v. 2, n. 9, 2022

International Journal of Health Science

EPIDEMIOLOGICAL PROFILE OF ARBOVIROSIS IN THE STATE OF MARANHÃO: DENGUE FROM 2010 TO 2020

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Abstract: Dengue is an arbovirus considered a growing problem in relation to public health worldwide. With this, the objective of this work is to describe, in a retrospective and analytical way, the epidemiological profile and the spatial distribution of dengue cases in the state of Maranhão between the years 2010 to 2020. This quantitative and retrospective study used secondary data provided by the State Department of Health (SES-MA) of confirmed and notified cases of the disease in a time frame between 2010 and 2020. In addition, geoprocessing techniques were also used to spatialize the data. The results indicate that there were oscillations in relation to confirmed and reported cases throughout this period in the state, especially in the north and southwest regions. Thus, Maranhão reveals a critical state in relation to the occurrence of the disease, which is possibly associated with environmental factors, infrastructure and lack of public policies related to basic sanitation.
Keywords: Geoprocessing, Dengue, SUS (Unified Health System).

INTRODUCTION

Dengue is an arbovirus transmitted by female mosquitoes, mainly of the species *Aedes aegypti* and, to a lesser extent, by Aedes albopictus. These mosquitoes are also vectors for chikungunya, yellow fever and zika viruses. The disease is widespread throughout the tropics, with local variations in risk and influenced by rainfall, temperature, relative humidity and unplanned urbanization. Several studies in Brazil and in the world have already empirically proved this relationship between dengue and temperature and humidity (WHO, 2021).

Dengue is endemic in more than 100 countries in Southeast Asia, the Americas, the Western Pacific, Africa and the Eastern Mediterranean regions, with a 30-fold increase in incidence in the last 50 years (WHO, 2012). In Brazil, the incidence rate was 48.9 cases per 100,000 inhabitants for the year 2021, where the Northeast region accounted for 18.4 cases per 100,000 inhabitants. Compared to 2020, there was a 74.3% reduction in registered cases for the same period analyzed (BRASIL, 2021). In relation to the state of Maranhão, in recent years, it has shown fluctuations in the number of infected with the virus, with the maximum number of probable cases around 24,000 in 2016 alone, representing triple when compared to 2015, where 7,943 were recorded. cases (BRAZIL, 2017).

The increase in the number and severity of dengue cases in Brazil and in the world, stimulates the need to conduct investigations to identify spatial patterns of occurrence in cities with similar characteristics (AUGUSTO LGS et al., 2016). The epidemiological knowledge about the indices in recent years on the dengue scenario in the state, are necessary for an efficient redefinition of public health policies aimed at the prophylaxis, control, diagnosis and treatment of this disease in Maranhão. The objective of this work is to describe, in a retrospective and analytical way, the epidemiological profile and the spatial distribution of dengue cases in the state of Maranhão between the years 2010 to 2020.

METHODOLOGY

STUDY AREA

The present study was carried out in the state of Maranhão, located in the transition zone between the northeast and north regions (SILVA., et al., 2017 & JANUÁRIO, 2018). By the end of this work, the state of Maranhão had an estimated population of 7,153,262 inhabitants and a population density of 19.81 inhab/km2 (IBGE, 2021).

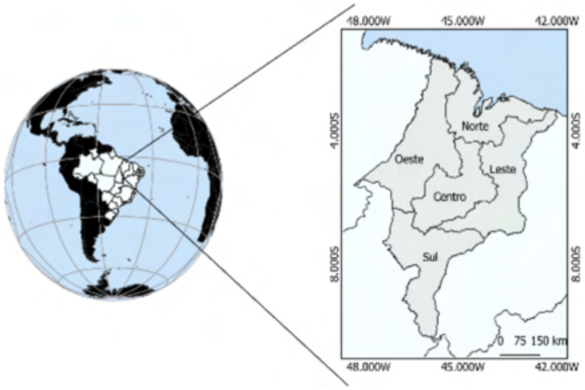


Figure 1 - Location of the study area

STUDY DESIGN AND DATA COLLECTION

This is a descriptive epidemiological study with a quantitative and retrospective approach, using secondary data provided by the State Department of Health of the State of Maranhão (SES-MA) corresponding to a time series of ten years (2010 to 2020).) taking into account all its 217 municipalities. The data were provided by SES-MA upon online request on the e-SIC platform (Electronic System of the Citizen Information Service), in the period of November/2021 in the form of spreadsheets. In addition, shapefiles containing the territorial limits of the study area were acquired from the database of the Brazilian Institute of Geography and Statistics (IBGE), for spatialization of these data.

SAMPLE SELECTION CRITERIA

All confirmed and reported cases of dengue provided by SES-MA during the years 2010 to 2020 were included in the study.

DATA ANALYSIS

The collected data were tabulated in a Microsoft Excel spreadsheet to process the graphs and tables presented in the results. Then, a vector file was generated and imported into the QGIS software to generate a point cloud containing information on the total number of dengue cases from the 10-year average for the 20 municipalities that had the highest rate of the disease. The point cloud was the basis for generating density maps, using the Kernel density estimator. The Heat Map provides a matrix as a result of the stacking sum of "n" other circular rasters of radius h for each input data point, mathematically described by Silverman (1986) as Oliveira & Oliveira (2017) adapted.

Fórmula 1: $f_h(x) = \frac{1}{nh} \sum_{i=1}^{n} K\left(\frac{x-X_i}{h}\right)$

Where K = Kernel function; h = search radius; x = position of the center of each cell of the output raster; Xi = position of point i coming from the centroid of each polygon; and n = total number of dengue cases.

To identify the concentration of dengue cases, 5 classes were used: no municipality (violet), one municipality (purple), two municipalities (orange), three municipalities (dark yellow) and four municipalities (light yellow).

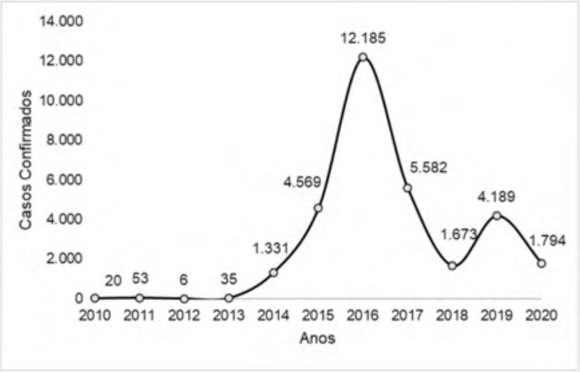
ETHICAL ASPECTS

The study was carried out using secondary data of public access and respecting the ethical principles contained in the Resolutions of the National Health Council (CNS) number 510 of April 7, 2016 (BRASIL, 2016).

RESULTS

CONFIRMED CASES

During the ten years analyzed, Maranhão had a total of 31,437 confirmed cases of dengue, with some years more expressive than others. Figure 2 reveals that the year 2016 had the highest number of confirmed cases, with a peak of 12,185 cases. This year it was possible to observe that São Luís presented 4,490 cases, and the municipalities of Balsas and São José de Ribamar with 1,213 and 813 cases respectively. However, most municipalities had no cases of dengue or had very low values compared to the municipalities mentioned above. This reflex can be observed between the years 2010 to 2013, which recorded few or almost no cases (Table 1).



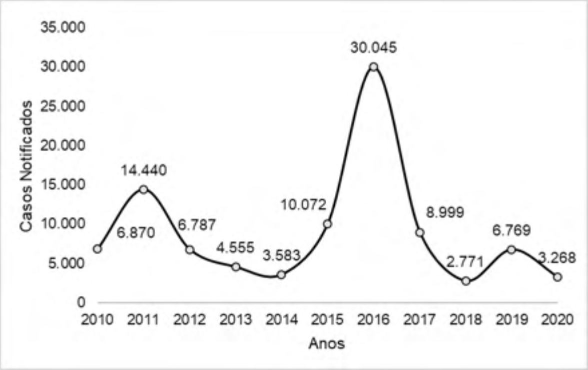
Casos confirmados = Confirmed cases

Anos = Years

Figure 2 - Number of confirmed cases between 2010 and 2020.

NOTIFIED CASES

The number of cases reported in Maranhão was 98,159 cases for the 10 years studied, with emphasis on 2015 and 2016, which presented values of 10,072 and 30,045 cases respectively (Figure 3). As well as confirmed cases, those notified had the highest numbers of notifications in São Luís and Barra do Corda (22,271 and 11,235). However, for the reported cases, gaps were observed in most municipalities, with the exception of the municipalities of Açailândia, Caxias, Imperatriz, Santa Inês, São José de Ribamar and São Luís. This gap does not refer to the lack of observation, but to lower values. than 20 cases not considered in the study (Table 2).



Casos notificados = Notified cases

Anos = Years

Figure 3 - Number of cases reported between the years 2010 to 2020.

KERNEL DENSITY FOR CONFIRMED AND REPORTED DENGUE CASES

The spatialization of confirmed dengue cases for the years 2010 to 2020 showed two large kernel density nuclei, the first is located in the northern region of the state covering the municipalities present on the island of São Luís (São Luís, São José de Ribamar, Paço do Lumiar and Raposa), while the second nucleus was limited to the southwest region of the state (Figure 4a).

In the northern region of the state, the capital stood out for concentrating the largest number (10,363) of confirmed cases, followed by São José de Ribamar with 1,755 cases. Municipalities such as Cururupu, Paço do Lumiar and Pinheiro also characterize the northern region, but with a lower number of cases when compared to the capital (Table 1).

The municipalities that make up the kernel density nucleus in the southwest region of the state of Maranhão (Figure 4a) highlight the municipalities of Imperatriz with a total of 1,146 cases, followed by Bom Jesus das Selvas and Campestre do Maranhão with values of 515 and 385. cases respectively. The municipalities Amarante do Maranhão, Carolina, Formosa da Serra Negra, Governador Edison Lobão, João Lisboa and São Pedro dos Crentes

Municípios	2010	2011	2012	2013	2014	2015	2016	2017	2018	2019	2020	Total
Amarante do Maranhão						32	28	85		62		207
Bacabal							193	38				231
Balsas							1213	707		47	42	2009
Barra do Corda					54	444	682	1985	325	516	318	4324
Bom Jesus das Selvas					24		491					515
Campestre do Maranhão						256		129				385
Carolina					29	22	65	24		154		294
Caxias					88	246	520	310	183	183		1530
Cururupu						124	429					553
Formosa da Serra Negra										128	69	197
Governador Edison Lobão										128	69	197
Imperatriz					85	149	536	202	34	110	30	1146
João Lisboa							214					214
Paço do Lumiar					42	88	153	29	25	62		399
Pinheiro					91	147						238
São José de Ribamar					27	455	813	207	110	118	25	1755
São Luís					641	1931	4490	980	562	1028	731	10363
São Pedro dos Crentes										295		295
Urbano Santos							184					184
Zé Doca						146	466			26		638

Table 1 - Municipalities with the highest number of confirmed cases between 2010 and 2020.

Municípios	2010	2011	2012	2013	2014	2015	2016	2017	2018	2019	2020	Total
Açailândia	144	264	51	75	67	125	1196	182	36	45	35	2220
Balsas	165	131	65	25		189	2120	1943	32	354	270	5294
Barra do Corda		170	136	264	76	581	6467	2080	400	609	452	11235
Bom Jesus das Selvas		20			31	24	540				93	708
Buriticupu		22		25	80	226	592			140		1085
Campestre do Maranhão	22					390	169	194				775
Caxias	82	476	340	104	206	450	1593	358	238	204	33	4084
Chapadinha		63	64	20		226	690	76	27	37		1203
Imperatriz	154	793	278	252	131	209	592	235	61	140	36	2881
Itapecuru Mirim		454	44	31		24	233		65	123	112	1086
João Lisboa		53				20	624					697
Paço do Lumiar	74	218	53	173	117	137	231	82	29	66		1180
Paraibano	40	124	47	31		127	154	79		79		681
Pedreiras	251	133	301	54	26	37			22			824
Santa Inês	51	108	87	57	45	124	120	237	74	149	27	1079
São José de Ribamar	248	405	148	101	75	583	880	240	126	137	59	3002
São Luís	2866	5378	1270	1121	972	2459	4804	1026	582	1054	739	22271
Timon	228	307	376	44	28	150	90	46		24	22	1315
Vargem Grande	56	111	286	78	59	244	480	55	37			1406
Zé Doca		108	29	31	31	155	574			32	22	982

Table 2 - Municipalities with the highest number of reported cases between 2010 and 2020.

Municípios = Cities

are also part of the southwest region, and presented values ranging between 100 and 300 confirmed cases.

Regarding the reported cases, it can be inferred that the spatial patterns showed Kernel density in the same regions of the confirmed cases. But there was a change in the municipalities that make up these regions (Figure 4b). In the northern region of the state, São Luís had 22,271 confirmed cases. And the municipalities of São José de Ribamar and Paço do Lumiar had 3,002 and 1,180 cases.

The western region showed high kernel density in the cities where there were the highest number of cases. As with the confirmed cases, Imperatriz had 2,881 reported cases in this region. Açailândia, Buriticupu and Santa Inês also had high kernel density, with 2220, 1085 and 1079 reported cases respectively. Then Zé Doca, Bom Jesus das Selvas and João Lisboa, with a total of cases ranging between 600 and 1,000 reported cases (Table 2).

DISCUSSION

The distribution of dengue cases in the state of Maranhão has shown significant characteristics in recent years. The study carried out by De Souza et al. (2020) indicated that dengue was responsible for approximately 70% of cases of illness caused by arboviruses between 2010 and 2017. Aragão et al. (2018), showed that the vector responsible for the disease has wide spread throughout the state of Maranhão.

In 2016, as shown in Figure 2, an anomalous period was considered in relation to the occurrence of the disease, the same represented by the study by De Costa (2018), which showed that those infected by the virus, for the same year, represented about 27,702 infected. It is important to consider that the precarious conditions in relation to infrastructure and the population explosion in tropical areas are important factors that can contribute to the proliferation of the vector

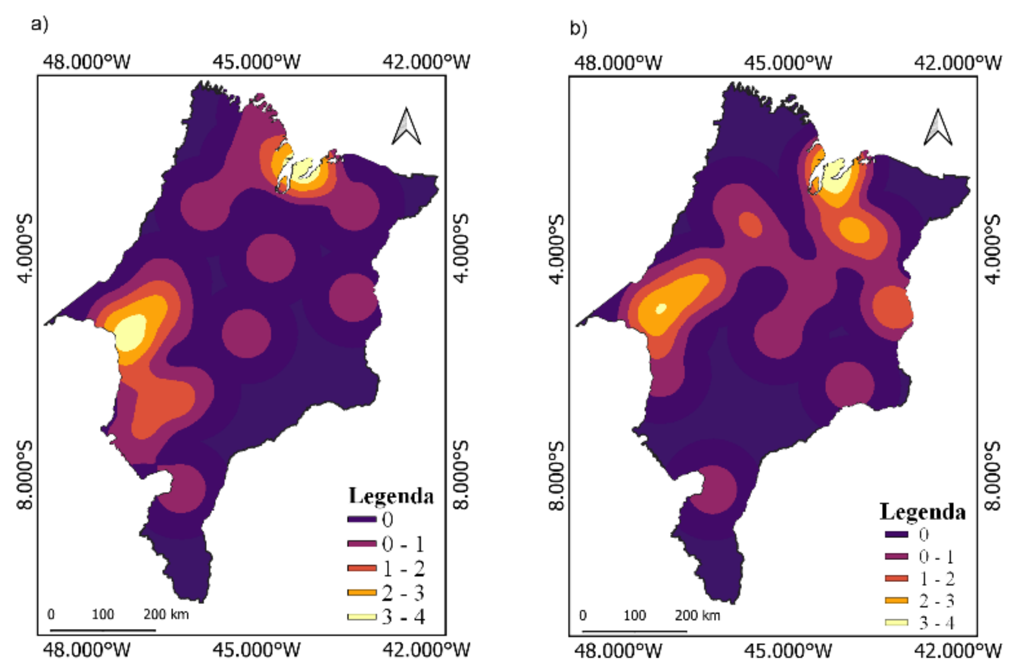


Figure 4 - Kernel density maps of the average between the years 2010 to 2020: a) Confirmed Cases, b) Notified Cases.

and, as a consequence, the transmission of the disease. It can also be inferred that the precariousness of garbage collection and water supply services are predisposing factors (TAUIL, 2001; GUIMARÃES NETO & REBÊLO, 2004).

The disease may also be related to meteorological factors, especially in the first half of the year, when rainfall and temperature reach higher levels in most of Brazil. Despite being considered a seasonal disease, dengue cases can be recorded both in the rainy season and in the dry season (VIANA, 2013).

Martins *et al.* (2015), analyzing 7 years of dengue occurrence in Salvador-BA, they found that 90% of cases occurred in urban area residents, corroborated by the study by Carvalho et al. (2016) who showed that in the state of Maranhão, outbreaks of the disease have important quantitative regional characteristics, with a greater number of cases reported in large urban centers, such as the capital São Luís. due to characteristics such as high population density (FULLER et al., 2017).

Regarding confirmations and notifications in the years between 2010 and 2014, presented in this study, there was a low number of records for both variables. In 2013, for example, 3,588 cases of the disease were reported and in 2014, 2,393 notifications (BRASIL, 2015). Some technical problems may have induced this result, such as: failures in the information system, little interest of professionals in making the notification and structural deficiencies in the assistance of SUS units (CARVALHO, 2016).

Regarding the use of geoprocessing techniques, Nardi (2013) states that the analysis of the spatial distribution of cases of a particular disease supports studies related to transmissibility in regions and areas with wide coverage. It also shows where the population is most affected, in addition to facilitating the work of professionals and decentralizing services. When analyzing the Kernel density map, there was a distribution in focal points in the state, with the highest records in municipalities with close radii (Figures 4a and 4b).

Similar to this study, Barbosa and Lourenço (2010) analyzed the spatio-temporal distribution of dengue in the municipality of Tupã-SP and demonstrated, through this tool, the clusters with the highest number of cases for the disease. Nunes (2013) emphasizes that the use of maps of indexes or incidence rates allows a more refined analysis in relation to the spatial patterns of the risk of the occurrence of a given event.

On the other hand, despite the advantages that geoprocessing offers, this type of approach often uses secondary data, in addition to being studies with an ecological approach that may present biases (ALMEIDA et al., 2007). In addition, epidemiological studies that use secondary data resulting from disease notification can be greatly influenced by the under or overestimation of cases due to diagnostic errors, problems in accessing health services and frequency of asymptomatic infections (TEIXEIRA et al., 2003).

CONCLUSION

The spatial distribution of dengue cases in Maranhão between 2010 and 2020 suggests that the state has two regions with the highest dengue cases, namely the north and southwest, with an epidemiological profile that stood out in 2016, Maranhão reveals a critical state in relation to the occurrence of the disease, which is possibly associated with environmental factors, infrastructure and lack of public policies related to basic sanitation.

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