

# CUIDADO É FUNDAMENTAL

Escola de Enfermagem Alfredo Pinto – UNIRIO

ORIGINAL ARTICLE

DOI:10.9789/2175-5361.rpcfo.v17.13923

## SPATIAL DISTRIBUTION OF DENGUE IN THE STATE OF RIO DE JANEIRO, 2016-2023

*Distribuição espacial da dengue no estado do rio de janeiro, 2016-2023**Distribución espacial del dengue en el estado de río de janeiro, 2016-2023***Antônio Henrique Raeder Silvano**<sup>1</sup> **Tatiana de Araujo Eleuterio**<sup>2</sup> **Delson da Silva**<sup>3</sup> **Renata de Sousa Palmieri**<sup>4</sup> **Dayanne Lima Silva Santos**<sup>5</sup> 

### RESUMO

**Objetivo:** analisar a distribuição espacial, incidência e sazonalidade da dengue no estado do Rio de Janeiro entre 2016 e 2023. **Método:** estudo ecológico descritivo com dados secundários do SINAN. Foram calculadas taxas de incidência por 100.000 habitantes e gerados mapas temáticos com o Tabwin. **Resultados:** notificaram-se 305.748 casos no período, com picos epidêmicos em 2016 e 2023. A sazonalidade mostrou maior número de casos entre março e junho, especialmente em abril e maio. As regiões Noroeste Fluminense e Baixada apresentaram as maiores taxas. Houve queda significativa nos casos durante a pandemia de COVID-19. **Conclusão:** a dengue permanece endêmica e demanda ações contínuas de vigilância, imunização, capacitação profissional e políticas públicas eficazes. O uso de novas tecnologias como vacinas e o controle biológico com *Wolbachia* podem auxiliar na redução dos casos.

**DESCRITORES:** Infecções por arbovirus; Notificação de doenças; Sistema de informação em saúde; Vigilância em saúde pública.

<sup>1,2,3,4,5</sup> State University of Rio de Janeiro, Rio de Janeiro, Rio de Janeiro, Brazil.

**Received:** 18/04/2025. **Accepted:** 29/05/2025

**CORRESPONDING AUTHOR:** Antônio Henrique Raeder Silvano

**Email:** antonio.henriquers04@gmail.com

**How to cite:** Silvano AHR, Eleuterio TA, Silva D, Palmieri RS, Santos DLS. Distribuição espacial da dengue no estado do Rio de Janeiro, 2016 - 2023. R Pesq Cuid Fundam (Online). [Internet]. 2025 [cited year month day];17:e13923. Available from: <https://doi.org/10.9789/2175-5361.rpcfo.v17.13923>.



## ABSTRACT

**Objective:** to analyze the spatial distribution, incidence, and seasonality of dengue in Rio de Janeiro State from 2016 to 2023. **Method:** descriptive ecological study using SINAN data. Incidence rates per 100,000 inhabitants were calculated and thematic maps were created using Tabwin. **Results:** a total of 305,748 cases were reported, with epidemic peaks in 2016 and 2023. Seasonality revealed a concentration of cases between March and June, particularly in April and May. The Northwest and Baixada Fluminense regions had the highest rates. A sharp decline in cases occurred during the COVID-19 pandemic. **Conclusion:** Dengue fever remains endemic and requires ongoing surveillance, immunization, professional training, and effective public health policies. New technologies, including vaccines and Wolbachia-based biological control, may reduce the incidence of the disease.

**DESCRIPTORS:** Arbovirus infections; Disease notification; Health information systems; Public health surveillance.

## RESUMEN

**Objetivo:** analizar la distribución espacial, la incidencia y la estacionalidad del dengue en el estado de Río de Janeiro entre 2016 y 2023. **Método:** estudio ecológico descriptivo con datos secundarios del SINAN. Se calcularon tasas de incidencia por 100.000 habitantes y se elaboraron mapas temáticos con Tabwin. **Resultados:** se notificaron 305.748 casos, con picos epidémicos en 2016 y 2023. La estacionalidad mostró concentración de casos entre marzo y junio, especialmente en abril y mayo. Las regiones del Noroeste Fluminense y Baixada presentaron las tasas más altas. Durante la pandemia de COVID-19 se observó una fuerte disminución en los casos. **Conclusión:** el dengue sigue siendo endémico y exige vigilancia continua, inmunización, capacitación profesional y políticas públicas eficaces. Tecnologías como las vacunas y el control biológico con Wolbachia pueden ayudar a reducir su incidencia.

**DESCRIPTORES:** Infecciones por arbovirus; Notificación de enfermedades; Sistemas de información en salud; Vigilancia en salud pública

## INTRODUCTION

Dengue is an arbovirus of extreme epidemiological relevance, particularly in the Americas. It is caused by a Flavivirus of the Flaviviridae family and is transmitted in urban areas by the bite of the *Aedes aegypti* mosquito, which usually proliferates in stagnant or standing water. The clinical spectrum of infection is highly variable and can present as asymptomatic, oligosymptomatic, or progress to hemorrhagic fever or shock.<sup>1</sup>

Classic cases of dengue present with sudden high fever (102-104°F), severe headache, retroorbital pain, arthralgia, myalgia, nausea, vomiting, asthenia, and rash. They may also present with hemorrhagic manifestations, such as petechiae, gingivorrhagia, epistaxis, and hematuria.<sup>2</sup>

The dengue virus has four antigenically distinct serotypes: DENV-1, DENV-2, DENV-3, and DENV-4. Dengue is considered endemic globally in more than 100 tropical and subtropical countries, including those in the Americas, Africa, Asia, the Middle East, the Pacific Islands, and the Western Pacific Region. Approximately 4 billion people live in at-risk areas.<sup>3</sup>

The National Health Surveillance Agency (ANVISA)<sup>4</sup> acknowledges that there are factors favoring the spread of

the virus in Brazil, primarily due to climate change and the unplanned growth of urban centers, which does not guarantee adequate infrastructure for the population. The lack of water, accumulation of standing water, ineffective collection and disposal of solid waste, and intense foot traffic, coupled with the humid climate and high temperatures, contribute to an uncontrolled proliferation of the dengue vector.<sup>5</sup> Prevention and control of dengue are also related to environmental surveillance of *Aedes aegypti* with the help of vector control teams. These teams must inspect the places they visit for foci conducive to the mosquito's reproduction and proliferation. They must also provide guidance through educational measures regarding vector control and disease dissemination, monitor risk situations, and report situations of irregularities that endanger public health to the state or municipal coordination.

The first recorded cases of dengue fever in Brazil date back to 1916 in São Paulo and 1923 in Niterói. Last year, a French ship docked in Salvador, Bahia, with suspected cases, though no autochthonous cases were recorded in the city. A serological survey conducted in the Amazon in 1953-1954 revealed evidence of dengue seropositivity, indicating that the virus had circulated in the region. The

first clinically and laboratory-confirmed dengue epidemic in the country occurred in Boa Vista, Roraima, in 1981. Twelve thousand cases were estimated, and two virus serotypes were isolated during the epidemic: DEN-1 and DEN-4. However, the virus did not spread to the rest of the country because it was quickly controlled.<sup>6</sup> Soon after, in 1986, an epidemic occurred in Rio de Janeiro, and the *Aedes aegypti* mosquito quickly dispersed over extensive areas of the country. Currently, the vector has been identified in at least 1,754 municipalities distributed across 18 federated units. However, these data only relate to areas covered by the National Health Foundation's activities, meaning an even greater number of municipalities may be infested.<sup>7</sup>

According to Brazil's latest epidemiological bulletin, 6,528,563 probable dengue cases were reported between epidemiological weeks 1 and 37 of 2024. An incidence coefficient of 3,215.1 cases per 100,000 inhabitants was also observed. Compared to the previous year, the number of cases increased by 395.8%. The macro-regions with the highest incidence rates were the Southeast, Midwest, and South. The highest incidence rates occurred in the Federal District, Minas Gerais, Paraná, Santa Catarina, São Paulo, and Goiás. Cases of severe dengue and dengue with alarm signs were concentrated in the Southeast Region (48.3%). Regarding mortality, São Paulo (1,679), Minas Gerais (995), Paraná (660), the Federal District (440), Goiás (381), and Santa Catarina (338) accounted for 84.1% of confirmed deaths nationwide. Rio de Janeiro had a total of 221 confirmed deaths and 296,017 probable cases, which highlights its significant role in the epidemiological situation of dengue in Brazil. Given that arboviruses present a challenge to Brazilian public health and interventions are related to vector control and continuous analysis of the population's health, monitoring the incidence and seasonality of dengue cases in Rio de Janeiro based on current data is relevant, as is mapping the spatial distribution of the disease by municipality.

This study aims to reinforce actions and services based on epidemiological evidence to prevent and educate the public about controlling the disease in urban spaces. The study describes the incidence and seasonality of reported dengue

cases in the Notifiable Diseases Information System (SINAN) in the state of Rio de Janeiro from 2016 to 2023.

## METHOD

This ecological, descriptive study examines the incidence and seasonal patterns of dengue in the state of Rio de Janeiro. It considers all dengue cases reported in the Notifiable Diseases Information System (SINAN), made available by the Department of Informatics of the Unified Health System (DATASUS).

The study was conducted in the state of Rio de Janeiro due to its high number of reported arbovirus cases, highlighting the need for improved prevention and control measures. According to the Brazilian Institute of Geography and Statistics (IBGE), the state had an estimated population of 16,055,174 in 2022 and an estimated population of 17,219,679 in 2024. This population is distributed across 92 municipalities. Administratively, Rio de Janeiro is divided into eight macro-regions and covers 43,750.425 km<sup>2</sup>.

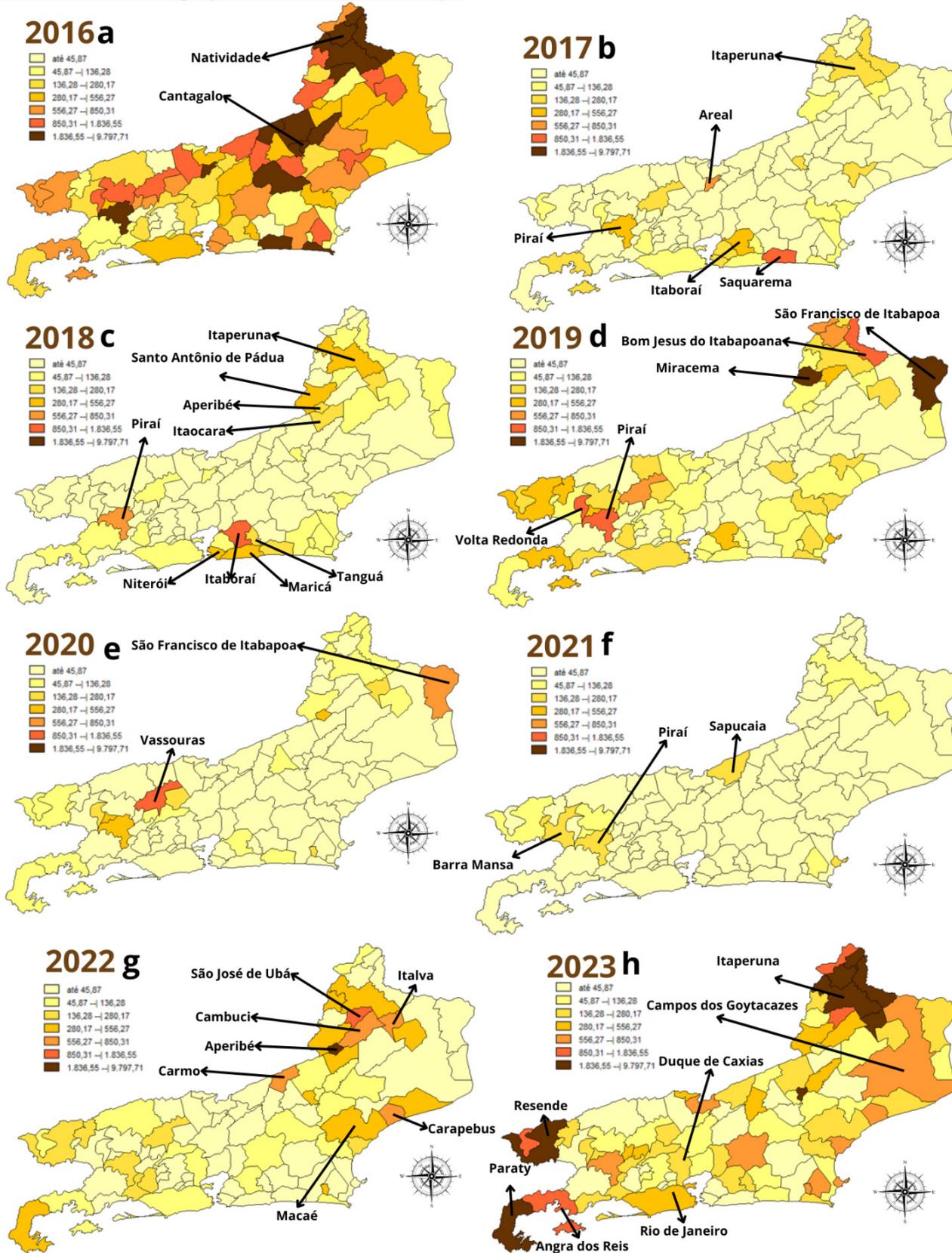
All dengue cases reported in the state from 2016 to 2023 were considered. The incidence rate per 100,000 inhabitants was calculated, and thematic maps were prepared using Tabwin software to identify areas with the highest incidence. To analyze the temporal evolution of cases between 2016 and 2023 in Rio de Janeiro, historical series graphs were generated using Microsoft Excel.

As this study uses secondary, publicly available, aggregated data without the possibility of identifying individuals or posing risks to them, the present research does not require consideration by the Research Ethics Committee. This study is an integral part of a research project that was submitted to and approved by the Ethics Committee of the State University of Rio de Janeiro (CEP/UERJ) with opinion number 4,000,701 and a certificate of presentation for ethical appraisal (CAAE) number 31057620.0.0000.5282

## RESULTS

A total of 305,748 dengue cases were reported throughout the state from 2016 to 2023.

Figure I – Incidence of dengue per 100,000 inhabitants. Rio de Janeiro State, Brazil, 2016-2023



Source: DATASUS, 2024.

In 2016, 87,866 cases were reported, resulting in an incidence rate of 528.29 cases per 100,000 people. This represented an epidemic year. The municipalities with the highest number of reported cases were Rio de Janeiro (26,344), São Gonçalo (7,990), Nova Friburgo (7,792), Itaperuna (4,188), Volta Redonda (3,998), Niterói (3,873), Cordeiro (2,073), and Saquarema (2,563). Cordeiro had the highest incidence rate (9,797/100,000), followed by Natividade (7,954.09/100,000) (Figure 1a).

In 2017, 10,985 cases were reported with an incidence rate of 65.70 per 100,000 people. The municipalities with the highest number of reported cases were Rio de Janeiro (3,765) and São Gonçalo (1,742). Regarding incidence, Saquarema (1,063.69/100,000), Areal (749.40/100,000), Piraí (460.63/100,000), Itaboraí (284.86/100,000), and Itaperuna (220.01/100,000) stood out. Additionally, 18 municipalities had no reported cases (Figure 1b).

In 2018, 14,849 cases were reported, with an incidence rate of 86.53 per 100,000 people. The municipalities with the highest number of reported cases were Rio de Janeiro (5,587), Itaboraí (2,727), Niterói (1,907), and São Gonçalo (1,200). Regarding incidence, the following stood out: Itaboraí (1,142.46/100,000), Piraí (668.99/100,000), Niterói (372.62/100,000), Santo Antônio de Pádua (328.15/100,000) and Itaperuna (311.81/100,000), Maricá (306.74/100,000), Tanguá (248.01/100,000), Itaocara (240.89/100,000), Aperibé (172.24/100,000), and Italva (172.04/100,000) (Figure 1c).

In 2019, 32,011 cases were reported, with an incidence rate of 185.41 per 100,000 people. The municipality of Rio de Janeiro accounted for approximately 56.41% of the cases observed in the state of Rio de Janeiro, and Volta Redonda reported 2,797 cases. The municipalities with the highest incidence were: Miracema (2,708.47/100,000), São Francisco de Itabapoana (2,025.83/100,000), Piraí (1,123.75/100,000), Volta Redonda (1,024.50/100,000), and Bom Jesus de Itabapoana (921.93/100,000). Notably, Miracema had 736 cases, São Francisco de Itabapoana had 855 cases, and Piraí had 329 cases. Thus, even relatively low absolute number of cases can result in a high incidence rate due to random fluctuations in rates in sparsely populated municipalities.

In 2020, the first year of the pandemic in Brazil, there was a drastic decline compared to previous years. The state had 4,479

cases, for a total incidence of 25.78 per 100,000 inhabitants. The municipality of Rio de Janeiro stood out again with 1,192 cases, representing 26.6% of the state total. Additionally, 16 municipalities did not report any cases (Figure 1e).

In 2021, the incidence rate was 15.40 per 100,000 people, and the total number of reported cases was lower (2,689 in the state). There were 23 municipalities with no reported cases, making it the year with the lowest number of cases in the period. The municipalities with the highest incidence were: Piraí (268.44/100,000), Sapucaia (257.25/100,000), and Barra Mansa (229.98/100,000). It should be noted that these municipalities had only 80, 47, and 426 reported cases, respectively (Figure 1f). The municipalities with the highest absolute number of cases were Rio de Janeiro (856), Barra Mansa (426), and Barra do Piraí (114).

In 2022, a new increase in cases was observed compared to previous years, with a total of 10,945 cases and an incidence rate of 62.33 per 100,000 inhabitants. Notably, the municipalities of Rio de Janeiro and Macaé presented 4,413 and 1,216 cases, respectively, accounting for 51.4% of the state's cases. The municipalities with the highest incidence were: Aperibé (2,513.76/100,000), São José de Ubá (948.58/100,000), Cambuci (708.40/100,000), Carapebus (647.76/100,000), Italva (588.01/100,000), Carmo (564.97/100,000), and Macaé (448.95/100,000). However, São José de Ubá, Italva, Carmo, Cambuci, and Carapebus did not have a high absolute number of cases (69, 91, 109, 110, and 111, respectively) (Figure 1g).

In 2023, there was a significant increase in cases, making it an epidemic year with 49,876 cases and an incidence rate of 282.43 per 100,000 people. Rio de Janeiro stood out with 22,210 cases, representing 45% of the state's total, and an incidence rate of 325.12 per 100,000 people. Campos dos Goytacazes followed with 3,442 cases and an incidence rate of 659, Itaperuna (2,097 cases and an incidence of 1,988.22/100,000), Resende (2,028 cases and an incidence of 1,500.80/100,000), Angra dos Reis (1,993 cases and an incidence of 920.27/100,000), and Duque de Caxias (1,362 cases and an incidence of 145.02/100,000). The North Fluminense region and the Baixada Fluminense were the most affected areas. No municipalities reported no cases that year (Figure 1h).

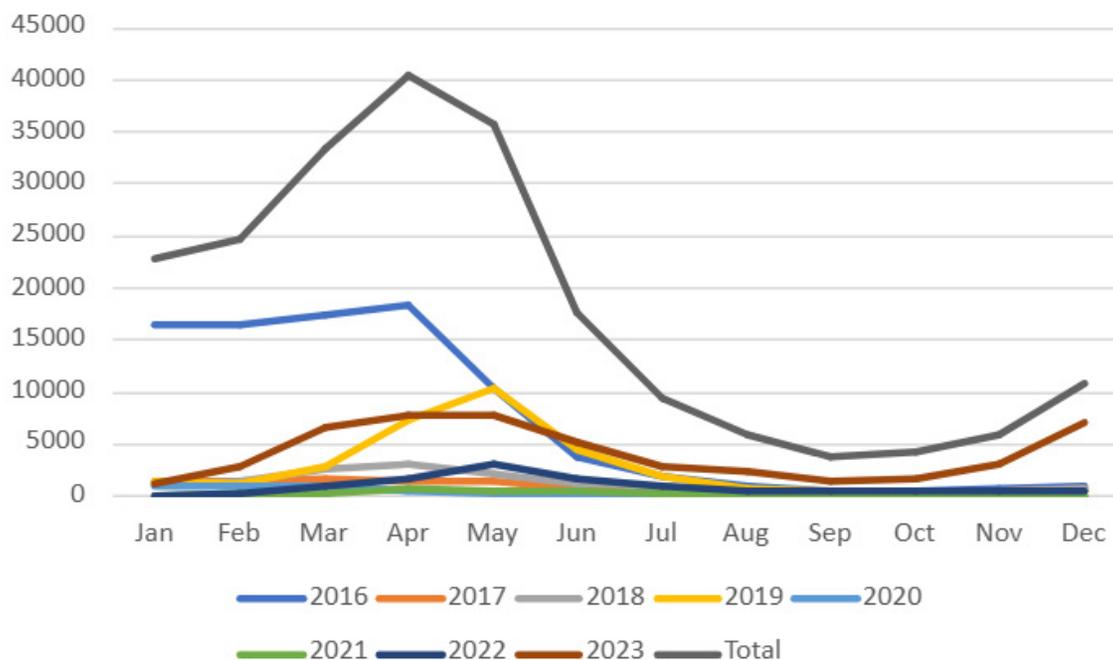
**Figure 2** – Dengue seasonality in the State of Rio de Janeiro, Brazil, 2016 – 2023

Figure 2 shows the monthly distribution of cases reported during the years studied, characterizing 2016 and 2023 as epidemic years.

In terms of seasonality, the months from January to July stood out in 2016, with a peak in April (18,464 cases). This is consistent with literature on the seasonal period of arboviruses in the country. In 2017, the months from January to May stood out, with a peak in March (1,638). In 2018, the months from January to June stood out, with a peak in April (2,967). In 2019, the period from April to June stood out, with a peak in May (10,303). In 2020, a year atypical due to the onset of the SARS-CoV-2 pandemic in Brazil in March, January (1,011 cases) and February (1,010 cases) saw the highest increases. In 2021, despite the decline in reported cases, the period from March to June saw a notable increase in cases. In 2022, the period from April to June saw a peak in May (3,066 cases). In 2023, the period from March to June saw a notable increase in cases, also peaking in May (7,860 cases). (Figure 2).

Therefore, in general, there is an increase in cases from March to June, consistent with literature on the seasonal occurrence of arboviruses in the country.

## DISCUSSION

Of the years studied, 2016 and 2023 stood out as epidemic years. There was a significant decline in reported cases in 2020 and 2021, one probable cause of which was the pandemic. A

study in the Brazilian state of São Paulo indicated a reduction in dengue cases associated with increased social isolation during the pandemic. The researchers suggested that decreased human mobility may have contributed to the reduction in dengue virus transmission since movement plays a significant role in spreading the disease. This may also explain the low number of cases reported in Rio de Janeiro.

The years 2023 and 2024 were marked by temperature and rainfall anomalies resulting from the El Niño weather phenomenon and human impact on the environment. Consequently, several countries, especially in the Americas, have experienced an increase in suspected dengue cases.<sup>12</sup> Rio de Janeiro was also affected by this phenomenon. Its sociodemographic characteristics, such as disorderly urban growth and climatic conditions, favor the proliferation of the mosquito vector.<sup>13</sup>

A study of dengue cases in Brazil between January 2001 and January 2019 complements the information that rainfall and humidity contribute to the spread of the disease. The risk of dengue increases after three months in wet periods.<sup>14</sup> The State of Rio de Janeiro has a predominantly humid climate, making it susceptible to greater epidemics.

Other studies suggest that global warming may affect the epidemiology of dengue in the long term due to the association of increased *Aedes aegypti* populations with higher temperatures and rainy periods. Since these factors affect vector dynamics and dengue is strongly related to these

climatic variables, climate change, specifically global warming, is expected to impact the epidemiology of this disease in the country and worldwide.<sup>15</sup>

The geographic distribution shown on the maps indicates that the northwest region of the state had the highest incidence rates in four of the eight years of the studied period. Other studies<sup>16,17</sup> show that this region stood out in relation to the others in terms of dengue and other arboviruses. This highlights possible problems regarding environmental surveillance of the vector. This may also be related to factors not evaluated in this study, such as an impaired water supply, standing water accumulation, and a deficit in solid waste collection and disposal. These conditions are favorable for the proliferation of the vector and result in an increase in dengue fever cases.<sup>5,15</sup>

Preventing arboviruses requires a holistic approach that covers basic sanitation, environmental management, and climate change adaptation. While the availability of treated water and adequate sewage treatment are fundamental measures, they are insufficient to contain vector proliferation.<sup>14</sup> However, improving these measures is an initial and essential step toward resolving the epidemics that devastate the Brazilian population. Health education is necessary to make the population aware of their responsibility to take care of their own health and avoid behaviors that favor the proliferation of vectors and the spread of arboviruses in urban areas.<sup>16</sup>

Another relevant factor is underreporting and delays in notification, processing, and transfer of information due to the possible misuse of SINAN. There was a coincidental decrease in notifications during the period when the country intensified health actions to combat the pandemic, suggesting underreporting during a period when an increase in dengue cases would be expected in Brazil. The lack of knowledge and perception of the importance of surveillance and notifiable diseases are factors that contribute to underreporting by health professionals responsible for reporting. Furthermore, delays can be caused by operational problems, such as failures in the information system itself and its processes. Thus, underreporting becomes a complex problem influenced by several factors: lack of knowledge about surveillance importance, difficulties using SINAN, operational problems, and undervaluing notifications. This situation compromises the quality of the data and the health system's response capacity.<sup>19</sup>

Advances in technology and health have led to the development of the QDENGGA<sup>®</sup> vaccine, which represents a promising milestone in reducing dengue cases and mortality. This is especially important after the recent 2024 epidemic, which had the largest number of probable cases (6,528,563)

to date. The QDENGGA<sup>®</sup> vaccination schedule consists of two doses. After 18 months, the vaccine is 76.1% effective in individuals with previous dengue virus exposure and 66.2% effective in individuals without previous exposure. The vaccine's effectiveness against different DENV serotypes ranges from 95.1% (DENV-2) to 48.9% (DENV-3). The Dengvaxia<sup>®</sup> vaccine was previously approved and introduced in Brazil in 2015 for individuals aged 9 to 44 years. However, this vaccine has only been shown to benefit individuals with prior exposure to the virus. As QDENGGA<sup>®</sup> was introduced in 2024 and has only been administered to a limited population due to the prioritization of the adolescent age group, its full protective impact on the Brazilian population has yet to be studied and evaluated.<sup>20</sup>

Another control method being studied is the use of Wolbachia, an endosymbiont bacterium not naturally found in *Aedes aegypti*. Inserting Wolbachia into the vector makes it less competent at transmitting dengue, Zika, and Chikungunya viruses, which could reduce cases of these arboviruses in the country. Additionally, the bacterium is transmitted to subsequent generations through eggs. This control method involves releasing infected adult mosquitoes into target areas for several months. Releasing these mosquitoes has shown positive results, but further analysis is needed before the measure can be implemented on a large scale.<sup>21</sup>

## CONCLUSION

Dengue fever remains endemic in Rio de Janeiro and Brazil, posing a significant public health challenge. Despite continuous health education campaigns, prevention must be intensified through immunization, training health professionals to manage and monitor the disease clinically and implementing public policies to reduce the occurrence of new epidemics.

Epidemiological and environmental surveillance actions must be intensified in areas with the highest incidence of arboviruses in the state. Continuous analysis of the health situation is necessary to enable the development of more effective control policies. This will enable the creation of preventive and educational strategies tailored to local needs. Government actions must prioritize vector control, social mobilization, and health education. These initiatives must be continuous and not restricted to epidemic periods to reduce the annual frequency of cases. Additionally, raising awareness about the importance of case notification and investigation by health professionals is essential, as these data are crucial for planning and implementing prevention and control measures.

## FINANCIAL SUPPORT

This scientific article received financial support from the following funding agencies: the Carlos Chagas Filho Foundation for Research Support of the State of Rio de Janeiro (FAPERJ), responsible for granting the Scientific Initiation scholarship to the author Antônio Henrique Raeder Silvano (Process SEI SEI-260003/018870/2024); and the Department of Training and Support for the Development of Human Resources (DCARH), responsible for granting the Scientific Initiation scholarship through the Institutional Program for Scientific Initiation Scholarships of the Rio de Janeiro State University (PIBIC/ UERJ) to the co-author Renata de Sousa Palmieri.

## REFERENCES

1. Silva FC de M, Bezerra H de S, Araújo AOC de, Carvalho LES de, Silva JA da. Temporal study of arboviroses: A space analysis. *Rev Research Society and Development*. [Internet]. 2021 [cited 2024 oct 15];10(7):e10910716220. Available from: <https://doi.org/10.33448/rsd-v10i7.16220>.
2. Aspectos clínicos e laboratoriais Paraná contra a Dengue: Mude sua atitude. [Internet]. [cited 2024 nov 01]. Available from: <https://www.dengue.pr.gov.br/Pagina/Aspectos-clinicos-e-laboratoriais>.
3. Lopes Nayara, Nozawa Carlos, Linhares Rosa Elisa Carvalho. Características gerais e epidemiologia dos arbovírus emergentes no Brasil. *Rev Pan-Amaz Saude*. [Internet]. 2014 [cited 2024 nov 9];5(3). Available from: <http://dx.doi.org/10.5123/s2176-62232014000300007>.
4. Agência Nacional de Vigilância Sanitária (Anvisa). Dengue: informações sobre prevenção e controle. Brasília, DF: Anvisa; 2022. [Internet]. [cited 2024 nov 9]. Available from: <https://www.gov.br/anvisa>.
5. Plano de Ação. [Internet]. [cited 2024 nov 9]. Available from: <https://www.gov.br/saude/pt-br/centrais-de-conteudo/publicacoes/guias-e-manuais/2024/guia-plano-de-acao-para-reducao-da-dengue-e-outras-arboviroses.pdf>.
6. Lara JT de. A emergência da dengue como desafio virológico: de doença-fantasma à endemia “de estimação”, 1986-1987. *Hist cienc saude-Manguinhos*. [Internet]. 2022 [cited 2024 nov 12];29(2). Available from: <https://doi.org/10.1590/S0104-59702022000200002>.
7. Teixeira, M.G.L.C. (2000). Dengue e espaços intra-urbanos: dinâmica de transmissão viral e efetividade das ações de combate vetorial. Tese (doutorado) - Universidade Federal da Bahia Salvador. 20-21. [Internet]. [cited 2024 nov 9]. Available from: <https://bvsmms.saude.gov.br/bvs/PDF>.
8. Brasil. Ministério da Saúde. Informe Semanal SNA nº 14. Brasília: Ministério da Saúde; 2023. [cited 2024 nov 9]. Available from: <https://www.gov.br/saude/pt-br/assuntos/saude-de-a-a-z/a/arboviroses/informe-semanal/informe-semanal-sna-no-14.pdf/view>.
9. Sistema de Informação de Agravos de Notificação - Sinan [Internet]. [cited 2024 nov 1]. Available from: <https://www.gov.br/aids/pt-br/sistemas-de-informacao/sinan>.
10. Instituto Brasileiro de Geografia e Estatística. Portal do IBGE [Internet]. [cited 2024 nov 1]. Available from: <https://www.ibge.gov.br/pt/inicio.html>.
11. Conceição GMS, Silva AAM, Santos AM, Siqueira-Filho AG, Nunes MAP, Barbosa MD, et al. Effect of social isolation in dengue cases in the state of Sao Paulo, Brazil: An analysis during the COVID-19 pandemic. *Travel Med Infect Dis*. [Internet]. 2021 [cited 2024 nov 1];44:102149. Available from: <https://doi.org/10.1016/j.tmaid.2021.102149>.
12. Brasil. Ministério da Saúde. Monitoramento das arboviroses e balanço de encerramento do Comitê de Operações de Emergência (COE) Dengue e outras Arboviroses 2024. *Boletim Epidemiológico*. [Internet]. 2024 [cited 2024 nov 9];55(11). Available from: <https://www.gov.br/saude/pt-br/centrais-de-conteudo/publicacoes/boletins/epidemiologicos/edicoes/2024/boletim-epidemiologico-volume-55-no-11.pdf>.
13. Almeida LS, Cota ALS, Rodrigues DF. Saneamento, Arboviroses e Determinantes Ambientais: impactos na saúde urbana. *Ciênc saúde coletiva*. [Internet]. 2020 [cited 2024 oct 6];25(10). Available from: <https://doi.org/10.1590/1413-812320202510.30712018>.
14. Lowe R, Barcellos C, Brasil P, Cruz OG, Honório NA, Kuper H, et al. Combined effects of hydrometeorological hazards and urbanisation on dengue risk in Brazil: a spatiotemporal modelling study. *Lancet Planet Health*. [Internet]. 2021 [cited 2025 apr 5];5(4):e209–19. Available from: [https://doi.org/10.1016/S2542-5196\(20\)30292-8](https://doi.org/10.1016/S2542-5196(20)30292-8).
15. Barcellos, C., Matos, V., Lana, R.M. et al. Climate change, thermal anomalies, and the recent progression of dengue in Brazil. *Sci Rep*. [Internet]. 2024 [cited 2025 apr 5];14. Available from: <https://doi.org/10.1038/s41598-024-56044-y>.
16. Eleuterio T de A, Velasco M dos S, Gomes RB, Menezes R de A, da Silva D. Incidence and seasonality of chikungunya cases in the state of Rio de Janeiro, 2017-2020. *Rev. Pesqui. (Univ. Fed. Estado Rio J., Online)*. [Internet]. 2023 [cited 2024 nov 9]. Available from: <https://bvsmms.saude.gov.br/bvs/PDF>.

- 2024 nov 4];15:e-12751. Available from: <https://doi.org/10.9789/2175-5361.rpcfo.v15.12751>.
17. Carvalho CO, dos Santos Rabello R, Gomes Thomé SM. Distribuição espacial da dengue no estado do Rio de Janeiro no período de 2001 a 2012. *Hygeia*. [Internet]. 2018 [cited 2025 apr 5];14(27). Available from: <https://doi.org/10.14393/Hygeia142709>.
  18. Mascarenhas MDM, Batista FM de A, Rodrigues MTP, Barbosa O de AA, Barros VC. Ocorrência simultânea de COVID-19 e dengue: o que os dados revelam?. *Cad Saúde Pública*. [Internet]. 2020 [cited 2025 apr 6];36(6):e00126520. Available from: <https://doi.org/10.1590/0102-311X00126520>.
  19. Sousa FG, Nunes ISS, Cunha MCM. Subnotificações: o impasse da comunicação de agravos nas análises epidemiológicas. *Sinapse Mult*. [Internet]. 2021 [cited 2025 apr 6];10(1). Available from: <https://periodicos.pucminas.br/index.php/sinapsemultipla/article/download/26729/18472/>.
  20. Lima-Camara TN. Dengue is a product of the environment: an approach to the impacts of the environment on the *Aedes aegypti* mosquito and disease cases. *Rev bras epidemiol*. [Internet]. 2024 [cited 2025 jan 1];27:e240048. Available from: <https://doi.org/10.1590/1980-549720240048>.
  21. Pinto SB, et al. Effectiveness of Wolbachia-infected mosquito deployments in reducing the incidence of dengue and other *Aedes*-borne diseases in Niterói, Brazil: a quasi-experimental study. *PLoS Negl Trop Dis*. [Internet]. 2021 [cited 2025 apr 5];15(7):e0009556. Available from: <https://doi.org/10.1371/journal.pntd.0009556>.