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ARTIGO ORIGINAL

Spatial analyaia and climatic factora related to dengue in a amall municipality of São Paulo, Brazil

Análiae eapacial e fatorea climáticoa relacionadoa à dengue, em município de pequeno porte de São Paulo, Brasil

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Abstract

Objective: to analyze the relationahip of climatic variablea, temperature and rainfall, - with dengue, in addition to identifying poaaible areaa of greater spatial concentration of confirmed dengue cases. **Methods**: This is an ecological study with secondary data in the city of Ubirajara / SP. The confirmed cases of Dengue, assumed as an outcome, were obtained from the Aging and Notification Information System (SINAN) of the Ministry of Health; while the climatic data were uaed aa independent variablea and temperature and precipitation were provided by IPMet - Center of Meteorology of Bauru / SP, from 2007 to 2015. Pearaon's correlation (r) waa uaed for atatiatical analyzea. The addreaaea were geocoded and related to the digital cartoFigureic baae of the municipality through the aoftware QGIS and elaborated the thematic map through the kernel intenaity eatimator. **Results:** 187 caaea of dengue were reported in the study period, with 119 cases (63.7%) occurring in 2015 with an incidence coefficient of 25.39 cases per 1,000 inhabitants. Mean annual temperature correlated positively with dengue and (r) (Pearson) cases = 0.6889, p = 0.0401 (α = Type I error) and β = 0.6652 (Type II error). The Kernel map identified four areas of greatest concentration for dengue transmission. **Conclusions:** The relationahip between temperature increaae and dengue cases requires adequate responses from the institutions, with continuous monitoring of trends, construction of predictive models for the formulation of plans by using spatial analysis in the identification of the priority areas for actions that will be performed.

Key words: Dengue. Climate. Spatial Analyaia

Resumo

Objetivo: analisar a relação das variáveis climáticas, temperatura e precipitação pluviométrica, com a dengue, além de identificar possíveis áreas de maior concentração espacial de casos confirmados de dengue. **Métodos:** Trata-ae de um eatudo ecológico com dadoa aecundárioa do município de Ubirajara/ SP. Os casos confirmados de Dengue, assumidos como desfecho, foram obtidos junto ao Sistema de Informação de Agravos e Notificações (SINAN) do Ministério da Saúde; enquanto os dados climáticos utilizados como variáveis independentes foram temperatura e precipitação, os quais foram fornecidos pelo Centro de Meteorologia de Bauru/ SP - IPMet, no período de 2007 a 2015. Utilizou- ae a correlação Pearaon (r) para aa anáiiaea eatatíaticaa. Oa endereçoa foram geocodificados e relacionados com a base cartográfica digital do município, por meio do software QGIS. Foi elaborado o mapa temático segundo o estimador de intensidade de Kernel. **Resultados:** Foram notificados 187 casos de dengue no período do estudo; no entanto, somente em 2015 registraram-se 119 casos (63,7%), com um coeficiente de incidência de 25,39 casos por 1.000 habitantes. A temperatura média anual se correlacionou positivamente com os casos de dengue e r (Pearson) = 0,6889, p = 0,0401 (α = Erro tipo I) e β = 0,6652 (Erro tipo II). O mapa de Kernel identificou quatro áreas de maior concentração para a tranamiaaão da dengue. **Conclusões:** A relação do aumento da temperatura com os casos de dengue exige respostas adequadas das instituições, como o acompanhamento permanente de tendências, de construção de modelos preditivos e de formulação de planos que façam uso de análise espacial na identificação de áreas prioritárias para as ações que serão realizadas.

Palavras-chave: Dengue. Clima. Análiae Eapacial

INTRODUÇÃO

Dengue fever is a rapidly developing viral disease in the world. Around three billion people are at risk of contracting the virus. It is considered a public health problem which involves annual expenses of millions of dollars in surveillance and assistance actions by public agencies. In Brazil, it presents a spatial behavior reaching all states of the Federation, being present over the years and establishing itself in the form of epidemics and increasing the incidence and prevalence of the reported cases[1].

Climate is considered a conditioning element of the dynamics in the environment and exerts direct influence both in physical and biological processes[2]. Studies have shown that climatic and meteorological conditions, such as temperature, rainfall and relative humidity, influence the behavior of dengue. Rainfall and especially temperature are important factors for longevity, fecundity and hematophageal activity of Aedes aegypti, vector of dengue[3]. In this sense, global warming, which presents a considerable intensification trend in this century, becomes

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an important condition with probable implications in human health, allowing dengue to find better conditions for its expansion while involving a large number of victims as a result of the variations in progress[4].

In addition, a spatial approach of dengue through the geoFigureic relationship of cases, as well as climatic factors, are important instruments to support the planning of actions appropriate to different Brazilian regional realities[4].

The objective of this study is to analyze the relationship of climatic variables, temperature and rainfall with dengue, in addition to identifying possible areas of greater spatial concentration of confirmed cases of dengue, in a municipality in the state of São Paulo, subsidizing measures of surveillance and control.

METHODOLOGY

This is an ecological study with a secondary data source in the city of Ubirajara / SP, Brazil, a territorial area of 282, 179 km2, population density 2010 (inhab. / Km2) 15,68, Municipal Human Development Index (IDHM)[5] of 0.727, with 100% population coverage by the local Family Health Strategy (ESF), which is partly in the Regional Health Department of Marília (DRS 9).

The study's outcome was the confirmed cases of Dengue obtained from the Health and Aging Information System (SINAN) of the Ministry of Health (MOH) from 2007 to 2015. The historical series of annual incidences was calculated using the coefficient of annual incidence, which is done by dividing the confirmed cases by the local population each year, multiplied by 1,000. The annual population estimates were obtained through DATASUS[6].

Climatic factors used were considered independent variables, such as annual mean temperature and precipitation provided by the IPMet - Bauru Meteorological Center, as measured monthly for the study period and the annual averages[7]. BioStat 5.0 software was used for statistical analysis through Pearson's correlation (r).

The spatial analysis for the study was carried out from the place of residence of the individuals notified and confirmed with dengue for the year 2015. The addresses were geocoded through a universal addressing system ("What3words.com")[8]. This system allowed to locate all the cases and relates them to the digital cartoFigureic base of the municipality of Ubirajara. The QGIS software was used to create a layer of points from the coordinates (X, Y) obtained in the geocoding, for the analysis and elaboration of the thematic map through the kernel intensity estimator. We chose the kernel map with a grid of 100 columns on the events and with an algorithm of quartic function with adaptive radius. The adaptive radius automatically estimates a band width considering the number of events and the total extent of the analyzed area. A nonparametric method for estimation of density curves, where each observation is weighted by the distance from a central value, the nucleus.

This estimator counts all the points within a region of influence, weighing them by the distance of each one in relation to the location of interest facilitating the visualization of clusters, through the creation of maps with nine levels of densities that vary according to the color and tonality being represented: the darker three mean very high density; the three classes with mean average density; three classes with lighter shade mean low density[2]. This assists the analysis because visually, when detected a band with a tint or a more intense color, it can be inferred that in this region, there is a high concentration, and the lighter the color, the least concentrated.

RESULTS

In the period studied (2007 to 2015), 187 cases of dengue (100%) were reported in the municipality, with 119 cases (63.7%) occurring in 2015 with an incidence rate of 25.39 cases per 1,000 inhabitants, which is equivalent to 25 times the average of previous incidents (Figure 1), that is, the year 2015 was marked by a major epidemic in the municipality (Figure 1).

Figure 1. Coefficient of incidence of dengue in Ubirajara / SP, Brazil, 2007 - 2015

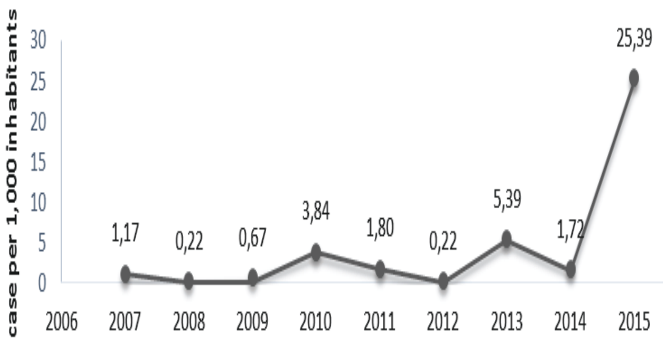


Table 1 shows the data from the historical series (2007-2015) of the means of the independent variables studied, with special attention to the increase in temperature in the years 2014 and 2015, as well as the incidence coefficient of dengue (dependent variable) in 2015 (25.39 / 1,000 inhabitants) (Figure 2) (Table 1).

Figure 2. Precipitation and confirmed cases of dengue in Ubirajara / SP, Brazil, 2007 - 2015.

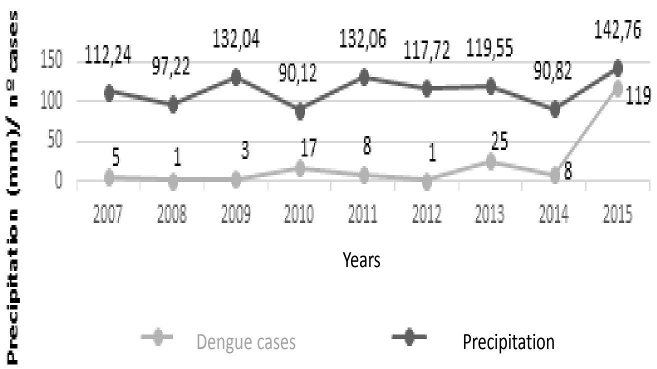
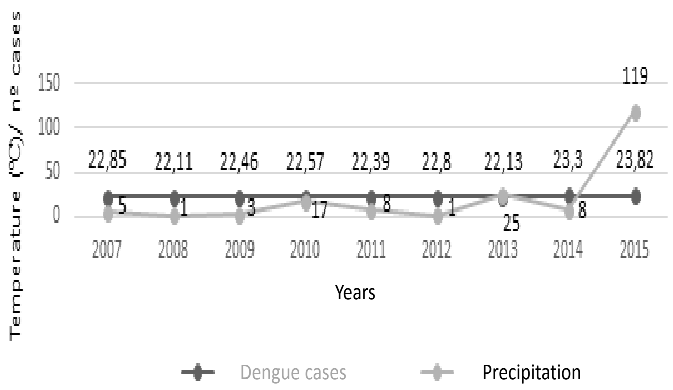


Table 1. Incidence coefficient and annual means of the variables, in the city of Ubirajara / SP, Brazil - 2007 to 2015.

Year	Coefficient Incidence (1:1000)	Precipitation (mm)	Temperature (ºC)
2007	1.17	112.24	22.85
2008	0.22	97.22	22.11
2009	0.67	132.04	22.46
2010	3.84	90.12	22.57
2011	1.8	132.06	22.39
2012	0.22	117.72	22.8
2013	5.39	119.55	22.13
2014	1.72	90.82	23.3
2015	25.39	142.76	23.82

Over the study period (2007 to 2015), the relationship between annual precipitation and dengue cases points to a growing trend of both, in a more pronounced way in the year of 2015, when there was an increase of 27.81 mm (24.2%) in relation to the historical series average (114.95 mm), but without statistical significance for a correlation with dengue cases (Figure 3).

Figure 3. Mean temperature and confirmed cases of dengue in Ubirajara / SP, Brazil, 2007 - 2015.

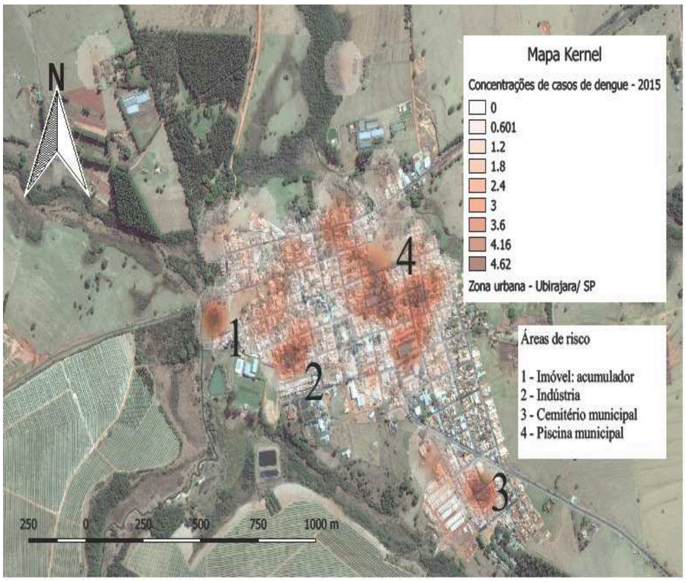


Mean annual temperature correlated positively with dengue cases (Figure 4) with statistical significance, r (Pearson) = 0.6889, p = 0.0401 (α = Type I error) and β = 0.6652 (Type error II). Especially during the last two years (2014 - 2015), there was a significant increase of 1.09 ° C compared to the average of previous years (22.47 ° C) (Figure 4).

The Kernel map identified four areas of higher concentration and consequently an increased risk for dengue transmission in the year 2015; this period was chosen because it is the time with the highest incidence rate of the disease. The previous years, due to the low rate, did not allow the spatial analysis. Three more peripheral and one larger and more central, can be reported.

In areas of greatest risk, water accumulation can be an important common factor, since area 1 covers the property of a "recycler"; area 2 is close to a food industry that uses standing water tanks in the open in its production process; area 3 is near the municipal cemetery, where the presence of pots and containers that are potentially accumulating water are present in large quantity and area 4, where there is a municipal swimming pool not open to the public, but with water. In addition, other regions of the municipality presented medium and low risk for dengue transmission (Figure 4).

Figure 4. Kernel map of reported cases of dengue in the city of Ubirajara / SP, Brazil, 2015.



DISCUSSION

An increase in the average annual temperature of 1.09 ºC was observed in the last two years of the study (2014 and 2015) in relation to the average of previous years (2007 to 2013). The variation, even if small, in the average temperature can lead to varied situations such as increased rainfall and longer periods of drought, among others9. This fact may have influenced the increase in the number of cases of Dengue. The positive correlation between mean annual temperature and the incidence of dengue confirms this hypothesis.

The average temperature of the Earth has increased since the Industrial Revolution, influencing climate change and provoking events of interest to human health, such as the increase in areas of disease transmission caused by vectors, like dengue9. In Brazil and in the world, the increase in the number of cases and a considerable geoFigureic expansion in recent decades may be related to the process of intensification of global warming4. In addition to one of the hypotheses for the development of the vector, it would be global warming, benefiting and increasing the area of occurrence of dengue and enhancing the risk of contracting the disease10.

In 2015, the epidemic in Ubirajara points to the fact that temperature is considered a critical factor for this type of event, as was also observed in the outbreaks in the city of Rio de Janeiro / RJ from 1986 to 200311.

The mean temperature recorded in the study was 22.71 ° C in the historical series, which according to previous studies can be associated with the abundance and development of the vector (aedes aegypti), which allows a greater chance of disease transmission[12,13]. The observed correlation between temperature and incidence of dengue can be justified by the findings brought about by the studies that showed events such as infestation by aedes aegypti, indicating that infestation by the vector, materialized in the onset of the disease, is directly related to transmission[14,15].

The spatial analysis of the reported cases of dengue, through the estimation of the kernel method, may be appropriate for local level study, since it is a subjective and exploratory method and depends on the researcher's perception for the definition of his parameters[16] and identification of clusters of cases. These clusters represent areas of higher risk, which have been close to potential reservoirs of water that can function as breeding sites for the mosquito, namely: municipal public swimming pool closed to the public, but with standing water; municipal cemetery with the presence of many vases and containers; water dam from irregular cassava flour industries and a residence collector of recycled materials ("recycler").

Considering that there was a tendency of growth of the variables, precipitation and incidence of dengue in the studied period, potential areas of accumulation of water favored the creation and infestation by the vector, resulting in the largest recorded epidemic of the disease. These areas are amenable to direct monitoring and control action, through sanitary and environmental surveillance services, in an attempt to eliminate these concrete sources of breeding sites of the Aedes aegypit mosquito.

The study may present as a limitation the small number of independent variables studied (temperature and precipitation), which are already known and the previous investigated conditions related to dengue. However, it is fundamental that the local conditions be analyzed, confirmed, or not, and considered for the planning of actions, mainly by local health systems.

CONCLUSION

The adaptation to this new context of increase, in relation to the average temperature of the Earth and considering the relationship established in this study with dengue cases, requires adequate responses from the institutions, with continuous monitoring of trends, construction of predictive models and formulation of specific plans for each locality and considering precisely the main variables involved. In addition to the aid of spatial analysis, which proved to be an important tool for the determination of the areas with the highest concentration of confirmed cases, directing the actions to combat the outbreaks with higher transmission risk, seems to be a wise initiative.

REFERÊNCIAS

1. Mondini A, Chiaravalloti-Neto F. Variáveis socioeconômicas e transmissão de dengue. Rev Saúde Pública. 2007 Dez; 41(6):923-30. doi: http://dx.doi.org/10.1590/S0034-89102007000600006.

2. Silva AM, Silva RM, Almeida CAP, Chaves JJS. Modelagem geoestatística dos casos de dengue e da variação termopluviométrica em João Pessoa, Brasil. Soc. nat. 2015 Jan-Abr; 27(1): 157-169. doi: http://dx.doi.org/10.1590/1982-451320150111.

3. Silva RF, Neves DP. Os mosquitos (Diptera: Culicidae) do Campus Ecológico da UFMG, Belo Horizonte, Minas Gerais. Men. Inst. Oswaldo Cruz. 1999; 84(Supl. 4): 501- 503. doi: http://dx.doi.org/10.1590/S0074-02761989000800088.

4. Mendonça F. Clima, tropicalidade e saúde: uma perspectiva a partir da intensificação do aquecimento global. Revista Brasileira de Climatologia. 2005 Dez; 1(1): 100-112.

5. Instituto Brasileiro de Geografia e Estatística. Acessado em https://cidades.ibge.gov.br/brasil/sp/ubirajara/panorama em 13 de março de 2017.

6. DATASUS. Departamento de Informática do SUS. Acessado em http://tabnet.datasus.gov.br/cgi/tabcgi.exe?ibge/cnv/poptsp.def em 10 de março de 2017.

7. IPMet – Centro de Meteorologia de Bauru. Acessado em http://www.ipmet.unesp.br/index2.php?menu_esq1=&abre=ipmet_html/estacao/historico.php em 01 de março de 2017.

8. What3words. Sistema de endereçamento universal. Acessado através de https://map.what3words.com/anexa%C3%A7%C3%A3o.pagante.pensou.

9. Barcellos C, Hacon SS. Um grau e meio. E daí?. Cad. Saúde Pública. 2016 Mar; 32(3):e00212315, mar, 2016. doi: http://dx.doi.org/10.1590/0102-311X00212315.

10. Ajuz LC, Vestena LR. Influência da pluviosidade e temperatura ambiente na longevidade e fecundidade dos Aedes aegypti e albopictus na cidade de Guarapuava-PR e possibilidade de superinfestação. Hygeia. 2014; 10(18): 1–18.

11. Câmara FP, Gomes AF, Santos GT, Câmara DCP. Clima e epidemias de dengue no Estado do Rio de Janeiro. Rev. Soc. Bras. Med. Trop. 2009 Mar-Abr; 42(2):137-140. doi: http://dx.doi.org/10.1590/S0037-86822009000200008.

12. Gomes AC, Forattini OP, Kakitani I, Marques GRAM, Marques CCA, Marucci D, et al. Microhabitats de Aedes albopictus (Skuse) na região do Vale do Paraíba, Estado de São Paulo, Brasil. Rev Saude Publica. 1992 Abr; 26(2): 108- 18. doi: http://dx.doi.org/10.1590/S0034-89101992000200007.

13. Honório NA, Codeço CT, Alves FC, Magalhães MA, Lourenço-De-Oliveira R. Temporal distribution of Aedes aegypti in different districts of Rio de Janeiro, Brazil, measured by two types of traps. J Med Entomol. 2009 Sep; 46(5): 1001-14.

14. Miyazaki RD, Ribeiro AL, Pignatti MG, Campelo JH Jr, Pignati M. Monitoramento do mosquito Aedes aegypti (Linnaeus, 1762) (Diptera: Culicidae), por meio de ovitrampas no Campus da Universidade Federal de Mato Grosso Campus, Cuiabá, estado de Mato Grosso. Rev Soc Bras Med Trop. 2009 Jul-Ago; 42(4): 392-97. doi: http://dx.doi.org/10.1590/S0037-86822009000400007.

15. Oliveira CL, Bier VA, Maier CR, Rorato GM, Frost KF; Barbosa MA, et al. Incidência da dengue relacionada às condições climáticas no município de Toledo – PR. Arq Ciências Saúde UNIPAR; 11(3): 211-6, 2007. doi: https://doi.org/10.25110/arqsaude.v11i3.2007.2041.

16. Flausino R, Souza-Santos R, Barcelllos C, Gracie R, Magalhães MAFM, Oliveira RM. Heterogeneidade espacial da dengue em estudos locais, Niteroi, RJ. Rev Saúde Pública. 2009 Dez; 43(6):1035-43. doi: http://dx.doi.org/10.1590/S0034-89102009005000064.

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