

The Climate Change as a Public Health Emergency: Health Consequences, Health Burden, and Adaptation

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Abstract. Climate change has become one of the most urgent global epidemiologic issues of the 21st century, and its direct or indirect effects on population health could become even more crucial. The current literature has however managed to point remarkable loopholes in process development and application of efficient health response measures. This paper concentrates on the health effects of climate change by looking at its manifestations in real life using three dimensions namely disease burden, socioeconomic burden and environmental burden. It determines the major directions, such as increases in temperature, shifts in humidity levels, and severe weather conditions, which have a great influence on the outcomes of population health. Further, this paper also carries out a comparative evaluation of the climate change health response efforts in various types of countries in order to establish common key problems in reducing and advancing the health effects of climate change. This study would also aim at offering viable recommendations that could help curb the negative effects of climate change on the health of the population by exploring sustainable ways of mitigating and adapting to these effects.

Keywords: Climate change, population health, response strategies

1. Introduction

The report of the World Meteorological Organization (WMO) State of the Global Climate in 2024 knowingly supports this statement by showing that 2024 has been declared as the warmest year in history and the average global near-surface temperature was 1.55 °C, above the level of 1859. Various major indicators of climate such as ocean heat content, rate of sea level rise, the size of the Antarctic sea ice, rate of glacier melting, high rates of extreme weather phenomena have all reached peaks never seen before and add to the growing speed of global climate change. The available evidence shows that climate change is increasingly threatening to the health of the population significantly. Besides infectious diseases, epidemiological studies indicate that climate-sensitive diseases affect about 90 percent of the known human infectious diseases on top of which 218 of the 375 identified human infectious diseases, including dengue fever, malaria, cholera, tuberculosis, chikungunya, and anthrax, are strongly associated with climate conditions [1]. However, beyond infectious diseases, chronic noncommunicable diseases (NCDs) are also being affected by climate changes to an enormous degree. The available reviews have pointed out that exposure to heat is one

of the primary avenues by which climate change impacts the onset and course of cardiovascular, respiratory, endocrine and metabolic and neurological diseases. Besides, there is developing evidence to support the fact that climate change is linked with the development or aggravation of mental health conditions, such as anxiety, depression, suicidal tendencies, domestic violence, and accidental injuries, yet the mechanisms through which it happens are partially unknown and need to be researched. Being a developing country with high geographical and climatic diversity, a great number of populations, and multifaceted socio-environmental situation, be it in relation to climate change, health risks become especially evident in China. To address these issues, on July 31, 2025, the National Center of Disease Control and Prevention (China CDC) created the so-called National Expert Committee on Climate Change and Health to improve the assessment of health risks related to climate change and to build adaptive capacity. Since there is an ever-increasing evidence on the health effects of climate change and the increasing necessity to adopt effective approaches in response, the current review aims at synthesizing the main pathways in which climate change is influencing the population health, critically assessing the current mitigation and adaptation measures, and using scientific sources as a base to develop sustainable development pathways aimed at ensuring that population health remains unaffected by climate-related health effects.

2. The real-world health effects of climate change

Climate change has significant impacts on the 8.2 billion of people in the whole world, and the consequences might pose threats or even nullify the social development of the world and acquired global health advancements over the last 50 years. The effects of it go beyond direct physiological damages to include socioeconomic systems and ecosystem, thus highlighting the urgency of multidimensional and cross-sectoral interventions.

2.1. Disease burden

The same has been echoed in the China Climate Change Blue Book (2024) that explains that under the climate change against global warming, China is experiencing a sharp rise in the number and severity of extreme weather, including extreme precipitation, typhoons, heatwaves, and cold waves. The report is a thorough evaluation of the present health effects and the future risks of climate change on human health and well-being along with the proposed specific measures of adaptation and solutions. It is particularly notable to note that climate change has been explicitly declared as posing increasing menaces of climate-sensitive infectious diseases, chronic noncommunicable diseases (NCDs), and mental wellbeing and a heightened risk of compound exposures and cascade public health occasions. It is estimated that these health dangers will even increase on a larger scale in future due to global warming being experienced [2]. The report highlights that albeit proactive and effective climate adaptation policies when taken in a timely manner can alleviate consequences and curb health hazards caused by climate to a considerable degree, they cannot completely avert all these hazards. In light of this discovery, the Blue Book highlights the seriousness and urgency of health implications associated with climate change which requires greater investment in scientific expertise, strategy, and action interventions and financial assets to enhance health-oriented climate adaptation efforts in future.

2.2. Socioeconomic burden

Fantastic global average temperature has increased by 1.2°C than in pre-industrial periods (1850-1900) and the possible effects of climate change on reproductive health are increasingly getting attention.

It was found in a recent systematic analysis of major extreme events in China between 2014 and 2020 that had direct economic losses of about 298 billion yuan and indirect one up to 91.1 billion yuan. Among them, 170.9 billion yuan was caused by climate change. Estimates of the damage of climate change on the global health systems show that by 2050, climate change will cause 14.5 million fatalities and 12.5 trillion economic destruction [3]. This burden does not just cause an increase in the overstrain of healthcare systems but also social inequalities, especially in the low-income population.

2.3. Environmental burden

The high prevalence of extreme weather events has a direct and severe effects on the ecological environment, which is constantly weakening the diversity, stability and sustainability of the ecosystems. By the year 2024, the near-surface temperature was 1.55°C, the highest temperature since 175 years of measurements were taken-fighter than the 1.5°C warning mark, compared to the temperature prior to industrialization. Not only this high temperature will have some effect on human health, but also on the ecology: the heat waves and droughts will intensify the evaporation of the soil moisture and will enhance the degradation of vegetation; high temperatures will additionally cause the biodiversity to decrease since some species will be forced to migrate or even become extinct, as they cannot endure the heating conditions; as well as altering crop pollination and causing a decrease in crops and killing the food security. Flooding may lead to the leaching of chemical pollutant into soil and water pollution thus raising the chances of food borne diseases [4]. Moreover, the devastating effect of extreme hurricanes like floods is unbelievable: topsoil is washed off, leading to loss of nutrients and soil erosion; pesticides and industrial wastewater are routinely carried away to rivers and lakes by floods and thus pollute the water body; heavy rains also know how to disrupt the hydrology of wetlands, changing the wetland ecology. This humiliation results in further reduction of the health risks in a vicious cycle.

3. The ways of climate change impacts on health

Climate change has several methods of influence on human health. An increasing temperature, changes in the pattern of temperatures and humidity, and severe weather conditions are some of the typical indicators of climate change with each having a considerable impact on human health in a unique way.

3.1. Health impacts of global warming

Heatwaves pose a threat to the health of people, and the danger is commonly accepted. Past research showed that, heatwaves present a high risk to the health of susceptible groups such as the elderly, persons with chronic conditions, and expectant women because their impacts are extensive and more burdensome to the overall state of the populace as well as exposing them to heat fatigue, heat stroke, and heat death [5].

Also, one cannot ignore the harmful impact of extended exposure to daytime and nighttime heat on mental health. ENRICH research team used four waves of data (2013-2018) of the China Health

and Retirement Longitudinal Study (CHARLS), consisting of 12,403 study participants aged 45 years and above in 125 cities with a total of 35,211 repeated measures. To measure depressive symptoms using Center of Epidemiological Studies Depression Scale (CES-D-10), the study used a logistic mixed-effects model to investigate the relationship between heatwaves and depression. This experimental research has demonstrated, on this cozy background of global warming, the possible risk of high temperatures and combined nocturnal to diurnal heatwave with depressive symptoms, and this also showed the urgency and need to develop specific public health solutions to reduce the mental health risks posed by climate change [6].

3.2. Impact of changing the temperature and humidity

According to the report released in January 2025 by the World Economic Forum and Allianz Insuring Against Extreme Heat: Navigating Risk in a Warming World, extreme heat is a disastrous risk to human health and the most fatal among all climate-related risks. It is estimated that extreme heat causes about 489,000 deaths each year, and that the annual productivity losses would be \$2.4 trillion by 2030. Besides, the prospects of the future influence of high temperatures on the fertility of humans are becoming more apparent. In a nationwide cohort study of 2.44 million reproductive-age couples in 350 cities, it was found that there was a strong correlation between high temperatures and impaired fertility. Increased temperatures were established to reduce the pregnancy rates, conception period and have an almost linear relationship between exposure and response [7]. This research offers epidemiological data on the effect of temperature exposure on the general fertility of reproductive age couples thus making it of paramount importance to devise intervention methods that may achieve reproductive wellbeing necessitating warmer temperatures be tackled.

The relative humidity is another risk factor that should be considered in terms of falls since they are a key universal health issue. The study used a case-crossover study design to examine the exposure-response relationship between the hourly relative humidity and fall-related injuries by considering the hourly relative humidity data together with close to 4.2 million fall-related injury data in China. Findings indicated that relative humidity showed a negative change that meant that the increased the relative humidity, the lower the risk of falls. The risk of fall injury rose with any 10-percentage-point drop in relative humidity, 1.35-fold. This result does not conform to the popular belief that climatic conditions are more humid hence making surfaces wet and slippery and thus fall outs are more likely. Age-group stratified analyses, occupational stratified analysis, workplace stratified analysis, region stratified analysis and population subgroup stratified analysis revealed more burdens among male, children and adolescent, public settings, and sports activities. A decrease in the humidity can have its effects through a change in friction or loss of balance mechanisms [8]. These results can provide evidence-based recommendations applied to the development of fall injury prevention measures, which will contribute to the decrease of fall injuries associated with future climate change.

3.3. Effects of severe climate occurrences

Extreme weather events have become the key issue in the global climate change investigation. Due to climate change, the frequency of extreme weather in the world has been increasing in recent years due to the influence of hydro-phenomena, including heatwaves, torrential rains and floods, and severe droughts. The effects that these phenomena have are so severe that they interfere with human production and everyday life significantly, and their direct impact on human health is dangerous. Floods which are the most common natural catastrophe in the world threatens about 23 per cent of

the entire world. With more frequent and fresh extreme precipitations coupled by rising sea levels resulting in global warming, estimates show that future floods will only become stronger, higher lasting, and more frequent. In addition to direct risks, including drowning, electrocution, and hypothermia, floods may trigger a few risk factors that cause extended health outcomes. Among the techniques that were used by a recent multinational analysis that assessed 304.7 million hospital records of 747 communities in eight countries and regions (Australia, Brazil, Canada, Chile, New Zealand, Taiwan, Thailand, and Vietnam) between 2000 and 2019 are attribution scoring and sensitivity analysis. The systematic finding of this study was that the risk of getting hospitalized after an exposure to floods has substantial time lags and persistence. Relative risk (RR) of all cause hospitalization was highest on day three following the flood and lasted up to 210 days [9]. The different patterns of disease-specific responses denote the difference in regional infrastructure strength and the size of the healthcare system. This review is valuable critical evidence that should be used to comprehend the health hazards of change in climate and should guide the formulation of specific interventions about health.

4. Discussion

At the 29th meeting of the parties (COP29) of the United Nations Framework Convention on Climate Change (UNFCCC), the World Meteorological Organization (WMO) indicated that this number had risen to above 20 percent of counties and cities in China that had recorded temperatures of 40°C and more. Historical records on summer heat were smashed in about 100 cities in the United States, and at least 37 cases of deaths were related to heat in July alone. Prolonged heatwaves in Northern India occurred in June and cost 40,000 heatstroke cases ([1]) ...This demonstrates the growing frequency and severity of extreme weather, which directly leads to the higher incidence and higher mortality of climate-sensitive diseases, including cardiovascular and respiratory diseases, and increases the transmission and geographic capabilities of disease vectors.

4.1. Comparative analysis between various types of countries

To compare the measures of health response to climate change undertaken by the European Union, the United States, China and India, the research will have 2025 which is the hottest year in history as its research context.

The European Union (EU) assumes a powerful role in climate action across the world. The vision of the EU Green Deal, which is reaching carbon neutrality by 2050, and its targets, are integrated into the European Climate Law offering legal limitations and protections to the member states in their green resolutions. In 2025, the EU countries-initiated health protection policies to respond to heatwaves. An example is the National Heatwave Contingency Plan by National Institute of Public Health and the Environment (RIVM), the Netherlands, was formulated as early as 2007. Since that time, it has begun an annual early warning mechanism, which includes encouraging the caregivers to be extra careful of heat-vulnerable populations such as the elderly and children. Austria updated its Heat Protection Regulations, according to which, employers must take certain protective actions when the perceived temperatures are 30-34°C. These can be installing company level heat protection plans, modifying company work schedules and practices, and providing operational equipment/ machinery such as the crane cabin with cooling systems. On May 27, France implemented Decree No. 2025-482 which provided a new four level system of weather alerts. Specifically, the decree requires employers to introduce the protections against heatwave that include providing employees with at least 3 liters of cool drinking water per day, streamlining workflow processes, and providing

them with the required heat protection equipment. In the meantime, the Ministry of Health of Spain published the National Action Plan on Preventing the Health Effects of Extreme Heat 2025 that follows the previously introduced heat health monitoring mechanism developed in 2004. The revised plan will put the priority on citizens who are 75 years or older; this is the group that has contributed to the huge percentage of those killed by heatwave in Spain over the last ten years. All these measures reveal clear indications that the EU countries are taking steps that ensure the development of their health resilience in adapting to climatic conditions. With the combination of legislative framework and specially tailored plans, they have been able to entrench health protection within the umbrella strategic framework of responding to climate change.

In the setting of record-breaking heat in the year 2025, the Federation of American Scientists (FAS) published its report A National Framework on Heat Preparedness in July in attempts to tackle the increasing threats of extreme heat to the general population. The framework suggests five main measures that are closely related: First, to create a lead agency to govern heat health to enable cross-departmental and non-governmental organizations to plan their work, second, to implement a uniform real-time assessment framework, which would help monitor the influence of extreme heat on human health, such as the incidence rates of heat-associated diseases, third, to design the heat health emergency response plans and apply heat health hazards to long-term plans to solve the immediate crisis and provide the long-term protection of vulnerable persons, fourth to invoke life-saving emergency actions once the Such actions highlight the active attitude of the United States toward global warming and problems with global temperature extremes, in particular, health hazards. However, their successful implementation as well as the creation of a scientifically rigorous monitoring and evaluation mechanism are also the most important issues that should be paid attention to in the long run.

China is a nation that is most climate-prone in the world since it is a country in the East Asian monsoon. China as the biggest developing nation under the influence of climate change has gradually concentrated on the pathways and breakthroughs of governance in climate in recent decades, although the country has started late on the path of climate action. A political framework of climatic-related health risks is developing slowly, and policy documents are released, including National Climate Change Adaptation Strategy 2035, Guidelines for Public Health Protection Against High Temperatures and Heat Waves, National Action Plan for Health Adaptation to Climate Change (2024-2030), and China Action Plan to Early Warning to Promote Climate Change Adaptation (2025-2027). These documents explain the health effects and risk posed by climate change and recommend comprehensive development of climate change health adaptation measures, ten key tasks, including enhancing risk prevention and intervention capacities; improving health security in response to climate change; improving the climate resilience of health systems; accelerating sci-tech innovation in health adaptation; and promoting global climate health adaptation. The plan aims at: in 2025, it is to have a successful multi-department cooperation framework and as well as the completion of the first round of health risk, vulnerability, and adaptation capacity assessment; in 2030, it is to create fundamentally a policy and standards framework and a positive social climate about the climate change health adaptation.

India is a South Asian nation that is close to the equator thus it is a tropical monsoon state. The southwest monsoon tends to hit its summers rendering the temperatures high. In 2025, India was hit by a record-long heatwave where its maximum temperature was 49.4 °C (118.7 °F). According to media reports, 25,000 individuals had to be hospitalized due to heatstroke during the period between March and May 2025. The article analyzed the potentially High in relation to infant mortality rates based on the data of the Large Family Survey in India. The result indicated that there was a great

increase in infant deaths associated with maternal heat exposure: 2 in 1,000 infants died as a result of this exposure [10]. This, however, only had an effect in rural India and dependent on population group. There is also evidence that high temperatures can be mitigated through public policy to have a beneficial effect on the health of infants in low-income regions. In comparison to the legally binding carbon neutrality target imposed by the EU and the attention paid to the dangers of extreme heat by the US, China tends to prioritize local adaptation strategies such as heatwave warning systems. Emerging economies like India are keen on protecting people at the disadvantage, but they do not have adequate financial resources and technology. Cross-national comparative analysis shows that developed nations are ahead of developing nations in terms of monitoring and research and the developing nations require more global collaboration.

4.2. Strategic development of health response

Climate change has been identified as a global issue and requires concerted efforts by individuals, communities, governments, and research institutions to address climate change, help to increase adaptive capacity, and preserve the health of the population.

On the individual and household level, people and households are to reinforce their health protection, develop the ability to handle extreme weather, be keen on the prevention of infectious diseases, ensure that vulnerable groups (elderly, children, pregnant women, and people with chronic diseases) are given special care, and specific dispensation on maintaining healthy lifestyles.

On the social policy level, it requires proactive actions to scientifically plan green urban conditions, improve the climate-adjustment of the healthcare systems and climate resilience on the whole, develop the power of the warning system of the health risks in heatwaves and flood-related health hazards, promote the population climate-health literacy, and boost the emergency response of communities. Additionally, interagency cooperation between climate, health, and environmental officials should be encouraged to incorporate health aspects into climate policy settings, focus on marginalized communities, including poor neighborhoods and indigenous people, and deal with health inequalities caused by structural disparities.

In order to promote scientific progress in this area, it is advisable to continue working on the in-depth research of the molecular responses created by climate change in the generation of inflammation and oxidative stress, thus making it possible to develop early warning signals based on particular biomarkers. At the same time, molecular targets must be identified, and precise protection techniques are to be elaborated - say, the development of metabolic regulation to cope with mitochondrial damages of heatwaves. Moreover, disaster biobanks and multi-omics databases need to be established to accommodate longitudinal studies in climate medicine, which will form a strong basis of evidence-based policy making.

5. Action and guidelines on managing climate change

5.1. Some of the most common problems in international mitigation and response to the impacts of climate change on human health

Three fundamental problems of global climate governance are lack of trust among stakeholders, unequal responsibility-sharing, and disjointed cooperation which pose a barrier to global climate governance that is vital to the health of the planet. There is an accumulating pool of evidence that is pointing at excessive geographic skews and ideological biases in the literature on climate change responses, namely that the overwhelming majority of subnational studies occur on communities in

high-income nations with low- and middle-income nations (LMICs) being underrepresented. More so, the global research agenda on climate change and health is overwhelmingly occupied by institutions in the Global North and contributes to ingrained inequities and colonial histories within the global health system, including: asymmetrical sharing of data and knowledge, uneven distribution of scientific credibility, inequitable distribution of international assistance.

5.2. Climate change mitigation and adaptation sustainable development pathways

In a bigger picture of climate cooperation on a global scale, the concept of One Health is vital to implement cross-sectional and transnational collaborative governance to thus manage the issue of climate change, ecosystems, and human health as a complex interrelation. It is also necessary to discuss how more balanced distribution models can be created within the current system of major international financial organizations, such as the World Bank, the International Monetary Fund (IMF), and the Green Climate Fund (GCF). This would assist in balancing the environmental protection requirements with the aims of global development equity within the global climate agenda at reaching the objective of achieving climate action without augmenting current health and economic disparities.

Disaggregating the longstanding geographic imbalance in climate change studies, in which communities in the Global North not only dominate the solutions led by the system, but also systematically undervalue and disadvantage the ethos that knowledges of the Global South are in the Global South, is essential; and that the principle should be tangibly realized and hailed as a victory.

On the domestic level, in developing responses to the health impacts of climate change there is an essential need to adopt a dual approach combining both mitigation and adaptation and by systematic incorporating health adaptation principles on all levels of the climate change policy framework. It is important to reinforce sound evidence-based research on the impacts of the climate change on health and to consider its overall extension to health solution development and implementation. Meanwhile, preventive approaches need to be put on the agenda by directly defining the climate crisis as a social health issue, which would mobilize the resources and political willingness to maintain the health of the population. There is a need to have a strong adaptation linkage process that is pioneered by climate change system health early warning systems. The mechanism will be used to advance the process of designing multi-level and diversified health adaptation policies, coordinated activities at sector and regions, and eventually increase overall climate change adaptation and public health risk prevention capacity.

5.3. Advisable recommendations of helping to limit the health impacts of climate change

At the international cooperation level, it is only the multilateralism that is viable and appropriate to resolve the global collective challenge of global warming. It is hence essential to reverse the aspect of climate diplomacy, to make it more of a win-win game rather than a global win-lose situation.

In the socioeconomic context, there is an immediate need to learn the way structural inequalities, including poverty, racial discrimination and unequal access of healthcare aggravate climate-related health risks. With this knowledge, we should subsequently facilitate comprehensive and joint actions that will bring together both social policies and biomedical solutions to the causative factors and health impacts of climate changes in a manner that is justifiable. In the discipline of epidemiology, there is an urgent need to consistently revamp and enhance the current pandemic surveillance, prevention and response systems to be more considerate of the health consequences of climate change. In particular, this necessitates the focus on epidemiological research of the impacts of

climate change on high-risk groups, such as the elderly, pregnant women, children, and people with chronic illnesses, and this action is justified by the research evidence, which would be applied to specific and practical health protection measures. In microbiology, more studies need to be performed on the cellular and molecular pathways underlying them, such as inflammation and dysfunction in mitochondria, which are instigated by environmental disruptions causing climate change.

6. Conclusion

Climate change has long distance, many-layered, and complex threats to population health having in consequence put large and unexamined demands to the global systems of public health. The evidences of climate change, such as global warming, the changes in temperature and humidity and the presence of the growing frequency and severity of extreme weather conditions directly cause a variety of population health issues along with the further increase in the relative risks of climate-specific diseases. Therefore, the health effects of climate change have become a highly relevant and a long-term issue of criticism and response to the global population of the world governing the health. The key answer is to make these challenges opportunities and utilize climate-related health risks to mobilize bold action on climate and the future development of the scenario of a harmonious combination of climate insecurity and human health and sustainable development. The emergence of the Biomarker-based early warning systems targeted to health hazards caused by climate change is a critical matter to examine. These systems would also allow the public health authorities to plan and implement focused actions at the early stage, thus successfully alleviating the negative health effects of the climate changes.

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