ISSN:1984-2295

Revista Brasileira de Geografia Física

Homepage: https://periodicos.ufpe.br/revistas/rbgfe

Correlation of dengue cases and pluviometric precipitation, in Pará state, Brazil (2014 to 2019)

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Artigo recebido em 27/07/2021 e aceito em 18/10/2021

ABSTRACT

The climate can lead to the emergence of environments conducive to the proliferation of dengue vectors, in addition to diseases and illnesses related to climatic phenomena. In this context, it is necessary to relate the exposure devices, that is, as associated variables associated with dengue cases. The objective of this research was to carry out a retrospective epidemiological study, with an emphasis on sex, age group and municipalities reporting dengue cases, as well as to correlate the cases of the disease with rainfall levels, in the state of Pará, Brazil. The correlation between rainy periods, transition from rainy to less rainy (C-MC) and less rainy to rainy (MC-C) showed a statistical correlation ($p < 0.05$) with dengue cases in the period studied. Thus, it was found that dengue cases had an increase in the year subsequent to 2018, in which the majority were women with complete high school, in the age group of 20 to 39 years old. Given this scenario, the analysis of epidemiological data is important so that preventive measures and control of the agent are adopted by the government.

Keywords: clinical-laboratory; epidemiological; gender; age group.

Correlação de casos de dengue e precipitação pluviométrica, no estado do Pará, Brasil (2014 a 2019)

R E S U M O

O clima pode levar ao surgimento de ambientes propícios à proliferação de vetores da dengue, além de doenças e enfermidades relacionadas aos fenômenos climáticos. Nesse contexto, é necessário relatar os mecanismos de exposição, ou seja, as variáveis climáticas associada aos casos de dengue. O objetivo desta pesquisa foi realizar um estudo epidemiológico retrospectivo, com ênfase no sexo, faixa etária e municípios que notificaram casos de dengue, bem como correlacionar os casos da doença com os níveis de precipitação, no estado do Pará, Brasil. A correlação entre os períodos chuvoso, transição de chuvoso para menos chuvoso (C-MC) e menos chuvoso para chuvoso (MC-C) apresentou correlação estatística ($p < 0,05$) com os casos de dengue no período estudado. Assim, constatou-se que os casos de dengue aumentaram no ano subsequente a 2018, em que a maioria eram mulheres com ensino médio completo, na faixa etária de 20 a 39 anos. Diante desse cenário, a análise dos dados epidemiológicos é importante para que medidas preventivas e de controle do agente sejam adotadas pelo poder público.

Palavras-chave: clínico-laboratorial; epidemiológico; Gênero sexual; grupo de idade.

Introduction

The human being is the main multiplying host of the dengue virus, although other studies show that monkeys in some countries serve as a source of viruses for mosquitões (Jansen and Beebe, 2010).

The increasing spread of dengue is linked to natural factors, land expansion, increase in the number of vectors associated with climate, especially rainfall, the urban site and streams, which in many cases lack basic sanitation, associated with residues incorrectly left by the residentes (Libanio, Favoreto, Pinheiro, 2014; Barbosa e Silva, 2015; Pelissari, 2016; Kajeguka et al., 2017; Castro et al., 2018; Mai et al., 2018; Paul et al., 2018; Mussato, 2020).

In this context, different studies report the aspects of a socio-environmental nature in relation to the rates of dengue cases. Factors such as age, ethnicity, education and sex have also been associated with cases of dengue infections (Je et al., 2016; Yung et al., 2016; Castanha et al., 2017; Eldigail et al., 2018; Piedrahita et al., 2018; Lee et al., 2019).

Thus, dengue is considered a worldwide pandemic, covering poor and also rich areas, and in the last 50 years its incidence has increased, becoming arbovirus of great importance worldwide (Oliveira, 2019).

Other studies have also traced the profile of dengue in Brazil, such as that of Fernando and Gomes (2018), who found, in Brasilia, in the period from 2007 to 2012, that the majority of reported cases were female, with an equivalent age range of 20 to 39 years old.

Andrade-Oliveira et al. (2018), in Ubá, Minas Gerais, also showed that females were the most affected, however, the age group that most presented rates of the disease was between 15 and 19 years.

In Palmas, from 2015 to 2017, Rodrigues et al. (2020) also reported that females were the most affected and that the age group between 20 and 29 years old was the most affected.

It is noteworthy that the climate can lead to the emergence of environments conducive to the proliferation of dengue vectors, in addition to diseases and illnesses related to climatic phenomena (Mala & Jat, 2019; Tuladhar et al., 2019; Zhang et al., 2019; Zhang et al., 2020; Robert, Stewart-Ibarra, Estalo, 2020). In this context, it is necessary to relate the mechanisms of exposure, that is, as climatic variables to dengue cases.

The hypothesis of this investigation was that the highest occurrence of dengue cases was in children, that is, within the age groups that were between 5 and 14 years old. This is because since 2007, cases that predominantly occurred in adults began to have a higher incidence in children (Agência, 2021).

Based on this information, the objective of this study was to carry out a retrospective epidemiological study, with an emphasis on sex, age group and municipalities for reporting dengue cases, as well as to correlate the cases of the disease with rainfall levels.

Area, material and methods

Study area

The study was carried out, considering all 144 municipalities in the state of Pará, located in the northern region of Brazil, which has a population equivalent to 8,690.7 million inhabitants, in a territory of 1,245,870.707 km², corresponding to 14.66 % of the Brazilian territory (IBGE, 2020) (Figure 1).

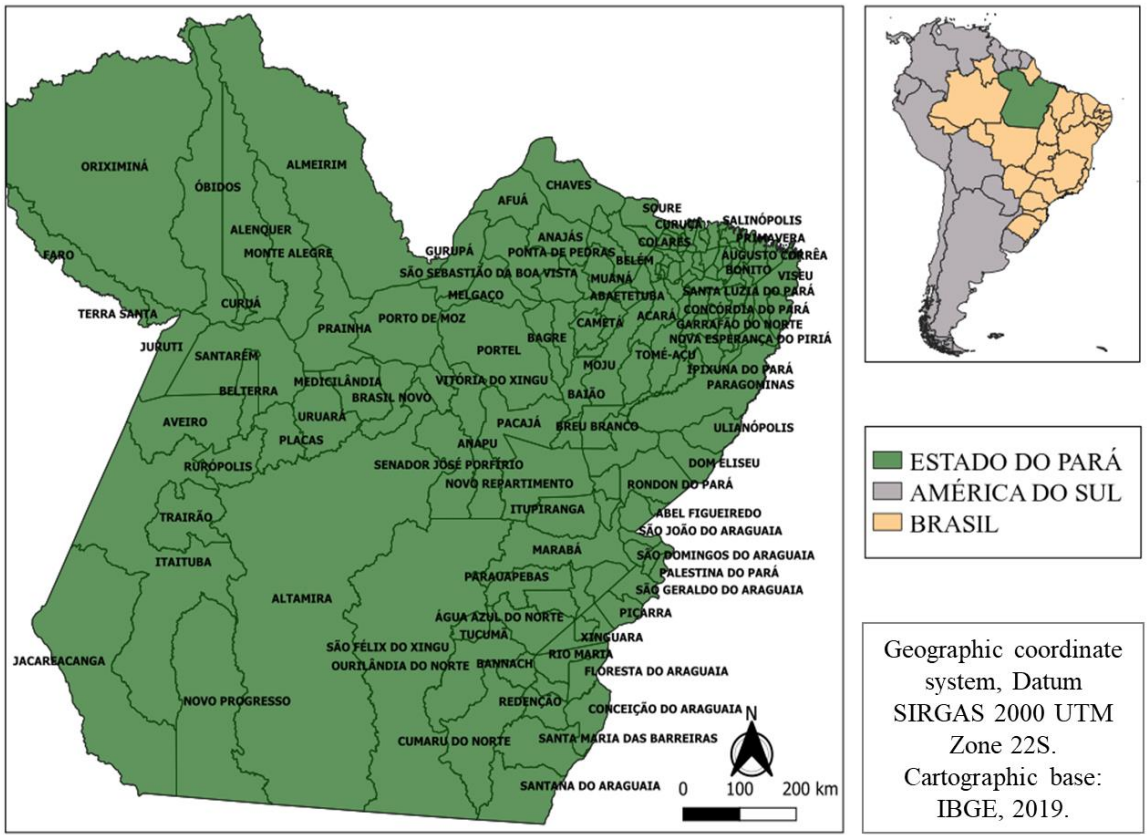

Figure 1. Geographic location map of the studied municipalities.

Climate Information

The state of Pará has a predominantly hot and humid climate, due to its geographical location being located on the equatorial strip. The variation of the average annual temperature is from 22ºC to 32ºC, with rainfall from 1300 to 3500 mm, as described by Parente et al. (2012). Thus, it is noteworthy that precipitation is a variable that presents the most variation in the state, having the highest rainfall index between summer and autumn.

Regarding seasonality, one can see that the least rainy season occurs in the months of June to November, and the most rainy season occurs between the months of December to May (Correa et al., 2016). Between these seasons, the transition period is evident, which refers to the moment when the rainy season changes to the less rainy season, and, from the less rainy season to the rainy season, both occur in the region between the months of May and June, and, November and December, respectively.

Dengue cases

A descriptive study was carried out through the collection of data made available on the website of the Sistema de Informação de Agravos de Notificação online (SINAN Online) about notified dengue cases, in the period from 2014 to 2019, in the state of Pará.

The analysis of the cases was carried out by means of the number of notified cases, considering the variables: sex (male and female), age group (<1 year old, 1-4 years old, 5-9 years old, 10-14 years old, 15 -19 years old, 20-39 years old, 40-59 years old, 60-64 years old, 65-69 years old, 70-79 years old,> 80 years old) and education (AFB: Illiterate, EFI: Incomplete Elementary Education, EFC: Complete Elementary Education, EMI: Incomplete High School, EMC: Complete High School, ESI: Incomplete Higher Education and ESC: Complete Higher Education).

Data were also collected regarding the criteria used to confirm dengue, taking into account the cases diagnosed through laboratory, epidemiological, investigation and "Ignored / White" exams. In addition, the number of cases per municipality (year / month) was verified.

Weather data

Regarding the rainfall data of the state of Pará for the years 2014 to 2019, they were collected

through the digital platform of the National Institute of Meteorology (INMET), from conventional stations, registered with the World Meteorological Organization (WMO), with registration numbers of 82353 (Altamira), 82741 (Alto Tapajós), 82191 (Belém), 82246 (Belterra), 82188 (Breves), 82263 (Cametá), 82861 (Conceição do Araguaia), 82445 (Itaituba), 82562 (Marabá), 82181 (Monte Alegre), 82178 (Óbidos), 82184 (Porto de Moz), 82144 (Salinópolis), 82243 (Santarém), 82668 (São Felix do Xingu), 82141 (Soure), 82194 (Tracuateua), 82145 (Tracuateua) and 82361 (Tucuruí).

Subsequently, the amount of rainfall per month and year was added up, obtaining the total millimeters of rainfall for the state, during the evaluated period.

Statistical description

Inferential analysis of variables was performed by Pearson's chi-square test at 5% significance, with Post-Hoc test, in the comparison between the years, with Bonferroni correction, at a significance level of 0.83%. To check if there is an association between rainfall and dengue cases, in four different periods, rainy (December to May), less rainy (June to November), transition from rainy to less rainy (May to June), from less rainy to rainy (November to December) Pearson's Linear correlation was performed considering 5% significance. All statistical analyzes were performed using RStudio Desktop 1.3.1093 software.

Results

It was found that in the period from 2014 to 2019 a total of 40,560 dengue cases were reported across the state of Pará. It is noteworthy that in 2016 the highest rates for the period studied were recorded with 10,957 cases, followed by a reduction in 2018 with 3,819 cases (Table 1), with a significant increase (0.86%) in 2019.

Table 1. Analysis of dengue cases per year in the sum of all municipalities in the state of Pará, Brazil, in the years 2014 to 2019.

Year	No. of reported cases
2014	4553 e
2015	7900 b
2016	10957 a
2017	7890 b
2018	3819 c
2019	5462 d

Note: Same lowercase letters in the column do not differ by the chi-square test with 0.83% Bonferroni correction.

In relation to the reporting criteria (Table 2), significant differences were evidenced between all the years evaluated for "ignored / White", which presented the highest rate of cases in the year 2016 and 2019, respectively, signaling that there are many underreported cases. In addition, in 2017 and 2019, no significant differences were observed for the clinical-laboratory criterion, which had the highest registration rate in 2015, with significant differences in the other years. The epidemiological criterion was higher in 2016, differing statistically from the other years, with the exception of 2018 and 2019. Finally, the investigation of dengue cases through another criterion differed between the years 2016 and 2017, however, there were no differences between the years 2014 and 2015; 2018 and 2019.

Regarding gender, it was evidenced that of the 40,560 cases notified in SINAN, 22,478 (55.42%) were female, with higher occurrences in 2016 and lower in 2018. In comparison, male was the one with the lowest index of notification with 18,082 (44.58%) cases, with the highest rate in 2017 and the lowest in 2018. In comparison, the male sex was the one with the lowest notification rate with 18,082 (44.58%) cases, with the highest rate in 2017 and the lowest in 2018. The years 2015 and 2017 did not differ statistically for both sexes (Table 3.

Table 2. Confirmation criteria for dengue cases in the state of Pará, Brazil, in the years 2014 to 2019.

Year	Ign. Blank	Laboratorial	Epidemiological	Investigation
2014	1264 e	1166 c	2076 d	47 c
2015	2042 d	3237 a	2571 c	50 c
2016	4121 a	2041 b	4773 a	22 d
2017	2662 c	846 d	4178 b	204 a
2018	1882 d	557 e	1245 e	135 b
2019	3159 b	793 d	1375 e	135 b

Note: Same lower case letters in the column do not differ by the chi-square test with 0.83% Bonferroni correction.

Table 3. Relationship between the gender of the population of the state of Pará, Brazil and the occurrence of dengue cases in the years 2014 to 2019.

Year	Males	Females
2014	2234 c	2313 d
2015	3482 b	4408 b
2016	4515 a	6440 a
2017	3546 b	4342 b
2018	1664 d	2154 e
2019	2641 e	2821 c

Note: Same lowercase letters in the column do not differ by the chi-square test with 0.83% Bonferroni correction.

Table 4 shows the cases of patients with dengue by age group. It is noticeable that there are significant differences between the years studied at most ages. The average age of greatest occurrence is between 20-39 years old with a total of 16,231 cases of dengue in the period from 2014 to 2019, followed by the age between 40 to 59 years old, with 8,540 cases. In contrast, we found that people over the age of 80 had fewer occurrences, with only 248 cases.

Table 4. Relationship between the age group of the population of the state of Pará, Brazil and the occurrence of dengue cases in the years 2014 to 2019.

Year	15 to 19	20 to 39	40 to 59	60 to 64	65 to 69	70 to 79	80 and +
2014	552 c	1806 d	902 e	124 d	74 c	93 c	24 b c
2015	830 b	3182 b	1856 b	218 b	147 b	137 b	43 b
2016	1174 a	4474 a	2358 a	304 a	203 a	230 a	80 a
2017	919 b	3097 b	1548 c	188 c	139 b	159 b	60 a
2018	398 d	1580 e	853 e	99 d	71 c	64 c	20 c
2019	640 c	2092 c	1023 d	125 d	85 c	83 c	21 b c

Note: Same lowercase letters in the column do not differ by the chi-square test with 0.83% Bonferroni correction.

With regard to education, it was observed that people with complete high school have a higher number of dengue cases (5,094 cases). The lowest occurrence of the disease is among the illiterate, with 653 cases. There were also significant differences between years in terms of education (Table 5).

Table 5**.** Relationship between the education of the population of the state of Pará, Brazil and the occurrence of dengue cases in the years 2014 to 2019.

Year	ILT	1 a 4 IES	> 4 IES	5 a 8 IES	CES	IHS	CHS	IHE	CHE
2014	77 c	454 d	189 c	594 d	230 cd	470 c	549 d	59 b	98 c
2015	149 b	685 c	302 b	877 b	376 b	660 b	1224 b	168 a	405 a
2016	206 a	1295 a	489 a	1472 a	513 a	892 a	1420 a	212 a	406 a
2017	94 c	884 b	343 b	730 c	333 b	410 c	608 d	91 b	145 b
2018	64 c	446 d	202 c	408 e	183 d	311 d	522 d	77 b	136 bc
2019	63 c	315 e	142 c	538 d	251 c	416 c	771 c	74 b	167 b

Note: Same lowercase letters in the column do not differ by the chi-square test with 0.83% Bonferroni correction.

Note: ILT: Illiterate, IES: Incomplete Elementary School, CES: Complete Elementary School, IHS: Incomplete High School, CHS: Complete High School, IHE: Incomplete Higher Education and CHE: Complete Higher Education.

Table 6 shows the distribution on the map of the state of Pará, of the cases of dengue in the studied period. Regarding the five municipalities that had the highest number of cases in the years 2014, 2015, 2016, 2017, 2018 and 2019, it is noteworthy that Parauapebas had the highest record of the disease in all the years studied, with 3,388 cases, followed by Pacajá (939 cases), Xinguara (935 cases), Belém (899 cases) and Senador José Ponfírio (897 cases).

Table 6. Number of municipalities with the highest dengue rates in the state of Pará, in the period from 2014 to 2020.

Municipality infection	2014	2015	2016	2017	2018	2019	Total	%
Parauapebas	524	436	325	1051	251	793	3388	8.3444
Pacajá	173	158	220	275	50	61	939	2.3127
Xinguara	11	30	33	856	2	2	935	2.3028
Belém	151	474	210	42	9	13	899	2.2142
Senador José Porfírio	496	181	21	7	1	189	896	2.2068
Alenquer	2	210	521	41	14	2	790	1.9457
Marabá	84	73	156	230	18	37	599	1.4753
Anapu	42	5	45	412	3	90	598	1.4728
Itaituba	37	44	416	31	28	19	575	1.4162
Oriximiná	197	41	291	27	9	5	572	1.4088
Novo Progresso	47	91	240	62	62	56	558	1.3743
São Félix do Xingu	173	68	132	46	63	61	543	1.3374
Tucuruí	1	16	327	145	12	10	511	1.2586
Novo Repartimento	0	1	107	143	91	109	451	1.1108
São Geraldo do Araguaia	52	28	91	217	4	3	395	0.9729
Monte Alegre	3	200	186	3	0	1	393	0.9679
Abaetetuba	3	20	109	137	19	7	295	0.7266
Brasil Novo	64	184	28	1	4	7	288	0.7093
Altamira	187	63	6	7	1	7	271	0.6675
Ourilândia do Norte	15	61	41	73	15	60	265	0.6527
Canaã dos Carajás	9	105	51	25	16	30	236	0.5813
Santana do Araguaia	4	11	141	20	1	59	236	0.5813
Rondon do Pará	6	38	115	42	20	12	233	0.5739
Nova Ipixuna	11	54	90	2	5	60	222	0.5468
Breves	6	159	42	3	2	1	213	0.5246
Redenção	5	26	17	88	60	9	205	0.5049
Conceição do Araguaia	10	2	4	4	2	174	196	0.4827
Jacundá	0	13	64	94	3	17	191	0.4704
Marapanim	0	1	0	0	163	9	173	0.4261
Santa Izabel do Pará	3	144	20	0	2	2	171	0.4212
Tomé-Açu	23	52	86	1	0	3	165	0.4064
Ponta de Pedras	13	115	32	0	1	1	162	0.3990
Castanhal	14	82	11	16	17	11	151	0.3719

Capitão Poço	1	17	36	52	39	2	147	0.3621
Mãe do Rio	0	6	3	0	99	13	121	0.2980
Vigia	2	0	1	83	20	3	109	0.2685
Barcarena	7	10	71	11	4	4	107	0.2635
Itupiranga	34	37	23	3	4	3	104	0.2561
Moju	2	3	3	0	56	37	101	0.2488
Paragominas	5	3	8	39	1	41	97	0.2389
Nova Esperança do Piriá	3	0	15	61	9	4	92	0.2266
Portel	12	58	20	0	2	0	92	0.2266
Pau D'Arco	0	2	40	7	42	0	91	0.2241
Vitória do Xingu	4	16	5	8	16	41	90	0.2217
Prainha	0	36	47	0	0	0	83	0.2044
Palestina do Pará	0	0	0	56	25	0	81	0.1995
Ananindeua	9	29	28	3	7	3	79	0.1946
Marituba	12	31	12	1	14	7	77	0.1896
Uruará	62	4	0	0	0	2	68	0.1675
Tailândia	21	18	9	4	2	13	67	0.1650
Inhangapi	1	49	8	0	6	0	64	0.1576
Rio Maria	1	3	0	26	5	28	63	0.1552
Gurupá	36	6	15	4	1	0	62	0.1527
Salinópolis	9	17	13	1	6	10	56	0.1379
Bannach	3	2	16	8	2	23	54	0.1330
Óbidos	8	10	33	2	1	0	54	0.1330
Almeirim	51	0	0	1	1	0	53	0.1305
Tucumã	9	26	1	3	0	13	52	0.1281
Santarém	20	8	1	2	4	16	51	0.1256
Bagre	0	50	0	0	0	0	50	0.1231
Dom Eliseu	14	4	3	2	2	20	45	0.1108
Brejo Grande do Araguaia	8	17	0	1	14	2	42	0.1034
Cametá	3	25	11	1	0	2	42	0.1034
Abel Figueiredo	9	15	1	6	1	7	39	0.0961
Irituia	4	20	3	2	6	2	37	0.0911
Rurópolis	2	13	2	0	0	20	37	0.0911
São João da Ponta	28	8	0	0	1	0	37	0.0911
Igarapé-Açu	3	3	19	0	3	6	34	0.0837
Benevides	0	23	3	0	1	0	27	0.0665
Cumaru do Norte	0	1	2	9	8	7	27	0.0665
Acará	24	0	1	0	0	0	25	0.0616
Augusto Corrêa	1	20	0	1	2	1	25	0.0616
Ipixuna do Pará	13	3	2	2	0	2	22	0.0542
Colares	0	18	2	1	0	0	21	0.0517
Santo Antônio do Tauá	0	9	9	2	1	0	21	0.0517
São Domingos do Capim	13	4	2	0	1	1	21	0.0517
Breu Branco	2	9	6	1	0	2	20	0.0493

Afuá	0	4	1	2	5	7	19	0.0468
Aurora do Pará	7	2	1	1	7	1	19	0.0468
Medicilândia	11	3	0	1	0	4	19	0.0468
Belterra	0	12	1	0	4	1	18	0.0443
São João de Pirabas	0	1	2	8	2	5	18	0.0443
Soure	1	0	1	15	0	1	18	0.0443
Bragança	1	9	3	2	0	2	17	0.0419
Curionópolis	4	1	10	2	0	0	17	0.0419
Mocajuba	1	9	1	0	0	6	17	0.0419
Placas	1	12	3	1	0	0	17	0.0419
São Domingos do Araguaia	0	0	8	0	0	8	16	0.0394
Juruti	5	2	4	1	3	0	15	0.0369
Limoeiro do Ajuru	0	0	2	13	0	0	15	0.0369
São João do Araguaia	5	2	1	0	1	6	15	0.0369
Santa Bárbara do Pará	0	0	4	0	5	5	14	0.0345
Igarapé-Miri	0	7	4	0	2	0	13	0.0320
Salvaterra	0	5	8	0	0	0	13	0.0320
Oeiras do Pará	1	0	7	3	0	0	11	0.0271
Santarém Novo	0	8	2	0	1	0	11	0.0271
Bonito	0	2	1	1	0	6	10	0.0246
Capanema	0	0	3	0	0	7	10	0.0246
Manaus	4	1	2	2	0	0	9	0.0222
Muaná	1	6	2	0	0	0	9	0.0222
Santa Luzia do Pará	1	1	1	0	4	2	9	0.0222
São Francisco do Pará	0	0	0	2	7	0	9	0.0222
Primavera	0	0	3	5	0	0	8	0.0197
Santa Maria do Pará	0	1	4	0	3	0	8	0.0197
Curuçá	0	0	2	0	5	0	7	0.0172
Mojuí dos Campos	1	4	1	0	1	0	7	0.0172
Santa Maria das Barreiras	2	0	3	0	0	2	7	0.0172
São Caetano de Odivelas	0	0	2	3	0	1	6	0.0148
Tracuateua	1	0	2	1	1	1	6	0.0148
Eldorado do Carajás	0	0	1	2	0	2	5	0.0123
Santana	0	1	0	4	0	0	5	0.0123
Terra Santa	1	0	4	0	0	0	5	0.0123
Baião	0	0	0	0	4	0	4	0.0099
Garrafão do Norte	0	0	1	2	1	0	4	0.0099
Maracanã	1	0	1	1	1	0	4	0.0099
Ulianópolis	0	2	1	1	0	0	4	0.0099
Bom Jesus do Tocantins	0	1	0	1	0	1	3	0.0074
Chaves	0	0	1	2	0	0	3	0.0074

Curralinho	0	0	1	0	1	1	3	0.0074
Floresta do Araguaia	0	0	2	0	0	1	3	0.0074
Piçarra	0	0	0	0	0	3	3	0.0074
Porto de Moz	0	0	3	0	0	0	3	0.0074
Terra Alta	1	2	0	0	0	0	3	0.0074
Água Azul do Norte	1	0	0	1	0	0	2	0.0049
Anajás	1	1	0	0	0	0	2	0.0049
Aveiro	0	1	1	0	0	0	2	0.0049
Colinas do Tocantins	0	0	0	0	0	2	2	0.0049
Concórdia do Pará	0	0	0	1	1	0	2	0.0049
Macapá	1	1	0	0	0	0	2	0.0049
Quatipuru	0	0	0	0	2	0	2	0.0049
São Luís	1	0	1	0	0	0	2	0.0049
São Miguel do Guamá	0	0	0	0	1	1	2	0.0049
São Sebastião da Boa Vista	0	2	0	0	0	0	2	0.0049
Açailândia	0	0	1	0	0	0	1	0.0025
Araçu	0	1	0	0	0	0	1	0.0025
Barreirinha	0	0	1	0	0	0	1	0.0025
Barueri	0	0	0	0	0	1	1	0.0025
Caçu	0	1	0	0	0	0	1	0.0025
Campina Grande	0	0	0	0	1	0	1	0.0025
Campinas	0	1	0	0	0	0	1	0.0025
Curuá	0	0	0	1	0	0	1	0.0025
Fortaleza do Tabocão	0	0	0	0	0	1	1	0.0025
Goianésia do Pará	0	0	0	0	1	0	1	0.0025
Grajaú	0	0	0	0	0	1	1	0.0025
Imperatriz	0	0	1	0	0	0	1	0.0025
Jacareacanga	0	0	0	0	0	1	1	0.0025
Laranjal do Jari	1	0	0	0	0	0	1	0.0025
Londrina	0	0	0	0	1	0	1	0.0025
Magalhães Barata	0	0	0	0	1	0	1	0.0025
Melgaço	1	0	0	0	0	0	1	0.0025
Muriaé	0	0	1	0	0	0	1	0.0025
Paraíso do Tocantins	0	0	0	0	0	1	1	0.0025
Porto Velho	0	0	0	1	0	0	1	0.0025
Rio de Janeiro	0	0	0	1	0	0	1	0.0025
São José do Rio Preto	1	0	0	0	0	0	1	0.0025
Sapucaia	0	0	0	1	0	0	1	0.0025
Trairão	0	0	0	1	0	0	1	0.0025
Valente	0	0	1	0	0	0	1	0.0025

There was a correlation between rainy periods, transition from rainy to less rainy (R-LR) and less rainy to rainy (LR-R) and dengue cases in the studied period. The less rainy period was not correlated with dengue cases (Table 7).

Discussion

In Pará, the non-adoption of prophylactic measures by the residents, possibly associated with the non-implementation and implementation of control measures by the government (Brasil, 2017), may have contributed to the state reaching more than 40 thousand cases of dengue in the period from 2014 to 2019, with the year 2016 having the highest rates of the disease accounted for, showing the increase in cases in 2019, when compared to the year 2018. This same justification can explain the highest rates of dengue cases in Parauapebas, Pacajá, Xinguara, Belém and Senador José Ponfírio.

The confirmation criterion most used in this study was the epidemiological and not the clinical-laboratory one. However, both had the highest rate of use for diagnosis during clinical routine, a fact also observed in the study by Santos et al. (2019). However, it is noteworthy that the laboratory diagnosis becomes extremely important, as it aims to confirm dengue cases through serological tests and viral identification, making it possible to map the circulating serotypes and avoiding diagnostic errors, and consequently, the underreporting of cases (Cordeiro, 2012).

Regarding age group, we can see that the dengue cases showed significant differences between the years studied, with the highest occurrence of age between 20-39 years old, corresponding to the economically active class. Similar results were evidenced by Silva and Camargo Junior (Silva and Camargo Junior, 2015) who identified a higher incidence of dengue cases in people aged 20 to 39 years old, in Santarém, Pará. Similar results were recorded in the state of Pernambuco, in the Brazilian territory, by Nascimento et al. (2020). Oliveira et al. (2018) also showed a greater number of notified cases of the disease in the age group of 20 to 49 years. Other similar results with the dengue age group among young adults were also observed in the study by Roque et al. (2015), Carvalho et al. (2016), Santos et al. (2016), Ferreira et al. (2018), Santos et al. (2019) and Silva et al. (2020).

People over 80 years old had the lowest case rates, which can be explained by underreporting or because this group has a lower rate of people.

In this study, patients with complete high school had the highest number of dengue cases and the illiterate had the lowest rate, indicating that this disease can affect people from different social groups. Thus, we can observe that the level of education does not necessarily influence citizens' knowledge about the disease, which could cause ignorance and, consequently, increase the number of cases, due to their vulnerability. However, it is noteworthy that education is a variable of complex interpretation, due to the low rates of filling out identification forms, as already reported by Predroza (2012), Braz et al. (2013), Santos et al. (2013) and Guimalhães and Cunha (2020).

Table 7. Correlation of the seasons in relation to dengue cases in the state of Pará, Brazil, in the years 2014 to 2019.

Season	r	[(1)]p-valor
Rainy	0,365	<< 0,0001
Less rainy	- 0,028	0,650
Transition R – LR	0,435	<< 0,0001
Transition VR - M	- 0,267	<< 0,0001

[(1)]p- values greater than 0.05 indicate that there is no linear Pearson correlation.

In this study, patients with complete high school had the highest number of dengue cases and the illiterate had the lowest rate, indicating that this disease can affect people from different social groups. Thus, we can observe that the level of education does not necessarily influence citizens' knowledge about the disease, which could cause ignorance and, consequently, increase the number of cases, due to their vulnerability. However, it is noteworthy that education is a variable of complex interpretation, due to the low rates of filling out identification forms, as already reported by Predroza (2012), Braz et al. (2013), Santos et al. (2013) and Guimalhães and Cunha (2020).

In this study, it was evident that the greatest number of cases occurred among women. This can be explained, possibly, due to the distribution of the mosquito (*Aedes aegypti*), because it inhabits peridomiciliar areas, an environment more experienced in the greater part of the time by the women, or they seek more the hospital service for diagnosis and treatment (Ferreira et al., 2018). Other studies have also shown similar results, such as those by Oliveira et al. (2014) and Cunha and Bohland (2012).

Precipitation and dengue cases correlated with rainy periods, shifting from rainy to less rainy (R-LR) and from less rainy to rainy (LR-R) ($p < 0.05$). This is related to the increase in rainfall indexes that provide an increase in the production of larvae, pupae and, consequently, a higher rate of dengue cases, a fact reported by Gomes et al. (1992) and Zeidler et al. (2008). In addition, even with the climatic differences evident in the regions of Brazil, several authors call attention to the increase of dengue cases when the rainy season starts, a fact verified by Chearavallotti (1997), Rebelo et al. (1999), Farottini et al. (2000), Pinheiro and Tadei (2002), Souza et al. (2007), Costa et al. (2008), the first and third being carried out in the state of São Paulo, and the others in Maranhão, Manaus, Paraíba and Minas Gerais, respectively.

With results similar to those shown, but in the northeast region of the Brazilian territory, Santos et al. (2019) also identified a correlation between precipitation and dengue cases. The same results were reported in the Northern region of Brazil by Silva et al. (2016) and Castro et al. (2018), and in different world continents (Dhimal et al., 2015; Paul et al., 2018; Chanprasopcha, Pongsumpun, Tang, 2017).

The non-correlation of the less rainy period with dengue cases can be explained by the volume of precipitation having decreased during this period, which minimizes the presence of mosquito breeding sites.

This study was able to identify possible groups with a greater chance of suffering dengue cases and this can be used to facilitate, perhaps contributing to improve the epidemiological surveillance of these groups regarding the occurrence.

Conclusion

We conclude that dengue cases increased in 2019, with an association between precipitation and dengue cases, notably there was a correlation between rainy periods (December to May), transition from rainy to less rainy (May to June) and less rainy to rainy (November to December), in which most cases were found in women with complete high school, aged between 20 and 39 years. Given this scenario, the analysis of epidemiological data is important so that preventive measures and control of the agent are adopted by the government.

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