

# Climate Change and Public Health: An Interdisciplinary Review of Emerging Challenges

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## Abstract

Climate change has become one of the most serious public health threats to the global population, affecting health through increased temperatures, severe weather, air pollution, food scarcity, and changing infection patterns. In this context, this paper analyzes the available literature in terms of human cohort, epidemiological, cross-sectional studies, systematic reviews, and meta-analyses, describing mechanisms of the impact of climate change on communicable and non-communicable diseases, mental disorders, malnutrition, and vulnerable population groups. This paper reviews interdisciplinary approaches such as environmental monitoring, climate-resilient health care systems, public health policies, digital health solutions, artificial intelligence, and community adaptation to address climate-induced health threats. The existing evidence shows that climate change impacts children, elderly people, pregnant women, and poor socio-economic communities, causing higher health burden, health disparities, and pressure on health care systems. Despite available data that provide convincing evidence of the relationship between climate change and public health, some research gaps remain in human cohort studies and in the methods employed in the investigation process.

**Keywords:** Climate Change; Public Health; Human Health; Climate-Resilient Healthcare; Mental Health; Environmental Surveillance

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Received: May 19, 2026

Revised: June 23, 2026

Accepted: July 11, 2026

Published: August 12, 2026

DOI: <https://doi.org/10.64474/3107-6351.Vol2.Issue2.4>

<https://ssjiels.nknpub.com/1/issue/archive>

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## 1. INTRODUCTION

Climate change has emerged as one of the defining global issues of the twenty-first century. The occurrence of natural disasters, temperature increase, deterioration of air quality, changes in the incidence of infectious diseases, and food and water insecurity due to climate change have caused an increase in the burden of illness across the globe<sup>1</sup>. Human studies from epidemiology, cohort studies, systematic reviews, and meta-analyses have found that climate

change has effects on physical health, psychological state, nutritional status, and health care systems, as well as affecting vulnerable groups including children, older people, pregnant women, and poorer population segments. The purpose of this review is to provide a thorough review of current knowledge about health effects of climate change, discuss interdisciplinary solutions to mitigation and adaptation and point out major research areas in this field.



**Figure 1: Climate Change<sup>2</sup>**

### **1.1 Background Information and Context**

Climate change has become one of the key problems of the twenty-first century, as it impacts the sustainability of the environment, economic growth, and health of the population. High temperature, changes in precipitation rates, air pollution, increase in sea level, and occurrence of more frequent adverse weather conditions such as heat waves, floods, drought, and fires have posed serious threats to health all over the globe<sup>3</sup>. Changes in the environment affect the health of people directly by causing illness, injuries, and deaths, and indirectly by influencing the occurrence of infectious disease, food and water insecurity, air pollution, and mental health disorders. Epidemiological research has shown that climate change has become an important factor in the development of communicable and non-communicable diseases<sup>4</sup>.

The negative impacts of climate change on health are not felt uniformly. People like children, the elderly, pregnant women, those suffering from chronic illnesses, and those who belong to economically poorer groups are more prone to the ill-effects of climate change due to high exposure and less adaptation<sup>5</sup>. These challenges highlight the need for integrated and evidence-based approaches to understand the complex interactions between climate change and public health.

### **1.2 Objectives of the Review**

The main objectives of this review include:

- To determine how the main mechanisms by which climate change affects human health and causes communicable and non-communicable diseases.
- To investigate the effects of climate change on mental health, food security, nutrition, and vulnerable populations based on evidence from human-based studies.
- To provide an overview of the multidisciplinary approaches such as environmental surveillance, climate-resilient health systems, public health policy, digital health, and community-based intervention in the context of health effects of climate change.
- To critically analyze the human-based scientific evidence on public health effects of climate change and highlight its strengths and weaknesses.
- To identify research gaps and propose future directions for strengthening climate adaptation strategies and evidence-based public health policies.

### **1.3 Importance of the Topic**

Climate change is one of the greatest challenges in terms of public health facing modern society, and thus requires collective effort through collaboration among many different disciplines<sup>6</sup>. It is imperative to gain knowledge on the various effects of climate change on health in order to create appropriate public health policy, improve the health care system, reduce inequalities in health, and ensure the protection of vulnerable populations. Through the use of human-based research, this review offers an analysis of the emerging health issues related to climate change<sup>7</sup>.

## **2. CLIMATE CHANGE AND HUMAN HEALTH: MECHANISMS AND PATHWAYS**

Climate change is now among the most critical public health issues in the world. Human studies conducted on climate change have found that there is an increased risk of communicable as well as non-communicable diseases due to climate change<sup>8</sup>. This happens due to factors such as increased temperature, extreme weather conditions, bad air quality, and changes in the pattern of diseases. Vulnerable groups like children, elderly people, pregnant women, and people living in poor economic conditions are among those affected by this problem. This chapter focuses on the health effects of climate change based on human studies<sup>9</sup>.

### **2.1 Climate Change and Human Health: An Overview**

The impacts of climate change on the health of humans include direct impacts, such as heat waves and flooding, and indirect impacts, which include air pollution, malnutrition, and changes in the transmission of diseases. Epidemiological studies and systematic reviews have found that higher temperatures lead to death, admission to hospitals, and poor health.



**Figure 2: Climate Change and Human Health<sup>10</sup>**

### Methodologies Used

- Cohort studies
- Cross-sectional studies
- Systematic reviews
- Meta-analysis

### Key Findings

- Climate change is responsible for more deaths and diseases.
- The elderly and those suffering from chronic diseases have increased risks.
- Health disparities increase because of climate change exposures.

## 2.2 Heatwaves, Air Pollution, and Extreme Weather Events

Several studies on humans have clearly demonstrated an increase in the risk of heatstroke, dehydration, heart problems, and respiratory disorders with long-term exposure to heat. Similarly, the effects of air pollution caused by climate change have been found in cohort and time-series studies to cause the onset of asthma, COPD, and early death. Extreme events, like floods and fires, increase injuries, infections, and mental illnesses<sup>11</sup>.

### Methodologies Used

- Time-series analyses
- Hospital-based studies
- Population cohort studies

### Key Findings

- Heatwaves lead to increased deaths and hospitalization.
- Pollution leads to aggravation of diseases of the lungs and heart.

- Climatic disasters affect health services.

### 2.3 Climate-Sensitive Infectious Diseases

Climate change has affected the occurrence of vector-transmitted, water-transmitted, and food-transmitted diseases<sup>12</sup>. There is evidence from human epidemiological research that increased temperatures and changed patterns of rainfall favor the transmission of diseases like malaria, dengue, cholera, and diarrhea. It has been found through geographical and surveillance research that environmental change favors disease transmission.



**Figure 3:** Climate Change and Infectious Disease Patterns<sup>13</sup>

### Methodologies Used

- Epidemiological surveillance
- Case control studies
- GIS based studies
- Meta analysis

### Key Findings

- Global warming increases the geographical spread of vectors.
- Flooding causes waterborne disease outbreaks.
- Environmental changes affect infectious disease transmission.

### 2.4 Non-Communicable Diseases Associated with Climate Change

Human studies in recent times have established an association between climate change and the prevalence of cardiovascular diseases, respiratory diseases, chronic kidney disease, and allergies<sup>14</sup>. Exposure to heat and air pollution in the long run has been linked to greater chances of admissions and deaths from chronic diseases.

### Methodologies Used

- Prospective cohort studies
- Clinical observational studies
- Systematic reviews

### Key Findings

- Heat exposure increases cardiovascular complications.
- Air pollution aggravates chronic respiratory diseases.
- Climate change contributes to the growing burden of non-communicable diseases.

## 2.5 Strengths and Weaknesses of Current Human Studies

### Strengths

- A lot of information available from research conducted on populations.
- Adequate backing from systematic reviews and meta-analysis.
- Advanced methods of environmental measurement and statistics improve study quality.
- Similar results observed in various geographic areas

### Weaknesses

- Observational research is more common and can't prove causality.
- Differences in measuring exposures hinder comparison.
- No sufficient data from developing countries.
- Lack of long-term multicenter studies.

Overall, human-based evidence currently shows that climate change is a significant risk to human health<sup>15</sup>. Further research is required to bolster the current evidence and enable appropriate policies to be developed.

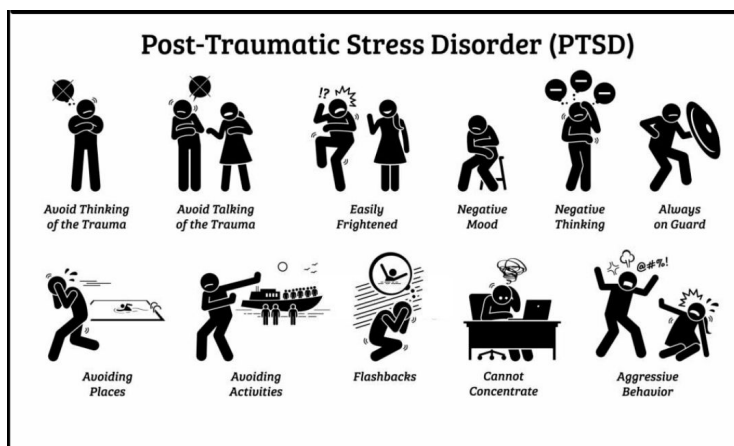
## 3. IMPACT OF CLIMATE CHANGE ON MENTAL HEALTH, NUTRITION, AND VULNERABLE POPULATIONS

The consequences of climate change have repercussions beyond the physical ailments and also have serious effects on mental well-being, nutrition, and the welfare of the vulnerable sections of society<sup>16</sup>. It has been proven through human studies that climate change events like heat waves, floods, droughts, and wildfires are the reasons behind psychological problems, malnutrition, and increasing health disparities. Children, the elderly population, pregnant women, poor families, and marginalized groups are severely affected by the consequences of climate change.

### 3.1 Climate Change and Mental Health Outcomes

The issue of climate change has been identified as a factor that has become a contributing factor to mental illnesses in human beings through direct and indirect methods<sup>17</sup>. The increase in prevalence of anxiety, depression, post-traumatic stress disorder (PTSD), psychological

distress, and eco-anxiety among people after climate events like flooding, wildfires, hurricanes, and extended heat waves has been observed by epidemiological studies in humans.



**Figure 4:** Post-Traumatic Stress Disorder (PTSD)<sup>18</sup>

However, recent systematic reviews suggest that people who are victims of such events suffer from psychological effects for an extended period of time, whereas vulnerable people face difficulties when accessing mental health services. This means that there is a need to include mental health support in climate change adaptation plans<sup>19</sup>.

### 3.2 Food Security, Nutrition, and Human Health

Food security is threatened by climate change due to low productivity, change in the pattern of rainfall, increased incidences of drought, and quality of crops. Population studies have found that environmental changes such as the above affect food security, malnutrition, and micronutrient deficiency, especially in developing countries.

Studies have also shown that disruption in food production due to climatic changes is linked to increased cases of child malnutrition in terms of stunting, wasting, anemia, and inadequate dietary diversity<sup>20</sup>. Moreover, decreased food availability and increases in food prices adversely impact economically poor people.

### 3.3 Maternal, Child, and Elderly Health

Climate change poses serious risks to vulnerable groups including pregnant women, children, and elderly people. In human studies, extreme heat and air pollution during pregnancy have been shown to lead to health risks including preterm delivery, low birth weight, and other pregnancy complications<sup>21</sup>.

The children are vulnerable to malnutrition, infections, and heat illnesses due to the development of the physiological system. On the other hand, the elderly become at risk of heat stress, heart diseases, respiratory ailments, and death as a result of climate change due to their reduced ability to adapt<sup>22</sup>.

### **3.4 Socioeconomic Inequalities and Health Disparities**

Climate change's effects on human health have not affected all populations equally, with the more vulnerable being socially and economically disadvantaged individuals. Human-based evidence has found that poverty, poor housing, lack of access to health care, occupations, and infrastructure all contribute to increased vulnerability to climate change illnesses<sup>23</sup>.

People living in poverty-stricken neighborhoods, rural inhabitants, ethnic groups, and immigrant workers are usually more vulnerable to environmental risks while lacking the ability to cope with and bounce back from such situations. Such inequalities result in the perpetuation of health inequities.

### **3.5 Public Health Implications for Vulnerable Communities**

There are major issues related to the impacts of climate change on mental well-being, nutrition, and vulnerability<sup>24</sup>. The current scientific knowledge suggests that health care services should become resilient to climate change, disease monitoring should be reinforced, nutrition interventions need to improve, and community-based adaptation approaches should be adopted.

A multidisciplinary approach where public health workers, healthcare workers, environmental scientists, policy makers, and the communities work together is necessary in order to ensure protection of vulnerable populations. In future, there will be a need for focusing on health equity, disaster preparedness, provision of mental health services, and sustainable solutions<sup>25</sup>.

## **4. INTERDISCIPLINARY APPROACHES TO CLIMATE CHANGE AND PUBLIC HEALTH**

The intricate connection between climate change and the public health sector demands an interdisciplinary approach, which entails the merging of environmental science, epidemiology, health sector, technology, and public policies. Studies involving humans have shown the significance of environmental and epidemiological surveillance systems in the tracking of climate-sensitive diseases, air pollution, heat-related illnesses, and health impacts resulting from disasters<sup>26</sup>. The merging of information from climate change and health allows the public health sector to determine vulnerable populations, health trends, and intervene appropriately. Additionally, building climate-resilient health care systems has become a critical issue worldwide as a means of ensuring continuous health care services amidst extreme climatic conditions<sup>27</sup>.

Adaptation strategies and public health policies are an important factor in the mitigation of adverse health effects resulting from climate change. Studies conducted among human populations indicate that some of the ways of mitigating climate change effects on human health involve the implementation of heat action plans, disease surveillance, disaster risk reduction programs, sustainable urban planning, and the implementation of policies to mitigate environmental pollution<sup>28</sup>. In addition to that, developments in digital health technology,

artificial intelligence, remote sensing, and early warning systems have enhanced the prediction of climate-induced adverse health effects to help in public health policy decisions.

Community engagement continues to be a key aspect in public health systems that are climate resilient. Research involving people has proven that health risk reduction from climate change through community participation and public education and awareness programs is highly effective. Sustainable health measures such as provision of safe drinking water, sanitation facilities, climate-smart agriculture, nutrition initiatives, and healthcare systems work towards minimizing health disparities and vulnerable groups' protection<sup>29</sup>. Generally, an interdisciplinary approach whereby scientific knowledge, technology, good governance, and community involvement are included is vital in creating sustainable and resilient public health systems capable of addressing the growing health challenges posed by climate change.

**Table 1:** Summary of Literature Review on Climate Change and Human Health<sup>30</sup>

| Author(s) & Year                           | Study Focus                                                            | Methodology/Model                                                                                              | Key Findings                                                                                                                                                                                                                                                                                                            |
|--------------------------------------------|------------------------------------------------------------------------|----------------------------------------------------------------------------------------------------------------|-------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|
| <b>Siders (2019)<sup>31</sup></b>          | Adaptive capacity to climate change and factors influencing resilience | Comprehensive review and synthesis of conceptual frameworks, empirical studies, and multidisciplinary research | Identified that adaptive capacity was determined by social, economic, institutional, technological, and environmental factors. Highlighted the need for standardized assessment frameworks to strengthen climate adaptation policies and improve human health resilience.                                               |
| <b>Charlson et al. (2021)<sup>32</sup></b> | Climate change and mental health outcomes in human populations         | Scoping review of human observational studies, systematic reviews, and epidemiological investigations          | Reported strong associations between climate change and increased anxiety, depression, PTSD, psychological distress, and eco-anxiety. Identified children, older adults, and socioeconomically disadvantaged populations as the most vulnerable groups, while emphasizing the need for more longitudinal human studies. |

|                                                  |                                                                                          |                                                                                                                 |                                                                                                                                                                                                                                                                                                                                                      |
|--------------------------------------------------|------------------------------------------------------------------------------------------|-----------------------------------------------------------------------------------------------------------------|------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|
| <b>Marjanac &amp; Patton (2018)<sup>33</sup></b> | Attribution science linking extreme weather events with climate change and public health | Review of legal, scientific, and climate attribution research                                                   | Demonstrated that advances in attribution science improved understanding of causal relationships between climate change and extreme weather events. Highlighted important public health consequences including mortality, injuries, disease outbreaks, displacement, food insecurity, and mental health impacts following climate-related disasters. |
| <b>Plowright et al. (2021)<sup>34</sup></b>      | Land-use change, zoonotic disease spillover, and One Health approach                     | Interdisciplinary review integrating epidemiological, ecological, environmental, and public health studies      | Found that deforestation, urbanization, and habitat fragmentation increased human–animal interactions and facilitated zoonotic disease emergence. Emphasized integrated environmental conservation, biodiversity protection, and public health surveillance as essential strategies for preventing infectious disease outbreaks.                     |
| <b>Zinsstag et al. (2020)<sup>35</sup></b>       | One Health approach for addressing climate-related public health challenges              | Comprehensive interdisciplinary review integrating human, veterinary, environmental, and public health research | Demonstrated that collaborative One Health approaches strengthened disease surveillance, outbreak prevention, food safety, antimicrobial resistance management, and climate adaptation. Concluded that interdisciplinary cooperation was essential for building resilient public health systems and addressing climate-sensitive health risks.       |

## 5. DISCUSSION

This review demonstrates that climate change represents a major risk factor to the health of the public through increased burden of diseases, mental health disorders, food insecurity, and

health inequities. While there is considerable evidence to prove the effect of climate change based on humans, more interdisciplinary and longitudinal studies are required<sup>36</sup>.

### **5.1 Interpretation and Analysis of Findings**

The results obtained from this systematic review clearly demonstrate that climate change is one of the most significant public health problems for both communicable and non-communicable diseases as a result of increasing temperatures, air pollution, and natural disasters<sup>37</sup>. In the case of human studies, there is a higher risk of developing diseases associated with cardiovascular system, respiratory system, infectious diseases, mental disorders, and poor nutrition.

### **5.2 Public Health and Policy Implications**

These results align with those from other human studies where climate change is identified as an emerging risk to public health. From the literature review above, there is a clear indication that it is important to adopt climate-proofing health care systems, disease surveillance, heat plans, sustainable environment policies and adaptation programs<sup>38</sup>. It is crucial to develop interdisciplinary cooperation between health practitioners, environmentalists and policymakers is essential to reduce climate-related health risks.

### **5.3 Strengths and Limitations of Existing Literature**

There is substantial literature with regard to cohort studies, epidemiological studies, systematic reviews, and meta-analyses carried out in different populations. The majority of studies, however, are observational in nature, making it difficult to make causation<sup>39</sup>. Exposures have not been well measured, data are sparse from developing nations, and long-term multicenter studies are lacking.

### **5.4 Research Gaps and Future Research Directions**

The future research work needs to concentrate on longitudinal research among human beings on a larger scale, standardized methodologies for research purposes, and increased involvement of vulnerable groups in research. There also need to be further studies about climate change adaptation, digital health technology, artificial intelligence, and climate resilient healthcare system. This would assist in formulating appropriate public health policies<sup>40</sup>.

## **6. CONCLUSION**

This review finds that climate change is one of the key health concerns of our times. It poses great danger to the health of people, the functioning of healthcare systems, and the process of sustainable development. The review of the current body of knowledge proves the existence of strong connections between climate change and communicable and non-communicable diseases due to higher temperatures, extreme weather events, deterioration of air quality, altered infectious disease patterns, food insecurity, and mental health problems. The review findings show that vulnerable groups of population such as children, the elderly, pregnant women, those suffering from chronic diseases, and socioeconomically disadvantaged communities are at an

elevated risk of facing negative effects on their health due to the heightened vulnerability and exposure. This review also emphasizes the need for an interdisciplinary approach that encompasses the use of climate and environmental surveillance, climate-resilient healthcare system, public health policy, digital health, artificial intelligence, and community-based adaptation measures. Despite the rich body of knowledge that supports the connection between climate change and health risks, certain important research gaps persist. They relate to the lack of longitudinal research on the topic based on humans and the need for more evidence of the same nature from low- and middle-income countries. Future research efforts should be dedicated to bridging those gaps.

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