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Forecasting Mosquito-Borne Disease Transmission Suitability under Climate Change

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Introduction

There are numerous vector-borne diseases that affect people all over the world, the majority of which are spread by mosquitos. Approximately 17% of all infectious diseases are vector-borne, and more than half of the world's population is currently at risk, with children in the world's poorest communities being the most vulnerable, where living conditions are poor, immunity is low, and malnourishment is common. Although death is the most serious outcome, these diseases can also cause permanent disability, pain, disfigurement, stigma, social exclusion, loss of earnings, and high medical bills, impeding economic development and putting children at risk.

Although these diseases have control, prevention, and treatment options, risk monitoring is critical to support decision-making for prioritisation and resource allocation. This is the goal of projects like the Malaria Atlas Project, which is looking into new and innovative ways to map current malaria distributions for prevention, control, and planning. However, the distributions of these diseases are expected to change as climate change progresses.

Description

This study uses a unified mechanistic model to estimate the number of months of transmission suitability for malaria, Zika virus, dengue fever, and all three diseases combined on a global scale today and by 2050 under two climate change scenarios based on the most recent climate model projections. SSP1-2.6 and SSP5-8.5, the two future shared socioeconomic pathway (SSP) scenarios chosen, span the range of plausible global warming projections used in the recent Intergovernmental Panel on Climate Change Sixth Assessment Report.

Using the most recent CMIP6 projections is critical for an up-to-date, comprehensive view of the impact of potential differences in climate change trajectories on vulnerable populations, as well as to support climate change mitigation strategies and disease prevention and control. The combination of a single metric for the three major mosquito-borne diseases allows for more efficient and effective future decision-making, planning, and reporting for a broad range of stakeholders across a variety of environmental and geopolitical contexts, such as UNICEF's Children's Climate Risk Index [1-3].

The main findings are that dengue fever and Zika virus transmission suitability will increase geographically and temporally, with the latter being more significant under the highest-emissions global warming scenario. Malaria follows a different pattern, with both climate change scenarios resulting in a decrease in overall temporal and geographical transmission suitability. Both scenarios, however, will result in significant increases in transmission suitability for concentrated areas of Central Africa. Some of the populations in these areas have never been exposed to malaria and thus lack immunity.

The geographic coverage of endemic transmission suitability for Zika virus and dengue fever is currently much greater than that of malaria, and this will increase further as global warming intensifies, particularly under the worst-case scenario. Unlike malaria, dengue fever and Zika virus are expected to experience much smaller decreases in both the temporal and geographic extent of transmission suitability under both climate change scenarios. This does not mean that malaria should be regarded as a receding threat, as the consequences remain severe, particularly for children, who are more likely to die from malaria than adults and when compared to their risk of dying from dengue or Zika [4,5].

Conclusion

However, considering these three major diseases together demonstrates the potential for reallocating resources for malaria prevention and control to newly and more severely affected regions, as well as prioritising Zika virus and dengue fever prevention and control across the worst affected tropical regions. The widespread risk areas for dengue fever and Zika virus make prioritising interventions difficult, but appropriate actions are required to protect global health now and in the future. Insecticides, which can have negative environmental consequences and increase mosquito resistance; removal of mosquito breeding sites; information campaigns to increase public awareness of how to avoid mosquito bites; and use of insecticide-treated nets are currently widely used interventions.

Acknowledgement

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Conflict of Interest

Authors declare no conflict of interest.

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