Cogitare Enfermagem

ORIGINAL ARTICLE

TIME TREND AND SPATIAL DISTRIBUTION OF DENGUE IN BRAZIL

Thiago Rodrigues da Silva[1]
Ana Karla Araújo Nascimento Costa[1]
Kelle Araújo Nascimento Alves[1]
Alisson Neves Santos[1]
Matheus de França Cota[1]

ABSTRACT

Objective: to determine the time trend and spatial distribution of the confirmed dengue cases in Brazil between 2009 and 2019. Method: this is an ecological and longitudinal study of a historical series of the dengue cases available in the Information System of Notifiable Health Problems. The data were analyzed by means of time trend and spatial distributions. Results: the study denoted a stationary trend of the incidence coefficient ($R=0.091$; $p>0.05$). The Midwest region stood out among the Brazilian regions, with 42.04% incidence. In relation to the Brazilian states, Acre was the one with the highest incidence: 45.06%. Finally, regarding the severe form of dengue, the Southeast region stood out with 38.35% of the cases. Conclusion: based on the epidemiological analyses, it was concluded that, in Brazil, dengue is still a relevant public health problem, given the high number of cases.

DESCRIPTORS: Spatial Distribution; Epidemiology; Public Health.

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[1]Centro Universitário de Guanambi. Guanambi, BA, Brasil.

INTRODUCTION

Dengue consists of an acute febrile infectious disease caused by a virus from the *Flavividae* family that has four serotypes in Brazil, namely DENV-1, DENV-2, DENV-3, and DENV-4, and is disseminated by mosquitoes from the *Aedes* genus, with the main vector being *Aedes aegypti*. Transmission takes place through bites by female *A. aegypti* mosquitoes[1]. Dengue represents one of the main public health problems worldwide, especially in tropical and subtropical countries, whose socioenvironmental characteristics contribute to development and proliferation of the vector[2].

According to data published by the World Health Organization (WHO), in the last decades there has been an increase in the number of dengue cases worldwide, rising from 505,430 in 2000 to 2.4 million in 2010, a number that was further increased to 4.2 million cases in 2019[3]. According to the Pan American Health Organization (PAHO), in 2020, the American continent reached the highest number of already cataloged cases, corresponding to more than 1.6 million. In turn, Brazil was the country that most stood out, with a total of 2,070,170 notified cases[4].

In the Brazilian setting, 987,173 cases of the disease were recorded in 2020, with an incidence of 469.8 cases for every 100,000 inhabitants. The Midwest region was the one with the highest incidence with 1,212,1 cases for every 100,000 inhabitants, followed by the South, Southeast, Northeast and North regions with 940.0, 379.4, 263.8 and 119.5 cases, respectively[5].

Dengue also represents a serious public health problem due to the severity of its infection, with the possibility of evolution to death. Consequently, conducting this study is significantly relevant, as research studies using time trend and spatial distribution allow monitoring the scope of the disease. Although the Ministry of Health has periodically published Epidemiological Bulletins, it is noted that organizing data into a time series makes it possible to analyze occurrence of the phenomenon, evidencing the evolution of the risks to which people are or were exposed and supporting causal explanations, which contributes to planning public policies targeted at prevention measures by assessing the impact of the interventions performed[6].

Given this context, the objective of this study is to determine the time trend and spatial distribution of the confirmed dengue cases in Brazil from 2009 to 2019.

METHOD

This is an ecological and longitudinal study of a historical series of the confirmed dengue cases in Brazil between 2009 and 2019. Brazil presents an estimate of 210,147,125 inhabitants, is constituted by 26 states and by the Federal District, encompassing 5,570 municipalities[7].

All cases confirmed by laboratory and clinical-epidemiological diagnosis from 2009 to 2019 were considered for analysis, excluding those discarded, under investigation and inconclusive, totaling 2,021,293 cases.

The data were collected by means of records available in the Information System on Notifiable Health Problems (*Sistema de Informação de Agravos de Notificação*, SINAN) database, linked to the Informatics Department of the Unified Health System (*Departamento de Informática do Sistema Único de Saúde*, DATASUS). The basis for classifying the cases and the variables that comprised the study are in accordance with the WHO classification, namely: dengue (with/without warning signs) and severe dengue[3].

The analysis included the following variables: gender, age group, schooling level, race, severe clinical form of dengue, and mean incidence coefficient.

In relation to data tabulation, it was performed in Microsoft Excel® 2016, where the graphs and tables were also generated. The statistical analysis was developed in the SPSS software, version 22.0.

The Kolmogorov-Smirnov (K-S) normality test was performed for the statistical analysis. As the hypothesis for this sample group was not verified, non-parametric tests were applied. The time trend analysis resorted to the Spearman's correlation coefficient to assess the intensity and direction of the monotonous relationship between the independent variables (X), the years evaluated (from 2009 to 2019), and the dependent variables (Y), dengue cases. A 5% ($p<0.05$) significance level was employed in this study.

The Spearman's correlation coefficient (R) was calculated by means of the following formula: (R=1-6∑id12/n(n2-1). Where n is the number of data points of both variables and di is the reach difference of the "n" element. When the p-values were significant ($p<0.05$) and the Spearman's coefficient was positive, the trend would be increasing. If this value was negative, it would be decreasing; and it would be stationary when the p-value was not significant ($p>0.05$)[8].

The comparative analysis between the clinical characteristics and gender was performed using the chi-square test, and the sociodemographic and epidemiological variables were compared between the groups using Analysis of Variance (ANOVA). Regarding calculation of the mean incidence coefficient, the incidence of the cases in each of the years from the time clipping was determined. For calculation, the number of new dengue cases in the regions and states in a given year was used as numerator, and the estimated population multiplied by 100,000 was the denominator[9]. Finally, the calculation was performed by means of the sum of the incidence results corresponding to each year, divided by the total of years in the period analyzed. The estimated population provided by the Brazilian Institute of Geography and Statistics (*Instituto Brasileiro de Geografia e Estatística*, IBGE)[7] was used for the calculations in question.

With regard to the classification of severe dengue cases, considering the previous categorization adopted up to 2013, dengue cases with complications, dengue hemorrhagic fever, and dengue shock syndrome were included[10]. In addition, severe dengue cases were included in the new classification, from 2014 onwards[11]. This classification was due to the fact that those forms of the disease present critical complications such as shock, severe bleeding and multiple organ impairment, leading to disease worsening[12].

The ArcGIS 10.4 software was used for geo-referencing, in which the thematic maps were prepared[13]. In order to prepare the maps, the geographical coordinates and the continuous cartographic databases of the Brazilian states and regions made available by the IGBE were introduced[14]. Finally, the data to be analyzed were introduced.

As this study involved secondary data, it waived Research Ethics Committee review; however, the entire research was conducted in compliance with the recommendations established by Resolution No. 466 of the National Health Council, dated December 12th, 2012[15].

RESULTS

A total of 7,927,927 notified and recorded dengue cases from 2009 to 2019 were eligible. Regarding the incidence coefficient for dengue (Figure 1), a stationary trend was observed, with R=0.091; $p>0.05$.

In relation to the mean incidence coefficient (Figure 2), the Midwest region stood out among the Brazilian regions, with a mean incidence of 765.00 cases for every 100,000 inhabitants, followed by the Southeast region (490.57 for every 100,000 inhabitants). In relation to the mean incidence coefficient by Brazilian states (Figure 3) from 2009 to 2019, Acre was the one with the highest incidence of cases, with 1,502.06 cases for every 100,000 inhabitants, followed by the states of Goiânia (988.21 cases for every 100,000 inhabitants), Mato Grosso do Sul (856.83 cases for every 100,000 inhabitants), Minas Gerais (769.39 cases for every 100,000 inhabitants), Espírito Santo (755.85 cases for every 100,000 inhabitants), and Mato Grosso (621.46 cases for every 100,000 inhabitants).

Table 1 - Percentage of the dengue cases according to sociodemographic profile in Brazil between 2009 and 2019. Guanambi, Bahia, Brazil, 2021

Profile	**N**	**(%)**	**X^2***	**p**
Gender				
Male	3,499,413	44.14	2,627.26	<0.001
Female	4,419,447	55.74		
**Unknown/Blank	9,067	0.11		
	N	(%)	F**	p
Age group				
≤19	2,114,290	26.67		
20-39	3,052,697	38.50		
40-59	1,979,613	24.97	5.50	0.003
≥60	758,823	9.57		
Unknown/Blank***	22,504	0.28		
Schooling				
Illiterate	52,394	0.66		
Incomplete 1st-4th grade	349,147	4.40		
Complete 4th grade	213,632	2.69		
Incomplete 5th-8th grade	559,713	7.06		
Complete Elementary School	299,125	3.77		
Incomplete High School	419,682	5.29	8.86	<0.001
Complete High School	881,911	11.12		
Incomplete Higher Education	129,830	1.64		
Complete Higher Education	236,742	2.99		
Unknown/Blank**	4,299,483	54.23		
Does not apply***	486,268	6.13		
Race				
White	2,457,483	31		
Black	302,662	3.82		
Asian	58,488	0.74	17.56	<0.001
Brown	2,411,608	30.42		

Indigenous	20,036	0.25	
Unknown/Blank***	2,677,650	33.77	

*Chi-square test
**ANOVA test
***The unknown variables did not comprise the significance test.
Source: SINAN/MS/SVS, 2021.

Regarding the sociodemographic variables (Table 1), the results point to predominance of cases and percentages in the female gender (55.75%) (p<0.001) and among people aged from 20 to 39 years old (38.50%) (p<0.003). In relation to schooling, higher percentages are observed in Complete High School (11.12%) (p<0.001) and in unknown and blank cases (54.23%) (p<0.001). In terms of race, the results presented higher percentages in the white race (31.00%) and in unknown and blank cases (33.77%) (p<0.001).

Table 2 – Number of cases of the severe form of dengue by Brazilian regions between 2009 and 2019. Guanambi, Bahia, Brazil, 2021

Year	Midwest* (N)	Northeast* (N)	North* (N)	Southeast* (N)	South* (N)
2009	3,078	2,833	1,147	3,530	10
2010	844	1,228	574	1,486	113
2011	134	1,178	230	1,517	106
2012	259	523	93	342	3
2013	515	355	100	688	97
2014	369	279	30	346	54
2015	399	309	52	1,088	128
2016	221	120	17	518	139
2017	136	83	14	72	4
2018	181	104	23	104	2
2019	325	281	42	754	59
Total (N)	6,461	7,293	2,322	10,445	715

Source: SINAN/MS/SVS, 2021.

Regarding the number of cases of the severe form of dengue (Table 2), the Southeast region was the one with the highest number during the time series, with 10,445 cases, denoting a decreasing trend (R=-0.627; p<0.05), followed by the Northeast region, also with a decreasing trend (R=-0.882; p<0.05), and by the Midwest, with a stationary trend (R=-0.482; p>0.05), North (R=-0.855; p>0.05), and South (R=-0.145; p>0.05) regions.

DISCUSSION

This study evidenced a stationary trend in the incidence coefficient, with incidence rates ranging from low to high in the time series analyzed. A study conducted in Central America reported a similar finding[17]. This stationary trend, with high and low peaks, is associated with the rainy season; and climate is strongly related to dissemination of the mosquito, which requires ideal conditions for its reproduction, in addition to aspects related to infrastructure that may contribute to proliferation of the vector[22].

The results revealed a high mean incidence of cases in the Midwest and Southeast regions. This situation was similar to the one observed in another study conducted in Brazil from 2002 to 2012[18]. This finding may result from the inefficiency of surveillance and control actions aimed at preventing the disease[19]. This is related to the fact that actions and prevention of infections caused by the dengue virus are a challenge in Brazil, as they involve social and environmental issues such as environmental aggression, investments in environmental sanitation, and need for the participation of governments and society. Therefore, adopting strategies and control programs targeted at addressing these issues would be an advance in the disease prevention and control policy[20].

In relation to the state with the highest mean incidence, although incidence was higher in the Midwest and Southeast regions, the results showed that Acre was the state with the highest mean incidence among the Brazilian states. This finding corroborates that of another research study conducted in Rio Branco, capital city of the state of Acre, Brazil[21]. It is suggested that this scenario is related to unplanned urbanization and deforestation, as such factors play a significant role in the increased incidence of dengue[20]. In addition to that, the spread of globalization, with changes in landscape, provided favorable conditions for transmission of the dengue virus, thus contributing to the high number of cases[18].

Regarding the gender variable, predominance of females was observed, a finding that is consistent with a study conducted in Brazilian capital cities[22]. This predominance may result from the higher prevalence of women in intra- or peri-domicile environments, places where most of the dengue foci are found[23]. In addition to that, this finding can be associated with the fact that men seek health services less frequently, leading to a lower number of notifications in the male gender[24].

In relation to age, there was predominance of individuals from 20 to 39 years old. This result was in line with that of a research study conducted in the municipality of Araraquara, São Paulo[25]. This finding can be due to the fact that people of this age represent the economically active population, who work or study during the day, thus being exposed to the vector, which leads to higher rates of dengue transmission[17].

As for schooling, there was a higher percentage of individuals with Complete High School. A similar result was found in a study conducted in the inland of Mato Grosso, Brazil[26]. This finding is possibly correlated with the fact that even individuals with knowledge and access to diverse information about the disease do not implement preventive and control measures and, as a consequence, are exposed and vulnerable to the vector[27]. There was also a high number of unknown and blank cases in the schooling variable and a high number of unknown cases in the race variable. This result can be due to failures in the system of notification and health problems, suggesting that the professionals responsible for filling out the data ignore some information when completing notification forms[28].

In relation to the race variable, there was predominance of white-skinned individuals, consistent with a research study conducted in the municipality of Primavera do Leste, Mato Grosso[29]. Literature findings show that dengue has no relationship with people's race. The increasing trend denoted in the study is possibly associated with the fact that people belonging to these races migrate to endemic regions, exposing themselves to infection[21].

With regard to the severe form of dengue, similar to what was found in the study in question, a reduction in the number of severe cases was also observed in a study conducted in Brazil and in Federation units[30]. This result suggests early disease diagnosis, which made it possible to identify warning signs that indicate disease severity, as well as to perform an appropriate clinical management of the patients, contributing to a reduction in the number of severe cases[23].

It is worth noting that, as the current study used secondary data, it does have some limitations such as underreporting; therefore, the numbers herein presented may not correspond to the actual incidence of the disease.

CONCLUSION

Although dengue presented a stationary trend in the incidence coefficient, the results show the predominance of this arbovirus in the Brazilian territory, with a high number of cases during the time frame analyzed, which evidences the need for more effective disease control actions, including training of health professionals to fill out the forms, as there was a high number of unknown cases.

The results found indicate that, even with control and combat measures, dengue still represents an important public health problem given the high number of cases, with the need to improve actions associated with prevention and control of this disease. In addition to that, actions to reduce the number of dengue cases should be implemented, focusing on the regions and states with the highest incidence values and through strategies aimed at controlling the vector and educational actions to raise awareness in the population.

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Corresponding author:
Thiago Rodrigues da Silva
Centro Universitário de Guanambi (UNIFG)
Avenida Pedro Felipe Duarte, 4911
E-mail: thiagor.biomed@gmail.com

Role of Authors:
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