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Temporal Analysis of Dengue Occurrence in the State of Piauí: Pre-Pandemic Epidemiological Incidence and During the Covid-19 Pandemic

Variação temporal da dengue no Estado do Piauí: incidência epidemiológica pré-pandemia e durante a pandemia de Covid-19

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Abstract

Introduction: Dengue, an infectious disease transmitted by mosquitoes, is a global concern. In Brazil, poor sanitation conditions contribute to its high prevalence. The COVID-19 pandemic may have increased exposure to Aedes aegypti, resulting in an increase in cases. **Objective:** It was analyzed the epidemiological aspects of dengue in the state of Piauí, Brazil, between 2018 and 2021, taking into consideration the disease incidence before and after the COVID-19 pandemic. **Methods:** An ecological study was conducted on probable dengue cases in the state of Piauí between 2018 and 2021, using epidemiological data from the Notifiable Diseases Information System (SINAN), provided by the Ministry of Health. The total number of cases was analyzed by gender, age group, municipality, and dengue virus serotype. The number of cases was compared between the two-year periods of 2018-2019 and 2020-2021, representing the period before and during the COVID-19 pandemic, respectively. **Results and discussion:** During the analyzed period, there were 15,958 cases of dengue, with a considerable variation in the number of occurrences each year. The female gender was more affected (2018 - 59.07%; 2019 - 56.53%; 2020 - 54.43%; 2021 - 55.48%), and adults between 20 and 59 years old were the most affected by the disease during the analyzed time period. The most prevalent serotype was DEN 1. Different municipalities showed variations in dengue cases over time. **Conclusion:** In Piauí, dengue exhibited variations throughout the years from 2018 to 2021. Apparently, the number of cases doesn't seem to be related to the Covid-19 pandemic. Thus, the need to enhance public awareness through educational campaigns and implement effective measures for mosquito control is evident.

Keywords: *Aedes aegypti*. Disease. Northeast.

Resumo

Introdução: A dengue é uma doença infecciosa transmitida por mosquitos, preocupa globalmente. No Brasil, condições precárias de saneamento básico contribuem para sua alta prevalência. A pandemia de Covid-19 pode ter aumentado a exposição aos *Aedes aegypti*, resultando em aumento de casos. **Objetivo:** Analisar aspectos epidemiológicos da dengue no Estado do Piauí, entre 2018 e 2021.**Métodos:** Foi realizado um estudo ecológico dos casos prováveis de dengue no Estado do Piauí entre 2018 e 2021, levando em consideração a incidência da doença antes e durante a pandemia de Covid-19. Utilizou dados epidemiológicos do Sistema de Informação de Agravos de Notificação (SINAN), do Ministério da Saúde. Analisaram-se total de casos por gênero, faixa etária, município e sorotipo do vírus da dengue. Comparou-se o número de casos entre os biênios 2018-2019 e 2020-2021, representando o período antes e durante a pandemia de Covid-19, respectivamente. **Resultados e discussão:** No período analisado houve 15.958 casos de dengue, com variação considerável no número de ocorrências em cada ano. O gênero feminino foi mais afetado (2018 - 59,07%; 2019 - 56,53; 2020 - 54,43%; 2021 - 55,48%), os adultos com idade entre 20 a 59 anos foram os mais atingidos pela doença no período de tempo analisado. O sorotipo DEN 1 foi o mais diagnosticado. **Conclusão:** No Piauí, a dengue apresentou variações ao longo dos anos 2018 a 2021. Aparentemente o número de casos não tem relação com a pandemia de Covid-19. Desse modo, é evidente a necessidade de aumentar a conscientização pública por meio de campanhas educativa e implementar medidas efetivas de controle dos mosquitos transmissores.

Palavras-chave: *Aedes aegypti*. Doença. Nordeste.

1 Introduction

Dengue is an acute febrile infectious disease caused by four serotypes (DENV-1, DENV-2, DENV-3, and DENV-4) of the virus belonging to the Flavivirus genus, which manifest in various forms and intensities (Uno & Ross, 2018). The virus is primarily transmitted by infected females of *Aedes aegypti and Aedes albopictus* mosquitoes during blood meals (Pan American Health Organization - PAHO, 2019). *Ae. aegypti*, the main dengue vector, inhabits urban areas, exhibits domestic habits, and displays a strong preference for human blood (Neres Rodrigues *et al.*, 2020).

The global incidence of dengue has dramatically increased in the past decades (OPAS, 2018). *Ae. aegypti*, originating from Africa, was first scientifically described in 1762 and currently inhabits tropical and subtropical regions worldwide (Silva *et al.*, 2018). In Brazil, the first indications of dengue epidemics date back to 1846 in the cities of São Paulo-SP and Rio de Janeiro-RJ, while evidence of the disease's spread dates to the late 20th century. This spread led to the disease becoming prevalent across all regions of the country, prompting compulsory reporting since 1975 (Uno & Ross, 2018). High incidence rates of this disease are strongly linked to socio-environmental factors and conditions such as lack of sanitation, absence or improper waste disposal, low-income populations, among others (Costa *et al.*, 2018).

It is estimated that 50 million dengue infections occur annually, with approximately 2.5 billion people living in countries where dengue is endemic. The regions of the world most affected by dengue are located in South America, Central America, North America, Africa, Australia, the Caribbean, China, Pacific Islands, India, Southeast Asia, and Taiwan. In South America, Brazil, Colombia, Bolivia, Paraguay, French Guiana, Suriname, Venezuela, and Ecuador are the most heavily affected countries (Maranhão, 2022).

In 2022, the World Health Organization (WHO) reported 1,450,270 probable cases of dengue, with an incidence rate of 679.9 cases per 100,000 population (*OPAS, 2018*). Between January and March 2023 alone, there were 301,800 cases reported, an incidence rate of 141.5 cases per 100,000 population, including 2,900 severe cases (OPAS, 2018). In Brazil, dengue epidemics have been recorded since 1986. In 2022, the country reported 1,390,673 probable dengue cases, 170,199 chikungunya cases, and 9,256 Zika cases (Ministry of Health of Piauí, 2022). In the same year, the state of Piauí reported 22,011 cases of dengue across 207 municipalities, whereas in 2021, there were 3,552 cases of the disease in 109 municipalities (Ministry of Health of Piauí, 2022).

Considering that Covid-19 and dengue are illnesses caused by viruses, but with different modes of transmission – dengue being transmitted through the bite of an infected female *Ae. aegypti* mosquito (Lorenz et al., 2020), while Covid-19 spreads through respiratory droplets from an infected person carrying the SARS-CoV-2 virus (Rabiu *et al.*, 2021) – fever, headache, muscle pain, and fatigue are common symptoms in both conditions, which can make distinguishing between them challenging (Lorenz *et al.,* 2020; Rabiu *et al., 2021*).

The health crisis of the Covid-19 pandemic, which began in March 2020, led to the worldwide population being confined to their dwellings. This isolation might have resulted in increased contact with *Ae.*

aegypti, particularly during the mosquito's peak blood-feeding hours. This factor could have contributed to the rise in dengue cases in 2020 when compared to previous years (Vicente *et al.*, 2021). This increase could be linked to the reduction of preventive and control measures for dengue during the Covid-19 pandemic, coupled with favorable climatic conditions such as heavy and prolonged rainfall, along with heat, additionally, areas with higher housing vulnerability in urban regions, especially impoverished zones, might have played a role in this phenomenon (Domingues, 2022).

In this context, epidemiological investigation of dengue provides valuable insights into its manifestation and the most vulnerable groups, aiding in the development of strategies for its management and control (Sousa *et al.*, 2022). Therefore, it is necessary to investigate a possible relationship between the increase in the number of dengue cases and the Covid-19 pandemic. Hence, the current study addresses epidemiological aspects of dengue in the state of Piauí between the years 2018 and 2021, considering the disease's incidence before and after the Covid-19 pandemic.

2 Materials and Methods

2.1 Data Source and Study Design

An ecological study of probable dengue cases in the State of Piauí was conducted covering the years from 2018 to 2021. Epidemiological data for the months of January and February 2023 were collected from the Notification of Injury Information System (SINAN), managed by the Department of Informatics of the Unified Health System (DATASUS), Ministry of Health (Ministry of Health, 2023) in Brazil. The data were sourced from a secondary, publicly available database, with patient identities anonymized, thereby obviating the need for approval from the Research Ethics Committee (REC) for utilization in this study, in accordance with Resolution No. 466/2012, dated December 12, 2012, of the National Health Council (CNS, 2012).

2.2 Data Analysis

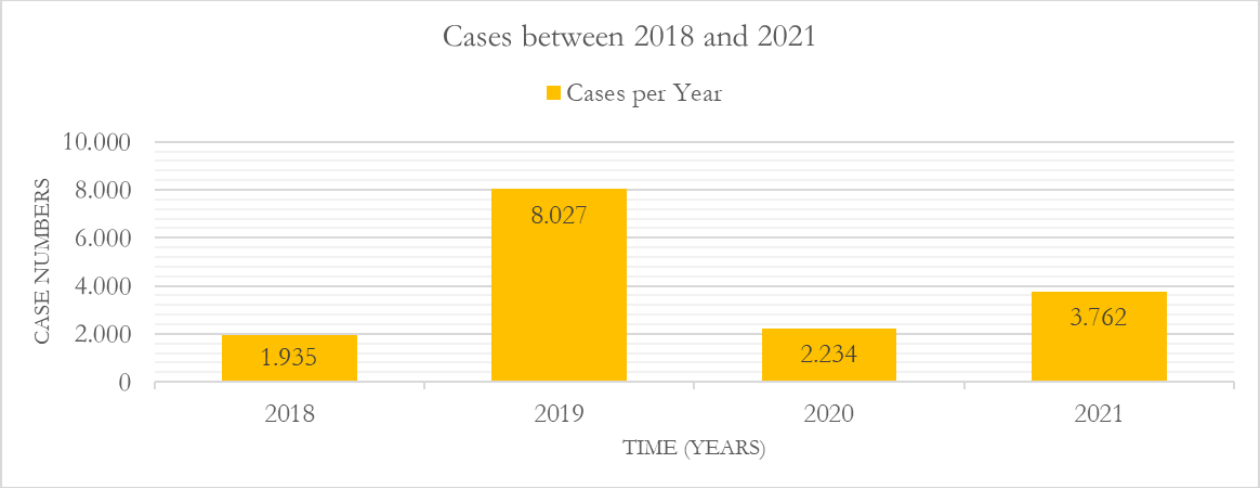
For the probable dengue cases in the State of Piauí from 2018 to 2022, the following variables were analyzed: the total number of cases and cases per year of occurrence, cases by gender, age group, municipality, and dengue virus serotype. These data were compiled into graphs and tables and presented descriptively.

Incidence of probable dengue cases per year was calculated by dividing the total population of the State of Piauí, according to the 2010 census (Instituto Brasileiro de Geografia e Estatística, 2010), by each 1,000 inhabitants (Gordis, 2017). Other data were converted into percentages. The number of cases was compared between the two-year periods 2018-2019 and 2020-2021, representing the period before and during the Covid-19 pandemic, respectively.

3 Results

During the period from 2018 to 2021, a total of 15,958 probable dengue cases were recorded in the State of Piauí. Data from DATASUS indicated a significant variation in the number of dengue cases each year. The year 2018 registered the lowest number, with 1,935 cases (12.12%), while 2019 witnessed the highest number of cases, totaling 8,027 (50.3%). In 2020, the first year of the Covid-19 pandemic, there was a significant reduction compared to 2019, followed by an increase again in 2021 (Figure 1).

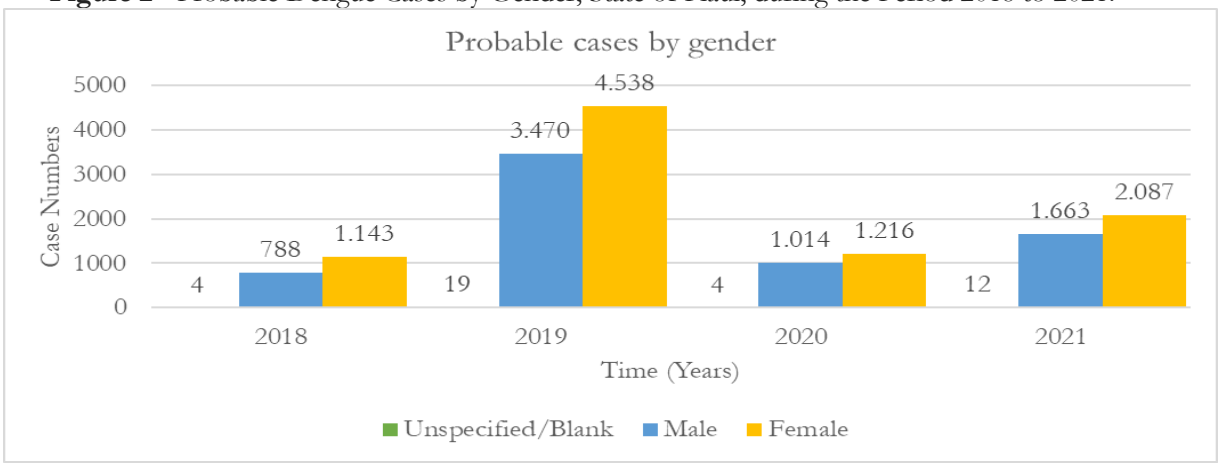
Figure 1 - Number of Cases by Year of Notification in the State of Piauí, from 2018 to 2021.



Fonte: Brasil, 2023.

The female gender showed a higher number of dengue cases in all years (Figure 2). In 2018, there were 788 (40.72%) probable cases of infection among males and 1,143 (59.07%) among females. In 2019, there was an increase in dengue cases for both genders, with 3,470 (43.23%) probable cases of infection among males and 4,538 (56.53%) probable cases among females. Although the number of cases decreased in 2020 compared to 2019, with 1,014 (45.39%) probable cases of infection among males and 1,216 (54.43%) among females, and in 2021, there was a new increase in the number of probable dengue cases, with 1,663 (44.21%) among males and 2,087 (55.48%) among females.

Figure 2 - Probable Dengue Cases by Gender, State of Piauí, during the Period 2018 to 2021.



Fonte: Brasil, 2023.

Throughout the assessed period, the year 2019 exhibited the highest number of dengue notifications across all age groups, with individuals between 20 and 59 years being the most affected in all years examined (Table 1). These findings indicate that dengue primarily affects adults in their productive years, underscoring the significance of maintaining preventive measures to reduce the disease's incidence across all age groups.

Table 1 **- Probable Dengue Cases by Year of Notification, According to Age Group, in the State of Piauí, during the Period 2018 to 2021.**

Age Group	2018		2019		2020		2021		Total	
	n	%	n	%	n	%	n	%	n	%
In blank/IGN	0	0,00%	5	0,06%	1	0,04%	4	0,11%	09	0,21%
<1 Ano	38	1,96%	184	2,29%	47	2,10%	67	1,78%	298	8,14%
1-4	47	2,43%	214	2,67%	76	3,40%	137	3,64%	477	12,14%
5-9	81	4,19%	614	7,65%	136	6,09%	270	7,18%	1101	25,10%
10-14	96	4,96%	825	10,28%	173	7,74%	360	9,57%	1454	32,55%
15-19	210	10,85%	917	11,42%	211	9,44%	365	9,70%	1703	41,42%
20-39	889	45,94%	3.099	38,61%	922	41,27%	1.453	38,62%	6363	164,44%
40-59	401	20,72%	1.551	19,32%	519	23,23%	795	21,13%	3266	84,41%
60-64	66	3,41%	213	2,65%	50	2,24%	111	2,95%	440	11,25%
65-69	38	1,96%	169	2,11%	33	1,48%	86	2,29%	326	7,83%
70-79	56	2,89%	175	2,18%	46	2,06%	78	2,07%	355	9,21%
80 e +	13	0,67%	61	0,76%	20	0,90%	36	0,96%	130	3,28%
Total	**1897**	**100%**	**8027**	100%	**2234**	100%	**3762**	100%	**15920**	100%

Fonte: Brasil, 2023.

During the analyzed period, in the city of Teresina, a significant number of dengue cases were observed in 2019, with 4,860 cases, and 1,194 cases in 2018, 1,076 cases in 2020, and 1,177 cases in 2021. These figures underscore the magnitude of the dengue issue within the city throughout these years. Additionally, from 2018 to 2021, the records of dengue cases across various municipalities in the state of Piauí exhibited substantial variation over time, with many municipalities experiencing a notable increase in cases (Table 2)."

Table 2 - Dengue Cases with Increased Incidence in Municipalities of Piauí, during the Period (2018 to 2021).

Municipality	2018		2019		2020		2021	
	n	%	n	%	n	%	n	%
Parnaíba	7	50%	106	44%	42	47%	155	20%
Gilbués	2	14%	8	3%	11	12%	145	19%
Santa Luz	0	0%	17	7%	0	0%	78	10%
Geminiano	0	0%	33	14%	3	3%	91	12%
Floriano	3	21%	42	18%	4	4%	71	9%
Domingos Mourão	1	7%	2	1%	0	0%	53	7%
Curralinhos	0	0%	0	0%	0	0%	36	5%
Corrente	0	0%	23	10%	17	19%	62	8%
Água Branca	0	0%	8	3%	12	13%	55	7%
Agricolândia	1	7%	1	0%	1	1%	17	2%
Total	14	100%	240	100%	90	100%	763	100%

Fonte: Brasil, 2023.

While on one hand, during the analyzed period, several municipalities experienced a significant increase in dengue cases, it is encouraging to note that São Raimundo Nonato stood out by recording a slight reduction in cases in the last year (Table 3).

Table 3 - Dengue Cases with Decreased Incidence in Municipalities of Piauí during the Period 2018 to 2021.

Municipality	2018		2019		2020		2021	
	n	%	n	%	n	%	n	%
Bom Jesus	14	9%	209	35%	49	46%	158	63%
Curimatá	36	23%	99	17%	7	7%	82	33%
Buriti Dos Montes	0	0%	56	10%	37	35%	4	2%
São Joao do Piauí	1	1%	29	5%	1	1%	4	2%
São Raimundo Nonato	101	65%	144	24%	6	6%	1	0%
Sebastião Leal	1	1%	32	5%	3	3%	1	0%
Paes Landim	2	1%	7	1%	2	2%	0	0%
Padre Marcos	0	0%	11	2%	1	1%	0	0%
São Gonçalo do Gurgueia	1	1%	2	0%	1	1%	0	0%
Total	156	100%	589	100%	107	100%	250	1

Fonte: Brasil, 2023.

However, it's important to highlight that 29 municipalities did not report any dengue notifications during the analyzed years, including Cajazeiras do Piauí, Conceição do Canindé, Currais, Esperantina, Fartura do Piauí, Flores do Piauí, among others. The municipalities of Acauã and Alto Longá experienced a significant decline in the number of notifications in 2020 and 2021 compared to previous years, while others like Agricolândia and Água Branca had an increase in 2021 compared to previous years. Overall, many municipalities witnessed an upsurge in dengue notifications in 2021 in comparison to previous years, based on the collected data.

During the analyzed period, only 1.57% (246) of the dengue cases reported in the state of Piauí were confirmed through serological tests. Among these, 63.82% (157) of the cases were diagnosed with serotype DEN-1, and 36.18% (89) with serotype DEN-2 (Table 4). The year 2019 recorded the highest number of diagnoses, with 139 cases of dengue type 1 and 78 cases of type 2, with lower numbers in the subsequent years. There were no reports of DEN-3 and DEN-4. These data indicate that many cases of the disease are diagnosed solely based on symptoms, and may include cases that are not correctly identified, which may affect the reliability of the data.

Table 4 **- Dengue Serotypes by Year in the State of Piauí, from 2018 to 2021.**

Serotypes	2018		2019		2020		2021		Total	
	n	%	n	%	n	%	n	%	n	%
Ignored/Blank	1925	99,48%	7810	97,30%	2227	99,69%	3750	99,68%	15712	396,15%
DEN 1	5	0,26%	139	1,73%	1	0,04%	12	0,32%	157	2,35%
DEN 2	5	0,26%	78	0,97%	6	0,27%	0	0,00%	89	1,50%
DEN 3	0	0,00%	0	0,00%	0	0,00%	0	0,00%	0	0,00%
DEN 4	0	0,00%	0	0,00%	0	0,00%	0	0,00%	0	0,00%
Total	1935	100%	8027	100%	2234	100%	3762	100%	15958	400%

Fonte: Brasil, 2023.

The data related to dengue serotypes are limited due to the low number of reported cases in some categories and years. Therefore, obtaining more information about the data source and the methodology employed is necessary for a more accurate and comprehensive analysis.

4 Discussion

Upon analyzing the data, it is evident that the number of probable cases reported has shown a general increase from 2018 to 2021. Furthermore, with the exception of 2018, the number of probable infection cases among females exceeded those among males in all years. In the municipality of Floriano, 3, 42, 4, and 71 dengue cases were reported in the years 2018 to 2021, respectively, while Bom Jesus reported 14, 209, 49, and 158 cases in the same period. These data indicate that the disease remains a concern in the region.

There was a significant increase in the reported dengue cases in 2019, compared to the other years under analysis. During the period from 2007 to 2017, a total of 45,180 dengue cases were confirmed in the State of Piauí, with the highest incidence recorded in 2017 (Porto *et al.*, 2019). From 2015 to 2019, a total of 21,944 dengue cases were confirmed in Piauí, with the highest number of cases registered in the year 2019 (Lemos *et al.*, 2022). The reduction in the number of cases in 2020 and 2021 could be attributed to the Covid-19 pandemic, which affected the functioning of healthcare interventions and individuals' seeking medical attention.

The reduction in the number of municipalities reporting dengue cases in 2020 compared to 2019 may have led to the underreporting of the disease. This hypothesis gains further support from the subsequent increase in cases in 2021, which coincided with the Covid-19 vaccination efforts and a potential relaxation of sanitary measures. The rise could also be attributed to heightened awareness and surveillance of other diseases due to the ongoing pandemic. In the study by Porto *et al.* (2019), 213 municipalities in Piauí documented cases of this arbovirus between 2007 and 2017. There was a notable upward trend in dengue cases within the state in 2022, with 31,400 probable cases reported and an incidence rate of 955.1 cases per 100,000 inhabitants (Ministry of Health, 2023).

During the analyzed period, dengue cases were predominant in the female gender. These data corroborate those of Porto *et al.* (2019) and Lemos *et al.* (2022), who analyzed dengue cases in Piauí during the periods 2007 to 2017 and from 2015 to 2019, respectively. Similar results were found in studies conducted in other states in the Northeast of Brazil (Costa *et al.*, 2019; Souza *et al.*, 2020; Silva *et al.*, 2022; Sousa *et al.*, 2022). This fact may be due to men's resistance to seeking medical care, which could lead to underreporting of cases in this gender (Johansen *et al.*, 2021). Another trend could be related to the presence of the disease vector in domestic environments, as well as to greater exposure of women, who often spend more time at home (Porto *et al.*, 2019; Silva *et al.*, 2021).

The dengue illness profile in the observed age range in this study is similar to the findings of Porto *et al.* (2019) and Lemos *et al.* (2022) in the state of Piauí, where the age group from 20 to 64 years is the most affected by the disease. Similar results were found by Costa *et al.* (2019) and Sousa *et al.* (2022) in the state of Maranhão, as well as by Gomes, Jesus & Quaresma (2023) in the state of Tocantins, Brazil. In the review study conducted by Silva *et al.* (2022), women aged between 15 and 49 years, with completed high school education and self-identified as mixed race, showed the highest percentage of disease cases.

In the state of Piauí, in 2019, there was an increase in the occurrence of DENV-1 and DENV-2 serotypes compared to 2018, 2020, and 2021, according to Silva et al. (2022). However, the prevalence of the serotypes is reversed, with the DENV-1 serotype being more predominant than the DENV-2 serotype. The contamination rate of the DENV-1 serotype is higher compared to the other serotypes, which could influence the increase in disease transmission (Souza *et al.*, 2020).

The data indicate that dengue remains a public health problem in the state of Piauí, with a high number of cases in 2019 compared to other years, and an increase in the number of cases in 2021 compared

to 2020. The disease can lead to severe complications and even death, underscoring the importance of adopting preventive measures, such as combating the transmitting mosquito.

While the comparative analysis of dengue cases between years can help understand the disease's behavior over time and in different regions of the state, this analysis doesn't allow for inferences about the actual occurrence of the disease in each municipality or its severity. Notification can be influenced by various factors, such as population size, efficiency of waste collection and public cleaning, educational campaigns against the *Ae. aegypti* mosquito, test availability, healthcare professionals' ability to recognize and report the disease, and the population's access to healthcare services.

The presence of similar clinical and laboratory symptoms between dengue and Covid-19 may have made it challenging to suspect dengue cases during the pandemic, affecting case reporting and leading to a reduction in notified dengue cases in 2020 (Mascarenhas *et al.*, 2020).

It becomes evident that dengue remains a disease that inflicts severe impacts on public health. Integrated and collaborative actions, especially during rainy periods and in municipalities with high rainfall, are important measures in combating *Ae. aegypti*. Such measures help contain the number of disease cases.

5 Conclusion

In the state of Piauí, the number of dengue cases has changed significantly from 2018 to 2021, with a higher occurrence in women and individuals in their productive age. Furthermore, different cities exhibited variations in dengue cases, highlighting the importance of a personalized approach to disease control.

For combating the mosquito vector of the arbovirus causing this disease, it is essential to raise awareness among the population and implement effective mosquito control measures. Eradicating potential breeding sites, using insect repellents, and seeking appropriate medical care are fundamental actions to reduce the disease's incidence.

Contribuições dos autores

All authors contributed to the methodology, writing and revision of the article.

Conflito de interesses

The authors declare that there are no conflicts of interest.

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