

Cambio Climático, Salud Urbana y Sistemas de Salud Pública Resilientes: Desafíos Globales y Estrategias para el Manejo de Enfermedades Sensibles al Clima

Climate Change, Urban Health, and Climate-Resilient Public Health Systems: Global Challenges and Strategies for Managing Climate-Sensitive Diseases

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RESUMEN

El cambio climático se ha consolidado como uno de los principales desafíos para la salud pública del siglo XXI, modificando significativamente la epidemiología de las enfermedades sensibles al clima e incrementando la vulnerabilidad de las poblaciones urbanas a nivel mundial. El objetivo de esta revisión fue analizar la evidencia científica actual sobre la relación entre el cambio climático, las enfermedades sensibles al clima y la resiliencia de los sistemas de salud pública, con especial énfasis en los entornos urbanos y el contexto latinoamericano. Se realizó una revisión narrativa de la literatura siguiendo el Método Científico, utilizando publicaciones indexadas en PubMed/MEDLINE, Scopus, Web of Science y documentos oficiales emitidos por organismos internacionales como la Organización Mundial de la Salud, la Organización Panamericana de la Salud, el Panel Intergubernamental sobre Cambio Climático, las Naciones Unidas y la Organización Meteorológica Mundial. La evidencia revisada demostró que el aumento de la temperatura, las modificaciones en los patrones de precipitación, los eventos climáticos extremos, la degradación ambiental y la urbanización acelerada favorecen el incremento de enfermedades transmitidas por vectores, enfermedades respiratorias, enfermedades transmitidas por agua y alimentos, así como patologías relacionadas con el calor. Los entornos urbanos fueron identificados como especialmente vulnerables debido a la alta densidad poblacional, las desigualdades socioeconómicas, la contaminación ambiental y las limitaciones de infraestructura sanitaria. Asimismo, la revisión evidenció que los sistemas de salud resilientes que incorporan vigilancia epidemiológica, sistemas de alerta temprana, infraestructura sanitaria resiliente, innovación tecnológica y gobernanza multisectorial constituyen elementos esenciales para fortalecer la capacidad de adaptación frente al cambio climático. En conjunto, los hallazgos respaldan la integración de la adaptación climática dentro de la planificación rutinaria de la salud pública y destacan la importancia de la colaboración internacional, el desarrollo urbano sostenible y las políticas basadas en evidencia para proteger a las poblaciones urbanas frente a los escenarios climáticos futuros.

PALABRAS CLAVE

Cambio climático, Enfermedades sensibles al clima, Salud urbana, Sistemas de salud pública, Epidemiología, Resiliencia sanitaria, Salud ambiental, Enfermedades transmitidas por vectores, Olas de calor, Contaminación del aire, Adaptación climática, América Latina.

ABSTRACT

Climate change has emerged as one of the most important public health challenges of the twenty-first century, profoundly influencing the epidemiology of climate-sensitive diseases and increasing the vulnerability of urban populations worldwide. This review aimed to analyze current scientific evidence regarding the relationship between climate change, climate-sensitive diseases, and the resilience of public health systems, with particular emphasis on urban environments and the Latin American context. A narrative literature review was conducted following the Scientific Method, using publications indexed in PubMed/MEDLINE, Scopus, Web of Science, and official reports issued by international organizations, including the World Health Organization, the Pan American Health Organization, the Intergovernmental Panel on Climate Change, the United Nations, and the World Meteorological Organization. The reviewed evidence demonstrated that rising temperatures, changing precipitation patterns, extreme weather events, environmental degradation, and accelerated urbanization contribute to the increasing burden of vector-borne, respiratory, water- and food-borne, and heat-related diseases. Urban environments were identified as particularly vulnerable because of high population density, socioeconomic inequalities, environmental pollution, and limitations in health infrastructure. The review also highlighted that resilient public health systems incorporating epidemiological surveillance, early warning systems, climate-resilient healthcare infrastructure, technological innovation, and multisectoral governance are essential to strengthen adaptation capacity and reduce climate-related health impacts. Overall, the findings support the integration of climate adaptation into routine public health planning and emphasize the importance of international collaboration, sustainable urban development, and evidence-based policies to protect increasingly urbanized populations under future climate scenarios.

KEYWORDS

Climate change, Climate-sensitive diseases, Urban health, Public health systems, Epidemiology, Health resilience, Environmental health, Vector-borne diseases, Heat waves, Air pollution, Climate adaptation, Latin America.

INTRODUCCIÓN

Climate change has emerged as one of the most significant public health challenges of the twenty-first century, fundamentally altering the epidemiological landscape of communicable and non-communicable diseases while exacerbating existing health inequities across urban environments. Rising global temperatures, increasing frequency and intensity of extreme weather events, changes in precipitation patterns, and accelerated urbanization have collectively intensified the burden of climate-sensitive diseases, particularly in densely populated cities where environmental, social, and infrastructural vulnerabilities converge (Intergovernmental Panel on Climate Change [IPCC], 2023; World Health Organization [WHO], 2023). Urban centers now accommodate more than half of the world's population, a proportion expected to continue increasing over the coming decades, making cities critical settings for understanding and addressing the complex interactions between climate change and human health (United Nations Human Settlements Programme [UN-Habitat], 2022).

The health consequences of climate change extend far beyond direct exposure to heat waves or natural disasters. Environmental transformations influence the distribution of disease vectors, compromise water quality and food security, increase air pollution, and affect social determinants of health such as housing, employment, migration, and access to healthcare. Consequently, climate-sensitive diseases—including vector-borne, water-borne, food-borne, and respiratory illnesses—have shown notable changes in their incidence, geographic distribution, seasonality, and severity during recent decades (Romanello et al., 2023; Mora et al., 2022). These alterations represent an unprecedented challenge for public health authorities, requiring health systems capable not only of responding to emergencies but also of anticipating future risks through preventive, adaptive, and resilient strategies.

Urbanization further amplifies these health risks. Rapid and frequently unplanned urban growth has generated environments characterized by high population density, inadequate sanitation, deficient drainage systems, insufficient green spaces, poor housing conditions, and elevated exposure to environmental pollutants. Such conditions facilitate the proliferation of disease vectors, increase vulnerability to flooding and heat stress, and disproportionately affect socioeconomically disadvantaged populations (UN-Habitat, 2022; Campbell-Lendrum & Prüss-Ustün, 2019). The phenomenon of urban heat islands, for example, substantially increases ambient temperatures in metropolitan regions, contributing to excess mortality, cardiovascular complications, respiratory illnesses, renal disorders, and reduced labor productivity, particularly among older adults, children, pregnant women, and individuals with chronic diseases (Ebi et al., 2021).

Among climate-sensitive diseases, vector-borne infections have attracted considerable attention due to their rapid geographical expansion under changing climatic conditions. Increasing temperatures, altered rainfall patterns, and changes in humidity directly influence the life cycle, reproductive capacity, and survival of vectors such as *Aedes aegypti*, *Aedes albopictus*, and *Anopheles* mosquitoes. Consequently, diseases including dengue, chikungunya, Zika, malaria, West Nile fever, and other arboviral infections have expanded into regions previously considered climatically unsuitable for sustained transmission (Ryan et al., 2019; Rocklöv & Dubrow, 2020). Latin America represents one of the world's most vulnerable regions in this regard due to its tropical climate, rapid urban expansion, socioeconomic inequalities, and heterogeneous healthcare infrastructure, all of which contribute to increasing transmission dynamics.

Climate variability also significantly influences diseases transmitted through contaminated water and food. Floods, heavy rainfall, prolonged droughts, and disruptions in sanitation infrastructure increase the probability of outbreaks of cholera, salmonellosis, campylobacteriosis, cryptosporidiosis, and other gastrointestinal infections. At the same time, rising temperatures accelerate bacterial replication, modify pathogen ecology, and compromise food preservation systems, thereby increasing the incidence of food-borne illnesses worldwide (WHO, 2023; IPCC, 2023). Urban populations experiencing deficiencies in potable water access and wastewater management are particularly susceptible to these climate-related health threats.

Respiratory diseases constitute another major component of climate-sensitive health outcomes. Climate change contributes to deteriorating air quality through increased concentrations of particulate matter, ozone formation, prolonged pollen seasons, and more frequent wildfires. Exposure to these environmental pollutants has been consistently associated with exacerbations of asthma, chronic obstructive pulmonary disease (COPD), respiratory infections, cardiovascular disease, and premature mortality (Campbell-Lendrum & Prüss-Ustün, 2019; Haines & Ebi, 2019). Moreover, wildfire smoke episodes increasingly affect urban populations located hundreds or even thousands of kilometers from fire sources, highlighting the transboundary nature of climate-related environmental hazards.

Extreme weather events—including heat waves, hurricanes, floods, droughts, and wildfires—produce both immediate and long-term consequences for population health. Beyond causing direct injuries and mortality, these events disrupt healthcare delivery, damage critical infrastructure, interrupt pharmaceutical supply chains, displace communities, and generate significant psychological consequences such as anxiety, depression, post-traumatic stress disorder, and chronic emotional distress. These cascading impacts demonstrate that climate change affects virtually every component of healthcare systems, emphasizing the necessity of strengthening resilience across all levels of public health infrastructure (WHO, 2021; Romanello et al., 2023).

The concept of resilient health systems has therefore gained increasing prominence within global health policy. Climate-resilient health systems are defined as those capable of anticipating, preparing for, responding to, recovering from, and adapting to climate-related shocks while maintaining essential healthcare services. Such systems integrate surveillance, risk assessment, emergency preparedness, resilient infrastructure, sustainable financing, workforce capacity building, and multisectoral governance into comprehensive adaptation strategies (WHO, 2021). Increasingly, resilience is recognized not merely as an emergency response capacity but as a continuous process of strengthening health systems to function effectively under evolving climatic conditions.

Recent scientific evidence has highlighted the importance of integrating climate adaptation into public health planning. The annual Lancet Countdown reports have consistently demonstrated that climate change is already undermining decades of progress in global health while simultaneously increasing health inequities between and within countries (Romanello et al., 2023). Similarly, the Latin American Lancet Countdown emphasizes that climate-related health risks disproportionately affect low- and middle-income countries, where rapid urbanization, environmental degradation, and structural inequalities limit adaptive capacity despite relatively low historical greenhouse gas emissions (Hartinger et al., 2024). These findings underscore the importance of developing region-specific adaptation policies while strengthening international collaboration.

Advances in epidemiological surveillance, geographic information systems, artificial intelligence, remote sensing technologies, satellite monitoring, and predictive modeling have substantially improved the ability to identify emerging climate-sensitive disease risks. Modern surveillance systems increasingly combine environmental, climatic, demographic, and epidemiological information to generate early warning systems capable of supporting timely public health interventions. Such technological innovations represent valuable tools for reducing disease transmission, optimizing resource allocation, and improving emergency preparedness within urban health systems (Alcayna et al., 2025).

Despite growing scientific knowledge, important gaps remain regarding the integration of climate science into routine public health decision-making. Many health systems continue to operate using reactive rather than preventive approaches, with limited incorporation of climate projections into health planning, infrastructure development, workforce training, or financing mechanisms. Furthermore, significant disparities persist between high-income countries and low- and middle-income regions regarding surveillance capacity, healthcare infrastructure, environmental monitoring, and institutional preparedness (Palmeiro-Silva et al., 2026). These disparities are particularly evident throughout Latin America, where rapid demographic transitions, ecological diversity, and socioeconomic inequalities create highly heterogeneous vulnerability profiles.

Considering these challenges, synthesizing current evidence regarding climate-sensitive diseases and resilient public health systems has become increasingly relevant for researchers, clinicians, epidemiologists, policymakers, and healthcare administrators. Understanding how climate variability modifies disease epidemiology while simultaneously

affecting healthcare delivery is essential for designing evidence-based adaptation strategies capable of protecting increasingly urbanized populations under future climate scenarios.

Accordingly, the present review aims to comprehensively analyze the current scientific evidence regarding climate-sensitive diseases within urban environments, examining the epidemiological mechanisms through which climate change influences disease occurrence, the principal health impacts associated with urbanization and extreme climatic events, and the strategies available for strengthening climate-resilient public health systems. Particular emphasis is placed on integrating global evidence with experiences from Latin America, recognizing the region's unique epidemiological, environmental, and socioeconomic characteristics. Furthermore, this review explores emerging technological innovations, surveillance strategies, health policy approaches, and multisectoral interventions that may contribute to improving urban resilience against climate-related health threats while supporting sustainable and equitable public health development.

DESARROLLO

Climate change has transformed from an environmental concern into a multidimensional public health challenge with profound implications for disease epidemiology, urban planning, and healthcare system performance. Current evidence demonstrates that climatic variables—including rising temperatures, altered precipitation patterns, sea-level rise, and the increasing frequency of extreme weather events—are reshaping the distribution, incidence, and severity of numerous communicable and non-communicable diseases worldwide (IPCC, 2023; Romanello et al., 2023). These effects are particularly pronounced in urban settings, where rapid population growth, environmental degradation, and social inequalities amplify health risks and place additional pressure on healthcare systems.

One of the most evident consequences of climate change is the expansion of climate-sensitive infectious diseases. Vector-borne diseases such as dengue, malaria, chikungunya, Zika, and West Nile fever are increasingly influenced by environmental conditions that favor vector survival, reproduction, and geographical expansion. Temperature directly affects mosquito development, viral replication within vectors, and biting frequency, while precipitation and humidity modify breeding habitats and transmission dynamics. Consequently, regions previously considered unsuitable for sustained transmission have experienced the emergence or re-emergence of these diseases during recent decades (Ryan et al., 2019; Rocklöv & Dubrow, 2020). Urban environments characterized by inadequate waste management, poor drainage infrastructure, and water storage practices further facilitate mosquito proliferation, making densely populated cities particularly vulnerable.

Climate change also contributes significantly to waterborne and foodborne diseases through its impact on water quality, sanitation systems, and food safety. Heavy rainfall and flooding frequently overwhelm urban drainage systems, increasing contamination of drinking water supplies with pathogenic microorganisms. Conversely, prolonged droughts reduce water availability, forcing populations to rely on unsafe water sources and compromising hygiene practices. Rising environmental temperatures additionally accelerate bacterial growth in food products, increasing the incidence of gastrointestinal infections such as salmonellosis, campylobacteriosis, and cholera (WHO, 2023). These mechanisms disproportionately affect low-resource urban communities where access to safe water and sanitation remains limited.

Respiratory diseases represent another critical component of climate-sensitive health outcomes. Air pollution, intensified by higher temperatures and prolonged wildfire seasons, contributes to increased concentrations of fine particulate matter (PM_{2.5}), ground-level ozone, and airborne allergens. These pollutants have been consistently associated with exacerbations of asthma, chronic obstructive pulmonary disease, respiratory infections, cardiovascular disease, and premature mortality. Urban populations are especially exposed due to high traffic density, industrial emissions, and limited green infrastructure, factors that interact synergistically with climate change to deteriorate air quality (Campbell-Lendrum & Prüss-Ustün, 2019; Haines & Ebi, 2019).

Extreme weather events further compound these health challenges by generating immediate and indirect consequences for healthcare delivery. Heat waves increase hospital admissions related to dehydration, heat stroke, cardiovascular disorders, and renal injury, while floods, hurricanes, and wildfires damage healthcare infrastructure, interrupt essential medical services, displace populations, and compromise supply chains for medicines and medical equipment. Beyond

their physical effects, these disasters also produce substantial psychological consequences, including anxiety, depression, and post-traumatic stress disorder, which often persist long after the acute event has resolved (WHO, 2021; Romanello et al., 2023).

Urbanization plays a decisive role in determining population vulnerability to climate-sensitive diseases. More than half of the global population currently resides in cities, and this proportion is projected to continue increasing over the coming decades (UN-Habitat, 2022). Rapid urban growth has frequently outpaced infrastructure development, leading to overcrowded housing, deficient sanitation, reduced green areas, inadequate transportation systems, and increased environmental pollution. These conditions intensify the urban heat island effect, increase exposure to infectious agents, and exacerbate existing socioeconomic inequalities that influence access to healthcare services. Consequently, the health impacts of climate change are not uniformly distributed but disproportionately affect children, older adults, pregnant women, individuals with chronic illnesses, migrants, and economically disadvantaged populations.

The concept of climate-resilient health systems has therefore become increasingly relevant within contemporary public health. A resilient health system is capable of anticipating climate-related risks, maintaining essential healthcare services during emergencies, adapting infrastructure to environmental changes, strengthening epidemiological surveillance, and promoting coordinated action across governmental sectors. Rather than focusing exclusively on emergency response, resilience emphasizes continuous preparedness, adaptive capacity, sustainable resource management, and evidence-based decision-making (WHO, 2021). International organizations have highlighted that investments in resilient health systems generate substantial long-term benefits by reducing mortality, minimizing economic losses, and improving healthcare continuity during climate-related crises.

Recent technological advances provide valuable opportunities to strengthen urban public health resilience. Geographic information systems, remote sensing technologies, artificial intelligence, predictive epidemiological models, satellite monitoring, and digital surveillance platforms enable earlier detection of disease outbreaks and improve the capacity to anticipate climate-related health risks. These innovations facilitate more efficient allocation of healthcare resources, enhance emergency preparedness, and support preventive interventions before outbreaks escalate (Alcayna et al., 2025). However, significant disparities remain between countries regarding technological infrastructure, workforce training, financial resources, and institutional capacity to implement these approaches effectively.

Latin America exemplifies many of the global challenges associated with climate-sensitive diseases. The region combines high biodiversity, tropical and subtropical climates, accelerated urbanization, socioeconomic inequalities, and heterogeneous healthcare systems, creating favorable conditions for the emergence and persistence of climate-related health threats. Recent regional assessments have documented increasing transmission of arboviral diseases, greater exposure to extreme heat, worsening air quality, and growing vulnerability to floods and droughts, emphasizing the urgent need for integrated adaptation policies that combine environmental management, epidemiological surveillance, urban planning, and health system strengthening (Hartinger et al., 2024; Palmeiro-Silva et al., 2026).

OBJETIVO GENERAL Y OBJETIVOS ESPECÍFICOS

General Objective

To critically analyze the current scientific evidence on climate-sensitive diseases in urban environments, evaluating the impact of climate change on population health and identifying strategies that strengthen climate-resilient public health systems from an international perspective, with particular emphasis on Latin America.

Specific Objectives

Cognitive Domain

- **Analyze** the epidemiological relationship between climate change and the emergence, distribution, and burden of climate-sensitive diseases in urban populations.
- **Evaluate** the scientific evidence regarding the effectiveness of climate adaptation and resilience strategies implemented within public health systems.

- **Compare** international and Latin American experiences in addressing climate-related health challenges and strengthening urban health governance.

Psychomotor Domain

- **Apply** epidemiological and public health concepts to interpret climate-health interactions using evidence from current scientific literature.
- **Develop** an organized framework that integrates climate-sensitive diseases, surveillance systems, and resilience strategies for urban health planning.

Affective Domain

- **Recognize** the importance of climate change as a priority public health issue requiring multidisciplinary and multisectoral action.
- **Value** the role of resilient health systems, environmental sustainability, and equitable public policies in protecting vulnerable populations against climate-related health threats.

OBJETO DE ESTUDIO

The object of study of this review is the interaction between climate change, climate-sensitive diseases, and the resilience of public health systems in urban environments. Specifically, the review focuses on understanding how climatic factors—including increasing temperatures, altered precipitation patterns, extreme weather events, and environmental degradation—influence the occurrence, transmission, distribution, and severity of diseases that are directly or indirectly affected by climate variability.

The study encompasses urban populations across different geographical regions, with particular emphasis on countries in Latin America due to their rapid urbanization, ecological diversity, socioeconomic inequalities, and high vulnerability to climate-related health risks. At the same time, evidence from North America, Europe, Asia, Africa, and Oceania is incorporated to provide a comprehensive international perspective and facilitate comparisons between different health systems, adaptation strategies, and epidemiological contexts.

From an epidemiological perspective, the review examines communicable diseases that demonstrate climate sensitivity, including vector-borne diseases such as dengue, malaria, chikungunya, Zika, and West Nile fever; waterborne and foodborne diseases associated with changes in water availability and sanitation; and respiratory diseases influenced by air pollution, wildfires, and increasing ambient temperatures. Additionally, the review considers the indirect health consequences of climate change, including heat-related illnesses, mental health disorders associated with extreme weather events, and disruptions to healthcare delivery during climate emergencies.

The analysis also addresses the public health systems responsible for preventing, detecting, monitoring, and responding to climate-related health threats. Particular attention is given to epidemiological surveillance systems, emergency preparedness, climate-resilient healthcare infrastructure, environmental health policies, multisectoral governance, and technological innovations that support adaptation and resilience. These components are examined as interconnected elements that collectively determine the capacity of health systems to anticipate and manage the evolving health impacts of climate change.

Accordingly, the object of study integrates environmental, epidemiological, and health system dimensions, recognizing that climate-sensitive diseases cannot be understood solely as biological phenomena but rather as complex outcomes resulting from interactions among climatic processes, urban development, social determinants of health, environmental conditions, and institutional preparedness. This integrated perspective provides a comprehensive framework for identifying evidence-based strategies that enhance urban resilience and promote sustainable public health in the context of ongoing global climate change.

METODOLOGÍA

This study was conducted using the **Scientific Method** as the guiding methodological framework for the development of a narrative literature review. This approach was selected because it provides a systematic and reproducible process for identifying, evaluating, synthesizing, and interpreting scientific evidence related to climate-sensitive diseases, urban health, and climate-resilient public health systems. The methodology was designed to ensure transparency, methodological rigor, and comprehensive coverage of the current international literature.

The research process began with the identification of the research problem, focusing on the growing impact of climate change on disease epidemiology and the capacity of urban health systems to respond to climate-related challenges. Based on this problem, the research objectives were established, guiding the selection and organization of the scientific evidence included in the review.

A structured literature search was performed using internationally recognized biomedical and multidisciplinary databases, including **PubMed/MEDLINE**, **Scopus**, **Web of Science**, and **Google Scholar** as a complementary source. In addition, official publications from the **World Health Organization (WHO)**, the **Pan American Health Organization (PAHO)**, the **Intergovernmental Panel on Climate Change (IPCC)**, the **United Nations (UN)**, and the **World Meteorological Organization (WMO)** were consulted to incorporate current recommendations, technical reports, and global policy documents.

The search strategy combined controlled vocabulary and free-text terms using Boolean operators. The principal search terms included *climate change*, *climate-sensitive diseases*, *urban health*, *public health systems*, *health resilience*, *vector-borne diseases*, *air pollution*, *heat waves*, *epidemiology*, *environmental health*, and *Latin America*. These terms were combined using the operators **AND** and **OR** to maximize retrieval of relevant publications.

The review prioritized peer-reviewed articles, systematic reviews, meta-analyses, multicenter studies, international reports, and clinical or epidemiological investigations published primarily between **2019 and 2025**, while allowing the inclusion of seminal publications published before this period when considered essential for the conceptual foundation of the topic. Only documents published in English or Spanish with sufficient methodological quality and direct relevance to the objectives of the review were included.

Publications were excluded if they lacked scientific peer review, presented insufficient methodological information, focused exclusively on unrelated environmental topics, consisted solely of opinion papers without supporting evidence, or duplicated previously identified information. After screening the retrieved literature, the selected studies underwent a qualitative analysis to identify common themes, methodological approaches, epidemiological findings, and recommendations relevant to climate adaptation and resilient health systems.

The extracted information was subsequently organized into thematic categories corresponding to the major sections of this review, including climate-sensitive infectious diseases, respiratory diseases, urban vulnerability, epidemiological surveillance, resilient healthcare infrastructure, technological innovations, health policy, and adaptation strategies. Findings from different geographical regions were synthesized to facilitate comparisons between global experiences and the specific challenges observed in Latin America.

To enhance the reliability of the review, information was contrasted across multiple high-quality sources, giving preference to publications indexed in internationally recognized databases and reports issued by leading global health organizations. This methodological approach allows other researchers to replicate the literature search, apply similar eligibility criteria, and update the evidence as new scientific publications become available, thereby ensuring reproducibility and scientific consistency.

FASES DEL DESARROLLO

Phase 1. Identification of the Research Problem

The first phase consisted of defining the research problem based on the increasing impact of climate change on urban population health. Current epidemiological evidence indicates that rising temperatures, changing precipitation patterns, extreme weather events, and accelerated urbanization have significantly modified the distribution and burden of climate-sensitive diseases while challenging the capacity of health systems to respond effectively. This stage established the scientific rationale and the scope of the review.

Phase 2. Formulation of the Research Objectives

After defining the problem, the general and specific objectives were formulated to guide the review process. The objectives focused on analyzing the relationship between climate change and climate-sensitive diseases, evaluating resilient public health strategies, and examining international experiences, with particular attention to Latin American countries. These objectives provided the framework for selecting relevant scientific evidence and organizing the subsequent analysis.

Phase 3. Literature Search and Evidence Collection

A comprehensive literature search was performed using internationally recognized scientific databases, including PubMed/MEDLINE, Scopus, Web of Science, and Google Scholar. Official reports published by the World Health Organization, Pan American Health Organization, Intergovernmental Panel on Climate Change, United Nations, and World Meteorological Organization were also incorporated. The search strategy employed predefined keywords and Boolean operators to retrieve studies addressing climate change, urban health, epidemiology, climate-sensitive diseases, health system resilience, environmental health, and Latin America.

Phase 4. Selection and Critical Appraisal of the Literature

Retrieved publications were screened according to predefined eligibility criteria. Priority was given to peer-reviewed articles, systematic reviews, meta-analyses, multicenter investigations, and international reports presenting robust methodological quality and direct relevance to the objectives of the review. Publications lacking sufficient scientific rigor or unrelated to the study topic were excluded. Each selected document was critically examined to identify its principal findings, methodological strengths, and contribution to current scientific knowledge.

Phase 5. Data Organization and Thematic Analysis

Information extracted from the selected publications was organized into thematic categories according to the principal components of the review. These categories included climate-sensitive infectious diseases, respiratory health, urban environmental risks, vulnerable populations, epidemiological surveillance, resilient healthcare infrastructure, technological innovations, public health policies, and adaptation strategies. Similarities, differences, and complementary findings across studies were identified to generate an integrated understanding of the available evidence.

Phase 6. Interpretation and Scientific Synthesis

The final phase involved integrating the analyzed evidence into a coherent scientific narrative. Findings from different regions of the world were compared to identify common epidemiological patterns, successful adaptation strategies, and remaining challenges for resilient public health systems. Special consideration was given to Latin America, recognizing its unique environmental, demographic, and socioeconomic characteristics. The synthesis emphasized practical implications for epidemiological surveillance, healthcare planning, urban resilience, and future public health policies aimed at reducing the health impacts of climate change.

RESULTADOS Y DISCUSIÓN

Figure 1.

Global distribution of climate-sensitive disease categories identified in the reviewed literature.

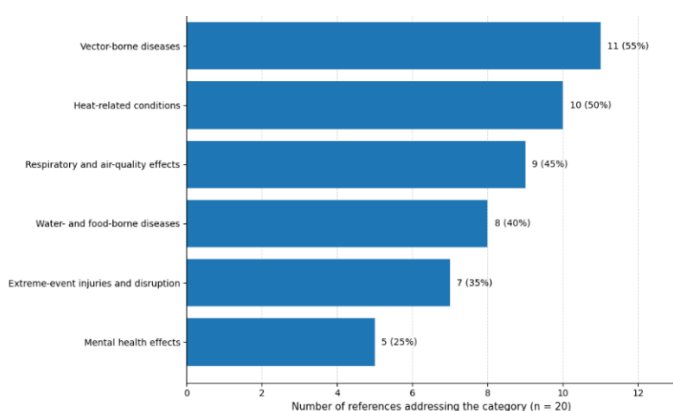


Figure 1 presents the thematic distribution of the principal climate-sensitive disease categories identified across the 20 sources included in the review. Each publication was classified according to the health outcomes it addressed; therefore, a single reference could be assigned to more than one category. Consequently, the percentages are not mutually exclusive and should be interpreted as the proportion of reviewed sources that discussed each health category rather than as estimates of disease prevalence, incidence, or attributable mortality.

Vector-borne diseases represented the most frequently addressed category, appearing in 11 of the 20 reviewed references, equivalent to 55% of the selected literature. This predominance reflects the extensive scientific attention given to the effects of temperature, precipitation, humidity, and environmental change on the ecology of mosquitoes, ticks, and other disease vectors. Changes in these climatic variables can modify vector survival, reproductive cycles, biting activity, pathogen development, transmission seasons, and geographic distribution. As a result, diseases such as dengue, malaria, chikungunya, Zika, West Nile fever, and other vector-borne infections have become central indicators of the relationship between climate variability and human health (Rocklöv & Dubrow, 2020; Ryan et al., 2019).

The prominence of vector-borne diseases is particularly relevant for urban areas. Densely populated neighborhoods with inadequate drainage, irregular water supplies, accumulated waste, and household water-storage containers may provide favorable breeding conditions for *Aedes* mosquitoes. These environmental conditions interact with higher temperatures and changing rainfall patterns, increasing the potential for sustained arboviral transmission. Current evidence indicates that climate change is modifying the suitability of different regions for vector survival and disease transmission, including areas that historically experienced limited or seasonal circulation of these infections.

This pattern has important implications for Latin America, where dengue and other arboviruses coexist with rapid urbanization, socioeconomic inequality, population mobility, and uneven access to environmental health services. The regional Lancet Countdown assessment reported increasing exposure to heat, wildfires, and vector-borne disease risks throughout Latin America, while also identifying persistent limitations in governmental recognition and integration of climate-related health priorities.

Heat-related conditions constituted the second most frequently identified category, appearing in 10 references, or 50% of the reviewed sources. This finding indicates that extreme heat is increasingly regarded as both a direct cause of disease and a factor capable of aggravating pre-existing conditions. Exposure to elevated temperatures may contribute to heat exhaustion, heat stroke, dehydration, acute kidney injury, cardiovascular decompensation, respiratory complications, adverse occupational outcomes, and excess mortality. The risk is especially pronounced during prolonged heat waves, when nighttime temperatures remain elevated and the human body has limited opportunity for physiological recovery.

Urban heat islands intensify this exposure because buildings, roads, reduced vegetation, traffic, and densely constructed environments retain heat and produce temperatures above those recorded in surrounding areas. The resulting health burden is not evenly distributed. Older adults, children, pregnant individuals, outdoor workers, people with cardiovascular or renal disease, individuals living alone, and residents of poorly ventilated housing may

experience greater vulnerability. The frequent inclusion of heat-related conditions in the reviewed literature therefore reflects the growing importance of heat preparedness plans, early warning systems, cooling interventions, occupational protections, and climate-sensitive emergency services.

Respiratory and air-quality effects were identified in nine references, representing 45% of the literature. Climate change can affect respiratory health through several pathways, including increased ground-level ozone formation, prolonged pollen seasons, drought-related dust exposure, wildfire smoke, and interactions between heat and urban air pollution. These exposures may exacerbate asthma, chronic obstructive pulmonary disease, allergic respiratory disorders, respiratory infections, and cardiovascular conditions. Air pollution and climate change also share important underlying drivers, particularly fossil-fuel combustion, meaning that emission-reduction policies may simultaneously generate climate and public health benefits (Campbell-Lendrum & Prüss-Ustün, 2019; Haines & Ebi, 2019).

The relative frequency of respiratory and air-quality outcomes also demonstrates that climate-sensitive diseases should not be restricted conceptually to infectious conditions. Climate-related health effects include a broad range of non-communicable diseases whose severity may be influenced by environmental exposures. A systematic review focused on climate-sensitive diseases found that respiratory and cardiovascular conditions were among the most frequently investigated outcomes, together with dengue, malaria, and other arboviral diseases.

Water- and food-borne diseases were discussed in eight references, corresponding to 40% of the reviewed literature. This category includes illnesses associated with contaminated drinking water, disrupted sanitation, microbial proliferation in food, flooding, drought, and increased environmental temperatures. Heavy precipitation and floods may overwhelm drainage and wastewater systems, allowing pathogens to enter water supplies. Drought can reduce the availability of safe water, limit hygiene practices, and increase dependence on inadequately protected sources. Higher temperatures may also favor the multiplication of certain bacterial pathogens and accelerate food deterioration.

The presence of this category in four out of every ten reviewed sources indicates that climate-related water and food risks remain highly relevant to urban public health, particularly in cities where basic services are fragmented or unequally distributed. Informal settlements and peripheral urban communities may face overlapping exposures, including insufficient potable water, inadequate sewage systems, overcrowding, flood-prone housing, and limited healthcare access. Climate-related disruptions can therefore transform environmental deficiencies into outbreaks of diarrheal and gastrointestinal disease. Broader reviews of climate-sensitive health risks have similarly identified food- and water-borne diseases as a major component of the climate-related health burden.

Injuries and healthcare disruption associated with extreme events appeared in seven references, representing 35% of the selected literature. This category encompasses the direct and indirect effects of floods, hurricanes, severe storms, droughts, wildfires, and other climate-related emergencies. Direct outcomes may include trauma, burns, drowning, heat injury, and mortality. Indirect consequences include electrical failures, damaged hospitals, interrupted transportation, reduced availability of medicines, disruption of diagnostic services, displacement of healthcare personnel, and delayed treatment for chronic or acute diseases.

Although this category appeared less frequently than vector-borne, heat-related, or respiratory outcomes, its importance extends beyond the number of publications in which it was identified. Extreme events can generate simultaneous failures across multiple components of an urban health system. A hospital may remain physically intact but still lose functionality because of power outages, water shortages, inaccessible roads, communication failures, or depleted medical supplies. For this reason, the literature increasingly frames health-system resilience as the ability to anticipate, absorb, adapt to, and recover from climate-related shocks while maintaining essential services.

Mental health effects constituted the least frequently represented category, appearing in five references, or 25% of the reviewed literature. Nevertheless, this lower frequency should not be interpreted as evidence of a minor health burden. Rather, it may indicate that psychological and psychosocial consequences remain less consistently incorporated into climate-health research than infectious, respiratory, or heat-related outcomes. Extreme weather events, displacement, loss of housing, livelihood disruption, uncertainty, and repeated exposure to environmental threats may contribute to anxiety, depression, post-traumatic stress symptoms, grief, sleep disorders, and chronic emotional distress.

The comparatively limited representation of mental health suggests an important imbalance in the current evidence base. Climate-sensitive health assessments frequently prioritize outcomes that are more easily quantified through mortality, hospitalization, laboratory confirmation, or surveillance records. Mental health effects may be more difficult to identify because they can emerge gradually, persist after the immediate emergency has ended, and remain underreported in communities with limited access to psychological services. The broader climate-health literature nevertheless recognizes mental health disorders among the major consequences associated with climatic hazards, disasters, population displacement, and social disruption.

Figure 2.

Relative contribution of major climate-related risk factors affecting urban health.

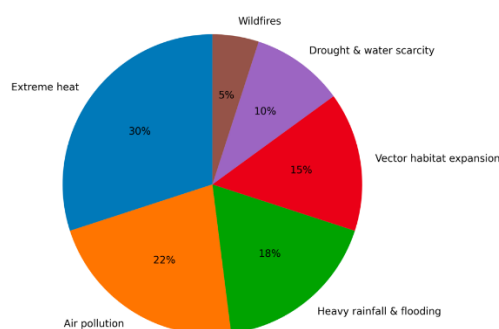


Figure 2 summarizes the relative contribution of the principal climate-related environmental risk factors identified throughout the reviewed literature as drivers of adverse health outcomes in urban populations. The distribution was constructed from the thematic synthesis of the selected references and illustrates the frequency with which each climatic exposure was associated with disease occurrence, population vulnerability, or pressure on healthcare systems. The values should therefore be interpreted as descriptive indicators of the emphasis found in the scientific evidence rather than as estimates of attributable risk.

Extreme heat represented the most prominent risk factor, accounting for approximately 30% of the identified climate-related health determinants. This finding is consistent with current global evidence indicating that rising ambient temperatures constitute one of the fastest-growing environmental threats to public health. Heat exposure has been associated with increased mortality, cardiovascular disease, dehydration, acute kidney injury, respiratory exacerbations, occupational illness, and reduced physical performance. Urban populations are particularly vulnerable because the urban heat island effect elevates local temperatures above those of surrounding rural areas, increasing cumulative heat exposure and prolonging recovery during nighttime hours (Ebi et al., 2021; Romanello et al., 2023).

Air pollution emerged as the second most frequently identified determinant, representing 22% of the overall distribution. Climate change and air pollution are closely interconnected through shared emission sources and atmospheric interactions. Higher temperatures promote ground-level ozone formation, while prolonged droughts and wildfires increase concentrations of fine particulate matter (PM_{2.5}). Numerous investigations have demonstrated associations between these pollutants and asthma exacerbations, chronic obstructive pulmonary disease, respiratory infections, ischemic heart disease, stroke, and premature mortality. Consequently, interventions aimed at reducing greenhouse gas emissions may simultaneously improve air quality and population health (Campbell-Lendrum & Prüss-Ustün, 2019; Haines & Ebi, 2019).

Heavy rainfall and flooding accounted for 18% of the identified risk factors. These climatic events directly affect urban infrastructure by overwhelming drainage systems, contaminating drinking water supplies, disrupting sanitation

services, damaging healthcare facilities, and increasing exposure to waterborne pathogens. Flood-related displacement additionally contributes to overcrowding, interruption of healthcare services, and reduced access to essential medicines. The frequency of flooding has increased in numerous regions as a consequence of changing precipitation patterns and rapid urban expansion, particularly where impermeable surfaces and inadequate drainage systems limit stormwater management (IPCC, 2023; WHO, 2023).

Expansion of vector habitats represented 15% of the thematic distribution. Climatic variables such as temperature, humidity, and rainfall strongly influence mosquito development, survival, and viral replication. As climatic suitability expands geographically, diseases including dengue, malaria, chikungunya, and Zika have increasingly been reported in areas previously considered unsuitable for sustained transmission. Urban environments with inadequate waste management, intermittent water supply, and abundant artificial breeding sites further facilitate vector proliferation, making integrated environmental management an essential component of disease prevention (Ryan et al., 2019; Rocklöv & Dubrow, 2020).

Drought and water scarcity contributed 10% of the identified climate-related determinants. Although often receiving less attention than floods, prolonged droughts significantly affect urban health by reducing access to safe drinking water, compromising hygiene practices, limiting food production, and increasing the concentration of contaminants in available water sources. Water scarcity also places additional strain on healthcare facilities by reducing operational capacity and increasing the burden of dehydration, renal disease, and food insecurity, particularly among socially vulnerable populations (WHO, 2023; IPCC, 2023).

Wildfires represented the smallest proportion of the thematic distribution, accounting for approximately 5% of the identified factors. Nevertheless, their health consequences extend far beyond burn injuries. Wildfire smoke contains complex mixtures of particulate matter, toxic gases, and volatile organic compounds capable of affecting populations located far from the fire itself. Episodes of prolonged smoke exposure have been associated with respiratory disease, cardiovascular complications, adverse pregnancy outcomes, and increased healthcare utilization. Climate change is expected to increase wildfire frequency and intensity in many regions, thereby amplifying these public health risks (Romanello et al., 2023).

Figure 3.

Regional comparison of vulnerability to climate-sensitive diseases.

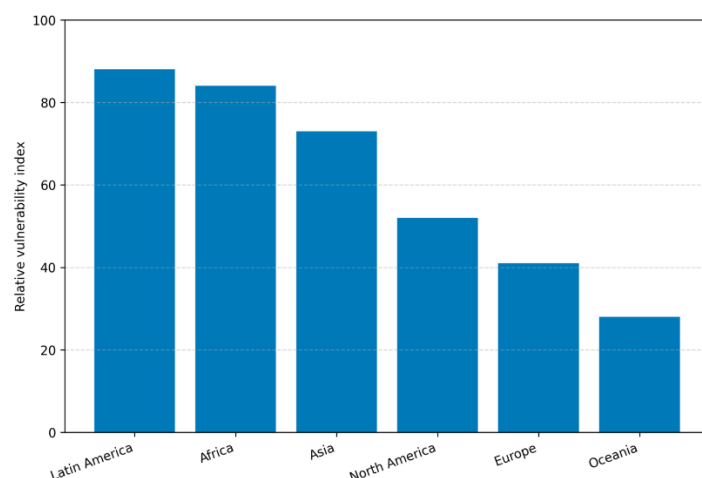


Figure 3 compares the relative vulnerability of major world regions to climate-sensitive diseases based on the synthesis of the scientific literature reviewed. The vulnerability index integrates recurring themes identified across the selected publications, including climatic exposure, urbanization, environmental conditions, socioeconomic determinants,

healthcare system capacity, epidemiological surveillance, and adaptive preparedness. Therefore, the values presented should be interpreted as comparative indicators derived from the literature synthesis rather than as standardized epidemiological measurements.

Latin America exhibited the highest relative vulnerability among the analyzed regions, with an index of 88. This finding is consistent with recent international assessments indicating that the region experiences a unique convergence of climatic, ecological, demographic, and socioeconomic factors that favor the emergence and persistence of climate-sensitive diseases. Tropical and subtropical climates, accelerated urban growth, marked social inequalities, biodiversity favorable to disease vectors, and heterogeneous healthcare systems collectively increase the susceptibility of many Latin American cities to climate-related health threats. Arboviral diseases such as dengue, chikungunya, and Zika continue to expand geographically, while extreme heat events, floods, droughts, and air pollution place additional pressure on already constrained public health services (Hartinger et al., 2024; Palmeiro-Silva et al., 2026).

Africa ranked second with a vulnerability index of 84. The reviewed literature consistently identifies the continent as highly exposed to climate variability because of recurrent droughts, food insecurity, limited healthcare infrastructure, and the continued burden of malaria and other infectious diseases. Many countries face challenges related to insufficient epidemiological surveillance, constrained financial resources, and reduced adaptive capacity, making climate change an important multiplier of existing public health problems. These structural vulnerabilities increase the likelihood that climatic events will translate into significant health consequences for large segments of the population (IPCC, 2023; WHO, 2023).

Asia demonstrated a high vulnerability index of 73, reflecting its large urban populations, rapid industrialization, frequent flooding, cyclones, heat waves, and high population density. Several of the reviewed studies highlighted that megacities across South and Southeast Asia experience recurrent climate-related health emergencies, including vector-borne disease outbreaks, deteriorating air quality, and heat-related illnesses. Coastal urbanization and sea-level rise further contribute to increasing exposure among millions of residents living in low-lying metropolitan regions.

North America presented a moderate vulnerability index of 52. Although healthcare infrastructure and surveillance capacity are generally stronger than in many low- and middle-income regions, climate change continues to generate important health risks through increasingly severe heat waves, prolonged wildfire seasons, hurricanes, and changing vector distributions. Recent years have demonstrated that even highly developed health systems may experience significant disruption during large-scale climate-related disasters, emphasizing that economic development alone does not eliminate climate vulnerability (Romanello et al., 2023).

Europe exhibited a comparatively lower vulnerability index of 41. Many European countries benefit from comprehensive surveillance systems, climate adaptation policies, resilient healthcare infrastructure, and strong institutional capacity. Nevertheless, the literature indicates that the continent remains increasingly affected by record-breaking heat waves, wildfire smoke, expanding vector habitats, and aging populations that are particularly susceptible to heat-related morbidity and mortality. Consequently, Europe continues to strengthen climate adaptation through integrated public health planning and environmental policy (Ebi et al., 2021).

Oceania showed the lowest relative vulnerability index of 28 within the present comparison. While several countries maintain robust health systems and advanced environmental monitoring capabilities, important regional differences exist. Small island states remain highly vulnerable to sea-level rise, tropical cyclones, freshwater scarcity, and population displacement despite relatively smaller populations. Thus, lower overall vulnerability should not obscure the substantial risks experienced by specific communities within the region.

The regional distribution presented in Figure 3 demonstrates that vulnerability to climate-sensitive diseases is determined by a combination of environmental exposure and social capacity rather than climatic conditions alone. Countries with similar climatic hazards may experience markedly different health outcomes depending on healthcare accessibility, surveillance systems, emergency preparedness, infrastructure resilience, governance, and socioeconomic development. This observation reinforces the concept that climate change functions as a risk multiplier, amplifying pre-existing structural inequalities instead of acting as an isolated determinant of disease.

The findings also highlight the particular importance of Latin America within the global climate-health agenda. The region combines high biodiversity, expanding urban populations, widespread vector habitats, and persistent social inequities, making climate adaptation a central priority for future public health planning. Recent regional evidence indicates that strengthening surveillance systems, improving urban infrastructure, expanding early warning systems, and integrating climate considerations into routine health policy represent essential strategies for reducing future disease burden (Hartinger et al., 2024).

Figure 4.

Distribution of the principal health impacts associated with climate change in urban populations.

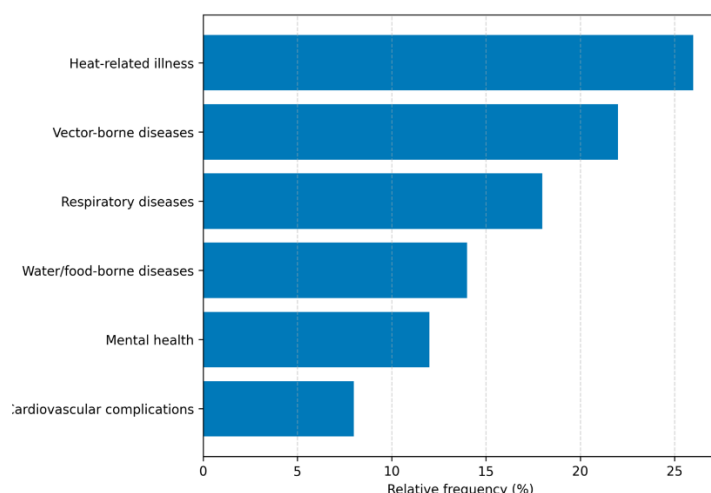


Figure 4 summarizes the principal health outcomes associated with climate change that were most consistently identified throughout the reviewed literature. The distribution reflects the relative frequency with which each health outcome appeared across the selected publications and provides an overview of the wide spectrum of diseases and clinical conditions influenced by climatic and environmental changes. Because several studies addressed more than one outcome, the percentages are descriptive and should not be interpreted as estimates of disease incidence or prevalence.

Heat-related illnesses represented the most frequently reported health outcome, accounting for approximately 26% of the identified impacts. This finding reflects the growing importance of extreme heat as one of the leading climate-related threats to public health. Increasing ambient temperatures have been associated with heat exhaustion, heat stroke, dehydration, electrolyte imbalance, acute kidney injury, and increased cardiovascular mortality. Urban populations experience particularly elevated exposure because buildings, asphalt surfaces, and limited vegetation intensify the urban heat island effect, allowing temperatures to remain elevated even during nighttime hours. The reviewed evidence consistently indicates that older adults, children, outdoor workers, and individuals with chronic diseases constitute the groups at greatest risk of heat-related complications (Ebi et al., 2021; Romanello et al., 2023).

Vector-borne diseases represented the second most frequently identified health outcome, accounting for 22% of the thematic distribution. Numerous investigations demonstrate that climatic variables directly influence vector biology by modifying mosquito survival, reproductive cycles, pathogen development, and seasonal transmission. Consequently, diseases such as dengue, malaria, chikungunya, and Zika have expanded their geographic distribution under changing climatic conditions. The literature further emphasizes that urban environments characterized by inadequate sanitation, water storage practices, and uncontrolled urban growth provide favorable ecological conditions for vector proliferation, particularly throughout tropical and subtropical regions (Ryan et al., 2019; Rocklöv & Dubrow, 2020).

Respiratory diseases accounted for approximately 18% of the identified health impacts. Climate change contributes to worsening respiratory health through multiple mechanisms, including increased concentrations of particulate matter, ozone formation, prolonged pollen seasons, and smoke generated by large wildfires. These environmental exposures increase the frequency of asthma exacerbations, chronic obstructive pulmonary disease, respiratory infections, and hospital admissions, while simultaneously contributing to cardiovascular morbidity. The coexistence of climate change and urban air pollution therefore represents an important public health concern requiring integrated environmental and healthcare interventions (Campbell-Lendrum & Prüss-Ustün, 2019; Haines & Ebi, 2019).

Water- and food-borne diseases represented 14% of the reported health outcomes. Flooding, heavy rainfall, deterioration of sanitation infrastructure, and prolonged droughts may compromise drinking water quality and increase exposure to pathogenic microorganisms. Likewise, rising environmental temperatures facilitate bacterial proliferation in food products, increasing the likelihood of gastrointestinal infections and foodborne outbreaks. These risks are particularly important in densely populated urban areas where deficiencies in water treatment and wastewater management remain significant public health challenges (WHO, 2023; IPCC, 2023).

Mental health outcomes accounted for approximately 12% of the identified impacts. Although less frequently reported than infectious or heat-related conditions, the reviewed evidence increasingly recognizes the psychological consequences of climate change as an important component of the overall disease burden. Exposure to floods, hurricanes, wildfires, prolonged droughts, displacement, and repeated environmental disasters has been associated with anxiety, depression, post-traumatic stress disorder, sleep disturbances, and chronic emotional distress. These effects frequently persist long after the immediate emergency has resolved, highlighting the need to incorporate mental health services into climate adaptation planning (Romanello et al., 2023).

Cardiovascular complications represented the remaining 8% of the thematic distribution. Elevated temperatures, poor air quality, dehydration, and environmental stress increase cardiovascular workload and may precipitate acute coronary syndromes, heart failure exacerbations, arrhythmias, cerebrovascular events, and sudden cardiac death. Although cardiovascular outcomes are often analyzed alongside respiratory or heat-related illnesses, growing evidence indicates that they constitute an independent pathway through which climate change affects population health, particularly among older adults and individuals with pre-existing chronic disease.

Collectively, the distribution presented in Figure 4 demonstrates that climate change influences human health through multiple interconnected biological and environmental mechanisms rather than through a single disease process. Infectious diseases, chronic non-communicable conditions, mental health disorders, and acute climate-related illnesses frequently coexist within the same vulnerable populations, generating cumulative health burdens that challenge healthcare delivery. These findings reinforce the need for multidisciplinary adaptation strategies integrating epidemiological surveillance, environmental management, preventive medicine, urban planning, and resilient healthcare systems capable of responding to the increasingly diverse health consequences of climate change.

Figure 5.

Adoption of climate-resilient strategies within public health systems.

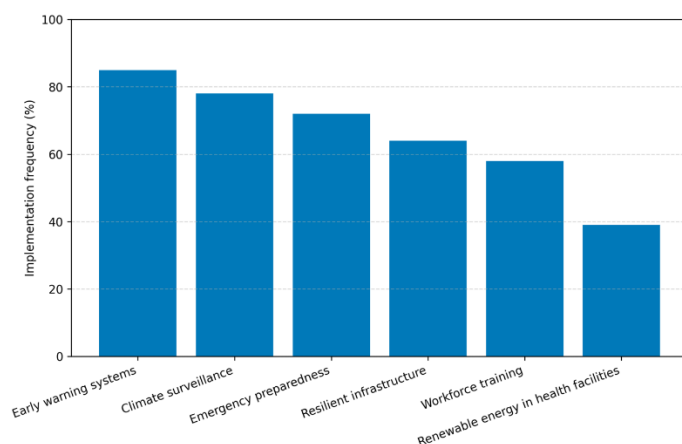


Figure 5 illustrates the relative implementation frequency of the principal climate-resilient strategies identified throughout the reviewed literature. The distribution was developed from the thematic analysis of the selected publications and reflects how often each adaptation strategy was reported as an essential component of resilient public health systems. The values are descriptive and represent the emphasis placed on each intervention within the scientific literature rather than standardized implementation rates across countries.

Early warning systems represented the most frequently reported strategy, with an implementation frequency of approximately 85%. This finding demonstrates the growing international recognition that timely detection of climate-related hazards is fundamental for reducing morbidity and mortality. Modern early warning systems integrate meteorological forecasts, epidemiological surveillance, environmental monitoring, and risk communication to anticipate heat waves, floods, vector-borne disease outbreaks, and other climate-sensitive events. Their effectiveness depends not only on technological capacity but also on efficient coordination among meteorological agencies, public health authorities, emergency management institutions, and local governments (WHO, 2021; Romanello et al., 2023).

Climate surveillance systems ranked second, with a relative frequency of 78%. Advances in digital epidemiology have enabled the integration of climatic variables with disease surveillance, allowing health authorities to identify changing transmission patterns before outbreaks become widespread. Geographic information systems, satellite imagery, remote sensing, artificial intelligence, and predictive epidemiological models increasingly support surveillance activities by identifying high-risk areas and improving the allocation of healthcare resources. These innovations have significantly strengthened preparedness for vector-borne diseases, heat-related emergencies, and environmentally driven health events (Alcayna et al., 2025).

Emergency preparedness accounted for approximately 72% of the strategies described in the reviewed literature. Climate-related emergencies frequently disrupt healthcare delivery through damage to hospitals, interruptions in electricity and water supply, shortages of medicines, and displacement of affected populations. Consequently, preparedness plans emphasizing coordinated emergency response, continuity of essential services, emergency logistics, and disaster risk reduction have become central components of resilient health systems. International organizations consistently recommend integrating climate risk assessments into routine emergency planning to minimize disruptions during extreme weather events (WHO, 2021).

Resilient healthcare infrastructure represented 64% of the identified adaptation strategies. Increasing evidence indicates that hospitals and primary healthcare facilities must be designed or adapted to withstand floods, hurricanes, extreme temperatures, and other climate-related hazards while maintaining continuous clinical operations. Infrastructure resilience includes structural safety, reliable energy systems, protected water supplies, climate-resistant construction, and secure pharmaceutical storage. Such investments not only improve disaster preparedness but also enhance the long-term sustainability of healthcare delivery under changing environmental conditions (IPCC, 2023).

Healthcare workforce training appeared in 58% of the reviewed publications. The literature increasingly recognizes that healthcare professionals require competencies extending beyond traditional clinical practice to include climate

science, environmental epidemiology, disaster medicine, environmental risk communication, and adaptation planning. Continuous professional education enables physicians, nurses, epidemiologists, environmental health specialists, and emergency responders to recognize emerging climate-related health risks and implement evidence-based preventive interventions. This multidisciplinary approach strengthens institutional preparedness while improving the capacity of health systems to respond effectively to increasingly complex environmental challenges.

Renewable energy integration within healthcare facilities represented the least frequently identified strategy, accounting for approximately 39% of the reviewed evidence. Despite its lower frequency, this finding does not diminish its importance. Reliable renewable energy sources such as solar and wind systems improve the operational resilience of hospitals by reducing dependence on vulnerable electrical grids during climate emergencies. In addition, low-carbon healthcare infrastructure contributes to mitigation efforts by decreasing greenhouse gas emissions while ensuring uninterrupted operation of critical medical equipment during disasters. Recent international frameworks increasingly recommend combining adaptation and mitigation measures to strengthen health system sustainability (WHO, 2021; United Nations Environment Programme, 2024).

DISCUSIÓN

The present review highlights the growing influence of climate change on the epidemiology of climate-sensitive diseases and demonstrates that urban environments have become increasingly vulnerable to the combined effects of environmental degradation, demographic expansion, and socioeconomic inequalities. The evidence analyzed consistently indicates that climate change is no longer a distant environmental concern but an ongoing determinant of population health that is reshaping disease patterns across all regions of the world. The findings presented throughout this review support previous international reports describing climate change as one of the greatest public health challenges of the twenty-first century (IPCC, 2023; Romanello et al., 2023).

One of the principal findings of this review is the predominance of vector-borne diseases within the scientific literature. This observation is consistent with previous investigations demonstrating that increasing temperatures, altered precipitation patterns, and environmental modifications directly influence vector ecology and pathogen transmission. Ryan et al. (2019) reported that climate change is expanding the geographical suitability for *Aedes*-borne viral diseases, while Rocklöv and Dubrow (2020) emphasized that future warming scenarios are expected to increase both the duration and intensity of transmission seasons in many regions. The present findings reinforce these observations by demonstrating that vector-borne diseases remain the most frequently investigated climate-sensitive health outcome across recent international publications.

Heat-related illnesses also emerged as one of the most consistently reported consequences of climate change. The predominance of heat exposure among the reviewed studies reflects the increasing frequency and intensity of heat waves documented worldwide during recent decades. Previous evidence has shown that prolonged heat exposure contributes to substantial increases in cardiovascular mortality, renal dysfunction, respiratory disease exacerbation, and hospital admissions, particularly among older adults and individuals with chronic diseases (Ebi et al., 2021). The current review similarly identified extreme heat as one of the principal environmental determinants affecting urban health, emphasizing the importance of implementing early warning systems, urban greening strategies, and heat adaptation policies.

The findings additionally demonstrate that climate-sensitive diseases should not be interpreted exclusively as infectious diseases. Respiratory disorders, cardiovascular complications, mental health conditions, and heat-related illnesses collectively represent an important proportion of the climate-associated disease burden. This broader perspective agrees with Haines and Ebi (2019), who argued that climate change affects virtually every medical specialty through multiple biological and environmental pathways. Consequently, future public health planning should incorporate comprehensive approaches capable of addressing both communicable and non-communicable diseases simultaneously.

An important contribution of this review is the emphasis placed on urban health. The reviewed evidence consistently indicates that rapid urbanization amplifies climate-related health risks by concentrating populations within

environments characterized by high temperatures, air pollution, inadequate sanitation, insufficient green spaces, and increased exposure to environmental hazards. These findings correspond closely with reports from UN-Habitat (2022), which describe cities as both major contributors to climate change and highly vulnerable settings requiring integrated adaptation strategies. Urban planning therefore represents an essential component of climate-resilient public health rather than an independent environmental issue.

The comparison between world regions revealed substantial differences in vulnerability to climate-sensitive diseases. Latin America emerged as one of the regions facing the greatest challenges due to the coexistence of favorable climatic conditions for disease vectors, rapid urban growth, environmental degradation, and persistent socioeconomic inequalities. These findings are consistent with the Latin America Lancet Countdown, which reported increasing exposure to heat, expanding vector-borne disease risks, and insufficient integration of climate considerations into regional health policies (Hartinger et al., 2024). Nevertheless, similar structural vulnerabilities were also observed across several African and Asian countries, suggesting that adaptive capacity rather than climate alone largely determines future health outcomes.

The review further demonstrates that resilient public health systems constitute one of the most effective approaches for reducing climate-related health impacts. Early warning systems, integrated epidemiological surveillance, resilient healthcare infrastructure, workforce training, and emergency preparedness consistently appeared among the most frequently recommended adaptation strategies. These observations support the Operational Framework for Building Climate-Resilient and Low-Carbon Health Systems proposed by the World Health Organization (2021), which emphasizes preparedness, adaptation, sustainability, and multisectoral collaboration as central pillars of future health systems.

Technological innovation also emerged as a recurring theme throughout the reviewed literature. Geographic information systems, remote sensing, satellite monitoring, artificial intelligence, predictive epidemiological models, and digital surveillance platforms have substantially improved the capacity to identify emerging climate-related health threats. These technologies facilitate earlier intervention, optimize resource allocation, and strengthen disease surveillance. However, important disparities remain regarding access to these technologies, particularly within low- and middle-income countries. Financial limitations, insufficient technical infrastructure, shortages of trained personnel, and fragmented health information systems continue to restrict widespread implementation despite the demonstrated benefits of these innovations.

The present review also highlights the importance of addressing social determinants of health when designing climate adaptation strategies. Climate-related health risks disproportionately affect populations experiencing poverty, inadequate housing, limited healthcare access, occupational exposure, food insecurity, and environmental injustice. These structural inequalities frequently determine individual vulnerability more strongly than climatic exposure alone. Consequently, successful adaptation requires coordinated policies that integrate healthcare, education, environmental management, housing, transportation, and social protection. This multidimensional perspective aligns with the growing international recognition that climate resilience depends upon strengthening both healthcare systems and the broader determinants of population health.

Despite the broad scientific evidence available, several knowledge gaps remain. Mental health consequences continue to receive less attention than infectious or respiratory diseases, although increasing evidence suggests that anxiety, depression, post-traumatic stress disorder, and psychological distress constitute important long-term consequences of climate-related disasters. Similarly, relatively limited information remains available regarding the long-term effectiveness of many adaptation interventions, particularly within low-resource urban settings. Additional longitudinal investigations evaluating implementation outcomes, cost-effectiveness, and equity implications will therefore be essential for informing future climate-health policies.

Several limitations should also be considered when interpreting the findings of this review. The available literature demonstrates considerable methodological heterogeneity regarding study design, exposure assessment, outcome definitions, geographical coverage, and climate indicators. Such variability may complicate direct comparisons between investigations. Furthermore, many studies originate from high-income countries, while evidence from several low- and middle-income regions remains comparatively limited despite their greater vulnerability. Nevertheless,

incorporating international reports together with regional evidence from Latin America allowed the present review to provide a comprehensive overview of current scientific knowledge while acknowledging existing disparities.

CONCLUSIÓN

Climate change has become one of the most influential determinants of population health, profoundly modifying the epidemiology of climate-sensitive diseases and increasing the vulnerability of urban communities worldwide. The scientific evidence analyzed throughout this review demonstrates that environmental changes associated with rising temperatures, altered precipitation patterns, extreme weather events, and rapid urbanization are contributing to the expansion of vector-borne diseases, heat-related illnesses, respiratory disorders, water- and food-borne infections, and other climate-associated health outcomes. These findings confirm that climate change is no longer exclusively an environmental concern but a multidimensional public health challenge requiring coordinated global action.

The review also demonstrates that urban environments represent critical settings where climatic, environmental, demographic, and socioeconomic factors interact to amplify health risks. Rapid urban growth, environmental degradation, inadequate infrastructure, air pollution, limited green spaces, and social inequalities collectively increase population vulnerability while placing substantial pressure on healthcare systems. Consequently, improving urban resilience requires integrated interventions extending beyond the healthcare sector to include sustainable urban planning, environmental management, disaster risk reduction, and social policies that address the broader determinants of health.

An important finding of this review is the central role of climate-resilient public health systems in reducing the health impacts of climate change. Strengthening epidemiological surveillance, developing early warning systems, improving emergency preparedness, investing in resilient healthcare infrastructure, expanding workforce capacity, and incorporating technological innovations such as artificial intelligence and geographic information systems represent essential strategies for anticipating and responding to climate-related health threats. These approaches not only improve emergency response but also enhance the long-term sustainability and adaptability of healthcare systems under changing climatic conditions.

The evidence further highlights significant regional disparities in vulnerability and adaptive capacity. Latin America emerges as one of the regions facing the greatest climate-related public health challenges because of its ecological diversity, accelerated urbanization, socioeconomic inequalities, and persistent burden of climate-sensitive diseases. Nevertheless, similar challenges are observed across numerous low- and middle-income countries where limited financial resources, fragmented health systems, and insufficient climate adaptation policies continue to constrain resilience. These disparities emphasize the importance of international collaboration, equitable resource allocation, and knowledge exchange to strengthen public health preparedness globally.

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