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ORIGINAL ARTICLE

EPIDEMIOLOGICAL ASPECTS AND SPATIAL ANALYSIS OF CHIKUNGUNYA FEVER CASES FROM 2017 TO 2021, IN A STATE IN THE NORTHEAST REGION OF BRAZIL

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ABSTRACT

This study aimed to characterize the epidemiological aspects and perform a spatial analysis of Chikungunya fever cases from 2017 to 2021, in the State of Maranhão, Brazil. This is an ecological, descriptive, observational, and retrospective study, conducted by collecting data on Chikungunya fever's confirmed cases in the State of Maranhão, available on the platform of the Department of Informatics of the Unified Health System. Most cases of Chikungunya fever occurred in the year 2017 ($p<0.0001$), in females ($p=0.54$), in people between 20 and 39 years old ($p=0.04$), and with a high school degree ($p=0.25$). Regarding the evolution of the disease, most cases were cured ($p=0.006$). The municipalities that obtained a High/High pattern of spatial correlation for the incidence rates of Chikungunya fever per 100,000 inhabitants in the State of Maranhão were located in the West and South Mesoregions in 2017; North and East in 2018; Central, North and East in 2019; North in 2020; and North, East and South in 2021. The epidemiological situation of Chikungunya fever in the State of Maranhão needs attention from public health agencies. Greater efforts towards vector and outbreaks prevention, as well as the improvement on health education programs that educate the population about the disease are necessary. Mainly in the most affected municipalities in order to effectively involve the population in reducing domestic mosquito breeder sites.

KEY WORDS: Chikungunya fever; epidemiology; spatial analysis.

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INTRODUCTION

Chikungunya fever is caused by Chikungunya virus (CHIKV), an RNA virus belonging to the Togaviridae family and the *Alphavirus* genus (Reinhold et al., 2018). CHIKV is transmitted to humans through the bite of female *Aedes* mosquitoes, being *Ae. aegypti* the best-known species (Linnaeus, 1762) (Diptera, Culicidae) (Markoff, 2020). The pathology of Chikungunya fever is characterized by a specific clinical condition, which can severely reduce the life quality of the affected individuals, due to post-Chikungunya rheumatism, which may destroy joints, impair daily life and require treatment with anti rheumatic drugs (Cunha et al., 2017; Paixão et al., 2017).

In Brazil, autochthonous transmission was detected in September 2014, in the city of Oiapoque (State of Amapá). During 2014, 2,772 cases of Chikungunya fever were confirmed in the country (Brasil, 2017a). From December 2019 to June 2020, more than 48,000 cases of Chikungunya fever were reported, and 11 deaths were confirmed in Brazil (Brasil, 2020). In 2021, 96,288 cases were reported and until May 2022, the number of probable cases was 98,540 in the country (Brasil, 2022). In Maranhão, the first confirmed autochthonous case occurred in 2015. In 2016, 13,830 cases and 11 deaths were reported, with an incidence of 65.5 cases per 100,000 inhabitants (Brasil, 2017a). In 2021, 197 cases were confirmed, with an incidence rate of 2.8 cases per 100,000 inhabitants, in the State (Brasil, 2021a).

There are still few studies addressing the epidemiological dynamics of Chikungunya fever in the State of Maranhão (Costa et al., 2018; dos Santos et al., 2021). Therefore, the present study aimed to characterize the epidemiology of Chikungunya fever in the State of Maranhão throughout the years 2017 to 2021 in order to have a description of the arbovirus situation in Maranhão through recent years, given that the epidemiological profile studies are useful for the development of epidemiological surveillance strategies. Therefore, the clinical and epidemiological knowledge of Chikungunya fever in the State studied, through the data obtained in research, directly influences the effective planning and the decision-making in public health by the agencies and the managers.

METHODS

Study area

The Sate of Maranhão is one of the 27 Federative Units of Brazil which is located in the Northeast region. It has an area of 329,651.496 km², with 217 municipalities, being the second largest State in the Northeast region and the eighth largest State in Brazil. It is the 11th most populous State in the country, with 7,153,262 inhabitants and a population density of 19.81 inhabitants/km^2 (IBGE, 2020; IBGE, 2021).

From a climatic point of view, the territory of Maranhão is characterized by a transitional character between the humid climates of the Amazon and the semi-arid region of the Northeast. The Western part of the State has a tropical, hot and humid climate, and rainfall reaches 2,800 mm per year. In the other parts of the territory, there is a hot and semi-humid tropical climate, with rainfall rates reaching 1,250 mm per year (Pinheiro, 2017).

The State of Maranhão is divided into five Mesoregions (Figure 1): North, with a total of 60 municipalities; West, with 52 municipalities; Central, with 42 municipalities; East, with 44 municipalities; and, South, with 19 municipalities (IBGE, 2020).

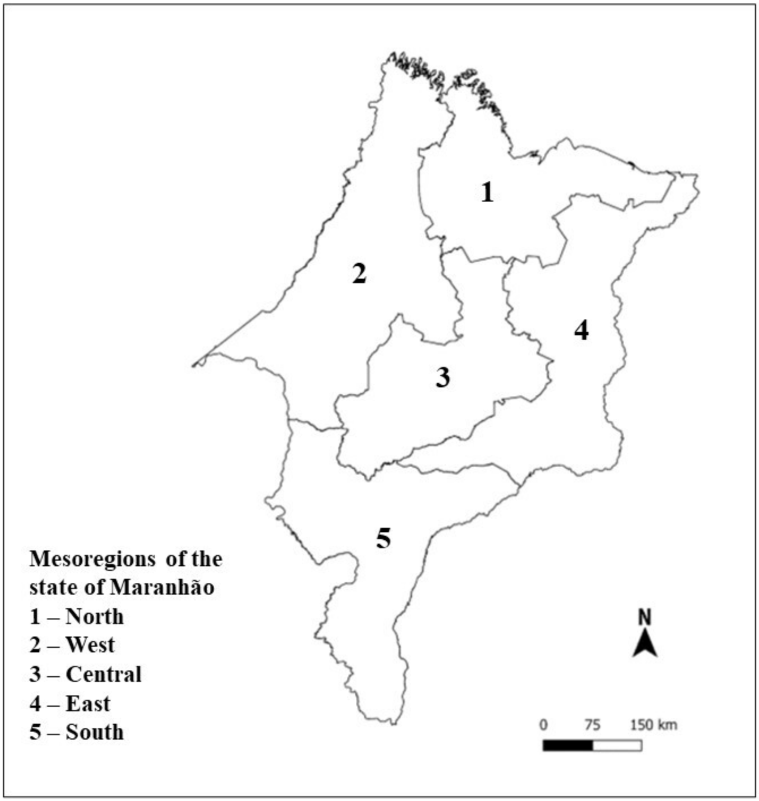

Figure 1. Mesoregions of the State of Maranhão.

Study design

This is an ecological, descriptive, observational and retrospective study, with consolidated data from Chikungunya fever analyzed for the State of Maranhão from 2017 to 2021.

Data source

The study was conducted through the collection of data on confirmed cases of Chikungunya fever for the State of Maranhão, made available on the platform of the Department of Informatics of the Unified Health System (*Departamento de Informática do Sistema Único de Saúde do Brasil* - DATASUS), through access to "*Doenças e Agravos de Notificação – 2007 em diante (Sistema de Informação de Agravos de Notificação* - SINAN)" (SINAN, 2021). Confirmed cases of Chikungunya fever had their last update in January 2022, on the aforementioned platform, and were collected on June 14, 2022. Chikungunya fever in the International Classification of Diseases (ICD) corresponds to ICD-10 A92.0 (ICD-10, 2019).

Inclusion and exclusion criteria

All cases reported and confirmed of Chikungunya fever for the State of Maranhão in the referred period were included in the study. However, all cases that, despite being notified, did not have diagnostic confirmation or that had inconsistencies regarding its confirmation, were excluded from the analysis.

Variables analyzed

In the present study, the following variables were analyzed: notifications per year and municipality in Maranhão, gender, age group, schooling, and case outcome.

Descriptive and statistical analysis

To calculate the incidence indicators in the years studied, per 100,000 inhabitants, an estimated population for the State of Maranhão was used as reference, calculated by the IBGE and available on its electronic platform (IBGE, 2021). Calculations of annual incidence rates were performed according to Gordis (2017). There was a description of the Mesoregion to which the prominent municipalities belong.

Data was submitted to the Shapiro-Wilk test to verify normality and, as it did not fit the normal distribution, corresponding non-parametric analysis were used. To examine whether there was a difference in the medians of confirmed cases by year, age group, schooling, and case outcome, the Kruskal-Wallis analysis (H value) was used. When the difference was found, Dunn's posteriori test was used. To examine whether there was a difference in the medians of confirmed cases by gender, the Mann-Whitney (U value) test was used (Ayres et al., 2007; Siqueira & Tibúrcio, 2011).

The significance level adopted in all analysis was 5% ($p < 0.05$). Data was managed using Microsoft Excel 2013 (Washington, United States of America), GraphPad Prism 7 (San Diego, United States of America) and OpenEpi 3.01 (Dean et al., 2013) software.

Spatial analysis

In this study, to calculate the Global Moran Index and Local Indicators of Spatial Association (LISA), a first order neighborhood matrix (Queen) was created to verify the dependence relationship between the areas considering neighboring areas that border each other. This parameter of the neighborhood matrix considers neighbors as border areas or shared vertices (Moran, 1948; Odland, 1988).

Similar clusters presented by LISA as High/High may influence neighboring sectors. Therefore, the Global Moran Index that showed positive spatial autocorrelation and all areas of High/High identification in the LISA were classified as the area of highest priority and control of Chikungunya fever in the State of Maranhão. There was a description of the Mesoregion to which the prominent municipalities in the spatial statistical analysis belong. The Global Moran Index was calculated using GeoDa software version 1.10 (Chicago, United States of America) and maps were constructed using QGIS software version 3.10 (Bucharest, Romania). The base shapefile file was taken from the platform of the *Núcleo de Economia Regional e Urbana do Estado de São Paulo* (NEREUS, 2020).

Ethical aspects

Data described in this study available by the DATASUS platform (Brasil, 2021b) are characterized by the anonymity of individuals affected by Chikungunya fever, which does not include information that may allow their identification or that may affect their confidentiality. Therefore, the present study only included secondary public data without any individual identification, and the approval of the Research Ethics Committee was unnecessary, according to *Resolução do Conselho Nacional de Saúde* (CNS) No. 466/2012, of December 12, 2012 (CNS, 2012).

RESULTS

Epidemiological characterization of confirmed cases of Chikungunya fever

Among 2017 and 2021, 10,372 cases were investigated for Chikungunya fever in the State of Maranhão, with 6,587 confirmations (63.5% of the investigated cases), being the majority in 2017, with 5,109 confirmed cases (77.6%) (Figure 2A and 2B). Also in 2017, there was the highest incidence rate of the disease among the years compared, with 72.98 cases per 100,000 inhabitants (Figure 2C). The 2017 year also had a statistically higher median of confirmed cases of the disease ($H=33.35$; $p<0.0001$) than 2020 ($p<0.0001$) and 2021 ($p<0.0001$); additionally, 2018 presented a median of confirmed cases statistically higher than 2021 ($p<0.05$) (Figure 2D).

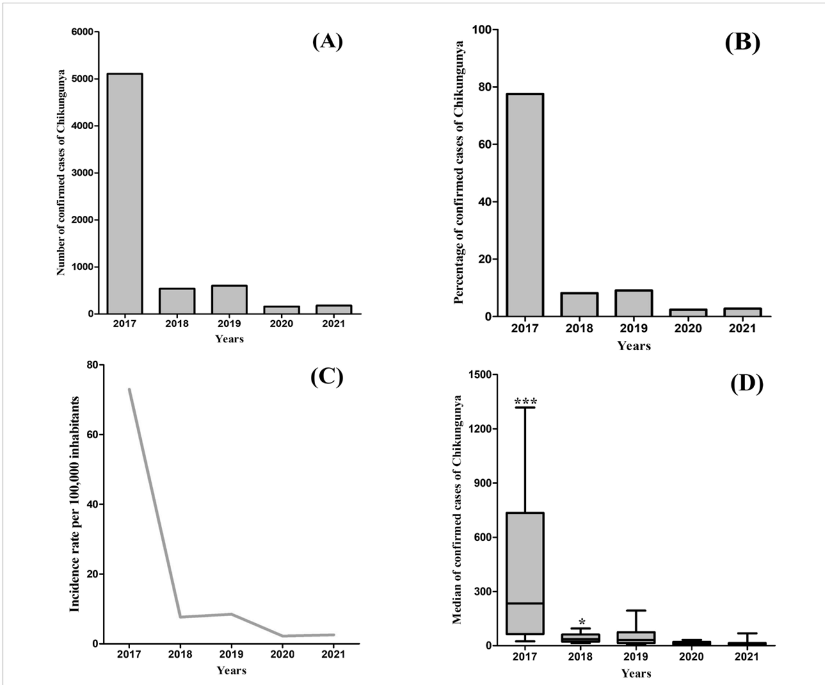

Figure 2. Confirmed cases of Chikungunya fever between 2017 and 2021 in the State of Maranhão. (A) Number of notifications. (B) Percentage of notifications. (C) Incidence rate per 100,000 inhabitants. (D) Median of notifications.
Source: DATASUS (Brasil, 2021b). ***Category with a significant median greater than other categories (value of p in Dunn's test: $p<0.0001$); *Category with a significant median greater than other category (value of p in Dunn's test: $p<0.05$). DATASUS data were updated until January 2022. Data collection was conducted on June 14, 2022.

Females were the most affected, with 3,909 cases (59.4%) by the arboviruses (U=9.00; p=0.54). For the age group, there was a predominance of cases among people aged 20 to 39 years, with 2,414 (36.7%; H=18.65; p=0.04), presenting a statistically significant difference in relation to the other categories. For the schooling variable, there was a majority of cases among individuals who had completed high school, with 1,260 (25.6%; H=11.31; p=0.25). Regarding the evolution of the disease, 99.8% (6,202) of the affected individuals were cured, with this variable having a statistically significant value (H=12.33; p=0.006) in relation to deaths from the disease (p value in Dunn's test: p<0.05), deaths due to another cause (p value in Dunn's test: p<0.05) and to deaths under investigation (p value in Dunn's test: p<0.01) (Table).

Spatial analysis of confirmed cases of Chikungunya fever

The highest incidence rates of Chikungunya fever for the year of 2017 were verified in the following municipalities: Campestre do Maranhão (1,476.90 cases per 100,000 inhabitants; South Mesoregion of the state of Maranhão), Balsas (1,107.84 cases per 100,000 inhabitants; South Mesoregion) and Loreto (1,015.90 cases per 100,000 inhabitants; South Mesoregion). In 2018, the three municipalities with the highest incidence rates were: Presidente Sarney (186.53 cases per 100,000 inhabitants; North Mesoregion), Maracaçumé (141.50 cases per 100,000 inhabitants; West Mesoregion) and Barra do Corda (123,02 cases per 100,000 inhabitants; Central Mesoregion). In 2019, the municipalities of Alto Alegre do Maranhão (539.68 cases per 100,000 inhabitants; East Mesoregion), Cidelândia (88.45 cases per 100,000 inhabitants; West Mesoregion) and Senador La Rocque (76.96 cases per 100,000 inhabitants; West Mesoregion) obtained the highest rates for the epidemiological indicator. In 2020, the highest incidence rates occurred in the municipalities of Governador Edison Lobão (43.20 cases per 100,000 inhabitants; West Mesoregion), Amapá do Maranhão (28.55 cases per 100,000 inhabitants; West Mesoregion) and São João do Paraíso (26.80 cases per 100,000 inhabitants; South Mesoregion). In 2021, the highest incidence rates occurred in the municipalities of São Domingos do Azeitão (886.10 cases per 100,000 inhabitants; South Mesoregion), Pastos Bons (91.40 cases per 100,000 inhabitants; East Mesoregion) and Bacabeira (17.20 cases per 100,000 inhabitants; North Mesoregion) (Figure 3A).

The Global Moran Indexes with the highest values were verified in 2017 with 0.104, and 2020 with 0.101. In other years, the Moran Global Index was below 0.030. Figure 3B shows the Local Significance Maps (LISA), with the representation of municipalities that obtained statistically significant spatial autocorrelation, in addition to areas without significance, for the years of study.

Table. Confirmed cases of Chikungunya fever in relation to sociodemographic variables and outcome of the disease, throughout the years 2017 to 2021, in the State of Maranhão.

Variable	Years					Total (n)	%	Statistical analysis
	2017	2018	2019	2020	2021			
Gender (n = 6,583)[1]								
Males	2,055	228	230	77	84	2,674	40.6	U = 9.00
Females	3,050	311	370	82	96	3,909	59.4	p = 0.54
Age range (years) (n = 6,586)[2]								
Under 1	101	32	26	22	20	201	3.0	
1 to 4	104	23	51	15	24	217	3.3	
5 to 9	250	22	49	21	26	368	5.6	
10 to 14	374	27	60	17	15	493	7.5	
15 to 19	483	43	40	11	6	583	8.9	H = 18.65
20 to 39*	1,930	199	203	45	37	2,414	36.7	p = 0.04
40 to 59	1,202	132	130	19	32	1,515	23.0	
60 to 64	191	16	13	3	7	230	3.5	
65 to 69	168	13	12	2	5	200	3.0	
70 to 79	218	25	14	2	4	263	4.0	
80 or more	88	7	2	2	3	102	1.6	
Schooling (n = 4,931)[3]								
No schooling	120	8	18	0	2	148	3.0	
1st to 4th grade incomplete	478	68	48	15	10	619	12.6	
4th grade complete	175	22	26	5	7	235	4.8	
5th to 8th grade incomplete	546	37	60	12	2	657	13.3	
Complete primary education	298	41	32	6	8	385	7.8	H = 11.31
Incomplete high school	533	72	52	6	4	667	13.5	p = 0.25
Complete high school	991	111	120	28	10	1,260	25.6	
Incomplete higher education	94	5	10	2	2	113	2.3	
Complete higher education	171	17	22	5	7	222	4.5	
Not applicable	345	61	108	49	62	625	12.7	
Outcome (n = 6,218)[4]								
Cure+	4,885	517	522	113	165	6,202	99.7	
Deaths from the grievance	2	2	1	2	0	7	0.1	H = 12.33
Deaths from other causes	4	0	1	0	1	6	0.1	p = 0.006
Deaths under investigation	1	1	1	0	0	3	0.1	

Source: DATASUS (Brasil, 2021b). N = number of confirmed cases. %=percentage. H=Kruskal-Wallis value. U=Mann-Whitney value. p=p value. 1: Four cases were ignored or left blank for the gender variable. 2: One case were ignored or left blank for the schooling variable. 3: One thousand six hundred and fifty-six cases were ignored or left blank for the race variable. 4: Three hundred and sixty-nine cases were ignored or left blank for the evolution variable. DATASUS data were updated until January 2022. Data collection was conducted on June 14, 2022. *Category with a significant median greater than other categories (value of p in Dunn's test: $p<0.05$), +Category with a significant median greater than that of death from the disease (p value in Dunn's test: $p<0.05$), deaths from other causes (p value in Dunn's test: $p<0.05$), and that of deaths under investigation (p value in Dunn's test: $p<0.01$).

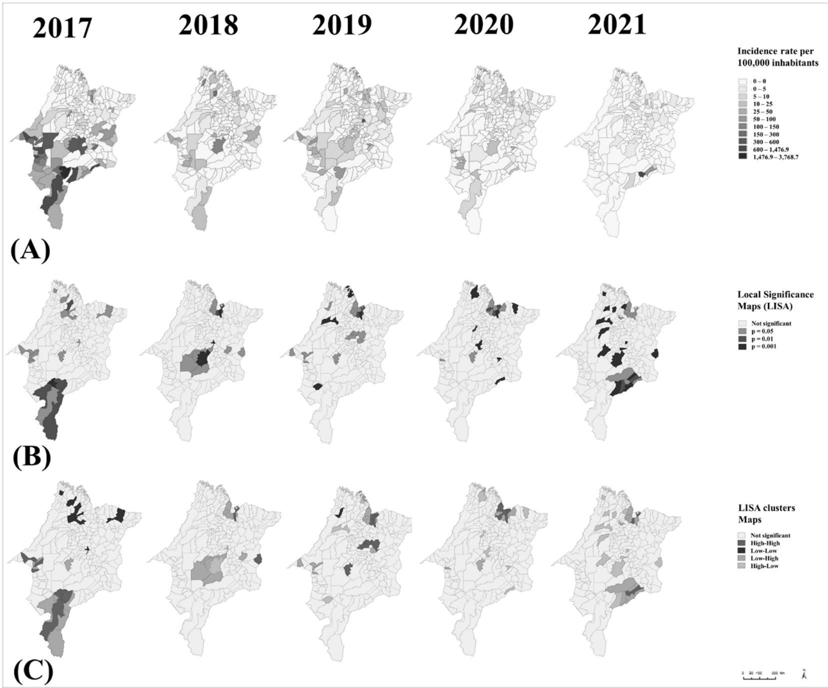

Figure 3. Spatial distribution of confirmed cases of Chikungunya fever between 2017 and 2021, in the municipalities of the State of Maranhão. (A) Incidence rate per 100,000 inhabitants of confirmed cases of Chikungunya fever. (B) Local Significance Maps (LISA), with the visualization of the municipalities that obtained statistically significant and non-significant spatial autocorrelation in relation to the incidence rates. (C) Local Cluster Maps (LISA), with visualization of the clusters formed by municipalities that obtained a High-High distribution pattern, in relation to the incidence rates.
Source: DATASUS (Brasil, 2021b). DATASUS data were updated until January 2022. Data collection was conducted on June 14, 2022.

In 2017, seven municipalities presented a High-High pattern: Balsas, São Raimundo das Mangabeiras, and Fortaleza dos Nogueiras (South Mesoregion); and, Cidelândia, Senador La Rocque, São Francisco do Brejão, and Governador Edison Lobão (West Mesoregion). In 2018, three municipalities achieved the High-High standard: Rosário and São José de Ribamar (North Mesoregion); and Timon (East Mesoregion). In 2019, the High-High pattern was verified in nine municipalities: Bacabal, Jenipapo dos Vieiras, and São Mateus do Maranhão (Central Mesoregion); Bacabeira, Paço do Lumiar, Rosário, São José de Ribamar, and São Luís (North Mesoregion); and Coroatá (East Mesoregion).

In 2020, six municipalities obtained the aforementioned distribution pattern: Alcântara, Cajapió, Paço do Lumiar, Rosário, São José de Ribamar, and São Luís (North Mesoregion). In 2021, four municipalities obtained the High-High pattern: Bacabeira, and São José de Ribamar (North Mesoregion); Pastos Bons (East Mesoregion); and São Domingos do Azeitão (South Mesoregion) (Figure 3C).

DISCUSSION

This study describes the epidemiological profile and spatial distribution of confirmed cases of Chikungunya fever in the State of Maranhão from 2017 to 2020. It was observed from the data obtained that, in the period in question, there was a predominance of cases in the year 2017, in female individuals, in people between 20 and 39 years old, and in individuals with a high school degree. Regarding the evolution of the disease, most cases were cured. It is also noteworthy that different Mesoregions of the State had a wide distribution of the disease in the studied period.

In Maranhão, the first confirmed autochthonous case of Chikungunya fever occurred in 2015. In 2016, 13,830 cases and 11 deaths were reported, with an incidence of 65.5 cases per 100,000 inhabitants (Brasil, 2017a). In the years of 2016 and 2017, the Northeast region of Brazil had the highest number of probable cases of Chikungunya fever. It is also noteworthy that, among the nine States that comprise the region, Maranhão ranked sixth, with 20,232 probable cases of the disease (Brasil, 2017a). With regard to the period from 2017 to 2021, analyzed in this study, it was found that 6,587 cases of Chikungunya fever were registered in the State of Maranhão.

It is worth emphasizing that 5,109 cases (77.6%) were confirmed in 2017, being the year with the highest incidence rate of arboviruses among the studied timeline, with 72.98 cases per 100,000 inhabitants. Considering the national scenario, the Northeast region was the most affected by Chikungunya fever, the State of Ceará was the leader of notifications in 2017, with 1,166 suspected cases per 100,000 inhabitants, 65.7% of Brazil's notifications (Lima et al., 2021).

Data collected during the study period (2017 to 2021) show that females were the most infected, with 3,909 cases (59.4%), in contrast to males, that had 2,674 registered cases. This difference found in the involvement of the disease between genders cannot necessarily be influenced by any biological determinant, but in part, it can be explained by the larger population of women. Female gender represents a little more than half (53.2%) of the Maranhão' s population (IBGE, 2011). Other authors of studies conducted in Brazil found the female gender to be the most affected by both Chikungunya fever (Ribeiro et al., 2018) and dengue (Assunção & Aguiar, 2014), also transmitted by *Ae. aegypti*.

One of the explanations given for this difference between genders would be the greater permanence of women in the domicile and peridomicile, being exposed to the anthropophilic feeding habits of the vector and household transmission (Assunção & Aguiar, 2014; Ribeiro et al., 2018). In addition, women tend to seek health services more than men, which could lead to biased records of notifications (Oliveira et al., 2018).

Regarding the age group, the present study showed that there was a significant predominance of cases in adulthood in individuals aged between 20 and 39 years, with 2,414 confirmed cases, that is, 36.7% of cases. This result corroborates with other study of Chikungunya fever cases in the State of Maranhão between 2015 and 2016, in which it was found that the age group between 20 to 44 years was the most affected, with 23.3% (Pereira, 2018). Research conducted in the Southeast region of Brazil, in the State of Espírito Santo, pointed to 20 to 60 years old (Silva et al., 2018); and 40 to 49 years old, in the State of Rio de Janeiro, as the age groups with the majority of arboviruses cases. These age groups are characteristic of active people doing labor activities. It is understood that when an economically active age group is affected by the disease, important social and economic impacts can occur, due to the removal of these people from their activities, due to the disability that Chikungunya fever might cause (Brasil, 2017b).

From the obtained data, it was found that, in the field of schooling, people who had completed high school were the most infected, with 1,260 (25.6%) of the cases. Divergent results were found in a study conducted in the State of Espírito Santo, considering that 23.5% of its sample had incomplete elementary and high school education, and only 15% had completed high school (Silva et al., 2018). In this context, low schooling can be a factor that worsens the spread of Chikungunya fever vectors, as they can impact mosquito control measures. Low levels of education impact and limit the ability of individuals to access, understand and act upon information about prophylaxis, increasing the risk of contagion (Whiteman, 2018).

Regarding the evolution of the disease, 99.7% (6,202) of the affected individuals were cured. In the municipality of Macaé, State of Rio de Janeiro, 93% of individuals did not require hospitalization, and only 2.5% were hospitalized during the Chikungunya fever epidemic (Silveira et al., 2019). Such information indicates that, despite the high number of notifications, most of them have not presented complications that progress to hospitalizations.

It was also noted in this study that the highest incidence rates for Chikungunya fever per 100,000 inhabitants were verified in municipalities in the South Mesoregion in 2017; Central, North and West in 2018; East and West in 2019; and, West and South in 2020; and, North, East and South Mesoregions in 2021. To verify the existence of spatial autocorrelation of the incidence rate of Chikungunya fever in the State of Maranhão, a Global

Moran Index was calculated. The highest Global Moran Index value was verified in 2017, with 0.104. The municipalities that obtained a High/High pattern of spatial correlation for the incidence rates of Chikungunya fever per 100,000 inhabitants in the State of Maranhão were located in the West and South Mesoregions in 2017; North and East in 2018; Central, North and East in 2019; North in 2020; and North, East and South in 2021.

The Moran Global Index is characterized by providing a general measure of the spatial association existing in the data set that will measure the degree of spatial correlation between neighborhood pairs by weighting geographic proximity (Druck et al., 2004). The Moran Index or Local Spatial Association Indicator (LISA) produces a specific value for each area, allowing the identification of clusters of areas with significant patterns of spatial association. LISA classifies municipalities according to the significance level of the values of their local indexes in: High/High and Low/Low, indicating the points of positive or similar spatial association with neighbors; and, High/Low and Low/High indicating points of negative spatial association, that means, that the location has neighbors with different values (Câmara et al., 2004).

From the data obtained, it was possible to observe that, for the High/High priority areas, the West and South regions of Maranhão prevailed with the highest spatial correlation rates in 2017, however, in the years that followed (2018 to 2021), the North Mesoregion of the State persisted with a higher rate of spatial correlation for the disease. Considering the statistically representative regions of Maranhão in the spatial analysis, studies that investigate a better characterization of these areas and factors associated with the occurrence of Chikungunya fever should be conducted, as they can guide protocols and public health measures. This tool has already been used in other studies that aim to evaluate the spatial and temporal analysis of Chikungunya fever in the Northeast in states, such as Ceará between 2016 and 2017 (Barbosa, 2019), and Pernambuco in 2018 (Freitas et al., 2020).

Considering the climate and biomes of Maranhão, it is observed that the equatorial climate is predominant in the West portion of the State, with high average of rainfall and temperatures. The rest of the territory is influenced by the tropical climate, with higher rainfall in the first months of the year. The State is also divided through the *Amazônia, Cerrado, Caatinga* and *Mata dos Cocais* biomes, gathering a great environmental diversity (PPCD-MA, 2011). Therefore, it is important to note that, in some way, these factors can interfere with the maintenance of arboviruses, as they influence the vector’s biological cycle. However, it should be noted that there are not enough studies that address the issue, nor that justify and explain this association in the areas that showed a spatial correlation for Chikungunya fever in Maranhão.

In this context, the present study takes a spatial and temporal approach, while identifying areas most affected by arboviruses in individual years in the State of Maranhão. This analysis has a fundamental importance to follow the epidemiological dynamics of Chikungunya fever in the territory of Maranhão. Studies with spatial analysis of arboviruses such as Chikungunya are considered relevant to understand the dynamics of distribution and possible factors related to this disease (Almeida et al., 2020).

Regarding the study limitations, as it is a study with an ecological approach, it has limitations inherent to its methodology. The use of information obtained from secondary databases is subject to underreporting bias. It is known that the real number of infected is not part of the official statistics due to some patients not seeking health services added to the difficulty in identifying and correct diagnosing cases of Chikungunya fever, due to its many unspecific symptoms that can be mistaken by other arboviruses, such as dengue and Zika. It is also worth mentioning the high proportion of blank and/or incomplete fields on the notification form, especially those regarding sociodemographic information. This limitation extends to professionals who analyze the situation of the disease directly, impairing the necessary knowledge of the epidemiological and clinical profile of patients and, consequently, the adoption of more effective public policies for its control and prevention, as well as a more resolute assistance of the cases.

It is also important to notice that in February 2020, Brazil was reached by the COVID-19 pandemic (Lana et al., 2020) and, since the confirmation of the first cases, there has been a decrease in records of probable cases and deaths from arboviruses in the country. This decrease may be a consequence of underreporting or delay in notifications, as observed in this study, with 2021 showing a considerable decrease in the number of cases of Chikungunya fever in Maranhão. In this context, this may have occurred due to the mobilization of surveillance and health care teams in the face of the emergency and the fear of the population to seek care at health units.

It can be seen that the epidemiological situation in the State remains a concerning public health problem, which requires great efforts towards vector and outbreaks prevention, as well as the improvement of health education programs that educate the population about this disease. In addition, is necessary to develop better protocols and guidance for medical staff on behalf of clinical diagnosis and management of cases, given that *Ae. aegypti* is also a vector of other endemic arboviruses with similar symptoms, such as dengue and Zika.

Despite Chikungunya fever being an endemic and relevant disease in Maranhão, there are only few studies of spatial analysis focused on this State. New studies and analysis are recommended, considering that they are fundamental subsidies to list priorities and places that need more attention, in order to aim at a greater impact of vector control measures on the health of the population.

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CONFLICT OF INTEREST

The authors declare they have no conflicts of interest to disclose.

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