World Journal of Biomedical Sciences
Print ISSN: 2960-0170
Online ISSN: 2960-0189
DOI: https://doi.org/10.61784/wjbs3019

THE CORRELATION BETWEEN CLIMATE CHANGE AND THE OUTBREAK OF EPIDEMIC DISEASES

RuJia Wei*, GaiGai Wang
Grand Diplomacy Youth Think Tank, Shenzhen 518056, Guangdong, China.
**Corresponding Author: RuJia Wei*

Abstract: Climate change is closely linked to human health. According to the backdrop of a series of severe consequences caused by global warming, global public health governance has entered a new stage of development. Climate change exerts impacts on multiple aspects of pathogens of various infectious diseases, such as their structure, transmission scope and drug resistance. The severe consequences it brings directly affect the prevention and treatment of infectious diseases. At present, it is imperative to enhance the international community's capability in responding to and collaborating on public health crises amid climate change. The study takes infectious diseases as an example to elaborate on the relationship between climate change and the outbreak of the epidemic diseases. The findings are mainly clustered into eleven categories, namely evidence assessment/potential malaria transmission areas, temporal variation, infectious diseases/Zika virus, respiratory diseases, compound disasters of extreme weather and epidemics, highlighting research gaps, and non-communicable diseases and nutrition. This visualization analysis of relevant studies based on bibliometric methods provides a practical basis for improving the global capacity of public health prevention and response.
Keywords: Climate change; Public health; Epidemic diseases; Greenhouse gases; Pathogens

1 INTRODUCTION

In recent years, extreme weather events triggered by global climate change (such as hurricanes, heatwaves, and floods) have occurred frequently. These events not only directly threaten the stability of ecosystems, but also profoundly affect the occurrence and prevalence patterns of infectious diseases by altering the living environments of pathogen transmission vectors, the activity ranges of hosts, and the mutation modes of pathogens.Data from the World Health Organization (WHO) shows that climate-related factors have become important drivers behind the rising incidence of zoonoses, foodborne diseases, waterborne diseases, and vector-borne diseases. Typical cases include cholera outbreaks following hurricanes, the expanded transmission range of malaria due to rising temperatures, and the correlation between climate variability and emerging infectious diseases such as SARS and avian influenza.Despite the deepening of relevant research, the global public health system still faces multiple predicaments, including infectious disease transmission prevention, weakened consensus on governance, and diversification of governance actors, resulting in a continuous deterioration of the public health security situation[1]. Against this backdrop, this study aims to analyze the correlation between climate change and epidemic diseases outbreak, thereby providing practical references for improving the level of global public health governance.

2 WHY CLIMATE CHANGE AFFECTS THE OUTBREAK OF INFECTIOUS DISEASES

During the process of industrialization, large-scale and borderless human activities have led to massive emissions of greenhouse gases, resulting in an increasingly severe greenhouse effect. Along with the emergence of extreme climates, animal migration has become more prominent, while the living environments for microorganisms have improved. The survival range of harmful organisms such as bacteria and viruses has expanded, and the deterioration of the surrounding environment has facilitated the spread of infectious diseases. For this reason, the occurrence and prevention of infectious diseases have gradually come into the spotlight of the international community. The main cause of infectious diseases lies in pathogenic agents. In an academic sense, a pathogen is a biological entity that acts as the fundamental cause of a disease during its prevention, onset and transmission. It refers to microorganisms (including bacteria and viruses), parasites, or microbial recombinants (i.e., hybrids or mutants) that cause infections in humans, animals or plants. Pathogen safety means subjecting infected microorganisms, parasites or other vectors to specific procedures (such as regulating temperature, humidity, light duration, etc.) to achieve attenuation or detoxification effects, keeping them within an appropriate and stable safety range, or promptly inactivating pathogens when they remain active as disease-causing agents.

Entering the post-pandemic era, issues related to international public health prevention and control remain a global concern. As a critical topic in non-traditional security, research in the field of public health fundamentally centers on disease prevention and treatment. Large-scale outbreaks of infectious diseases can plunge the international community into public health crises. Therefore, the issues of disease prevention and pathogen control in global public health governance have become particularly important in the context of human survival and development.

2.1 The Greenhouse Effect and Its Global Climate Impacts

The greenhouse effect has led to a continuous deterioration of global climatic conditions, with the frequency of global disasters rising steadily and extreme weather events becoming normalized.

According to the Climate Status Report released by the World Meteorological Organization (WMO) in 2020, the rate of warming over the past decade has outpaced the long-term average. During the summer monsoon season, most parts of the Sahel region stretching from Senegal to Sudan recorded above-average rainfall. Conversely, many inland areas of South America were severely hit by an intense summer drought, with the most notable impacts felt in northeastern Argentina, Paraguay, and the western border regions of Brazil. It is estimated that Brazil suffered nearly USD3 billion in agricultural production losses; the losses incurred by Argentina, Uruguay, and Paraguay were even greater, with Paraguay also experiencing rainfall far below its average level during this period[2].

Meanwhile, the report also indicated that the annual minimum Arctic sea ice extent in 2020 was the second-lowest on record[3]. As a sensitive barometer for perceiving climate change, polar weather is characterized by abrupt temperature fluctuations and large variability ranges, meaning the polar regions have been distinctly and severely affected by climate change.

In other parts of the world, drastic climate change has also exerted a tangible impact on human beings' normal production, daily lives, and physical health. The catastrophic consequences it has triggered have exacerbated resource conflicts and violent acts between nations, undermined social stability, and thus are likely to give rise to more social problems.

2.2 How Climate Change Impacts on Pathogens

The impact of climate change on pathogens is mainly attributed to changes in various climatic factors, such as temperature and humidity. Industrial economy is one of the pillar sectors in the industrial structure of the national economy. With the expansion of industrialization, greenhouse gas emissions have been gradually increasing, which in turn has led to a rise in temperature—a key climatic driver. This has resulted in changes to the overall ecological environment encompassing multiple elements such as air temperature, geology, soil, flora, and fauna. Among these factors, air temperature plays a crucial role in the prevention and control of pathogens.Typically, greenhouse gas sources are divided into two main categories:(1) Human activities, namely industrial production, coal combustion, etc.;(2) Natural sources, namely swamps, forests, etc[4]. A large body of scientific research indicates that the reproduction of pathogens—the causal agents of major diseases—requires specific conditions, that is, appropriate temperature and humidity levels. Most bacteria and viruses have a fixed temperature range for survival; temperatures below or above this range will render them unable to survive. For instance, rising global temperatures have contributed to the rampant spread of viruses, which in turn has triggered large-scale outbreaks of epidemic diseases[5]. The mechanisms underlying the occurrence and spread of infectious diseases evolve alongside changes in social and ecological environments. Studies have shown that certain infectious diseases mostly occur in winter and spring, meaning the outbreak rates of some epidemic diseases increase as temperatures drop. Meanwhile, the massive emission of greenhouse gases has led to a sharp rise in atmospheric carbon dioxide concentrations and a severe deterioration of air quality. Some vulnerable populations are affected in terms of respiratory function due to inhaling excessive amounts of polluted air.

2.3 Extreme Weather can Lead to the Accelerated Spread of Infectious Diseases

Climate diseases caused by extreme climates will accelerate the spread of various vector-borne infectious diseases as the climate changes, such as intestinal infectious diseases. The outbreak of intestinal infectious diseases is closely related to diet and drinking water. Changes in water quality and food quality will affect the breeding environment of intestinal infectious diseases. When the ambient temperature rises, people consume a large amount of cold food and cold water, leading to a sharp increase in regional water consumption. Meanwhile, the actual shelf life of food is shortened at higher temperatures. Due to the simultaneous changes in both consumers and the consumed, the possibility of humans being infected with infectious diseases increases accordingly. Studies have found that environmental factors directly affect the growth and reproduction of Vibrio cholerae (the pathogen of human cholera, which is one of the ancient and widely prevalent severe infectious diseases) and the expression of its virulence factors. Higher water temperatures are conducive to the rapid growth and reproduction of Vibrio cholerae, thus enhancing its reproductive capacity in higher-temperature environments. Moreover, abnormal climate changes such as floods and droughts will lead to a sharp rise in water pollution rates, allowing more pathogenic factors to enter drinking water sources. As a result, diseases like cholera The change in the incidence rate of infectious disease outbreaks is inseparable from climate disaster phenomena[6], and will also hinder the smooth progress of biosecurity governance agendas affected by climate disasters. Therefore, pathogenic microorganisms stimulated by changes in environmental conditions have enhanced pathogenicity, which may also result in an increased threat to humans and other biological species[7].

Extreme weather brings about tremendous changes in the social environment and an increase in infectious diseases. The fundamental reason is that pathogens, the root cause of diseases, undergo a series of changes under the influence of the greenhouse gas effect, including structural variations, enhanced spread, host shifts, and increased drug resistance.

(1) Pathogen structural variation.The construction and decomposition of the internal structure of pathogens are closely related to growth factors such as temperature. By altering their surface structures, pathogens can evade recognition by

the human immune system, enabling them to successfully invade and reproduce in animal, plant, and other hosts. For influenza viruses from different sources, researchers need to identify corresponding recognizable fragments through genetic information comparison, and then develop diagnosis, treatment, and prevention strategies based on specific mechanistic responses.

(2) Enhanced pathogen spread capacity. Global warming has led to the shrinking of habitats for animals and plants, with tropical regions likely to be more severely affected. Thermotolerant pathogens show little change in survival rates in hot climates. As a result, infectious diseases in tropical, subtropical, and some temperate regions can expand their host range along with changes in pathogens or social environments. Scientific research indicates that the optimal living temperature for mosquitoes is generally between 28-30℃, and they enter hibernation below -10℃. As major carriers of vector-borne diseases, the expanded survival range of mosquitoes promotes the spread of diseases to more regions[8].

(3) Host shifts. During the variation of influenza viruses, the original hosts are mostly virus-carrying animals such as palm civets. However, large-scale hunting of wild animals by humans has led to some original hosts becoming human food sources, turning humans into secondary transmitters and carriers. This transforms the transmission mode from animal-to-human to human-to-human, which accelerates the spread rate of viruses. Therefore, changes in intermediate or final hosts have a certain impact on the reproduction rate and mode of pathogens. Extreme weather creates favorable conditions for disease transmission by a large number of vectors such as mosquitoes. Natural disasters caused by severe weather lead to increased casualties in climate-vulnerable regions or disrupt the overall ecosystem balance, which may trigger the prevalence of infectious diseases and pose potential threats to healthy populations[9].

(4) Increased pathogen drug resistance. Since the development of Penicillin to the discovery and synthesis of broad-spectrum antibiotics today, the variety of antibiotics has continued to expand. With changes in the social environment, the microscopic structure of microorganisms may change accordingly, increasing the difficulty of mutual recognition between specific substances in specific mechanistic responses. Consequently, the recognition effect of antibiotics on pathogenic bacteria decreases, and the efficacy of pathogens increases. Facts have repeatedly proven that global biosecurity governance issues under climate disasters should receive widespread attention from the international community.

3 Visual Analysis of Literature on the Correlation between Infectious Diseases and Climate Change

The field of climate change is a topic of considerable global concern today. Due to its impacts on numerous aspects such as human health, political development, and economic revitalization, scholars' research focus has gradually shifted to this field. Infectious diseases prone to outbreaks influenced by the climatic environment are mainly vector-borne diseases, which are greatly affected by external environmental factors including air quality, geographical location, rainfall, and humidity. In the Web of Science (WOS) database, there are more than 2,000 literatures on climate change and infectious diseases. After screening based on literature titles, 2,000 literatures were selected for bibliometric analysis, and the results are shown in the following figure.

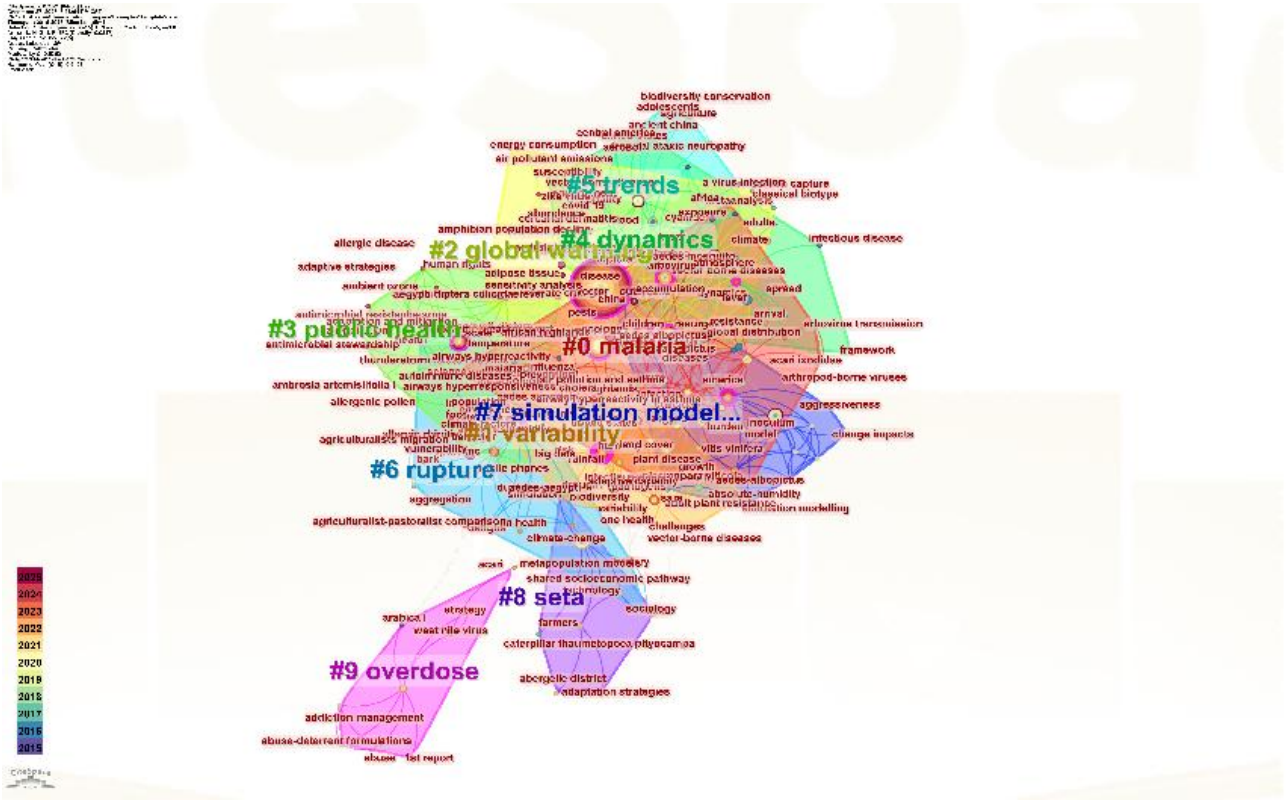

Figure 1 Search the theme of "Climate Change and Infectious Diseases" in Web of Science, Export 2000 Core Literatures, and Perform Keyword Clustering to Obtain the above Image

This image is a scientific research knowledge map for visual analysis of the field related to "Extreme Climate and Human Health", forming 11 main research clusters.

(1) The core of this cluster is the long-term and fundamental research line on the impact of climate change on infectious diseases (especially vector-borne diseases) (cluster #0, #2); the combined disasters of extreme weather and epidemics (cluster #4) is the current emerging frontier, mainly focusing on dynamics, transmission and mortality; the research is expanding from traditional vector-borne infectious diseases to respiratory diseases (cluster #3), non-communicable diseases and nutrition (such as konzo disease) (cluster #5), and paying attention to the influence of climate variability (such as rapid weather changes) (cluster #1); evidence evaluation, model simulation (cluster #0, #7) and policy response (cluster #9) are important supporting directions. At the same time, within the field, it is clearly recognized and a systematic review of research gaps has begun (cluster #6).

(2) Cluster #4 "Extreme Weather - Epidemic Compound Disasters" focuses on how extreme weather events such as floods, hurricanes, and heat waves can overlap with the outbreak of infectious diseases, causing more complex public health disasters. The representative paper of this cluster is Huang, J (2025), published in "Science Bulletin"; Cluster #0 "Evidence Evaluation/ Potential Malaria Transmission Areas" represents research using models and data for risk assessment and prediction, which is a classic paradigm in climate change health impact studies, main focusing on geographical distribution and risk transfer; Cluster #2 "Infectious Diseases/Zika Virus" is the largest and most highly cited knowledge foundation cluster, with the keywords "climate change", "temperature", and "transmission" all coming from this cluster, constituting the theoretical and methodological foundation of the entire field; Cluster #1 "Temporal Variation" focuses on the temporal volatility of climate factors (such as rapid weather changes) on health (such as influenza), and is a more refined study of the mechanism of action; Cluster #6 "Highlighting Research Gaps" directly points to the knowledge gaps in the field.

(3) Key nodes. High-cited nodes, such as climate change, temperature, and transmission, represent the classics and the fundamentals; high-suddenness nodes, such as global warming, transmission, and mortality rate, represent those that have recently received intense attention suddenly; high-betweenness centrality nodes, such as risk, transmission, and impact, connect multiple subfields and play a crucial role in theoretical construction; high-Sigma value nodes, such as global warming, mortality rate, and disease concept, combine "suddenness" and "centrality", and are potential "turning points" or "emerging important concepts".

4 CONCLUSION

With the development of globalization, the geographical boundaries between countries cannot clearly separate them. In the field of borderless biomedicine, the world is quietly changing. The prevention and treatment of infectious disease outbreaks caused by climate change are becoming core international issues. Currently, research in the field of global public health demonstrates increasing interdisciplinarity and diversification. The scope of inquiry has moved beyond the constraints of traditional single-disciplinary approaches, necessitating the integration of advanced technologies such as artificial intelligence and big data analytics to enable comprehensive forecasting. Consequently, evolving natural and technological environments have propelled global public health research into a new phase. Nevertheless, despite notable advancements, significant knowledge gaps and uncertainties persist concerning the relationship between climate change and infectious diseases. Future studies must further investigate the complex causal mechanisms underlying this relationship, with particular attention to variations across different geographical regions and socioeconomic contexts. Furthermore, enhancing early warning systems and emergency response capacities for extreme weather events and disease outbreaks, as well as strengthening global public health governance, remain critical challenges requiring urgent attention. Only through sustained international collaboration and continuous investment can the global community effectively address the public health threats posed by climate change and safeguard human health and long-term development.

COMPETING INTERESTS

The authors have no relevant financial or non-financial interests to disclose.

REFERENCES

[1] Fu Yu. Fragmentation of Global Governance and the Construction of China's International Leadership: A Case Study of Global Public Health Governance. People's Forum · Academic Frontiers, 2025(14): 88-99.

[2] World Meteological Organization. State of the Global Climate 2020. World Meteological Organization, 2021: 23-24. https://library.wmo.int/doc_num.php?explnum_id=10618.

[3] World Meteological Organization. State of the Global Climate 2020. World Meteological Organization, 2021: 18-20. https://library.wmo.int/doc_num.php?explnum_id=10618.

[4] Guo Yunhai, He Hongxuan. Global Climate Warming and Infectious Diseases. Modern Preventive Medicine, 2008, 22: 4504.

[5] E Paul J Gibbs, Tara C Anderson. Equine and Canine Influenza: a Review of Current Events. Animal Health Research Reviews, 2010, 11(1): 43-51.

[6] Wang Luxi, Biao Kan. Research Progress on the Impact of Climate Change on Cholera Epidemics. Disease Surveillance, 2011, 5: 406-407.
[7] Wu Xiaoxu. Impacts of Global Change on the Occurrence and Transmission of Human Infectious Diseases. Science China: Earth Sciences, 2013, 11: 1744-1746.
[8] Lin Zhaojing, Qiu Yue, Li Han. Research Progress on the Impact of Climate Change on Infectious Diseases. Contemporary Chinese Medicine, 2010, 20: 158-159.
[9] Lin Jianyan, Guo Zeqiang. The Impact of Climate Change on the Occurrence of Infectious Diseases. Disease Monitoring and Control, 2013, 7: 414-416.