Warming climate in Brazil may increase risk of Zika, dengue by 2050

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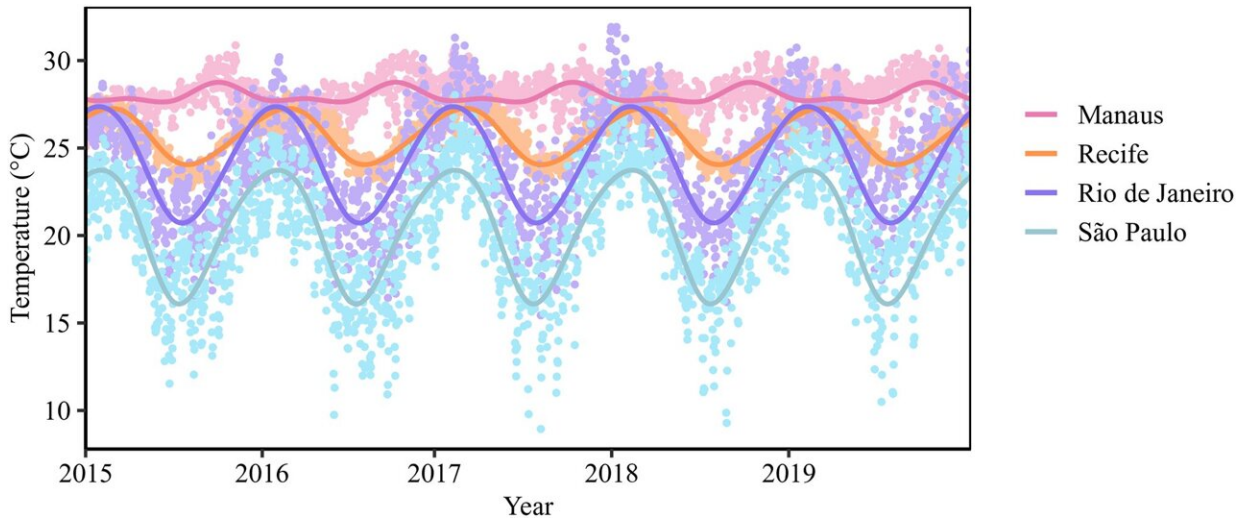

Daily temperature in 4 Brazilian cities, 2015–2019. Periodic cubic spline models are fit to the data for Manaus, Recife, Rio de Janeiro, and São Paulo to develop mean seasonal temperature models. Credit: *PLOS Neglected Tropical Diseases* (2023). DOI: 10.1371/journal.pntd.0010839

The transmission potential of Zika or dengue in Brazil may increase by 10% to 20% in the next 30 years due to warming temperatures linked to climate change, according to University of Michigan researchers.

Their study, which investigated four separate regions of Brazil and was published in the journal *PLOS Neglected Tropical Diseases*, found that

the transmission seasons will also lengthen by about two months per year, with increasing potential for seasonal outbreaks, even in the cooler regions of the country.

"We can expect Zika and other arboviruses to become more of a challenge in Brazil and other countries, like Colombia and Venezuela, as climate change contributes to warming temperatures," said epidemiologist Andrew Brouwer, assistant research scientist at the School of Public Health.

Transmission potential is measured by a concept known as the basic reproduction number or R_0. For Zika, it means estimating the number of new cases that mosquitoes would cause in a susceptible population after biting a single infected person.

"The average R_0 in Manaus, for example, is about 2.3 now, and we expect that to increase to about 2.5 by 2050. Although that may not sound like a huge increase, it can quickly add up over transmission chains and lead to larger, faster outbreaks," Brouwer said.

Brouwer, along with public health doctoral student Hannah Van Wyk and Joseph Eisenberg, professor of epidemiology, examined the potential impacts of climate change across various climates and selected four cities from diverse climatic regions of Brazil.

All are at approximately sea level and within the suitable elevation range for an abundance of Aedes Aegypti, or yellow fever mosquitoes, which spread Zika, dengue, yellow fever and other viruses:

- Manaus, a city in the Amazon Rainforest with a tropical rainforest climate
- Recife, an Atlantic coastal city with a tropical monsoon climate
- Rio de Janeiro, an Atlantic coastal city with a tropical savanna

climate
- São Paulo, a southern city with a humid subtropical climate

To measure Zika's epidemic potential, researchers obtained historical temperature data for 2015-2019 and projections for 2045-2049. They used a predictive model that accounted for how the mosquito's biting rates, the eggs they laid, the probability of adult survival and mortality rate, and the incubation period depend on temperature.

"Mathematical modeling allows us to simultaneously examine the impact of multiple temperature-dependent vector characteristics on disease risk ," Van Wyk said.

Their results suggest that the epidemic potential of Zika will increase beyond current levels in Brazil in all of the climate scenarios. For example, the arbovirus risk season for Rio de Janeiro will increase by about 2-3 months by 2045-2049, and the Zika risk seasons in Recife will increase by roughly two months. With cooler temperatures, São Paulo today lies on the borderline of transmission potential but may become more vulnerable to outbreaks from November to April, the researchers say.

The projections for Manaus are different from the other three cities. For example, risk is relatively consistent year round, with a small increase in the slightly hotter months of August through November. But using the temperature-dependent transmission model, researchers estimate that in some years the region will see temperatures too hot for mosquitoes to transmit Zika optimally and experience a decrease in risk.

However, such decreases in risk are not certain. Optimal Zika transmission occurs when mean daily temperatures are around 30C, but outbreaks are still possible up to about 35C.

"We had expected that Manaus might experience an overall reduction in risk in 30 years, but we found that average risk is likely to increase across the board," Brouwer said. "We would expect to see decreases in risk only at the hottest times of year and only in the more severe climate change scenarios."

For the researchers, climate forecasts connected with transmission models provide a source of evidence to guide future planning to mitigate health impacts due to climate change. In addition, local and national health departments can leverage these sources in preparing for increases in transmission pressure due to climatic warming.

"Our recommendations are to consider warming temperatures when planning for prevention and early detection of outbreaks," Brouwer said. "Also, to prepare Zika surveillance systems for extended transmission seasons. Greater flexibility and adaptability of arbovirus response and prevention may be necessary to accommodate spatial and temporal heterogeneity in risk projections, especially in a country with as much climatic diversity as Brazil."

More information: Hannah Van Wyk et al, Long-term projections of the impacts of warming temperatures on Zika and dengue risk in four Brazilian cities using a temperature-dependent basic reproduction number, *PLOS Neglected Tropical Diseases* (2023). DOI: 10.1371/journal.pntd.0010839

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