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The effect of climate change on global infectious disease patterns

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Introduction:

Climate change has become a significant and urgent problem in recent years, posing extensive consequences for different elements of life on our planet. The influence of climate change on global disease patterns is a growing worry for public health professionals and politicians worldwide, among the many implications of climate change. The complex interaction between environmental elements and human health has been acknowledged for a long time, but the increasing speed of climate change is currently worsening pre-existing health risks and adding new ones (Abbass, et al.2022).

Climate change refers to long-term changes in weather patterns, including changes in usual weather conditions and the distribution of weather conditions around the average, which can lead to the occurrence of extreme weather events. Tackling worldwide transformations by striving for sustainable development presents a substantial obstacle to human society. The influence of climate change on human health is notably substantial, especially concerning infectious diseases. Infectious diseases often necessitate three essential elements: an agent (also known as a pathogen), a host (or vector), and a transmission environment. Some infections are spread by vectors or depend on intermediate hosts to complete their life cycle. Optimal climatic and meteorological conditions are crucial for the survival, reproduction, distribution, and transmission of disease-causing microorganisms, carriers, and organisms that harbour the disease. Therefore, changes in temperature or weather conditions can affect infectious diseases by affecting the pathogens, vectors, hosts, and their habitat. The variability in temperature, precipitation, and humidity influences the transmission and distribution of infectious diseases (Bai, et al. 2014). Prolonged climatic warming facilitates the proliferation of certain infectious diseases, whereas severe weather events might lead to the occurrence of disease outbreaks in specific areas or at unusual times and places. Climate conditions typically restrict the regional and seasonal distribution of infectious diseases, whereas weather patterns impact the timing and intensity of disease outbreaks (Wu, et al.2016).

The global origin, comeback, and redistribution of infectious illnesses are increasingly influenced by a warming and unstable environment. Numerous prevalent infectious diseases, especially those spread by insects, are extremely susceptible to changes in climate. There is a widespread presence of newly emerging and recurring infectious diseases transmitted by vectors, such as dengue, malaria, hantavirus, and cholera. Elevated temperatures and flooding can lead to increased outbreaks of other infectious diseases, such as salmonellosis, cholera, and giardiasis. Long-term cooperation is necessary to build Early Warning Systems (EWS) for infectious diseases, taking into account climate change (Van de Vuurst, & Escobar, 2023).

- **Causes of climate change and their connection to infectious diseases:**

Environmental and climatic change is influenced by a variety of variables, including both human and natural forces. Human activities that have the potential to impact climatic changes are those that emit

detrimental gases into the environment. These noxious gases are generated through various means such as deforestation and combustion of fossil fuels, particularly from industrial operations. Agriculture, being a human activity, has a substantial influence on climate change due to the emission of many types of greenhouse gases by animals, such as methane, which is a more potent greenhouse gas than carbon dioxide (Uwishema, et al.2023).

- **Climate-Driven Changes in Disease Distribution:**

The climate significantly influences human health, encompassing both noninfectious and infectious diseases. Climate change directly and indirectly affects the propagation of infectious illnesses. One of the ways in which climate change indirectly affects infectious diseases is by causing changes in biological and ecological processes. Climate changes encompass modifications in one or more climatic factors, such as temperature, precipitation, wind, and sunshine. These changes can affect the ability of disease pathogens and hosts to survive, reproduce, and spread, as well as the availability and methods of their transmission environment. The affects mentioned above typically manifest as alterations in the geographical and seasonal distribution of human infectious diseases, as well as variations in the frequency and intensity of disease outbreaks. Climate change is significantly changing the geographic spread of infectious diseases by modifying the habitats of disease-carrying organisms and the animals that harbour these diseases (Plowright, et al.2012). An exemplary instance is the spread of mosquito-borne illnesses such as malaria, dengue fever, and chikungunya to formerly unaffected areas due to increasing temperatures and altered precipitation patterns, which result in more conducive environments for mosquito breeding. Elevated temperatures can expedite the growth of mosquito larvae and reduce the time it takes for viruses to mature inside mosquitoes, resulting in higher rates of disease transmission in regions that were previously untouched by these illnesses (Uwishema, et al.2023).

Climate change has a substantial impact on the spread patterns of airborne diseases, especially respiratory viruses like influenza and COVID-19. The continuing COVID-19 epidemic has emphasised the significance of comprehending the connection between climate change and airborne infections. Although the precise impact of climate change on the transmission of COVID-19 is still under investigation, environmental factors like temperature and humidity could potentially affect the survival and spread of the SARS-CoV-2 virus. Additionally, these factors might also influence the way individuals and communities respond to public health measures (Lin, et al.2022).

Ticks, known carriers of Lyme disease and tick-borne encephalitis, are spreading to higher latitudes and elevations due to increasing temperatures. Warmer winters and milder temperatures facilitate the survival and reproduction of ticks in locations where they were previously unable to flourish, hence augmenting the likelihood of tick-borne diseases in areas with minimal historical exposure. Furthermore, alterations in vegetation patterns and land use practices caused by climate change might generate fresh habitats for

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ticks and enhance human-wildlife interactions, hence promoting the transmission of tick-borne diseases (Wallace, et al.2019).

An additional instance is the occurrence of diseases such as leishmaniasis and hantavirus pulmonary syndrome in areas undergoing ecological changes as a result of climate change. Changes in rainfall patterns and the functioning of ecosystems can impact the number and geographical spread of reservoir hosts, such as rodents and small mammals, that are essential for the transmission of these illnesses to humans. As the climate becomes increasingly favourable for reservoir hosts, the likelihood of zoonotic spillover events and human diseases increases in places that were previously unaffected (Meena, & Jha, 2023).

In general, the climate change is causing changes in the patterns of disease distribution by modifying the geographic areas and ecological roles of disease vectors and reservoir hosts. These changes present substantial obstacles for disease management and preventive endeavours and emphasise the interdependence of environmental health and human health in the context of continuing climate change. To tackle these new and developing diseases, it is necessary to have cooperation between different fields of study, active monitoring, and specific actions to reduce the effects of climate-related changes on worldwide public health.

- **Waterborne and Foodborne Diseases:**

1. **Impact on Water Quality and Availability:**
   - Climate change impacts the hydrological cycle, causing changes in the distribution of rainfall, rates of evaporation, and the flow of water (Grover, 2015).
   - Elevated temperatures can stimulate the proliferation of algal blooms and bacterial proliferation in aquatic environments, affecting the quality of water and heightening the likelihood of pathogen contamination.
   - Variations in the intensity and frequency of rainfall can cause oscillations in the amount of water available, worsening water scarcity in certain areas and increasing dependence on dangerous water sources (Grover, 2015).
2. **Implications for Waterborne Diseases:**
   - Cholera, typhoid fever, and cryptosporidiosis are examples of waterborne diseases that are spread when people consume water or food that has been polluted (Levy, et al.2018).
   - Climate change can enhance the spread of waterborne infections by generating favourable environmental conditions for their survival and transmission.
   - Elevated temperatures can expedite the proliferation and procreation of bacteria, viruses, and parasites in water sources, heightening the probability of illness outbreaks (Levy, et al.2018).

3. **Role of Extreme Weather Events:**
   - Severe weather phenomena, such as floods and droughts, can significantly affect water and food resources, worsening the likelihood of pollution and the spread of diseases (McMichael, 2015).
   - Floods have the potential to overpower sanitary infrastructure, resulting in the contamination of drinking water sources with sewage and the transmission of waterborne infections.
   - Droughts can diminish water accessibility for hygiene and sanitation, compelling people to depend on hazardous water sources and escalating the likelihood of waterborne illness transmission (McMichael, 2015).
4. **Cholera:**
   - Is a disease caused by the bacterium Vibrio cholerae. It is most commonly found in warm, brackish environments and is strongly associated with inadequate sanitation and hygiene standards (Asadgol, et al.2019).
   - Climate change can facilitate the proliferation of cholera by raising water temperatures and modifying precipitation patterns.
   - Floods have the potential to pollute drinking water sources with faecal matter, which can result in the occurrence of cholera outbreaks in impacted areas (Asadgol, et al.2019).
5. **Typhoid fever:**
   - Typhoid fever, which is caused by the bacterium Salmonella Typhi, is spread by consuming food or drink that has been contaminated with faeces from sick individuals.
   - Climate change can impact the occurrence of typhoid fever by altering water quality and availability, as well as sanitation practices.
   - Severe weather conditions, such as intense rainfall and flooding, can aid in the spread of typhoid fever by polluting water supplies and disrupting sanitary systems.
6. **Cryptosporidiosis:**
   - Cryptosporidiosis is a disease caused by a microscopic organism called Cryptosporidium. This parasite is commonly found in water that has been contaminated, and it can lead to illness in the digestive system.
   - The occurrence of cryptosporidiosis can be influenced by climate change through its effects on the geographical range and viability of Cryptosporidium oocysts in the surroundings.
   - Flooding events might heighten the likelihood of cryptosporidiosis outbreaks by polluting water sources with faecal matter that contains Cryptosporidium oocysts (Helmy, & Hafez, 2022).

- **Disproportionate Impact on Vulnerable Populations:**
  - Disadvantaged populations, such as those residing in low- and middle-income nations, marginalised groups, and persons with restricted access to healthcare and resources, bear a disproportionate burden of the health consequences resulting from climate change.
  - The lack of sufficient access to clean water, sanitation, and healthcare facilities heightens the vulnerability of at-risk populations to waterborne and vector-borne diseases, hence worsening the impact of infectious diseases.
  - The vulnerability of these groups to the harmful effects of climate change on health is exacerbated by socioeconomic inequality, insufficient infrastructure, and social marginalisation.
- **Strategies for adaptation, and sustainable mitigation measures:**

1. **Enhanced Surveillance and Early Warning Systems:**
   - Developing resilient surveillance systems to track patterns of infectious diseases and identify early indicators of epidemics (Wang, et al.2023).
   - Improving communication networks and information sharing systems to enable quick reaction and coordination between public health authorities and international organisations.
2. **Healthcare infrastructure investment:**
   - Enhancing the healthcare infrastructure, encompassing hospitals, clinics, laboratories, and the capacity of the healthcare personnel, to enhance readiness and response to outbreaks of infectious diseases.
   - Ensuring fair and equal access to vital healthcare services, diagnoses, treatments, and immunisations, especially in low- and middle-income countries and underserved populations (Kruk, et al.2018).
3. **Community Engagement and Capacity Building:**
   - Strengthening communities by providing education, training, and capacity-building programmes to improve their ability to respond effectively to infectious disease threats.
   - Advocating for the implementation of community-centered strategies for preventing, monitoring, and managing diseases, utilising the expertise and assets of the local community to tackle specific health issues.
4. **Vector Control and Disease Prevention:**
   - Utilising comprehensive approaches to control the spread of vector-borne diseases, such as malaria, dengue fever, and Zika virus, by implementing tactics that include monitoring vectors, modifying their habitats, using insecticides, and engaging with the community.

- Advocating for the adoption of personal protective measures, such as the use of bed nets treated with pesticide, repellents, and proper storage of water, in order to minimise contact between humans and disease-carrying vectors and avoid the spread of diseases (Wilson, et al.2020).

5. **Climate-Resilient Water and Sanitation Infrastructure:**
   - Allocating resources towards the development of water and sanitation infrastructure that can withstand the impacts of climate change, with the goal of guaranteeing access to clean drinking water, sanitation facilities, and hygiene practices. This will ultimately decrease the likelihood of waterborne and foodborne illnesses.
   - Integrating climate change considerations into the management of water resources, planning for sanitation, and preparing for disasters in order to reduce the impact of severe weather events on water and sanitation services (Taylor, et al.2015).
6. **Promotion of Sustainable Land Use and Agriculture:**
   - Adopting sustainable land use methods, such as reforestation, soil conservation, and agroecological farming techniques, to protect biodiversity, strengthen ecosystem resilience, and decrease the likelihood of zoonotic disease transmission (Çakmakçı, et al.2023).
   - Promoting sustainable agricultural methods such as crop diversity, integrated pest management, and reduced dependence on chemical inputs to reduce the spread of plant diseases and improve food security.
7. **Policy Coherence and Multisectoral Collaboration:**
   - Facilitating the alignment of policies and promoting collaboration among various stakeholders, including government departments, international agencies, civil society organisations, and the commercial sector, to tackle the interrelated issues of climate change and infectious diseases.
   - Incorporating climate change adaptation and mitigation measures into national health policies, catastrophe risk reduction initiatives, and sustainable development plans to enhance collaboration and optimise mutual benefits (GUIDANCE).
8. **Vaccination Campaigns:**
   - Scaling up vaccination campaigns against priority infectious diseases can enhance population immunity and reduce the burden of vaccine-preventable illnesses.
   - Targeted vaccination efforts in high-risk populations and outbreak-prone areas can help mitigate the impact of climate-driven changes in disease transmission.
9. **Research and Innovation:**
   - Supporting research and innovation in the development of new tools, technologies, and interventions for infectious disease prevention, diagnosis, treatment, and control, with a focus on climate-resilient solutions.

- Supporting interdisciplinary research collaborations to enhance comprehension of the intricate interplay of climate change, environmental factors, and infectious disease dynamics, and to guide evidence-based decision-making and policy formulation (Rocklöv, et al.2023).

Conclusion:

The complex interaction between climate change and global infectious diseases poses substantial obstacles to public health on a global scale. The accelerating rate of climate change is worsening pre-existing health hazards and adding novel ones, particularly among susceptible groups with restricted access to resources and services. The unequal effect of climate change on marginalised communities emphasises the immediate necessity for implementing adaptation and mitigation strategies to protect human well-being in a shifting climate. Tackling the intricate connection between climate change and infectious illnesses necessitates the implementation of diverse policies and the collaboration of various sectors and stakeholders. Adopting advanced monitoring and alert systems, allocating resources to strengthen healthcare infrastructure, and actively involving communities are essential elements of adaptive strategies to address health concerns caused by climate change. Implementing vector control measures, constructing climate-resilient water and sanitation infrastructure, and adopting sustainable land use practices can effectively reduce the transmission of waterborne and vector-borne diseases, while also promoting environmental sustainability.

References:

- Abbass, K., Qasim, M. Z., Song, H., Murshed, M., Mahmood, H., & Younis, I. (2022). A review of the global climate change impacts, adaptation, and sustainable mitigation measures. Environmental Science and Pollution Research, 29(28), 42539-42559.
- Asadgol, Z., Mohammadi, H., Kermani, M., Badirzadeh, A., & Gholami, M. (2019). The effect of climate change on cholera disease: The road ahead using artificial neural network. PloS one, 14(11), e0224813.
- Bai, L., Woodward, A., & Liu, Q. (2014). Temperature and mortality on the roof of the world: a time-series analysis in three Tibetan counties, China. *Science of the total environment*, *485*, 41-48.
- Çakmakçı, R., Salık, M. A., & Çakmakçı, S. (2023). Assessment and principles of environmentally sustainable food and agriculture systems. Agriculture, 13(5), 1073.
- Dąbek, J., Sierka, O., & Gąsior, Z. (2022). Protective vaccinations in the control and prevention of infectious diseases—Knowledge of adult Poles in this field. Preliminary results. BMC Public Health, 22(1), 2342.
- Grover, V. I. (2015). Impact of climate change on the water cycle. Managing Water Resources under Climate Uncertainty: Examples from Asia, Europe, Latin America, and Australia, 3-30.
- GUIDANCE, P. Integrating Climate Change Adaptation into Development Co-operation.
- Helmy, Y. A., & Hafez, H. M. (2022). Cryptosporidiosis: from prevention to treatment, a narrative review. Microorganisms, 10(12), 2456.
- Kruk, M. E., Gage, A. D., Arsenault, C., Jordan, K., Leslie, H. H., Roder-DeWan, S., ... & Pate, M. (2018). High-quality health systems in the Sustainable Development Goals era: time for a revolution. The Lancet global health, 6(11), e1196-e1252.
- Levy, K., Smith, S. M., & Carlton, E. J. (2018). Climate change impacts on waterborne diseases: moving toward designing interventions. Current environmental health reports, 5, 272-282.
- Lin, R., Wang, X., & Huang, J. (2022). The influence of weather conditions on the COVID-19 epidemic: Evidence from 279 prefecture-level panel data in China. Environmental Research, 206, 112272.
- McMichael, A. J. (2015). Extreme weather events and infectious disease outbreaks. Virulence, 6(6), 543-547.
- Meena, P., & Jha, V. (2023). Environmental change, changing biodiversity and infections–lessons for kidney health community. Kidney International Reports.

- Plowright, R. K., Cross, P. C., Tabor, G. M., Almberg, E., Bienen, L., & Hudson, P. J. (2012). Climate change and infectious disease dynamics. New directions in conservation medicine: applied cases of ecological health. Oxford University Press, New York, NY, 111-121.
- Rocklöv, J., Semenza, J. C., Dasgupta, S., Robinson, E. J., Abd El Wahed, A., Alcayna, T., ... & de Roode, S. (2023). Decision-support tools to build climate resilience against emerging infectious diseases in Europe and beyond. The Lancet Regional Health–Europe, 32.
- Taylor, D. L., Kahawita, T. M., Cairncross, S., & Ensink, J. H. (2015). The impact of water, sanitation and hygiene interventions to control cholera: a systematic review. PLoS one, 10(8), e0135676.
- Uwishema, O., Masunga, D. S., Naisikye, K. M., Bhanji, F. G., Rapheal, A. J., Mbwana, R., ... & Wellington, J. (2023). Impacts of environmental and climatic changes on future infectious diseases. International Journal of Surgery, 109(2), 167-170.
- Van de Vuurst, P., & Escobar, L. E. (2023). Climate change and infectious disease: a review of evidence and research trends. Infectious Diseases of Poverty, 12(1), 51.
- Wallace, D., Ratti, V., Kodali, A., Winter, J. M., Ayres, M. P., Chipman, J. W., ... & Webb, M. J. (2019). Effect of rising temperature on Lyme disease: Ixodes scapularis population dynamics and Borrelia burgdorferi transmission and prevalence. Canadian Journal of Infectious Diseases and Medical Microbiology, 2019.
- Wang, F., Harindintwali, J. D., Wei, K., Shan, Y., Mi, Z., Costello, M. J., ... & Tiedje, J. M. (2023). Climate change: Strategies for mitigation and adaptation. The Innovation Geoscience, 1(1), 100015-61.
- Wilson, A. L., Courtenay, O., Kelly-Hope, L. A., Scott, T. W., Takken, W., Torr, S. J., & Lindsay, S. W. (2020). The importance of vector control for the control and elimination of vector-borne diseases. PLoS neglected tropical diseases, 14(1), e0007831.
- Wu, X., Lu, Y., Zhou, S., Chen, L., & Xu, B. (2016). Impact of climate change on human infectious diseases: Empirical evidence and human adaptation. Environment international, 86, 14-23.