Analysis of the temporal space distribution of reported Dengue cases: a systematic review of the literature

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Abstract: Dengue is considered an infectious pathogenesis of acute evolution, which in recent years has seen an increase in the number of cases, constituting a serious public health problem in the world, especially in tropical countries, where environmental conditions favor the development and proliferation of Aedes aegypti, the main vector mosquito. This study aimed to randomizer a systematic review of the literature in order to understand how the temporal space distribution of dengue cases occurs. A survey of the literature was carried out in July 2019, in the periodic databases CAPES and Google Scholar. The descriptors used were: "Temporal space distribution" AND "Dengue" AND "Geoprocessing". A total of 10 articles were selected and included according to the eligibility criteria. The inclusion criteria were articles in English, Spanish and Portuguese, in the last five years, involving analysis of the temporal space distribution of reported dengue cases. Geoprocessing techniques and geostatistics have made it possible for ecological studies to make more evident the participation of the conjunction of factors, including contextual factors, in the determination of the disease by incorporating effects of the specific characteristics of each social space. The sand-time analyses of dengue cases allowed the knowledge of the geographic distribution of the disease. As well as the techniques of analysis of time trends defined as useful areas in all studies allowed the development and construction of practices applied in the process of prevention and health promotion.

Keywords: Geoprocessing; *Aedes aegypti*; epidemiology.

1. Introduction

Dengue is transmitted by viruses of type (RNA virus) and is considered an infectious pathogenesis of acute evolution. The human being is infected through the bite of the female insect Aedes aegypti. It has variable signs and symptoms, presenting symptomatic oligo forms, classical forms (febrile) and severe hemorrhagic forms, and may even present hypopovoic cardiovascular syndrome (Xavier *et al.*, 2014). It is described as one of the most relevant tropical diseases worldwide due to its high incidence. Related to climatic variables and socioeconomic, socio-environmental and political conditions, which favor the proliferation of the entire vector in the territory (Carvalho *et al.*, 2017).

According to the World Health Organization (WHO), 2015 was the year with the highest epidemic peaks in brazil' dengue disease, surpassing the epidemiological records consolidated in previous years, 2010 and 2013, described as the period in which notifications presented a categorization pattern. Once epidemiological investigation occurs, reported cases can be completed as: confirmed cases, discarded cases, inconclusive and ignored cases. Inadequate filling out of forms or the presence of gaps in their production and management can directly affect the quality of an information system (Brazil, 2016a).

However, several environmental, individual, vector and virus factors directly influence the incidence of asymptomatic infections. The occurrence of short-term nonspecific fever, accompanied by pharyngitis, rinitis and mild cough, has its highest concentration in lactating and preschoolers. Occasionally it is possible that this febrile condition pops associated with maculopapular eruption, impairing its diagnosis exclusively in clinical databases (Brazil, 2016b).

On the other hand, space is no longer considered only as a geographical delimitation, beginning to contemplate the social, economic and political relationships and dynamics that have changed it throughout history. In this sense, the development of spatial analysis represented a valuable tool for understanding how a given context affects the health of the population and population groups (Kleinbaum *et al.*, 1998). There is a set of time trend analysis techniques that may be useful in epidemiological studies and their more frequent use will certainly lead to new developments in health prevention and promotion practices. Likewise, geoprocessing techniques and analysis models for spatial distributions can provide new tools for describing diseases in population. The conceptual refinement of the categories used for the characterization of the most affected groups may also increase the explanatory power of descriptive studies (Clayton & Hill, 1993).

However, in recent years, there has been an increase in the number of cases, constituting a serious public health problem in the world, especially in tropical countries, where environmental conditions favor the development and proliferation of Aedes aegypti, the main vector mosquito: acute febrile disease, of viral etiology and benign evolution in the classical form, and when presented in hemorrhagic form.

Considering the various studies that demonstrate and affirm the relationship of environmental determinants and climatic factors under the dynamics of endemic smaemias, and knowing the pertinence and magnitude of dengue in Brazil and worldwide, the development of a systematic review of the literature becomes relevant. The present study aimed to conduct a systematic review of the scientific literature in order to understand how the temporal space distribution of dengue cases occurs.

2. Methodology

A survey of the literature was carried out in July 2019, in the periodic databases CAPES and Google Scholar. The descriptors used were: "Temporal space distribution" AND "Dengue" AND "Geoprocessing" in both databases. A total of 10 articles were selected and included according to the eligibility criteria according to Figure 1. Inclusion criteria were: articles in English, Spanish and Portuguese in the last five years, involving analysis of the temporal space distribution of reported dengue cases. Exclusion criteria were literature review articles or meta-analysis.

3. Results

The results of the present study are found in Table 1.

4. Discussion

Dengue is characterized as a serious public health problem, responsible for about 100 million sick peoplefor years7, making it necessary to implementincentive programs to control and combat its vector, Aedes aegypti (Fernandes & Gomes, 2018).

According to reports[3], dengue epidemics in Brazil have emerged since 1846, being the first concrete indication of the occurrence of an epidemic in 1982, when the serotypes DENV1 and DENV4 were isolated in the municipality of Boa Vista (RR). The year 2015 showed a total of 815,903 cases reported for dengue disease in Brazil (Barbosa *et al.*, 2015). The World Health Organization highlighted that 2015 presented superior epidemiological records related to the number of notifications made for dengue, offering a worldwide picture of an increase in the incidence rate of this disease (Brasil, 2016a). There is a higher concentration of notification of serotype DENV1 (64% and 82%, respectively) followed by the SEROTYPE DENV4 (32% and 16%, respectively) in Brazil in the years 2014 and 2015 (Brazil, 2016a, 2016b).

According to the records consolidated in 2015, 1,649,008 dengue cases were requested in the country. The Southeast region had the highest number of reported cases (1,026,226 cases, 62.20%), followed by the Northeast (311,519 cases, 18.9%), Midwest (220,966 cases, 13.4%), South (56,187 cases, 3.4%) and North (34,110 cases, 2.1%). From January to September 2016 (up to the 37th

epidemiological week), 1,438,624 confirmed dengue cases were reported to the Ministry of Health nationwide, 762 of severe dengue and 7,449 dengue with alarm signs (Brazil, 2016b).

In reference to the analysis of the temporal space distribution of reported dengue cases, the correct application of the geoprocessing and statistical analysis technique directly contribute to the interpretation of the factors that implied the occurrence of the disease (Skaba *et al*., 2004). On the result of the time series performed by Defavari *et al*. (2017), the increase in the incidence rate of dengue, allowed, alert the authorities to a probable endemic reaction of the disease in the studied area.

However, municipalities should be cautious when applying the geoprocessing tool as a unit of analysis, especially when it comes to investigating the behavior of a disease described in a time series. The spatial statistical analysis is considered in this context, responsible for identifying probable correlations of the event and space (Carvalho *et al*., 2018).

As for the spatial association of dengue, Defavari *et al*. (2017) demonstrates that during the years 2011, 2012 and 2013 there was a spatial association of dengue with neighborhoods, representing an increase in the incidence rate of the disease. There is a spatial dependence between the nearest neighborhoods. With regard to spatial distribution analysis, the Kernel estimator is considered a nonparametric method for estimating density curves, where each observation is weighted by distance relative to a central value, the nucleus.

Performing a count of all points within a region of influence, pondering them by the distance of each one in relation to the location of interest.   A prominent instrument for planning actions, since it can and should be used to better understand the factors that contribute to the occurrence of dengue (Barbosa & Lourenço, 2010).

Geoprocessing techniques and geostatistics have made it possible for ecological studies to make more evident the participation of the conjunction of factors, including contextual factors, in the determination of the disease by incorporating effects of the specific characteristics of each social space. Although with limitations, this approach contributes so that epidemiology can integrate, dialectically, the social with the natural, as supported by the thinkers of social epidemiology (Skalinski *et al*., 2019).

According to Skaba *et al*. (2004), the georeferencing techniques applied properly can consolidate an evaluation of the spatial distribution of assertive dengue, leading to an understanding and interpretation of factors related to the occurrence of reported cases. However, it is necessary that the storage of the data in the information systems is compiled correctly.

In a study conducted by Flauzino *et al*. (2009), in the city of Niterói, RJ, applied the Kernel estimator, it is suggested that after the use of kernel density and proportion, the areas that present the highest occurrence of dengue may be related to the social vulnerability of individuals.

It is noteworthy that Scandar *et al*. (2010), states that the use of data geoprocessing can directly assist in the perception and analysis of data, ingesting and deliberating the construction of tools to support the fight against epidemics.

5. Conclusion

The sand-time analyses of dengue cases allowed the knowledge of the geographic distribution of the disease, identifying non-homogeneous patterns, with concentrations in vulnerable areas: social, economic and environmental. As well as the techniques of analysis of time trends defined as useful areas in all studies allowed the development and construction of practices applied in the process of prevention and health promotion. Similarly, geoprocessing trends and analysis models for spatial distributions provided tools for the detailed description of dengue.

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Attachments

Table 1 - Statement of the articles that make up the Integrative Review

N	Date	Title	Authors	Periodic	Goals	Findings
1	2018	Analysis of the epidemiological situation of dengue, Chikungunya and Zika arboviruses in the state of Rio Grande do Norte, Brazil	Vanessa Pinheiro Barreto	Dissertation presented to the Graduate Program in Nursing of the Federal University of Rio Grande do Norte.	Perform an analysis of the time series, epidemiological profile and spatial distribution of dengue, Chikungunya and Zika cases in the State of Rio Grande do Norte	The region in which the most reported cases of dengue were recorded during the time series was the Metropolitan region (VII) with 93,424 reported cases. The year in which the three arboviruses were most affected was 2016 and the health region with the most confirmed cases in the period 2015-2017 was the Region of Mossoró (II), with a total of 12,253 confirmed cases of dengue, Chikungunya and Zika.
2	2018	Spatial Distribution of Dengue in the State of Rio de Janeiro from 2001 to 2012	Camila de Oliveira Carvalho; Renata dos Santos Rabello	HYGEIA - Brazilian Journal of Medical and Health Geography	To analyze the spatial distribution of dengue cases in the state of Rio de Janeiro, from 2001 to 2012, in order to identify the regions with the greatest risks for the occurrence of the	According to the incidence rates calculated for the study period, the municipalities with the highest number of notifications are located in the BaixadaS Litorâneas and Norte Fluminens

#	Year	Title	Authors	Journal	Objective	Method / Results	#	Year	Title	Authors	Journal	Objective	Results
					disease.	e regions.							11,397 cases were reported in the period, and the highest incidence coefficient was in 2015. In 2008, the incidence of dengue was 14.77/100,000 inhabitants going to 949.80/100,000 inhabitants in 2015. From 2011 to 2013, the Morran Global Indices were 0.28, 0.40 and 0.14 respectively (p<0.05). There was no association with IEX.
3	2017	Analysis of the spatial distribution of dengue cases in the city of Rio de Janeiro, 2011 and 2012	Silvia Carvalho; Monica of Avelar Figueiredo Mafra Magalhães; Roberto de Andrade Medronho	PublicHealthReview	To analyze the spatial distribution of cases of classic dengue and severe dengue in the city of Rio de Janeiro.	Kernel density pointed to hot areas for classic dengue not geographically coincident to severe dengue, being located within or near slums. The kernel ratio calculation showed no significant change in the spatial distribution pattern observed in kernel density analysis. The georeferencing process showed loss of 41% of the records of classic dengue and 17% of severe dengue due to the addressing of the notifiable diseases information system form.	4	2017	Spatial analysis of dengue incidence in a medium-sized municipality in the state of São Paulo from 2008 to 2015	Elaine Regina Defavari; Emilio Prado da Fonseca; Renato Pereira da Silva, Rafael da Silveira Moreira; Antonio Carlos Pereira, Marília Jesus Batista	UEFS Collective Health Journal	To evaluate the incidence and spatial distribution of dengue in a municipality in the State of São Paulo.	
							5	2017	Geospatial analysis of dengue cases and their relationship with socio-environmental factors in Bayeux - PB	Caio Américo Pereira de Almeida	HYGEIA - Brazilian Journal of Medical and Health Geography	To analyze the spatial behavior of dengue between 2011 and 2014 in the urban space of Bayeux.	It was observed that the Immaculate neighborhood presented the highest Kernel density and the highest number of dengue cases (17.5%), this

6 Lima, A.F.P.S.; Silva, E.T.B.; Silva, E.B.; Lima, J.B.A.S.; Guimarães, E.A.; Santana, A.J.; Leite, A.G.B.; Alves, S.M.F.; Damazio, S.L.C.; Martins, I.C.; Leite, A.F.B.; Lira, A.S.S.; Silva, V.B.; Álvares, E.B.S.O. Analysis of the temporal space distribution of reported Dengue cases: a systematic review of the literature...

neighborhood also presented its urban environment vulnerable to dengue due to inadequate disposal of solid waste. Urban environments weakened due to inadequate waste disposal, neighborhoods unassisted by public agencies, with greater population density and with a high number of people living in the lower income range, together with climatic circumstances, have become the main responsible for the occurrence of dengue in Bayeux.	6	2017	Space-time diffusion of dengue in the city of Rio de Janeiro, Brazil, in the period 2000 - 2013	Diego Ricardo Xavier; Monica of Avelar Figueiredo Mafra Magalhães; Renata Gracie; Izabel Cristina dos Reis; Vanderlei Pascoal de Matos; Christovam Barcellos	Public Health Notebooks	To identify epidemics and the pattern of diffusion of dengue transmission under the dimension of time and space.	Only in the period between 2000 and 2013 there were 616,419 cases reported by SMS/RJ. The years 2002, 2008, 2011, 2012 and 2013 account for 87% of the cases that occurred in the municipality in the period.
	7	2017	The use of geoprocessing in the analysis of the occurrences of dengue cases in Patos de Minas, MG	Fernanda Santos Andrade; Neide Maria Silva Martins	SEPIT - Anais of the Seminar on Research and Technological Innovation.	To evaluate the geographical distribution of reported dengue cases from March to November 2016 in the municipality of Patos de Minas-MG.	Trends in the occurrence of dengue outbreaks studied over time and space can contribute to the formulation of public policies that involve and benefit the health of the population. After georeferencing, the areas with the highest number of occurrences were evaluated from the

					perspective of social indexes to find factors that influence the presence of dengue cases in these areas.	2007, 2009, 2011 and 2013 of the totals analyzed, with distribution tending towards the southeast-northwest direction of the study area. Trends in the occurrence of dengue outbreaks studied over time and space can contribute to the formulation of public policies that involve and benefit the health of the population. After georeferencing, the areas with the highest number of occurrences were evaluated from the perspective of social indexes to find factors that influence the presence of dengue
8	2016	Spatial analysis of the cases of Aedes aegypti and its relationship with the urban environment	Helio Henrique Ferreira	Dissertation presented to the Graduate Program in Environmental Sciences of the State University of São Paulo.	To analyze the spatial distribution of autoctotic and imported confirmed dengue cases, as well as mosquito larvae containers in the municipality of Itu, São Paulo from 2005 to 2014.	There was an increasing increase in cases and incidence over the years studied in the 10-year range, and autoctonic cases overlap in terms of occurrence to imported ones by 88%. In addition, it was possible to verify a spatial distribution with higher occurrences in the central regions of the urban area of the municipality. Presenting the highest concentrations in the years

#	Year	Title	Author	Type/Source	Objective	Results	#	Year	Title	Author	Magazine	Objective	Results
						cases in these areas.							higher concentration in DS Bequimão.
9	2016	Spatial-temporal analysis of dengue cases by health district, São Luís, Maranhão, Brazil	Emnielle Pinto Borges Moreira	Dissertation presented to the Health and Environment Graduate Program of the Federal University of Maranhão	To analyze the spatial-temporal distribution of dengue cases of residents in São Luís, Maranhão, Brazil, notified in the Notifiable Diseases Information System (SINAN), relating them to the seven health districts (SD) of the municipality.	There was a predominance of females and brown race. The first semester concentrated higher frequency of cases. There was an increase in the occurrence of the disease in children under 15 years of age, an increase in hospital admissions since 2002, and the four serotypes were identified in the period studied. In all SD there were records of dengue cases, with	10	2015	Influence of social and environmental determinants of the spatial distribution of dengue in the municipality of Natal-RN	Isabelle Ribeiro Barbosa and Lúcio Pereira da Silva	Science and Plural Magazine	To identify the pattern of spatial distribution of dengue in the municipality of Natal-RN and quantify the influence of social and environmental determinants in this distribution.	From 2008 to 2012, the highest incidences of dengue were observed in the neighborhoods of Quintas, Alecrim, and Cidade Alta. The Global Moran index (I) was 0.31702 (p=0.05). In the bivariate analysis by Moran Local, the variables population growth rate (-0.2349) and proportion of wastelands (-0.2094) showed a negative and weak spatial correlation with the incidence rate of dengue. Monthly rainfall and monthly incidence of dengue

in the city of Natal showed a weak correlation (r=0.399).