The expansion of chikungunya in Brazil

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Chikungunya is a life-threatening and disabling infectious disease caused by an *Alphavirus* transmitted by *Aedes* mosquitoes. Since its first detection in the American continent in 2013, 3,606,678 cases have been reported to the Pan American Health Organization (PAHO/WHO).[1,2] This number is highly underestimated due to misdiagnosis and low coverage of laboratory tests.[3] In 2022–23, after a period of relatively low activity, the disease struck back, hitting Paraguay and parts of Brazil. In 2023, until epidemiological week 23, the cumulative incidence reached 1216 cases per 100,000 inhabitants in Paraguay.[2] In Brazil, the state of Minas Gerais had the highest number of reported cases, with 395 cases per 100,000 inhabitants as of the same epidemiological week.[4]

In Brazil, chikungunya was introduced in Amapá, at the border with French Guiana (Asian Lineage), as well as in Bahia, in the Northeast (East/Central/South African genotype–ECSA lineage), in 2014. Since then, the latter lineage became the dominant variant in the country.[5] From 2014 to 2017, the disease epicenter was the Northeast (Fig. 1), a region characterized by high temperatures, frequent water shortages, and marked social vulnerability.[6] In 2018–2019, the incidence was relatively lower, and the epicenter shifted towards the Southeast, with a high population density, high summer temperatures, and humidity. Dengue fever has historically been prevalent in both regions. In 2020–2022, cases went up again (175,040 cases) in both regions, associated with a new reintroduction of the ECSA variant.[6] In the first 10 weeks of 2023, cases in the Southeast (30,724) were already twice the number in the entire year of 2022. During the last two years, 570 new municipalities reported chikungunya for the first time, representing approximately 7 million new individuals at risk. Within this region, the basic reproduction number of chikungunya (R0) has varied from 1.5 to 2.5 (IQR). Overall, the highest transmission rates occurred in 2018 and 2022, with at least 50% of the outbreaks with R0 $\geq$ 2 in both years.

This upsurge in chikungunya cases occurs concurrently with the geographical expansion of dengue towards the south and also to less densely populated areas.[7] Data science has evolved in response to the covid pandemic, with a legacy of highly trained data scientists and data tools for nowcasting and forecasting.[8] Still, predicting chikungunya emergence is challenging, despite constant vigilance, including ours, from Infodengue.[4] The co-occurrence of dengue and chikungunya is common, and most cases are defined by clinical-epidemiological criteria with no laboratory tests. In this scenario, doctors often need to choose one of the diseases with high uncertainty, since some symptoms are quite similar among these diseases, such as high fever, rash, headaches, nausea, and body aches. We urgently need to advance the way surveillance is done in a way that considers these uncertainties. Syndromic surveillance associated with a network of sentinel units can be a potentially cost-effective protocol. Mosquito surveillance integrated with epidemiological models has the potential to improve predictive models. It can be an opportunity for innovation by enabling a comprehensive understanding of the link between climate, vector, and arboviruses transmission, including chikungunya. However, the current vector surveillance exhibits limitations, including delayed data processing and reporting, and more timely protocols are necessary. A fruitful collaboration between medical entomologists and data scientists can lead the way to find the best protocols and strengthen vector surveillance.

Although, in Brazil, *Aedes aegypti* is recognized as the main vector for chikungunya, another species with known vector competence, *Aedes albopictus*, is also present in the country, and its role in the transmission of chikungunya remains to be investigated. Nevertheless, more research is needed to assess the role of vertical transmission in mosquitoes to maintain endemicity, as well as conduct new studies to assess whether these vector species are adapting to new environments and the role of climate change on mosquito establishment in new areas.[9,10] There is a concern that climate change is involved in the expansion and intensification of outbreaks of urban arbovirus in higher latitudes, but more studies are needed.[10] New tools and techniques for case surveillance, vector monitoring, and improved laboratory diagnosis are necessary to reduce the time of the

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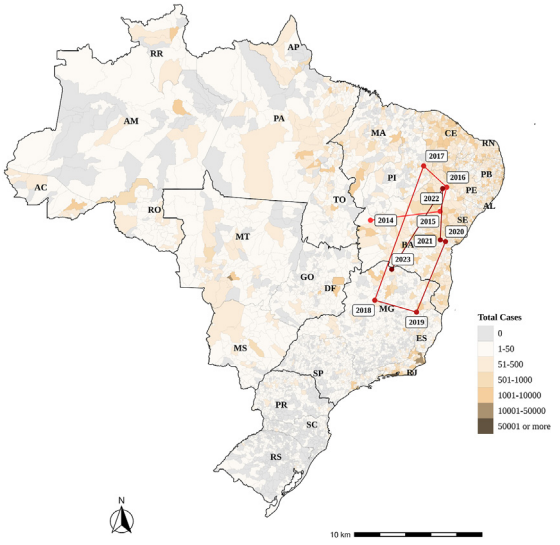

Fig. 1: **Map of the epicenters of chikungunya cases each year and the accumulated cases per municipality until 2023.** The red dots and lines show the path of the epicenters of chikungunya cases per year in Brazil, from 2014 to 2023. The colors indicate the accumulated cases per municipality until 2023.

response in the arboviruses surveillance avoiding new outbreaks or minimizing the number of severe cases. Moreover, clear and effective risk communication is essential to inform the public about chikungunya and encourage prevention and control measures adherence. In summary, an integrated and multidisciplinary approach is required for effective surveillance.

Contributors

IFA, CTC, RML, LSB, SSO, DACF, VBG, TISR, OGC, and FCC contributed to the investigation, conceptualization, and writing of this comment. IFA, VBG, and FCC contributed to the formal analysis and the visualizations.

Editor's note

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Declaration of interests

All authors declare no conflict of interest.

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