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ORIGINAL ARTICLE

EPIDEMIOLOGICAL ANALYSIS OF DENGUE IN A BRAZILIAN NORTHEAST REGION POPULATION

ANÁLISE EPIDEMIOLÓGICA DA DENGUE EM UMA POPULAÇÃO DO NORDESTE ANÁLISIS EPIDEMIOLÓGICO DEL DENGUE EN UNA POBLACIÓN DEL NORDESTE

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ABSTRACT

Objective: to describe the epidemiological situation of dengue. **Method:** descriptive and ecological study using secondary data of dengue reported cases obtained in the National Notifiable Diseases Information System (SINAN) during the period from 2007 to 2013. The variables analyzed were time (year / month) and demography (gender and age) levels and the rate of infestation. The descriptive analysis was performed using Graphpad Prism 5.0 software. **Results:** of the 21,579 reported cases, 19,686 were classified as dengue fever, 98 as dengue with complications, 44 as dengue hemorrhagic fever and 1 as dengue shock syndrome. The prevalence of reported cases was female (12,180 cases) and individuals aged from 20 to 49 years old (9,978 cases). The children were the most affected by dengue hemorrhagic fever (21 cases). **Conclusion:** surveillance health and entomological strategies are needed to combat the vector of the disease. **Descriptors:** Dengue; Epidemiology; Information System for Notifiable Diseases.

RESUMO

Objetivo: descrever a situação epidemiológica da dengue. **Método:** estudo descritivo e ecológico que utilizou dados secundários dos casos notificados de dengue obtidos no Sistema Nacional de Agravos de Notificação (SINAN) durante o período de 2007 a 2013. As variáveis analisadas foram a nível temporal (ano/mês) e demográfico (sexo e faixa etária) e a taxa de infestação predial. A análise descritiva foi realizada pelo software Graphpad Prism 5.0. **Resultados:** dos 21.579 casos notificados, 19.686 foram classificados como dengue clássica, 98 como dengue com complicações, 44 como febre hemorrágica da dengue e 1 síndrome do choque do dengue. Predominância dos casos notificados foi do gênero feminino (12.180 casos) e dos indivíduos na faixa etária de 20-49 anos (9.978 casos). As crianças foram as mais acometidas pela febre da dengue hemorrágica (21 casos). **Conclusão:** estratégias de vigilância em saúde e entomológica são necessárias para o combate ao vetor da doença. **Descritores:** Dengue; Epidemiologia; Sistema de Informação de Agravos de Notificação.

RESUMEN

Objetivo: describir la situación epidemiológica del dengue. **Método:** estudio descriptivo y ecológico que utilizó datos secundarios de los casos notificados de dengue obtenidos en el Sistema Nacional de Problemas de Notificación (SINAN) durante el período de 2007 a 2013. Las variables analizadas fueron a nivel temporal (año/mes) y demográfico (sexo y edad) y la tasa de infestación predial. El análisis descriptivo fue realizado por el software Graphpad Prism 5.0. **Resultados:** de los 21.579 casos notificados, 19.686 fueron clasificados como dengue clásico, 98 como dengue con complicaciones, 44 como fiebre hemorrágica del dengue y 1 síndrome del choque del dengue. Predominancia de los casos notificados fue del género femenino (12.180 casos) y de los individuos en la edad entre 20-49 años (9.978 casos). Los niños fueron los más afectados por la fiebre del dengue hemorrágico (21 casos). **Conclusión:** estrategias de vigilancia en salud y entomológica son necesarias para el combate al vector de la enfermedad. **Descriptores:** Dengue; Epidemiología; Sistema de Información de Problemas de Notificación.

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INTRODUCTION

It is estimated that dengue is responsible for about 100 million cases per year, threatening around three billion people in the world.¹ Dengue is the most important arboviral disease of tropical and subtropical regions, being one of the major public health problems, causing concern due to its epidemic character. The disease has a high proliferation in tropical countries because of the hot / wet weather and environmental conditions.^{2,3,4}

Brazil has environmental and climatic conditions favorable for the proliferation of the mosquito vector of the disease. In recent years, the country has gone through geographical and social changes, such as rapid urbanization that facilitates the emergence of epidemics in the country, since the *Aedes aegypti* is widely associated with human activities.⁵ The reinfestation by *Aedes aegypti* in urban areas of Brazil, and the introduction of DENV in 1986 resulted in the resurgence of dengue outbreaks and an increased risk of urbanization of yellow fever in the country.⁶

In 1986, a sequence of dengue epidemics occurred in Rio de Janeiro and spread in various regions of the Southeast and Northeast of Brazil. Between 1987 and 1991, the number of dengue cases notifications increased substantially, possibly due to the introduction of DENV-1 and DENV-2 serotypes. The first cases of dengue hemorrhagic fever were confirmed in 1990 after the introduction of DENV-2 in Brazil. During the following decade, 893 cases of DHF were reported, with 44 deaths. During 2001-2002, a marked increase in the number of DHF cases was identified, with incidence rates of 2.9 / 100,000 inhabitants in 2001, and 12.9 /100.000 inhabitants, in 2002.⁷

From the 2000s, some Brazilian states have presented epidemic character: Rio de Janeiro, São Paulo, Bahia and Minas Gerais.⁸ In 2010, dengue outbreaks have been documented in many parts of the country involving the DENV-1, DENV-2 and DENV-3 serotypes. In the state of Roraima (1981-1982), the DENV-4 serotype reappeared and spread to other regions of the country increasing the risk for the development of severe forms of the disease, since the hosts had no immunity to the DENV-4 and due to the occurrence of previous epidemics caused by other serotypes, culminating in new epidemics, besides increasing the number of deaths.^{9,10}

In Alagoas, dengue has been a public health problem since 1996 and is considered the most important endemic disease. When investigating the historical series of the State

of Alagoas in the years 1996-2013, it was observed epidemic peaks in the years 1998, 2002, 2003, 2007, 2008. The year 2010 stood out as the most critical, with the introduction of DENV-3 serotype and recirculation of DENV-1 serotype, and in 2012 the detection of DENV-4 serotype, which resulted in the occurrence of severe forms of the disease.¹¹

The incubation period by the dengue virus is from 3 to 15 days; at this time, the disease can present a clinical spectrum ranging from asymptomatic forms to severe and fatal illness. Infection with any of the serotypes presents an epidemiological picture that can vary in severity, depending on the presence of risk factors such as the serotype of the infecting virus, virulence, immune status of the individual, age and genetic pattern of human host.¹²

The adoption of methods for epidemiological survey has been stimulated by the World Health Organization (WHO) and the Pan American Health Organization (PAHO), for ensuring quality and speed information is essential so that necessary measures to combat the mosquito vector can be developed.¹⁷ Considering this perspective, the information obtained through secondary data may reflect epidemiological characteristics of dengue and thus provide information to support vector control measures. Given the importance of knowing the epidemiological aspects of dengue in the state of Alagoas, due to the complexity of the disease, this study aims to analyze the epidemiological situation of dengue in the city of Arapiraca - Alagoas from 2007 to 2013.

METHOD

♦ Study area

The city of Arapiraca is located in the state of Alagoas, in the Northeast region of Brazil. The municipality composes the Agreste region of Alagoas, with a total area of 352 km², being the main city of the interior of the state, with approximately 214,006 inhabitants, according to the 2010 census. Of these, 101,884 inhabitants are men and 112,122 are women.¹³ It has an approximated altitude of 264 m and geographical coordinates of 9°45' 09" South latitude and 36°39' 40" West longitude.¹⁴ According to the Köppen classification, this city has a tropical climate, with dry seasons in summer and rainy in winter.¹⁵

♦ Study design

It is a study of descriptive and ecological type that used secondary data obtained from the National Notifiable Diseases Information

System (SINAN). All reported cases of dengue in Agreste region of Alagoas from 2007 to 2013 were included.

◆ **Data source**

The results were obtained from the National Notifiable Diseases Information System (SINAN) through the mandatory reporting forms that were in the Municipal Health Department of Arapiraca. The variables analyzed were time (year / month) and demography (gender and age). The population data used to calculate incidence rates and building infestation rates were obtained from the Brazilian Institute of Geography and Statistics (IBGE), based on the 2010 census.

◆ **Classification of cases**

The classification of cases was according to the categorization of the World Health Organization¹⁶, in which the cases reported, after epidemiological investigation, can be concluded as confirmed cases, dismissed, inconclusive and ignored. The reported / confirmed cases were classified as Dengue Fever (DF), Dengue Hemorrhagic Fever (DHF) Dengue with complications (DWC), Dengue Shock Syndrome (DSS) and Dismissed.

◆ **Statistical analysis**

For the analysis of dengue incidence in the city of Arapiraca it was considered the basis of 100,000 inhabitants, whereas for the specific population by sex the basis used was 10,000 inhabitants. The calculation of the

incidence rate (IR) of dengue was obtained by the formula: $IR = \text{reported cases} \times 10n / \text{exposed population}$.¹⁷ The method used to calculate the incidence rate was the total population and finally stratified according to sex and age group obtained from the IBGE (2010).

As for the vector aspects, it was described the building infestation rate (BIR), calculated from the annual average in percentage according to the second cycle of activities. The source of data on BIR of each cycle during the study period was obtained from the Municipal Health Department of Arapiraca. For data analysis, it was used the chi-square test (χ^2), in which the data were considered statistically significant if $p < 0.05$, using the Graphpad Prism 5.0 program.

RESULTS

In the period from 2007 to 2013, SINAN reported a total of 21,579 cases of dengue in the city of Arapiraca. Regarding classification, 19,686 were classified as Dengue Fever (DF), 98 as Dengue With Complications (DWC), 44 as Dengue Hemorrhagic Fever (DHF), 1 as Dengue Shock Syndrome (DSS), 1,178 cases were dismissed, 508 inconclusive and 64 blank cases. The incidence and the number of dengue cases according to year can be seen in Fig. 1.

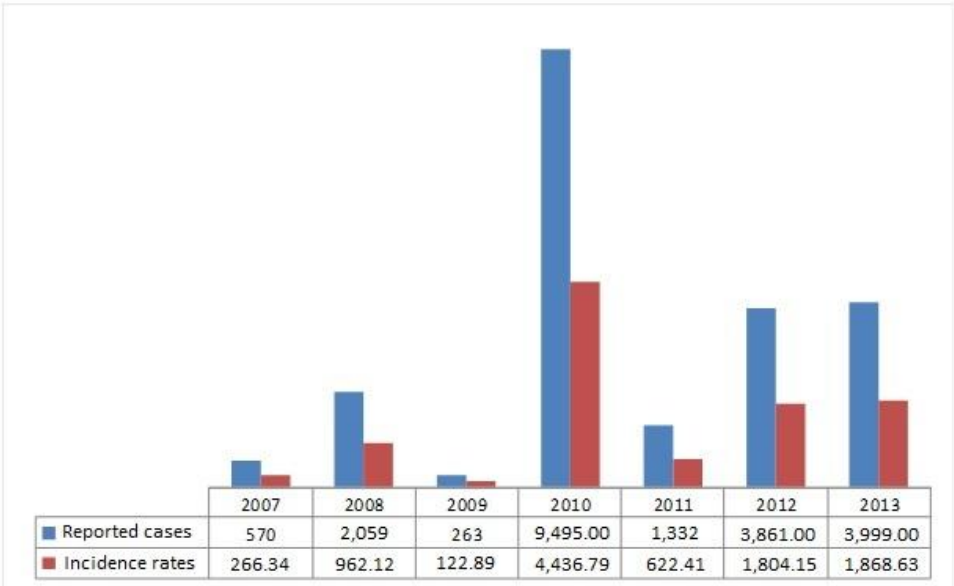


Figure 1. Reported dengue cases and annual incidence per 100,000 inhabitants in the city of Arapiraca, Alagoas 2007-2013.

The age distribution showed that dengue and dengue hemorrhagic fever affected individuals of all ages. Among the cases of dengue hemorrhagic fever, the age group that had the highest number of reported cases was

between 5 and 9 years old. The subsequent most affected age groups were between 20 and 34 years old and between 1 to 4 years old. In the age group of more than 80 years old it was not recorded any notification of cases of DHF (Tabela 1).

The highest rate was recorded in females, representing 57% of the notifications (12,289 cases), whereas males accounted for 43% (9,278 cases). The year that exposed the largest number of DHF cases was 2010, with 34 cases, in which 19 cases were registered in women and 15 in men. The difference was statistically significant in the cases reported during the study period in both sexes, in which the most affected gender was female ($p < 0.0001$). Consequently, the incidence rate (IR) by gender was elevated in women (**Fig.2**).

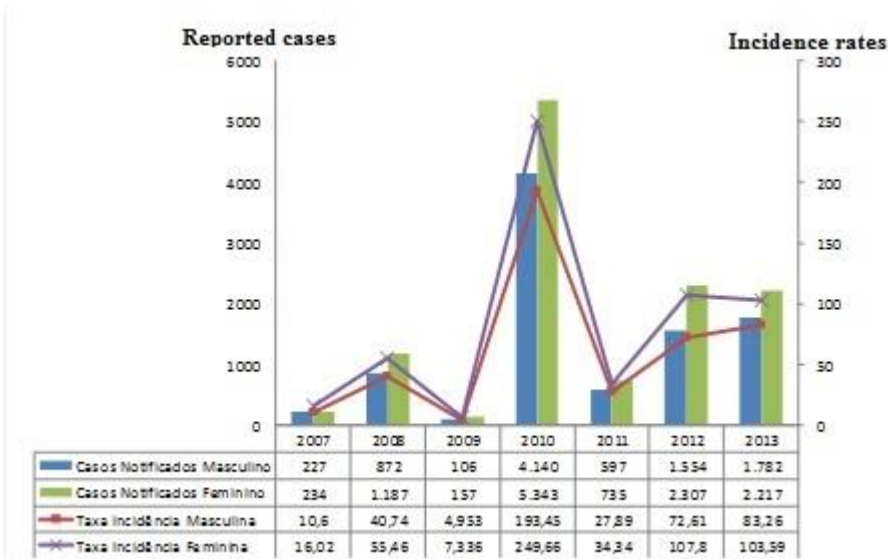


Figure 2. Reported cases and incidence rate of dengue per year, according to gender in the city of Arapiraca, Alagoas 2007-2013.

According to the World Health Organization, the incidence rate for dengue is classified into control (IR <100 cases / 100,000 inhabitants), alert (IR between 100 and 300 / 100,000 inhabitants) and epidemic situation (IR > 300 cases / 100,000 inhabitants). Thus, the municipality in 2007 and 2009 was in a state of alert by having an incidence between 100 and 300 cases per 100,000 inhabitants.

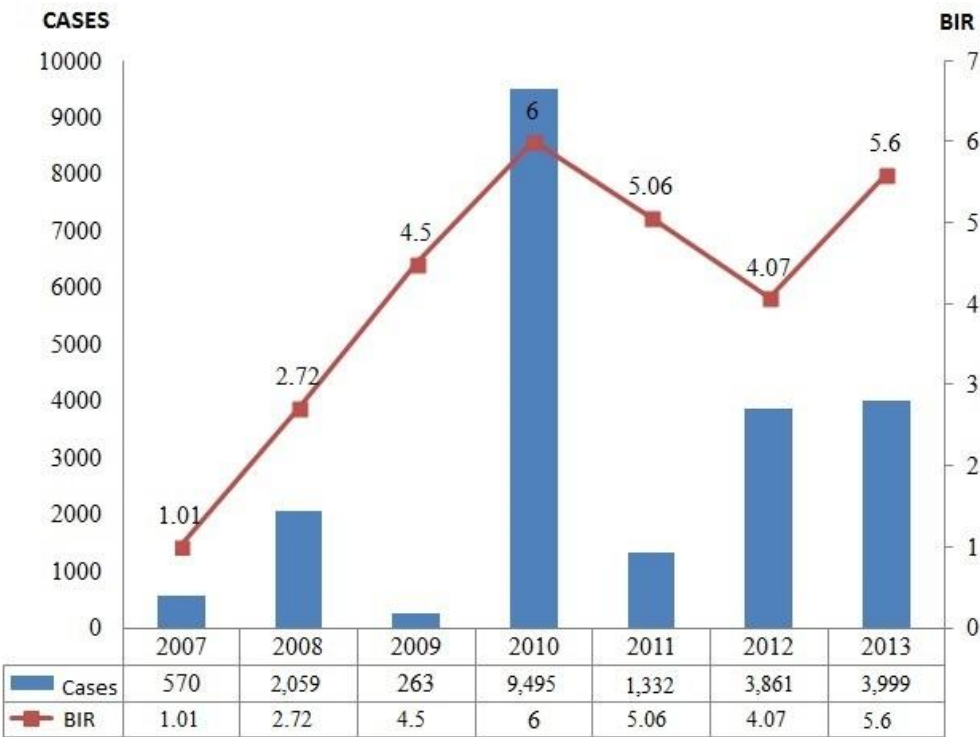
In 2008, 2010, 2011, 2012 and 2013, the situation was epidemic, because the incidence rate showed values greater than 300 cases per 100,000 inhabitants. The year with the highest number of reported cases was in 2010, with 9,495 cases and with an annual incidence that exceeded 4,000 cases per 100,000 inhabitants.

Table 1. Distribution of notification of cases of dengue and dengue hemorrhagic fever in accordance with the age group and the SINAN in the city of Arapiraca, Alagoas, 2007-2013.

Age group	2007		2008		2009		2010		2011		2012		2013		Total
	DF	DHF	DF	DHF	DF	DHF	DF	DHF	DF	DHF	DF	DHF	DF	DHF	
<1 year old	18	0	68	0	12	0	142	1	20	0	61	0	57	0	379
1-4	33	1	228	2	25	0	711	2	36	2	199	0	148	0	1387
5-9	49	1	357	0	30	0	1,266	12	94	0	234	0	300	0	2343
10-14	63	0	305	0	29	0	1,347	3	92	0	330	1	369	0	2539
15-19	54	0	224	0	29	0	1,160	1	203	0	529	0	609	1	2810
20-34	200	0	512	1	78	1	2,565	7	441	0	1,465	0	1,419	0	6689
35-49	100	0	234	0	41	0	1,378	5	198	0	692	0	664	0	3312
50-64	44	0	98	0	12	0	652	2	94	0	266	0	290	0	1458
65-79	9	0	31	0	7	0	193	1	140	0	73	0	107	0	561
>80	*	0	*	0	*	0	30	0	4	0	8	0	28	0	70
Ignored	-	-	2	-	*	-	51	-	10	-	4	-	8	-	75

In 2007, it was observed in Arapiraca a period of 4 months with a high incidence rate that corresponded to May until August. In the following months there was a decrease in cases of incidence, becoming increased from April 2008, following by the month of May (IR = 413.07 cases / 100,000 inhabitants).

From July 2008 there was a low incidence rate, remaining like this in 2009, presenting the highest incidence rate in May, with 27.56 cases / 100,000 inhabitants (Fig.3).



onthly incidence rate and average infestation rate (AIR) of dengue in the city of Arapiraca, Alagoas, 2007-2013.

In 2010, there is highlight to the months of March, April and May. The most critical point observed in this year was in April, which presented the highest incidence rate during the study period (1,284.54 cases / 100,000 inhabitants), followed by May (1,242.02 cases / 100,000 inhabitants). In the following months there was a decrease in the incidence; however, the year 2011 presented only in March an increase in the incidence rate (107.94 cases / 100,000 inhabitants).

In 2012, there is highlight for the incidences in the first five months, in which the month of April had 438.77 cases / 100,000 inhabitants. From June the dengue incidence rates remained low until the first four months of 2013, returning to rise in the months of May, June and July with more than 200 cases / 100,000 inhabitants.

Considering the dengue incidence rate in the city of Arapiraca, all months reported disease occurrences (Table 2).

Table 2. Number of cases and monthly incidence rate (IR) of dengue in the city of Arapiraca, Alagoas, 2007-2013.

Month	2007		2008		2009		2010		2011		2012		2013	
	Cases	IR	Cases	IR	Cases	IR	Cases	IR	Cases	IR I	Cases	IR	Cases	IR
Jan	4	1.8	11	5.1	4	1.8	60	28	33	15.4	658	307.46	48	22.42
Feb	3	1.4	10	4.6	12	5.6	243	113	183	85.5	437	204.19	27	12.61
Mar	11	5.1	42	19.6	26	12.1	2.1	1,019	231	107.9	585	273.35	52	24.29
Apr	16	7.4	815	380	21	9.8	27	1,284	133	62.1	939	438.77	346	161.67
May	74	34.5	884	413	59	27.5	2,658	1,242.02	133	62.1	521	243.45	555	259.33
Jun	100	46.7	237	110	49	22.8	867	405	108	50.4	216	100.93	600	280.36
Jul	135	63	35	16	24	11.2	391	182	53	24.7	173	80.83	617	288.30
Aug	138	64.4	8	3.7	20	9.3	154	71.9	58	27.1	89	41.58	338	157.93
Sep	37	17.2	5	2.3	10	4.6	69	32.2	63	29.4	151	70.55	367	171.49
Oct	21	9.8	4	1.8	6	2.8	36	16.8	38	17.7	40	18.69	380	177.56
Nov	20	9.3	3	1.4	12	5.6	46	21.4	105	49	23	10.74	408	190.64
Dec	11	5.1	5	2.33	20	9.3	40	18.6	194	90	29	13.55	261	121.95

Considering the total number of reported cases of dengue in each month during the study period, one can see the seasonal aspect of the occurrence of cases in the city of Arapiraca. It was also possible to observe the occurrence of dengue in all months of the year, which shows an endemic picture, showing a considerable increase of notifications from March, followed by the months of April and May, and decreasing from June on.

Significance levels for the building infestation rate (BIR) can be considered as satisfactory (BIR <1%), alert (between 1% and 3.9%) and risk (BIR > 3.9%) ²³. Alert situations in relation to the building infestation index were identified in Arapiraca during the period evaluated in this study. From 2009 until 2013 the municipality presented characteristics of risk of outbreak, and 2010 was the most

critical with the annual average of BIR of 6%. Among the cycles per year, the highest (9.3%) and the lowest (0.2%) were found in the second cycle of 2010 and in the first cycle of 2007, respectively.

The years 2009 to 2013 (Table 3) showed a BIR characteristic of risk of outbreak for dengue with IR for epidemics in the years 2010 to 2013. The year 2009, even with a risk BIR, did not show an IR characteristic of epidemic for dengue. That same year, an alert rate for dengue culminated in 2010 with higher BIR and IR. In 2011, there was a considerable decrease in the incidence rate compared to 2010, but the same decrease was not attributed in the BIR between 2010 and 2011. Between 2011 and 2012, there was a reduction of BIR, but with an increase in IR in 2012.

Table 3. Monthly incidence rate of dengue in the city of Arapiraca, Alagoas, 2007-2013.

Monthly incidence rate							
Months of the year	2007	2008	2009	2010	2011	2012	2013
January	1.86	5.14	1.86	28.03	15.42	307.46	22.42
February	1.4	4.67	5.6	113.54	85.51	204.19	12.61
March	5.14	19.62	12.14	1.019.59	107.94	273.35	24.29
April	7.47	380.83	9.81	1.284.54	62.14	438.77	161.67
May	34.57	413.07	27.56	1.242.02	62.14	243.45	259.33
June	46.72	110.74	22.89	405.12	50.46	100.93	280.36
July	63.08	16.35	11.21	182.7	24.76	80.83	288.3
August	64.48	3.73	9.34	71.96	27.1	41.58	157.93
September	17.28	2.33	4.67	32.24	29.43	70.55	171.49
October	9.81	1.86	2.8	16.82	17.75	18.69	177.56
November	9.34	1.4	5.6	21.49	49.06	10.74	190.64
December	5.14	2.33	9.34	18.69	90.65	13.55	121.95

DISCUSSION

In 2008, 2010, 2011, 2012 and 2013, records showed the epidemic character of dengue, where incidence rates showed values greater than 300 cases per 100,000 inhabitants. This temporal characteristic was shown in the literature corresponding to the range of 3 to 5 years for the onset of an outbreak ¹⁸, however, the space between the years in this study is different from the reported. In view of that particularity in the municipality analyzed, it is necessary to investigate other aspects that can describe which peculiarities are involved in this differentiation of outbreak intervals.

The year with the highest number of reported cases was in 2010, with 9,495 cases and an annual incidence reached 4,436.79 cases per 100,000 inhabitants. The epidemiological risk of dengue infection has been identified for the population of Arapiraca with high incidence and building infestation of the disease. A similar scenario was observed in other cities of the country: Uberaba in Minas Gerais. ¹⁹

In the year 2010, there was a hyperendemic transmission model that implies in an increase of the severe forms of dengue and therefore an increased mortality of the disease due to the presence of sequential infections antibodies. The first infection antibodies do not neutralize the second virus and further increases the infection, since the immunity of the first infection is permanent, but temporary to the other serotypes, resulting in a significant increase of cross-infection. ^{20,21}

Females have a higher frequency in cases of dengue fever, dengue with complications and dengue hemorrhagic fever. This difference has been observed in other studies in Brazil. ^{19, 22,23} The explanation for this would be the presence of the disease vector next to homes, a favorable environment for the chain of transmission, and since women spend most of their time in their homes, this increases the risk of transmission. ⁵

Individuals of all ages have developed dengue infection, however the age group most affected by dengue fever was the 20-49, totaling 9,978 cases of dengue reported in the

city. Other studies have shown a higher incidence in the age group 20-49 years old.^{22,23 24} The age group of 5-9 was the one with the most reported cases of dengue hemorrhagic fever (13 cases), followed by ages between 1 and 4 years old (7 cases) and between 20 and 34 years of age (9 cases). This corroborates with other studies in the literature.^{22,23,25}

The literature refers that for the development of the most severe form of dengue it is necessary that the individual has a history of at least two different serotypes infections, thus the secondary infection can be a risk factor for the development of dengue hemorrhagic fever.²⁶ Other issues, such as host characteristics, such as age, ethnicity, presence of chronic diseases and genetic components have been reported in the literature.^{27,28,29} This study demonstrated that the presence of infection by more than one serotype is possibly not related to worsening of clinical symptoms of dengue.

Regarding the analysis of annual average of BIR in the municipality, the lowest average was recorded in 2007 (1.01%) and the highest in 2010 (6.0%). When the BIR and dengue cases were related, it was realized that this indicator (BIR) did not affect the course of the epidemic, as in years when the BIR values were high the reports of cases were low, with the exception of the year 2010, when both values were showed. The presence of mosquito foci was not correlated with the increased infection.

Considering the total number of reported cases of dengue in each month during the study period it was possible to identify the seasonal aspect in which there was the occurrence of dengue cases in all months of the year, which demonstrates an endemic process of the disease. The months from March to July showed the highest incidence rates of the disease. The year 2010 was the one with the highest rates (1,284.54 cases / 100,000 inhabitants) when compared to the other years. The results show a significant increase of notifications from March, followed by months of April and May, decreasing from June in all evaluated years, corroborating the study of Ribeiro.⁵

The profile of high notifications observed in the months from March to May of the study period (2007 to 2013) and progressive decrease from June on may be related to the rainfall profile of the city, since they form the ideal scenario for the development of mosquito vector, enabling the implementation of perfect breeding sites for the *Aedes aegypti*. Xavier¹⁵ analyzed the behavior of

rainfall in Arapiraca city and found that the rainy season begins in March so that the above months are considered with the highest rainfalls. It is worth mentioning that there are other factors that favor the occurrence of disease, such as humidity, temperature, poor infrastructure of cities, meteorological variables and rainfall.^{5, 28}

It was observed that in 2009 the city had an alert index for dengue culminating in 2010 with a higher BIR and IR during the study period. The high rates observed in 2010 may be related to the introduction of DENV-3 serotype in the state of Alagoas. In 2011, there was a considerable decrease in IR compared to 2010, but the same decrease was not the characteristic in the BIR between 2010 and 2011. Between 2011 and 2012 there was a decrease in the BIR, but an increase in IR in the year 2012, which can be explained by the introduction of DENV-4.

A study in the state of Goiás correlated the BIR and rainfall to dengue cases, concluding that from January to April the spread of the disease was high, coinciding with the rainy season due to the larval density of the mosquito that varied with the climatic variations, demonstrating higher density in the months with high rainfall, due to the availability of breeding sites for the development of the vector, resulting in increased incidence.³⁰

This study found that the city of Arapiraca presented alert state in 2007 and 2009 and epidemic character for the years 2008, 2010, 2011, 2012 and 2013. The epidemiological risk of dengue infection for the population was high, with high rates in 2010. Female had a higher frequency in cases of dengue fever and dengue hemorrhagic fever. Regarding the age range, the 1-9 years old was the most affected with the fever of dengue hemorrhagic fever.

From this research, it was found that the epidemiological situation of dengue in Arapiraca municipality is configured as a public health problem. The development of measures for controlling and combating outbreaks of disease, while the entomological surveillance becomes crucial because, in the absence of effective vaccine against the disease, vector control and the elimination of breeding sites are the only way possible to combat the spread of disease.

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