, Raju, & Saggurti, 2021; van der Merwe et al., 2022). Notably, climate-driven changes to food availability have also contributed to the “double burden” of malnutrition, where undernutrition and obesity coexist (Dietz, 2020).

Musculoskeletal and Occupational Health Hazards

Rising temperatures and extreme weather also pose a threat to occupational health, particularly in sectors that require outdoor physical labor. Heat stress reduces productivity, estimated at a 6.5% decline, and has been linked to over €292 million in insurance costs across several years in Europe (Marinaccio et al., 2025). In Switzerland, extreme temperatures result in approximately 2,600 workplace accidents annually, which cost CHF 91 million (Drescher & Janzen, 2025).

In Italy alone, outdoor heat exposure has resulted in over 25,000 occupational injuries and a significant drop in productivity between 2014 and 2019, with corresponding compensation costs exceeding €292 million (Marinaccio et al., 2025). Heat stress not only impairs worker efficiency but also increases the risk of accidents, dehydration, and physical exhaustion. Severe weather can further result in physical trauma from falling debris, infrastructure collapse, and other hazards (M, Mj, & R, 2025). Climate-induced displacement may also increase physical workloads, particularly in informal labor and survival-based activities undertaken in hazardous environments (A. Li et al., 2023).

Effect of Climate Change on the Health Care System

Beyond its direct and indirect impacts on physical health, climate change poses a serious and escalating threat to the capacity, efficiency, and resilience of healthcare systems globally (Ansah, Amoadu, Obeng, & Sarfo, 2024). Health systems—particularly in low- and middle-income countries—are increasingly under strain due to the rising frequency and severity of climate-related health risks (Nayna Schwerdtle et al., 2024). This section examines the implications of climate change on health infrastructure, human resources, supply chains, healthcare delivery, and economic sustainability.

Health Infrastructure Vulnerabilities

Healthcare infrastructure is especially vulnerable to climate-induced disasters such as floods, storms, and extreme heat events (Sherman et al., 2023). Facilities located in low-lying or coastal regions face heightened risks of structural damage, power outages, and water contamination during severe weather (Spekkers, Rözer, Thielen, ten Veldhuis, & Kreibich, 2017). These vulnerabilities are often exacerbated by poor drainage, substandard construction, and lack of climate-resilient design (Chohan, Awad, Che-Ani, & Awad, 2025).

In rapidly urbanizing areas, the combination of impervious surfaces and insufficient planning has increased surface runoff by approximately 180%—a figure nearly three times greater than the effect of climate change alone (Hassan, Yassine, & Amin, 2022). Prolonged high temperatures can also undermine indoor thermal conditions, impacting patient safety (Baquero Larriva, Mendes, & Forcada, 2022) and equipment performance (Rahman, Haw, & Fazlizan, 2021), particularly in facilities lacking adequate ventilation or climate control.

Disasters that damage or disable health facilities can interrupt essential services, delay emergency response, and result in the loss of critical medical records (Blagooee, Burrows, Gopaul, & Johnson, 2025). Such disruptions jeopardize continuity of care during times of heightened need.

Growing Disease Burden and Health Service Demand

As climate change fuels the rise of infectious diseases, respiratory illnesses, heat-related conditions, and malnutrition, healthcare systems are facing increased patient loads and demand for services (Al-Marwani, 2023). Seasonal surges in vector-borne illnesses or heat-related admissions may overwhelm facilities that are already operating at or beyond capacity, compromising care quality (Grigoroudis, Kouikoglou, & Phillis, 2022). Additionally, the growing prevalence of chronic diseases linked to climate change necessitates long-term treatment and management, further burdening outpatient and inpatient systems (Xu et al., 2025). Mental health demands are also on the rise due to displacement, trauma, and stress associated with environmental disruption, compounding pressures on already limited services (Nkoulete, 2025).

Disruption of Supply Chains (Medications, Equipment, Vaccines)

Climate-related events can severely disrupt the supply chains for essential medical supplies, including medications, vaccines, equipment, and nutritional products (Tchoukouang, Onyeaka, & Nkoutchou, 2024). Floods and infrastructure damage impede transportation and logistics, delaying deliveries of lifesaving supplies to health facilities (Papilloud, Steiner, Zischg, & Keiler, 2024). Heatwaves and power outages threaten the integrity of cold storage systems, affecting the stability of temperature-sensitive products such as vaccines, insulin, and blood derivatives (Kosari et al., 2018). These disruptions undermine emergency response capabilities and continuity of care, particularly in disaster-affected areas (Altay & Ramirez, 2010).

Workforce Challenges and Preparedness

Healthcare personnel are on the front lines of climate emergencies (Domingo et al., 2024), yet many systems struggle with workforce shortages, inadequate training, and low preparedness (Robinson, Bhandari, Donohue, & Lokmic-Tomkins, 2025). Heat stress, excessive workloads, and emotional exhaustion diminish staff performance and well-being during crisis periods (Chan & Yi, 2016). A notable gap exists in the lack of climate-sensitive health training, including topics such as heat illness management, disaster response, and vector-borne disease control, leaving health professionals ill-equipped to address emerging challenges (Hamilton et al., 2023). These challenges are especially acute in rural and remote regions where healthcare staffing is already minimal, resulting in significant disparities in access to climate-resilient care.

Economic Consequences for Health Systems

The economic toll of climate change on health systems is both substantial and multifaceted (Tanaka, 2017). An estimated \$143 billion per year in damages from extreme events is attributable to climate change, with the majority (63%) of this figure linked to loss of human life (Newman & Noy, 2022). Direct costs include damage to infrastructure, increased expenditures on medication and treatment, and emergency response operations. Indirect costs manifest as lost productivity, disability-adjusted life years (DALYs), and the long-term care of chronic climate-related conditions (Nordeng et al., 2024). For instance, economic modeling indicates that climate-induced undernourishment alone could reduce global GDP by up to 0.4% by 2100—with some regions projected to lose as much as 4% of their GDP due to increased morbidity, mortality, and decreased labor force participation (Hasegawa, Fujimori, Takahashi, Yokohata, & Masui, 2016).

As rates of climate-sensitive diseases rise—especially undernutrition, heat-related illnesses, and vector-borne outbreaks—so too does the demand for medical services, infrastructure, and personnel. This places a

disproportionate burden on health systems in low- and middle-income countries, which face the dual challenge of responding to growing demand with limited financial and institutional capacity (Grigoroudis et al., 2022; Hasegawa et al., 2016).

Adaptation and Mitigation Strategies in Health Care Systems

As climate change intensifies, strengthening the resilience of healthcare systems is no longer optional—it is essential. Adaptation and mitigation strategies are critical not only for protecting health infrastructure but also for ensuring the continuity of quality care amid emerging climate threats. This section highlights key strategies identified in the literature for equipping health systems to meet climate-related challenges.

Climate-Resilient Health Facilities

Building climate-resilient health infrastructure is central to effective adaptation. Such infrastructure enables healthcare systems to withstand and recover from extreme weather events, temperature extremes, and supply chain disruptions, thereby sustaining the delivery of essential services (Corvalan et al., 2020; Nayna Schwerdtle et al., 2024). This involves constructing or retrofitting healthcare facilities to resist climate-related hazards—such as floods, storms, and heatwaves—through improved drainage systems, flood barriers, and reinforced structural design. Integrating renewable energy systems, particularly solar power, ensures continuity of operations during power outages (Aghazadeh Ardebili et al., 2024). Additionally, proper ventilation and climate control in facility design help protect both patients and sensitive equipment during extreme heat. A decentralized network of health facilities also reduces reliance on single large centers, enabling more agile and equitable emergency responses during climate-induced disruptions.

Surveillance and Early Warning Systems

Timely detection and rapid response are vital to mitigating the health impacts of climate-sensitive threats (Moreira et al., 2022). Strengthening disease surveillance systems enhances the early identification of outbreaks, particularly those related to vector- and water-borne diseases. Integrated early warning systems that combine meteorological data with health surveillance can forecast extreme events—such as heatwaves, floods, and shifts in vector habitats—allowing health services to pre-position resources and initiate targeted interventions (Asaaga et al., 2024). Effective implementation requires cross-sector collaboration among health, meteorological, agricultural, and environmental agencies (Kachali, Storsjö, Haavisto, & Kovács, 2018).

Public Health Education and Community Engagement

Community engagement and public education are fundamental to fostering resilience at the population level (Bajayo, 2012). Awareness campaigns can inform communities about protective behaviors—such as heat safety, hygiene, sanitation, nutrition, and disease prevention—empowering individuals to take proactive steps in reducing health risks. Community participation in emergency preparedness planning also ensures interventions are culturally appropriate and locally trusted. Strengthening the capacities of local health workers and community leaders enhances the speed and effectiveness of responses, especially in remote or underserved areas (Jacobs et al., 2014).

Policy Development and International Cooperation

Robust policy frameworks and international partnerships are essential for integrating climate resilience into health systems. National adaptation plans must incorporate health-specific strategies that include sustainable financing, intersectoral governance, and professional capacity building. Global organizations such as the World Health Organization (WHO) and the United Nations Framework Convention on Climate Change (UNFCCC), along with international donors, play a key role by providing technical guidance, funding, and platforms for knowledge exchange. The WHO's Operational Framework for Building Climate-Resilient Health Systems offers a structured approach to mainstreaming resilience into national health policies and planning (Ebi, Kovats, & Menne, 2006; Ebi & Prats, 2015; Nhamo & Muchuru, 2019).

Research Gaps and Future Directions

Despite growing awareness and significant advances in understanding the health effects of climate change, substantial research gaps persist. Addressing these gaps is essential for developing evidence-based policies, effective adaptation strategies, and resilient health systems, mainly to protect the most vulnerable populations.

One of the most pressing gaps is the limited availability of high-quality longitudinal data that links climate variables to specific physical health outcomes. While numerous associations have been documented, a critical need remains for more robust causal research to strengthen the evidence base. Current studies are also disproportionately focused on high-income countries, leaving a considerable void in the data for low- and middle-income countries (LMICs), which often experience the most severe climate-related health burdens. As a result, there is insufficient evidence to inform targeted adaptation strategies in these high-risk settings.

Moreover, little attention has been given to the cumulative and repeated exposures to climate extremes—such as multiple heatwaves or prolonged droughts—and their long-term implications for chronic disease progression and multimorbidity. Occupational health impacts, particularly among outdoor and informal sector workers, remain under-explored despite their increased vulnerability to rising temperatures.

Another under-researched area is the complex relationship between climate change, nutrition, and food security, particularly in resource-constrained settings. Further studies are needed to investigate how these dynamics interact to influence long-term health outcomes. Within health systems, there is a dearth of research evaluating the adaptive capacity of infrastructure, supply chains, and workforce preparedness under various climate scenarios. Additionally, limited work has been done on cost-effective interventions—such as the role of digital technologies, decentralized energy systems, and innovative financing—in building climate-resilient health systems.

Priorities for Future Research

Future research must adopt multidisciplinary approaches that integrate climate science, public health, epidemiology, economics, health policy, and systems thinking. Strengthening systems for real-time data collection and surveillance of climate-sensitive health conditions will enable more agile and targeted interventions. A key priority is understanding how climate change interacts with social determinants of health—including poverty, gender, displacement, and inequity—to drive disproportionate impacts on marginalized groups. Such understanding is vital for developing inclusive and equitable health policies.

Operational research should evaluate the effectiveness of specific adaptation interventions, such as early warning systems, risk communication strategies, and infrastructure resilience programs. These assessments will help prioritize scalable, evidence-based approaches. Interdisciplinary collaboration—among researchers, national governments, international organizations, and affected communities—is essential to generate context-specific knowledge that informs both national policy agendas and global health governance.

Conclusions

Climate change presents a critical and multifaceted threat to global physical health and the sustainability of healthcare systems. This scoping review has highlighted both direct and indirect impacts, ranging from heat-related illness, cardiovascular and respiratory disorders, and infectious diseases, to malnutrition and occupational hazards. Vulnerable populations—including the elderly, children, people with chronic illnesses, and socioeconomically disadvantaged groups—are disproportionately affected, deepening existing health inequities. Simultaneously, healthcare systems face growing pressure due to rising disease burdens, infrastructure vulnerabilities, supply chain disruptions, and workforce limitations. Most systems, especially those in low-resource settings, cannot respond adequately to these escalating challenges. The economic implications are equally concerning, as climate-sensitive diseases increase the demand for health services and place additional strain on limited budgets.

Implications for Policy, Practice, and Research

To meet these challenges, urgent and integrated adaptation and mitigation efforts are required. Key priorities include:

1. Investing in climate-resilient health infrastructure
2. Enhancing early warning and disease surveillance systems
3. Strengthening health workforce capacity
4. Promoting community engagement and education
5. Mainstreaming climate adaptation into national health policies

International collaboration—facilitated through funding, knowledge sharing, and technical assistance—will be vital to support capacity-building, especially in LMICs. Frameworks such as the WHO's Operational Framework for Building Climate-Resilient Health Systems provide valuable guidance in this regard.

From a research perspective, a deeper understanding is needed of the complex relationships between climate stressors, health outcomes, and health system responses. Special emphasis should be placed on filling data gaps in LMICs, improving data quality, and rigorously evaluating adaptation strategies.

Ultimately, addressing the health impacts of climate change demands a coordinated, interdisciplinary, and equity-focused approach—one that links health, environmental sustainability, and social justice to ensure well-being in an increasingly unstable climate.

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