Impact of Climate Change on Transmission Patterns of Infectious Diseases and Public Health Responses

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Abstract. Global warming has expanded the transmission range of some pathogens and disease vectors (such as mosquitoes) that initially lived in tropical or subtropical regions, increasing their chances of disease transmission. This change increases the risk of the spread of some infectious diseases, such as dengue fever, malaria and cholera. These infectious diseases have caused a huge impact and harm to human health. Therefore, this article analyzes and summarizes some academic research articles to study infectious disease changes and spread ways, and why these infectious diseases are affected by climate change and the influence of public health measures, through this topic research also can clearly know how climate change will make the pathogen life cycle and transmission route, expand media activities, finally should strengthen monitoring and early warning system, promote international cooperation, improve public health facilities and environmental health targeted control strategies, strengthen public education and health propaganda.

Keywords: Climate change, infectious disease, transmission.

1. Introduction

As it's known that an infectious disease is a medical condition caused by the invasion and multiplication of pathogenic microorganisms such as bacteria, viruses, fungi, or parasites in the body. There are many causes of the spread of infectious diseases, of which climate change is the main cause. The impact of climate change on the transmission patterns of infectious diseases is a complex and multidimensional problem involving the interaction of pathogens, hosts, vectors, and environmental factors. This topic can analyze how climate change affects the spread of infectious diseases from the following aspects:

Climate change leads to ecosystem changes, including species distribution, migration patterns, providing more opportunities for pathogens to spread among different species. Changing species interactions in the ecosystem may make the spread of some infectious diseases more complex and uncertain. First, changes in air temperature and humidity directly affect the life cycle and transmission route of the pathogen. For example, a high-temperature environment may accelerate the mosquito developmental cycle and shorten the incubation time of pathogens in the mosquito, thus increasing the chance of infection [1]. This change has increased the risk of transmission of some infectious diseases (such as dengue, malaria, etc.) [2, 3]. Second, climate warming expands the range of some vectors (such as mosquitoes, ticks, etc.) to migrate to a wider area to carry and spread infectious diseases. For example, Aedes ranges extend to higher altitudes, leading to an increased risk of insect-borne diseases such as dengue. Third, extreme weather events (such as floods, droughts, hurricanes, etc.) not only directly damage the environment and infrastructure, but also may indirectly increase the risk of infectious diseases by polluting water sources and promoting the transmission of pathogens [4]. For example, flooding may cause water contamination that triggering outbreaks of water-borne diseases such as cholera [5]. And ecosystem changes can have indirect effects:

The purpose of the research is to use the methods derived from the literature in recent years to deeply understand the relationship between climate change and infectious disease transmission, to assess the risk of infectious disease transmission, to develop effective public health countermeasures and to ensure human health and social stability.

2. Common Diseases

2.1. Malaria

First, the case of malaria transmission occurred in Pakistan, Nigeria, Uganda, Ethiopia, Papua New Guinea and other countries, where climate change, especially the climate impact of extreme weather events (such as floods, heat waves) and changes in rainfall patterns, has directly affected the transmission of malaria.

For the massive flood in Pakistan in 2022 that flooded a third of the land in Pakistan, the stagnant water left after the flood retreat provided an ideal breeding environment for anopheles carrying malaria parasites. Extreme rainfall and melting glaciers were the direct causes of this flood, all being attributed to climate change. According to the Climate Attribution Organization, the probability of such a strong and long duration of extreme rainfall in Pakistan has increased by 50% due to the impact of climate change. Nigeria, Uganda, Ethiopia and Papua New Guinea: These countries have also reported a surge in malaria cases, with climate change as an important factor. Changes in temperature, humidity, and rainfall alter mosquito behavior and survival conditions, thereby promoting malaria transmission [6].

2.2. Dengue

The background of the case of dengue fever transmission is that in Singapore, Brazil and other countries, more and more places are suitable for the survival of thermophilic mosquitoes such as Aedes aegypti, thus expanding the spread of dengue fever. Its specific impact in Singapore is that the tropical climate of Singapore is a natural breeding ground for Aedes mosquitoes, but in recent years, the number of dengue cases has increased significantly. Far more dengue cases were recorded in Singapore in 2022 than in previous years, and it even held the first Asian Dengue Summit to explore disease control strategies. Its specific impact in Brazil is that the number of dengue cases in Brazil has also risen sharply due to climate change and the Pacific El Nino weather patterns. In early 2024, Brazilian health officials warned that the number of dengue cases could reach a record 5 million this year, and cities like Rio de Janeiro have declared a public health emergency [7].

2.3. Cholera

In Pakistan and Malawi, climate change has also led to outbreaks of water-borne diseases such as cholera, which have not only caused huge casualties and property losses, but also caused a serious public health crisis [8]. Other mosquito-borne diseases, such as Zika virus and other mosquito-borne diseases, are also on the rise globally, and climate change provides favorable conditions for the spread of these diseases [9].

The above cases show that climate change is affecting the spread of infectious diseases in many ways. Climate change is having a profound impact on the spread patterns of infectious diseases by changing temperature, humidity, rainfall patterns, and ecosystems. the case of virus transmission across species, against a global context, where species migration and ecosystem changes caused by climate change increase the risk of virus transmission among different species. According to research published in the journal Nature, climate change will cause a large number of mammals to migrate to cooler areas that have a chance to "spill over" to humans, causing new infectious diseases. The study predicts that the first contact between species will greatly increase by 2070, due to climate change, resulting in a significant increase in for the spillover events of the virus into new hosts [10]. Therefore, addressing climate change, strengthening the monitoring and prevention and control of infectious diseases have become important tasks in the field of global public health.

3. The Effects of Climate Change

3.1. Changes in the Pathogen and Its Carriers

Global warming leads to elevated temperatures, which directly promotes the reproduction and activity of certain pathogens and their carriers. For example, insect-borne infectious diseases such as dengue and malaria are more active in warm climates. In addition, increased temperature can also affect the pathogen's life cycle and survival rate, thus increasing the risk of transmission [11].

3.2. Changes in the Host Behavior

Extreme weather events such as floods and storms can alter the habitats of humans and animals, bringing them closer to pathogens. For example, Lassa fever and Legionellosis are associated with displacement due to storms or flooding. At the same time, high temperatures and other climatic disasters can promote interspecies contact, further increasing the risk of cross-species virus transmission [12].

3.3. The Activities of the Organisms

Climate change has a significant impact on the activity of vectors (such as mosquitoes, ticks, etc.). Rising temperature facilitates the breeding of vector insects, for example, the time from egg to adult is shortened and the range of mosquitoes expands. Changes in rainfall patterns can also affect the living environment of vectors, such as the dry season may reduce the number of some vectors, while the wet season increases its number [13].

3.4. Socioeconomic Factor

The level of socioeconomic development and the weakness of the public health infrastructure are also important factors affecting the spread of infectious diseases. In areas with a lack of population immunity or weak public health infrastructure, climate change may extend the transmission season of the disease and expand its geographic reach, so the lack of effective public health interventions may exacerbate the health threat posed by climate change [14].

3.5. Other Indirect Effects

Changes in human activities can also be affected by climate change, which indirectly affects the spread of infectious diseases. For example, the central air conditioning system is used frequently in hot weather, which may become a hiding place and diffusion tool for bacteria. In addition, climate change may also affect the spread of respiratory infections by altering air pollution patterns.

4. Suggestions

To build an effective public health infrastructure to address the risk of infectious diseases caused by climate change requires a number of aspects, including health risk assessment, infrastructure construction and upgrading, monitoring and early warning systems, and training and science popularization. It is already known that climate change affects the distribution and number of pathogens, vectors (such as mosquitoes, ticks, etc.) and hosts by changing temperature, humidity and rainfall patterns. For example, climate warming accelerates the development and reproduction of pathogenic microorganisms and prompts them to expand to higher latitudes and elevations. Moreover, increasing extreme weather events can also lead to changes in the number and density of vectorial populations, which increasing the risk of transmission of infectious diseases. Here are the detailed suggestions:

4.1. Infrastructure

To organize health assessments of the impact of climate change, identify climate-sensitive diseases, and formulate corresponding prevention and control measures. For example, China has launched the

"Healthy Environment Promotion Initiative" and launched the prevention and control of climate-sensitive diseases.

Expansion of the capacity of centralized treatment of infectious diseases will be carried out. Infrastructure construction and equipment upgrading will be strengthened. The design requirements of "three districts and two channels" will be implemented. Necessary equipment such as negative pressure ambulances and negative pressure stretchers will be allocated. Material reserves will be strengthened. Appropriate emergency sites will be reserved. Moreover, the planning and design of healthcare facilities should consider local climate and disaster characteristics, such as high-performance glass in new buildings to prevent heat and introduce natural light and fresh air, and internal and external insulation in cold areas.

Establishment and improvement of the monitoring and early warning system for climate-sensitive diseases will be carried out. Continued participation in the popularization and implementation of the Adaptation Strategy 2035 will be ensured. Climate resilience in the field of health will be enhanced. At the same time, the infectious disease foresight action will be strengthened through data pipelines and machine learning technologies. Strengthen the construction of water, sanitation and personal sanitation facilities, eliminate mosquito breeding sites, especially in poor communities and urban areas, and revise and implement public health regulations to regulate water storage. Community cleanup activities can help reduce the probability of mosquito breeding during floods or hurricanes. In addition, it is important to support tourism and entry ports for the prevention and control of infectious diseases, such as vaccination of yellow fever and malaria.

4.2. Skills Development

Develop the skills of healthcare workers and laboratory staff, which can be provided by higher education institutions through short courses and online training modules. For instance, finding ways to ensure access to essential supplies during a lockdown, or devising strategies to maintain physical and mental health while staying at home for an extended period. Enhancing their skills in using digital tools and platforms can be extremely helpful. This includes being able to access reliable health information online, use telemedicine services, and participate in virtual support groups. What's more, strengthen the maintenance and management capabilities of central air conditioning systems, improve indoor environmental quality, and raise public awareness and behavior can also help.

4.3. Scientific Research

Increase in scientific research on climate change and health will be carried out. Exploration of the impact of climate types, air pollution and other factors on the health of residents will be conducted. Research on the impact of climate change on the spread of infectious diseases will be carried out. Cooperation with the World Health Organization (WHO) and the World Meteorological Organization (WMO) will be maintained to develop work plans focusing on extreme weather events, poor air quality and other issues. Establishment of a global heat health information network will be pursued.

5. Conclusion

This article explores the impact of climate change on the transmission patterns of infectious diseases and public health responses. From this exploration, it is found that there are aspects such as the geographical distribution of pathogens and vectors, the improvement of the survival and reproductive conditions of pathogens; the indirect effects of ecosystem change; the release of ancient pathogens. Strengthening of the monitoring and early warning system should be done: establishment and improvement of the infectious disease monitoring network, and strengthening of the monitoring and research of the relationship between climate change and infectious disease transmission. Through timely collection and analysis of data, to predict and warn the occurrence and transmission trend of infectious diseases. Improve the vaccine research and development and vaccination rate: increase the investment in the research and development and production of infectious disease vaccines and

improve the safety and effectiveness of vaccines. At the same time, vaccination programs should be promoted to improve the immunity level of the population and reduce the occurrence and spread of infectious diseases. Improving public health facilities and environmental health: strengthen the construction of public health facilities and improve the level of public health services. Improve environmental sanitation conditions and reduce the survival and reproduction environment of pathogens and vectors. Climate change and infectious disease prevention and control are global issues that require countries to strengthen cooperation and information sharing. To jointly address the impact of climate change on the spread of infectious diseases through international organizations and multilateral cooperation mechanisms, this article strengthens experience exchange and technical support to enhance the capacity and effectiveness of all countries in dealing with the spread of infectious diseases. It is significant to raise public health awareness and protection capacity, strengthen health education and publicity, and raise public awareness and attention to the public on climate change and the prevention and control of infectious diseases. Advocate good personal hygiene habits and healthy lifestyle, improve the public protection ability. Formulate contingency plans to deal with extreme weather events: formulate and improve corresponding emergency contingency plans according to the possible risk of infectious diseases spread caused by extreme weather events. Strengthening emergency drills and training to enhance the ability to respond to extreme weather events and infectious diseases. Conducting environmental disinfection and epidemic prevention after extreme weather events to prevent the spread and dissemination of diseases.

Climate change has had profound impacts on infectious disease transmission patterns, and comprehensive public health response research measures are needed to address these challenges. By strengthening monitoring and early warning, improve vaccine development and vaccination rate, improve public health facilities and environmental health, strengthen international cooperation and information sharing, improve public health awareness and protection ability, promote scientific research and technological innovation and make plans to extreme weather events, can effectively reduce the occurrence of infectious diseases and transmission risk, protect human health and life safety.

For specific types of infectious diseases, it is of great scientific significance to reveal the complex association between climate change and these diseases, and to clarify the potential mechanisms of climate and environmental factors in the influence of their occurrence and prevalence. Many current studies focus on simulations based on computer data and ignore empirical studies based on field and laboratory data. More comprehensive empirical work is needed in the future to validate the simulation results and provide more reliable decision making. Climate change is a global issue that requires international cooperation and information sharing. Through international cooperation, the impact of climate change on infectious diseases can be better monitored and predicted, and response strategies can be developed together.

In short, the impact of climate change on the transmission pattern of infectious diseases is multifaceted, involving pathogens, transmission routes, human resistance, and the spatial and temporal distribution of diseases. Public health response strategies need to start from system building, prediction and simulation, interdisciplinary collaboration, and public education to effectively address this global challenge.

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