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Spatial distribution of Chikungunya cases in the state of Piauí – Brazil (2015-2019)

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ABSTRACT. This study aimed to analyze the spatial distribution of chikungunya cases in Piauí between 2015 and 2019. This was a spatial ecological study of notified and confirmed cases of chikungunya, with data from the Notifiable Diseases Information System (SINAN) from 2015 to 2019. The X^2 association test was applied for the bivariate analysis and the spatial analysis was performed from the data treatment to combine with the cartographic base in the free software Qgis (version 3.16.7 Hannover). During this period, 9596 cases and 7950 confirmed cases of chikungunya were reported. The city of Teresina (53.21%) and the health region Entre Rios (58.27%) had the highest records. Females (58.40%), aged between 20 and 34 years (29.63%) and mixed race (50.26%) were the most affected. Regarding education, 56.55% were ignored and, regarding the months of notification, the months of the 1st semester had the highest number of cases (62.8%). Chikungunya cases are concentrated in poles with large population flows. In this way, the identification of the epidemiological profile, as well as its main risk factors, is a way of helping the health system of the entire state in the elaboration of specific control policies for the population most vulnerable to the disease.

Keywords: Chikungunya; Epidemiology; Public Health.

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Introduction

Chikungunya fever is an arbovirus caused by chikungunya (CHIKV), a ribonucleic acid (RNA) virus belonging to the Togaviridae family and Alphavirus genus, found mainly in tropical and subtropical regions of Africa, on the islands of the Indian Ocean, as well as in the South and Southeast Asia. In 2013, the chikungunya virus spread in the Americas, with the beginning of an epidemic in several Caribbean islands (Brasil, 2017a).

According to some authors, the word (Chikungunya) means (the one who bends) and originates from the Makonde language, a Bantu language spoken in some areas of northern Mozambique and southern Tanzania, referring to the antalgic position that patients acquired during the period of clinical manifestation of the disease (Powers & Logue, 2007).

Chikungunya is characterized as an emerging acute febrile illness in the American continent and its transmission occurs mainly through the bite of infected female mosquitoes of the genus Aedes (especially A. aegypti and A. albopictus), widely distributed geographically, which makes Brazil highly susceptible to the spread of the CHIKV virus (Brasil, 2017b).

Chikungunya fever is transmitted through the bite of Aedes aegypti and Aedes albopictus mosquitoes already infected with the CHIKV virus. Contagion occurs when these mosquitoes bite infected individuals who are in the viremia phase, which corresponds to the symptomatic period of the disease. Thus, symptomatic patients should be on guard against new bites to prevent the spread of the virus (Terra & Silva, 2017).

Initially, the infection caused by CHIKV is characterized by severe joint pain of sudden onset and episodes of high fever, being defined as self-limited, since the acute symptoms usually regress within one to two weeks (Cunha & Trinta, 2017). The most affected joints are those of the fingers, hips, ankles and knees. In addition, myalgias are common, as well as tiredness, general malaise, gastrointestinal symptoms and skin rashes, which are usually maculopapular eruptions on the trunk, face and extremities (Mateo & Roure, 2017).

According to Martí-Carvajal et al. (2017), CHIKV can be delimited by a post-acute stage and a chronic stage, the first being characterized by intense arthritis and increased periarticular and synovial inflammation, peripheral vascular disorders, neuropathy, neuropsychiatric dysfunctions or other clinical manifestations. The chronic stage of the disease appears when rheumatic, musculoskeletal and other symptoms last for more than three months, thus increasing psychological suffering, causing a worsening in quality of life and reducing well-being.

Thus, Messias et al. (2018) state that, in view of the global scenario outlined by the expansion of vector-borne diseases, health surveillance actions are considered an essential strategy for tackling the problem from the beginning of its spread. Therefore, with the expansion of arboviruses in Brazil and in the world, several studies report the relationship between Chikungunya fever and the actions taken to minimize its effects on the health of populations.

As it is a disease with a recent record in Brazil, the various studies in progress can contribute to the development of strategic actions for the prevention and control of vector exposure, in order to help reduce new cases and alert to the possibility of more severe cases, with associated comorbidities or preexisting joint disease (Dourado et al., 2019). The present study aims to analyze the spatial distribution of Chikungunya cases in the state of Piauí between the years 2015 and 2019.

Methodology

This is an ecological, quantitative, analytical, descriptive and retrospective epidemiological study on cases of Chikungunya in the state of Piauí, where it was conducted between December 2020 and September 2021.

The state of Piauí is located in the Northeast region of Brazil, with a total area of 251,611 and 93 km², which corresponds to 16.19% and 2.95% of the total areas of the Northeast and Brazil, respectively. It is the third largest state in the Northeast in terms of land area. According to the last demographic census of 2010, Piauí has 3,118,360 inhabitants. As for the political-administrative division, Piauí has 224 municipalities, divided into four development mesoregions: North of Piauí, Center-North of Piauí, Southeast of Piauí and Southwest of Piauí (Cepro, 2019).

The state has 11 health regions: I – Planície Litorânea (11 municipalities); II – Cocais (22 municipalities); III – Entre Rios (31 municipalities); IV – Carnaubais (16 municipalities); V – Vale do Guaribas (42 municipalities); VI – Vale do Canindé (14 municipalities); VII – Vale do Sambito (14 municipalities); VIII – Vale do Rios Piauí e Itaueiras (28 municipalities), IX – Serra da Capivara (18 municipalities); X – Chapada das Mangabeiras (23 municipalities); and XI – Tabuleiros do Alto Parnaíba (5 municipalities) (Sesapi, 2016).

The study population consisted of registered cases of Chikungunya in the Notifiable Diseases Information System (SINAN) during the period from 2015 to 2019, obtained through the State Department of Health of Piauí (SESAPI), located in the capital Teresina. Notified and confirmed cases of Chikungunya that occurred between 2015 and 2019 in all municipalities in the state were included. Data that were incomplete with regard to the variables used were excluded.

Data collection took place through the use of a collection instrument developed and adapted by the researchers, containing the variables gender, age group, race/color, education, month of notification, reported cases, confirmed cases and confirmation criteria. Data were collected in April and May 2021 and extracted from the SINAN of the State Department of Health of Piauí.

The spatial analysis was carried out from the data processing for combination with the cartographic base in the free software Qgis (version 3.16.7 Hannover), which is a Geographic Information System (GIS) widely used in the handling of tabular data and vectors for production of maps. The spatial distribution of cases by municipalities used the combination of secondary data obtained with SESAPI and a transformation to the (csv) extension, which is accepted by the GIS Environment. Next, the names of the municipalities were used to link the cartographic base with the tabular data for the table of attributes. The same process was carried out for the 11 health regions; however, for the delimitation of these data, it was necessary to use the geoprocessing command dissolve, as this is the only way to obtain the delimitation of the 11 health regions of the state. Finally, the confirmed cases of Chikungunya in the municipalities of each region were added to obtain the total number of cases per region.

Exploratory descriptive analysis was applied to verify data consistency, and absolute and relative frequencies were used to characterize them. For the bivariate analysis, the X^2 association test was used in order to calculate the evidence of statistical association of the qualitative data. For all analyses, the

significance level p <0.05 was considered. Data were entered into an electronic spreadsheet in the Microsoft Excel® editor and analyzed using the Software Statistical Package for the Social Sciences, version 26.

The study was carried out in accordance with Resolution 466/12 of the National Health Council (CNS), which deals with research involving human beings. The research was carried out after approval of the project by the Research Ethics Committee (CEP) of the Federal University of Piauí (UFPI), with opinion number 4,518,995 and Presentation Certificate for Ethical Appreciation (CAAE) number 41610720.2.0000.5214.

Results

In the period from 2015 to 2019, respectively, 9,596 notified cases and 7,950 confirmed cases of Chikungunya were registered in the state of Piauí. In 2015, 9 cases (0.09%) were reported and 3 cases (0.04%) were confirmed; in 2016, 1,812 cases were reported (18.88%) and 1,233 (15.51%) were confirmed; in 2017, 6,274 cases were reported (65.38%) and 5,401 were confirmed (67.94%); in 2018, 612 cases (6.38%) were reported and 507 (6.38%) confirmed; finally, in 2019, 889 cases were reported (9.26%) and 806 confirmed (10.14%) (Figure 1).

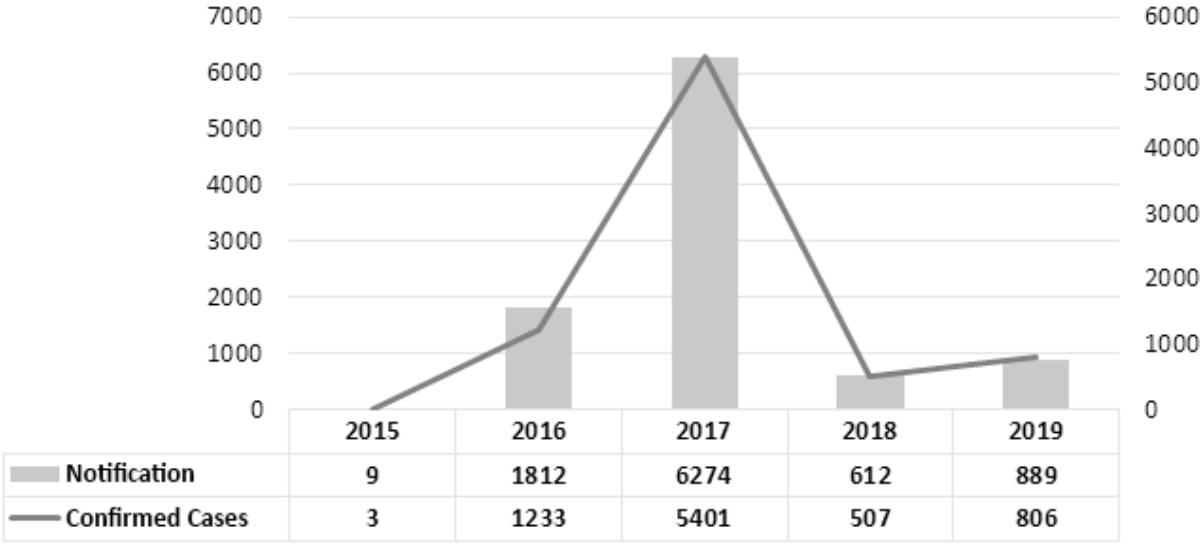


Figure 1. Spatial distribution of notified and confirmed cases of Chikungunya in the state of Piauí, 2015 to 2019 (SINAN/SESAPI)

Figure 2 shows the spatial distribution of notified cases of Chikungunya in the state of Piauí in the period covered by the study. Of the total, 139 municipalities recorded notifications, with Teresina having the highest number of records, corresponding to 5,106 cases (53.21%), followed by Parnaíba, with 1071 notifications (11.16%); São Raimundo Nonato, with 560 (5.84%); Luís Correia, with 300 (3.13%); Floriano, with 262 (2.73%); and Cajueiro da Praia, with 187 notifications (1.95%).

Considering the confirmed cases of Chikungunya, 4,673 (58.78%) were registered in Teresina, 1,071 (13.47%) in Parnaíba, (6.30%) in São Raimundo Nonato, 252 (3.17%) in Luís Correia, 183 (2.30%) in Cajueiro da Praia and 171 (2.15%) in Floriano.

Regarding the prevalence of confirmed cases of Chikungunya, Teresina had a rate of 5.73/1000 inhab.; Parnaíba, 7.35/1000 inhab.; São Raimundo Nonato, 15.49/1000 inhab.; Luís Correia, 8.87/1000 in hab.; Cajueiro da Praia, 25.54/1000 in hab.; and Floriano, 2.96/1000 in hab.

As for notified cases of Chikungunya by health region, in the state of Piauí, the Entre Rios region had the highest number of cases (n=5,592), followed by Litoraneal Plain (n=1,675), Serra da Capivara (n=733), Vale do Rio Guaribas (n=475), Vale do Rio Piauí e Itaueiras (n=341), Cocais (n=323), Vale do Canindé (n=188), Vale do Sambito (n=107), Chapada das Mangabeiras (n=91), Carnaubais (n=46) and Tabuleiros do Alto Parnaíba, with 25 cases (Figure 3).

As for the gender variable of notified cases of Chikungunya, the majority corresponded to females, with a percentage of 58.40% (n=5.200), 41,40% (n=3.680) male and 0.11 (n=22) unknown/blank. Regarding ethnicity, 50.26 (n=4,823) were brown, 35.29% (n=3,386) unknown/blank, 9.30% (n=892) white, 0.59% (n=57) asian and 0.05% indigenous (n=5).

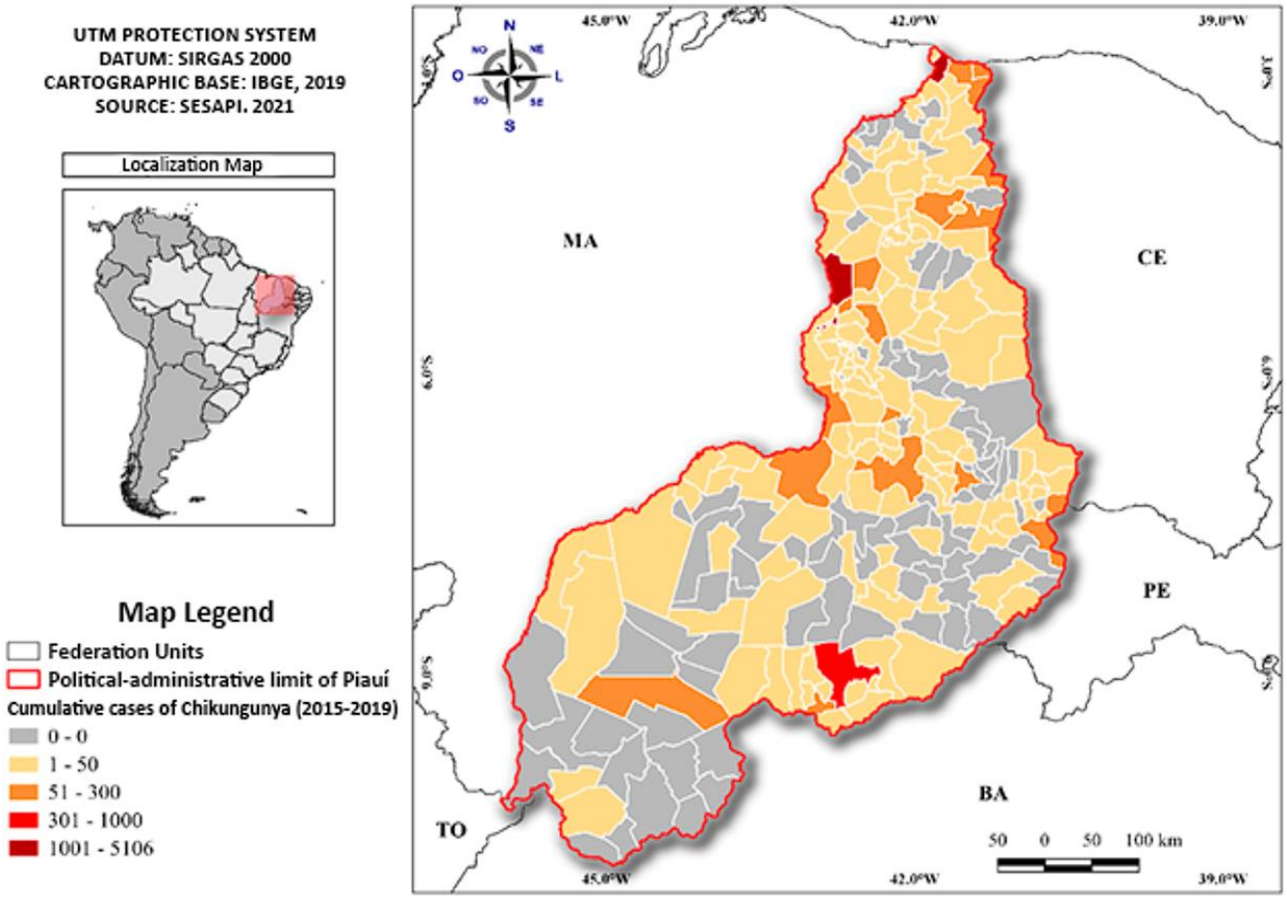


Figure 2. Spatial distribution of notified cases of Chikungunya by municipality in the state of Piauí, 2015 to 2019 (SINAN/SESAPI).

With regard to age group, the highest number of records of notified cases of Chikungunya occurred between 20 and 34 years old, with a total of 2,843 notifications (29.63%), followed by the group between 35 and 49 with 2,291 records (23 .87%), 50 and 64 years old with 1,719 notifications (17.91%), 65 and 79 years old with 840 (8.75%), 15 and 19 years old with 670 (6.98%), 10 and 14 years old with 481 (5.01%), 5 and 9 years old with 335 (3.49%), 80 years old or more with 169 (1.76%), 1 and 4 years old with 137 (1.43%) and < 1 year old with 111 notifications (1.16%).

With regard to the education of notified cases of Chikungunya: 56.55%, unknown/blank (n=5,427); 10.04% completed High School n=963); 5.44%, incomplete 5th to 8th grade of Middle School (n=522); 5.20%, incomplete 1st to 4th grade of Elementary School (n=499); 4.71%, incomplete High School (n=452); 4.51%, not applicable (n=433); 4.15% completed higher education (n=398); 3.06%, completed Elementary School (n=294); .69%, completed 4th grade of Elementary School (n=258); 1.88% illiterate (n=180 and 1.77%, incomplete higher education (n=170) (Table 1). All independent variables had a statistically significant association.

Between 2015 and 2019, 9,596 cases of Chikungunya were reported and 7,950 confirmed in the state of Piauí. As for deaths from this disease, 11 were confirmed throughout the state, 1 in the city of Teresina in 2016 and 4 in Teresina in 2017. In 2018, 1 death was also recorded in the municipality of Matias Olimpo, 1 in São João do Piauí, 2 in São Julião and 2 in Teresina.

Considering the confirmation criteria for Chikungunya, of the 9,596 notified cases, 58.9% (n=5651) occurred through clinical-epidemiological means, 24.2% (n=2,324) through laboratory diagnosis, 15.6% (n =1,500) unknown/blank and 1.3% (n=121) under investigation.

As for the monthly distribution of Chikungunya cases, the month of May had the highest number of notifications, with 2,361 cases (24.6%), followed by the month of June, with 2,085 (21.7%). Regarding notifications per semester, the 1st semester had the highest number of records, with a total of 6,544 cases (62.8%); in the 2nd semester, 3,052 cases (31.8%) were registered (Figure 4). In addition, an increase in case notifications was observed in the months that correspond to the rainiest period in the state.

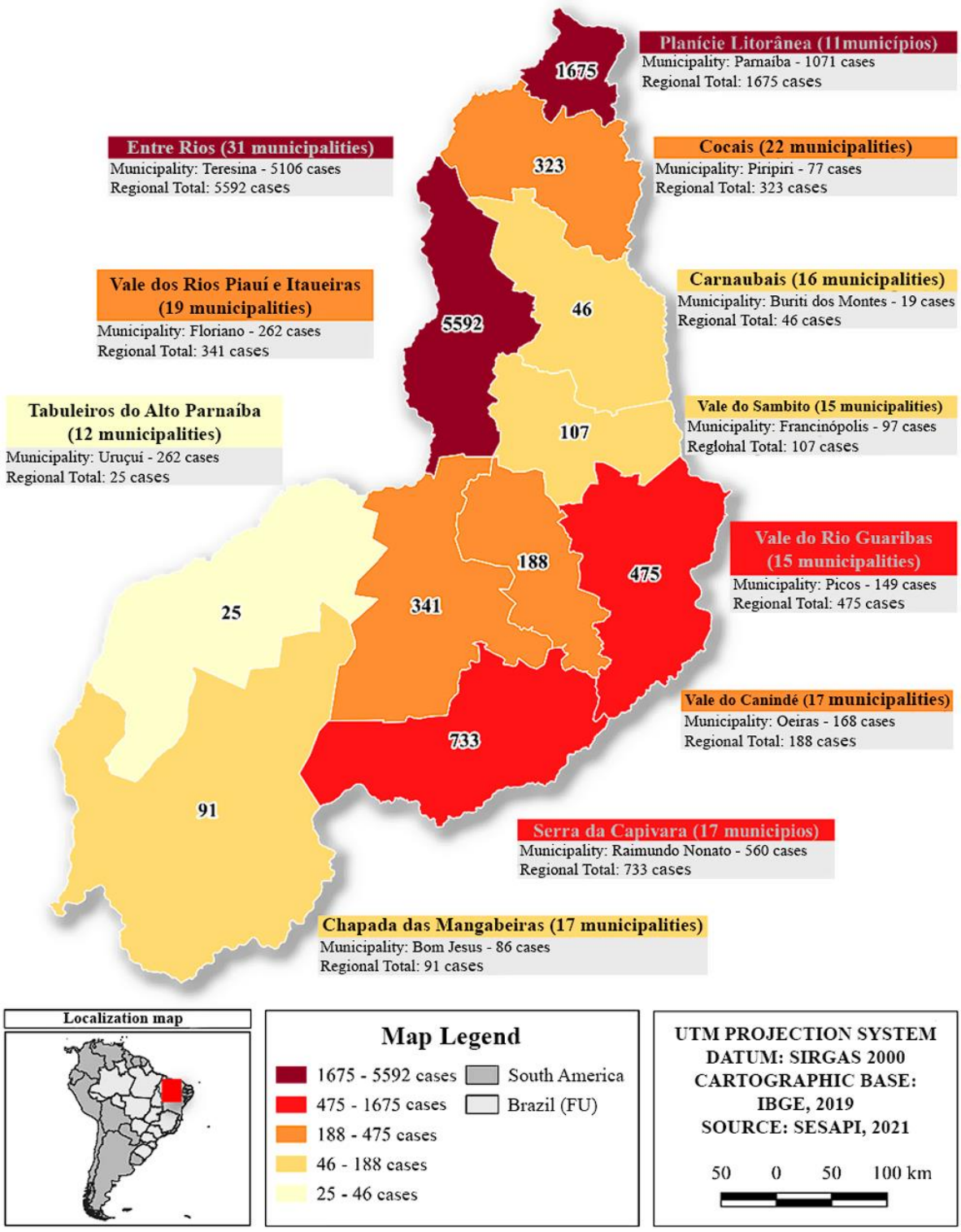


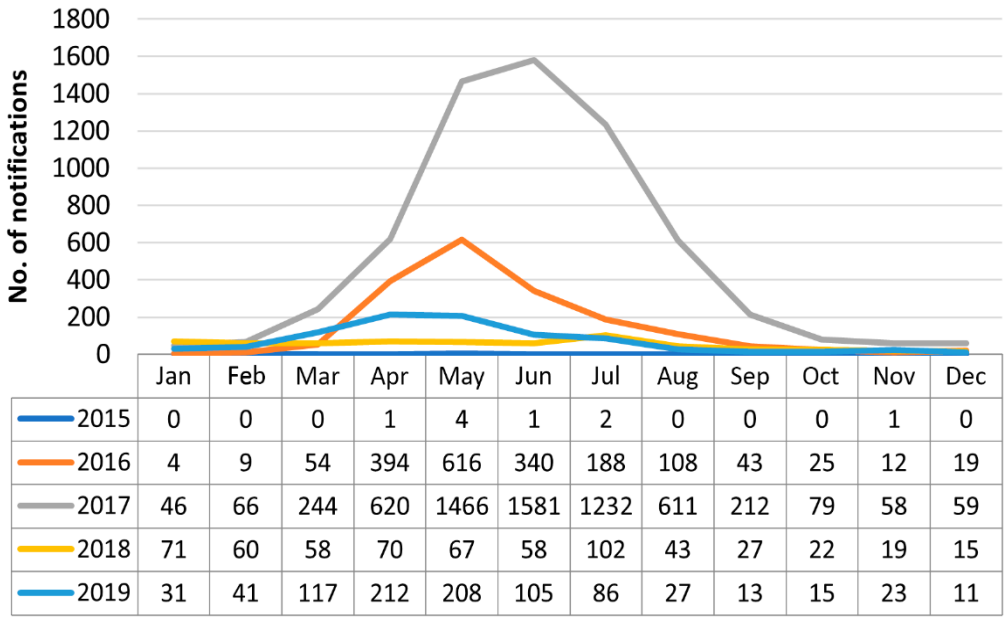
Figure 3. Spatial distribution of notified cases of Chikungunya by health region in the state of Piauí, 2015 to 2019 (SINAN/SESAPI).

Table 1. Characterization of notified cases of Chikungunya according to gender, age group, race/color and education in the state of Piauí, 2015 to 2019

	2015		2016		2017		2018		2019		P-valor
Gender	N	%	N	%	N	%	N	%	N	%	<0,001
Unknown/Blank	0	0,0	3	0,2	18	0,3	0	0,0	1	0,1	
Male	9	100	700	38,6	2.252	35,9	248	40,5	368	41,4	
Female	0	0,0	1.109	61,2	4.004	63,8	364	59,3	520	58,5	
Age											<0,001
<1 y/o	0	0,0	15	0,8	68	1,1	8	1,3	20	2,2	
1-4 y/o	0	0,0	24	1,3	85	1,4	9	1,5	19	2,1	

5-9 y/o	0	0,0	55	3,0	214	3,4	23	3,8	43	4,8	
10-14 y/o	0	0,0	80	4,4	314	5,0	18	2,9	69	7,8	
15-19 y/o	0	0,0	109	6,0	430	6,9	44	7,2	87	9,8	
20-34 y/o	1	11,1	581	32,1	1.761	28,1	214	35,0	286	32,2	
35-49 y/o	5	55,6	411	22,7	1.531	24,4	156	25,5	188	21,1	
50-64 y/o	3	33,3	339	18,7	1.167	18,6	78	12,7	132	14,8	
65-79 y/o	0	0,0	171	9,4	576	9,2	51	8,3	42	4,7	
80 y/o e+	0	0,0	27	1,5	128	2,0	11	1,8	3	0,3	
Race											<0,001
Unknown/Blank	0	0,0	781	43,1	1.984	31,6	309	50,5	312	35,1	
White	1	11,1	174	9,6	599	9,5	34	5,6	84	9,4	
Black	0	0,0	74	4,1	277	4,4	30	4,9	52	5,8	
Asian	0	0,0	8	0,4	31	0,5	7	1,1	11	1,2	
Brown	8	88,9	775	42,8	3379	53,9	231	37,7	430	48,4	
Indigenous	0	0,0	0	0,0	4	0,1	1	0,2	0	0,0	
Educational Level											<0,001
Unknown/Blank	3	33,3	1.173	64,7	3.484	55,5	386	63,1	381	42,9	
Illiterate	0	0,0	21	1,2	141	2,2	8	1,3	10	1,1	
1st to4th grade incomplete of ES	0	0,0	72	4,0	361	5,8	22	3,6	44	4,9	
4th grade complete of ES	1	11,1	54	3,0	178	2,8	10	1,6	15	1,7	
5th to8th grade incomplete of MS	0	0,0	92	5,1	324	5,2	29	4,7	77	8,7	
Complete Elementary School	0	0,0	55	3,0	197	3,1	18	2,9	24	2,7	
Incomplete High School	0	0,0	64	3,5	288	4,6	27	4,4	73	8,2	
Complete High School	4	44,4	118	6,5	642	10,2	57	9,3	142	16,0	
Incomplete higher education	1	11,1	20	1,1	115	1,8	6	1,0	28	3,1	
Complete higher education	0	0,0	74	4,1	268	4,3	23	3,8	33	3,7	
Not applicable	0	0,0	69	3,8	276	4,4	26	4,2	62	7,0	

SINAN/SESAPI - Chi-square test of proportions, at the 5% level.



	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec
2015	0	0	0	1	4	1	2	0	0	0	1	0
2016	4	9	54	394	616	340	188	108	43	25	12	19
2017	46	66	244	620	1466	1581	1232	611	212	79	58	59
2018	71	60	58	70	67	58	102	43	27	22	19	15
2019	31	41	117	212	208	105	86	27	13	15	23	11

Figure 4. Monthly distribution of notified cases of Chikungunya in the state of Piauí, 2015 to 2019 (SINAN/SESAPI).

Discussion

In Northeast Brazil, the simultaneous circulation of three arboviruses (chikungunya, dengue and zika) has generated a great challenge and, therefore, there is a need to know the clinical, socioeconomic and demographic characteristics of Chikungunya cases. A study of suspected cases of the disease in Brazil between 2014 and 2016 showed that the highest concentration of notifications was in the Northeast region (Silva et al., 2018b).

Opposing the low frequency of notifications reported at the beginning of transmission, another study, also conducted in Brazil, recorded a higher proportion of deaths in 2016, with 201 confirmations, emphasizing the importance of deepening knowledge about this problem, as well as their severity and consequences, in order to allow greater interference in the determinants to contain the occurrence of deaths (Brasil, 2017c).

With regard to the transmissibility of the chikungunya virus, researchers developed a study pointing out the main risk factors, such as high temperatures in the time before the infection, socioeconomically disadvantaged areas, occurrence of cases of the disease in the neighborhood, low altitude housing, high rainfall in the month prior to infection, occupational inactivity and little knowledge about disease transmission (Fred et al., 2018). In the study, all age groups reported suspected cases for these diseases.

Another study, carried out by Silva et al. (2018b), on the time series of suspected cases of chikungunya in Brazil, showed that there were cases in all age groups, with a higher concentration in the age group between 20 and 39 years old. Internationally, research carried out in Mexico corroborates the findings of this research, also finding a greater number of cases in this age group (Garay-Morán et al., 2017).

Still regarding the age group, we observed that Chikungunya can interfere with the individual's quality of life, due to reduced productivity, including the simplest and most routine activities. It is understood that the disease, when affecting the working age group, can cause significant social and economic impacts on society (Brasil, 2017).

The social and economic impacts originating from the involvement by Chikungunya of the economically active age group are also pointed out by Marques (2017) and Teich, Arineli & Fahham (2017), since the disease has the potential to generate disabilities, chronicity and neurological complications that imply directly social costs, such as work absenteeism and a decrease in the individual's productive capacity.

As for sociodemographic indicators, there was a predominance of females in suspected cases of Chikungunya in the state of Piauí. Studies carried out in the states of Rio de Janeiro, Minas Gerais, Pernambuco and Ceará corroborate these findings (Kohler, João, Mariana, Rodrigo, & Luiz, 2018; Rodrigues, Costa, & Lima, 2018; Dourado et al., 2019; Alves et al., 2020).

According to Silva et al. (2021), such prevalence may be related to the fact that women have greater exposure to the vector, given the greater ease of transmission of arboviruses in the home, where women who play the role of (housewives) spend more time than men. However, one cannot fail to mention that women tend to seek medical assistance at health centers more often than men when they become ill or suspect a pathology. Thus, it is possible to assume that there is a loss in the notifications of cases of Chikungunya disease in men.

Research carried out by Silva, Santos, Moussallem, Koski and Nader (2017) and Silveira et al. (2020) confirm the findings of the present study, in which, in relation to race and ethnicity, most suspected cases of Chikungunya were concentrated in the population that self-declared brown, and, in relation to the educational factor, among individuals with completed High School and incomplete Middle School. A caveat is necessary regarding the education variable, since Teresina (city with the highest number of notifications and confirmed cases) is characterized by being a university city and presenting a good average level of education.

The months with the highest number of Chikungunya cases, between 2015 and 2019, were May and June. The findings on the distribution coincide with studies carried out in Espírito Santo, which pointed out, within the period studied, a greater number of cases between the months of January and July, evidencing the most significant period of transmission of the disease (Silva, Santos, Moussallem, Koski , & Nader, 2018a).

According to the study carried out by Melo, Rodrigues, Gonçalves and Cruz (2020) in Brazil, considering the seasonality patterns shown in the curves of CHIKV cases can help in the planning of health promotion and disease prevention actions, indicating that seasonal and socioeconomic factors influence the distribution of breeding sites, as well as the number of reported cases.

The wide variability of the seroepidemiological profile for CHIKV infection may be linked to several reasons, such as vector control, climatic factors, population immunity and the circulating viral variant associated with the outbreak (Gallian et al., 2017).

In this study, regarding the confirmation criteria for Chikungunya cases, the clinical-epidemiological criterion prevailed over the laboratory one. This finding is in line with the guidelines of the Ministry of Health, in which it is recommended that, through laboratory confirmation of the first cases of the disease, the remaining cases should be confirmed by clinical-epidemiological criteria (Brasil, 2016b).

Timely diagnosis is fundamental for the appropriate clinical and therapeutic management of cases, especially in endemic areas for other diseases with similar symptoms, as is the case of dengue. The differential diagnosis is also necessary in relation to other diseases, such as malaria, leptospirosis, rheumatic fever, septic arthritis, Zika virus and Mayaro virus (Honório, Câmara, Calvet & Brasil, 2015).

According to some authors, the infection caused by CHIKV can be considered benign; however, the publication of studies that address the increase in mortality, as well as the decompensation of pre-existing

diseases in patients who were infected with CHIKV is increasingly frequent (Cunha & Trinta, 2017; Oliveira et al., 2018; Cavalcanti et al., 2019).

During the study period, 11 confirmed deaths due to Chikungunya fever were recorded in the state of Piauí. According to Cavalcanti et al. (2019), most deaths seem to occur during the post-acute or even chronic phase of the disease, thus creating a challenge in determining the related causes. This is because the infection decompensates underlying diseases, making it difficult to investigate the real cause of death.

It is worth remembering that in patients aged over 45 years there is a chronic disease, which leads to a worsening of symptoms, such as neurological, cardiac, renal and ocular alterations, which may result in future complications and, consequently, lead the patient to deaths (Azevedo, Oliveira & Vasconcelos, 2015).

In this study, it was noticeable, for all variables, a large number of unknown/blank. Silva et al. (2018b) state that the high proportion of blank and/or incomplete fields in the notification form, as well as the lack of relevant information, can influence the characterization of the epidemiological and clinical profile of the disease in the country.

Conclusion

It can be concluded, with the present study, that Chikungunya has a wide distribution and constitutes an important problem for all municipalities in the state of Piauí. It was observed that Teresina, the most populous and economically active city in the state, had most of the notified and confirmed cases, affecting mainly the female population, young people, brown and with a lower level of education. Thus, the spatial analysis identified the groups and municipalities with the highest concentration, allowing strategies to be implemented to control this arbovirus.

It is believed that epidemiological surveillance is the greatest strategy for controlling the transmitting vector of the chikungunya virus. Thus, it is necessary to work in an interstate perspective, with health education actions that sensitize people to act in the fight against this arbovirus, and that there is a better training of professionals to fully complete the notification forms, with the aim of to monitor cases across the state more accurately.

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