Research note

Characteristics of the dengue epidemic in Pinhalzinho, Santa Catarina, Brazil, 2015-2016*

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Abstract

Objective: To describe the characteristics of the dengue epidemic in Pinhalzinho, Santa Catarina, Brazil, and to investigate the effects of climate variables on *Aedes aegypti* mosquito infestation. **Methods:** This was an ecological study using data on dengue cases, hospitalizations and deaths in 2015 and 2016; in addition to climate variables and *Aedes aegypti* breeding grounds from 2015 to 2018. **Results:** In the 2015-2016 epidemic, the dengue incidence rate was 12,695.2/100,000 inhabitants. Higher incidence was registered in the female sex (13,926.4/100,000 inhabitants) and in the 50 years and over age group (17,162.0/100,000 inhabitants). Average temperature and relative humidity showed a positive relationship with increase in *Aedes aegypti* breeding grounds. **Conclusion:** Dengue incidence during the epidemic was the highest ever recorded in the country. Climate conditions must be considered when planning vector control and dengue prevention actions.

Keywords: *Aedes*; Climate; Epidemiology, Descriptive.

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Introduction

Infection cause by Dengue virus, responsible for some 390 million infections each year, is considered to be one of the world's biggest Public Health problems.[1,2] The same applies to Brazil, where new challenges have been posed by the introduction of chikungunya fever virus in 2014 and Zika virus in 2015,[3] as well as by the persistent and growing number of severe cases and deaths caused by dengue with effect from 2010.[4]

Santa Catarina was the last Brazilian state to record autochthonous dengue cases, in 2011.[5] In 2015, the first dengue epidemic was recorded in the state, in the municipality of Itajaí. Identification and evaluation of dengue epidemics are important for informing the adoption of more efficient strategies for control of the disease and prevention of new epidemics.

> *Santa Catarina was the last Brazilian state to record autochthonous dengue cases, in 2011. In 2015, the first dengue epidemic was recorded in the state, in the municipality of Itajaí.*

Based on this understanding, the objective of this study was to describe the characteristics of the dengue epidemic in the Santa Catarina municipality of Pinhalzinho, which occurred between 2015 and 2016, as well as to investigate the effects of climatic variables on the number of *Aedes aegypti* mosquito breeding grounds in that municipality from 2015 to 2018.

Methods

An ecological study was conducted in the municipality of Pinhalzinho, located in the western region of the state of Santa Catarina (26°50'53"S; 52°59'31"W), Brazil. In 2015, the local population was comprised of 18,700 inhabitants, 84% of whom lived in the urban area of the municipality. Pinhalzinho has a subtropical climate, a human development index (HDI) of 0.783 and 94.9% of its households have adequate sewerage systems, according to the most recent Demographic Census conducted in 2010.[6]

Data on dengue cases notified in 2015 and 2016 and related hospitalizations were obtained from the Municipal Health Department by means of the Notifiable Health Conditions Information System (SINAN) and the TABNET system of the Brazilian National Health System Information Technology Department (DATASUS). Incidence rates were calculated according to age range and sex per groups of 100,000 inhabitants. The chi-square (χ^2) test with a 5% significance level was used to check for possible association between nominal variables.

The meteorological data relating to the period from July 2015 to December 2018 were obtained from the Santa Catarina Environmental Resources and Hydrometeorology Information Center. The data relating to the evolution of *Aedes aegypti* mosquito infestation were obtained from the Santa Cataraina Epidemiological Surveillance Directorate. The study period was defined so as to gain knowledge of the vector's behavior in relation to climatic variables during and after the epidemic. Descriptive analyses of frequencies, crude analysis and multiple linear regression analysis (significance level: $p<0,05$) were used.

The data were tabulated using Excel, version 2016. SPSS, version 20.0 was used for the statistical analyses.

The research project was approved by the Human Research Ethics Committee, as per Opinion No. 2.633.107, dated May 3rd 2018.

Results

Between 2015 and 2016, the municipality of Pinhalzinho faced a dengue epidemic, with 2,374 cases notified (DENV-1) and an incidence rate of 12,695.2 case per 100,000 inhabitants. There was one death associated with the disease during the period.

The majority of notified cases (54.3%) were of the female sex, with an incidence rate of 13,926.4/100,000 inhabitants. Mean case age was 38 years (SD±20) – minimum age zero and maximum age 103 years –, whereby the 20-29 age range was the most affected. Higher case incidence was found in the older age groups (Figure 1).

In 2015, four dengue cases were confirmed, i.e. one in November (imported) and three in December (autochthonous).

In 2016, 2,370 autochthonous cases were confirmed (Figure 2). In this period 130 hospitalizations due to dengue were recorded in the municipality. The highest number of cases was recorded in March 2016, with 53 hospitalizations (41% of hospitalizations that year), followed by February (34 hospitalizations, or 26% of hospitalizations that year) and April (22 hospitalizations; 17%) of the same year.

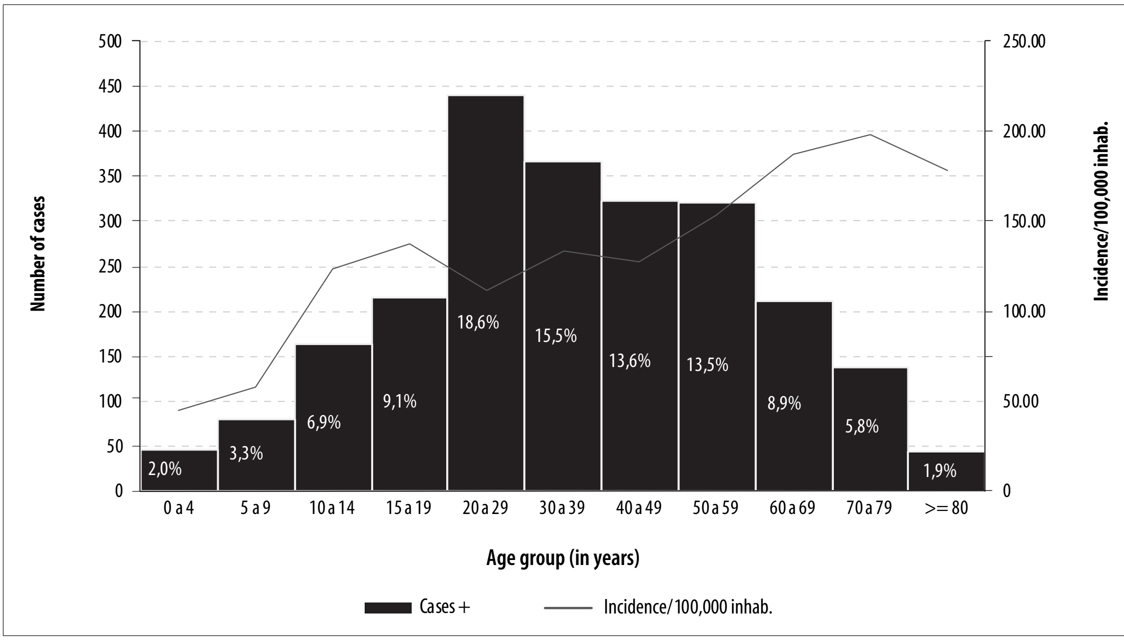

Figure 1 – Dengue case number and incidence distribution by age group, Pinhalzinho, Santa Catarina, 2015-2016

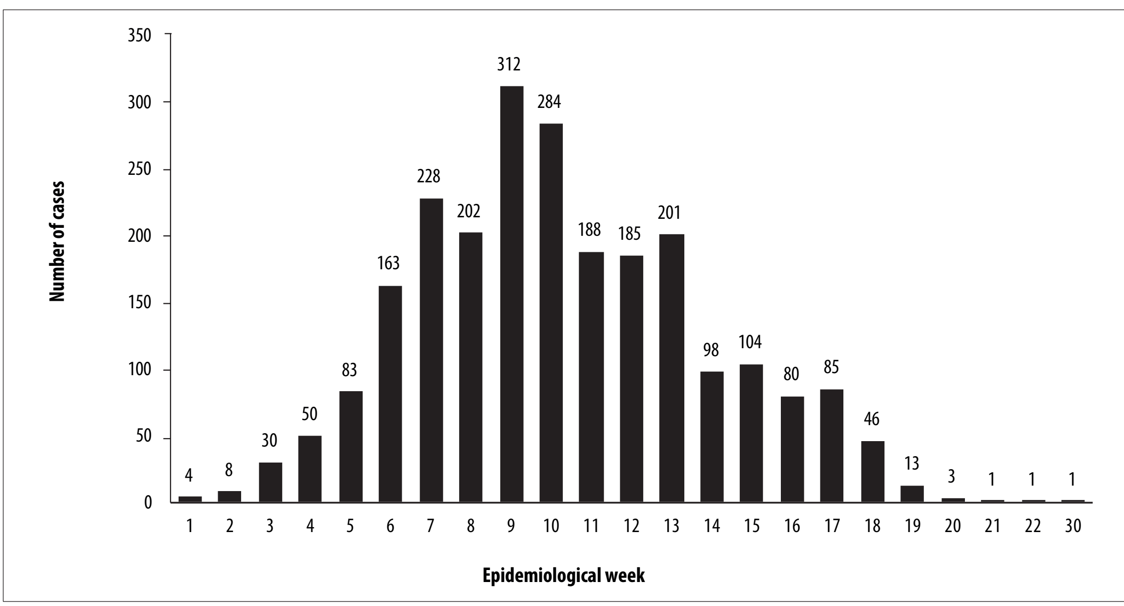

Figure 2 – Distribution of number of confirmed dengue cases per epidemiological week of notification, Pinhalzinho, Santa Catarina, 2016

With regard to the climatic variables, during the period studied the minimum monthly temperature varied between -3.58 and 16.04ºC (SD±5.48), while the maximum monthly temperature varied between 26.65 and 36.48ºC (SD±2.52); mean monthly temperature varied between 10.88 and 25.17ºC (SD±3.67). Monthly precipitation varied between 9.6 and 428mm (SD±107.18), while relative humidity of the air varied between 70.22 and 90.52% (SD±4.84). There was positive and significant association between relative humidity and mean temperature of the air and monthly *Ae. Aegypti* mosquito infestation: F (2.39) = 28.481; p-value<0.001; R^2 = 59.4% (Figure 3).

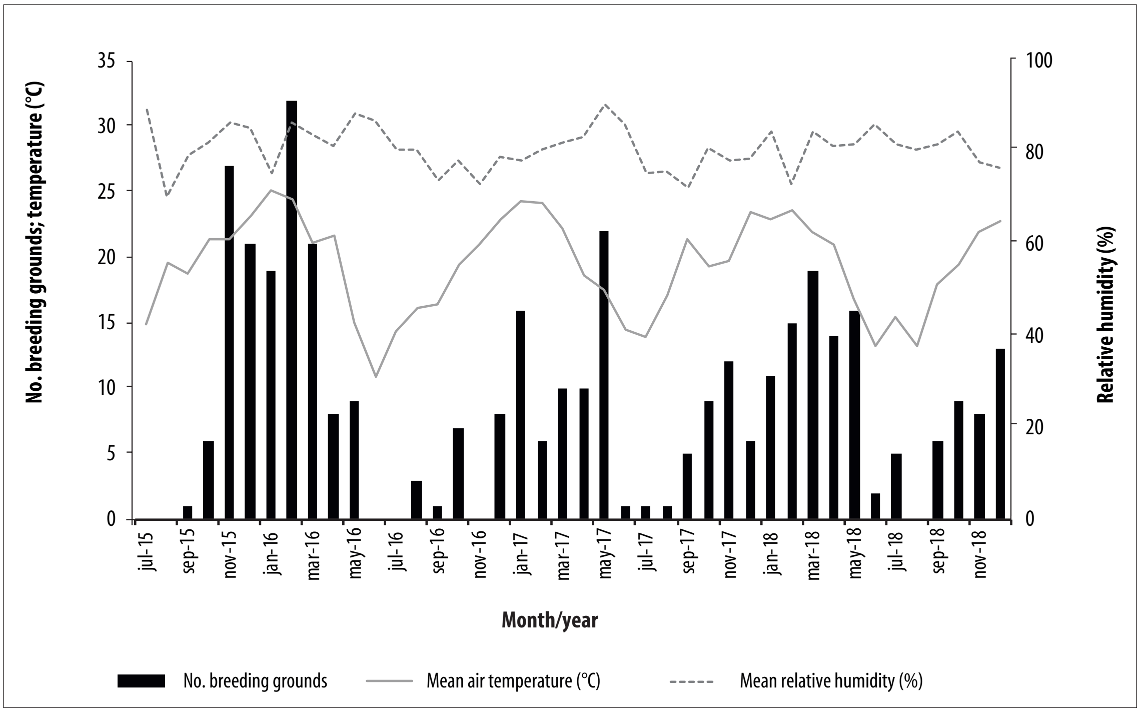

Figure 3 – Monthly distribution of *Aedes aegypti* breeding grounds in comparison to mean monthly temperature and relative humidity of the air, Pinhalzinho, Santa Catarina, 2015-2018

Discussion

Pinhalzinho faced the largest dengue epidemic ever recorded in Brazil, with an incidence rate of 12,695.2 cases per 100,000 inhab., caused by the DENV-1 serotype. Higher incidence rates were found in females, people aged 50 or more and during the summer. Mosquito breeding ground distribution was found to be associated with increased mean temperature and relative humidity of the air in the municipality.

That epidemic demonstrated the increase in the disease's geographic expansion and the process of its transmission in interior areas of the country, with increasingly frequent records in small cities and interior areas.[4] Considering that for each apparent dengue case there are a further four non-apparent or asymptomatic cases,[1,2] it is estimated that possibly around 50% of Pinhalzinho's population was infected and sensitized by DENV-1. A high dengue incidence rate, like the one seen in Pinhalzinho, generally occurs when surveillance and control actions used to prevent the disease are not fully effective.[7,8] Moreover, such a high incidence rate can be attributed to high infestation by the *Ae. aegypti* vector and to the introduction or reintroduction of virus serotypes in areas where there is a large proportion of susceptible individuals.

With regard to sex, higher numbers of cases recorded among females have also been found in other studies.[9-12] This pattern may be related to *Ae. Aegypti* distribution, principally inside and around households,[13] these being environments frequented more by females; or also to the fact of women seeking health services and medical care.[9-11]

A greater incidence coefficient was also found in older people aged 50 or more. This finding diverges from patterns reported by other studies conducted in Brazil, whereby this coefficient is greater among young adults, particularly in the 20-49 age group.[9,10,12] It should be noted that although all age ranges are equally susceptible, elderly people have more risk of developing dengue with alarm signs and severe dengue with the possibility of leading to death.[4]

The temporal analysis indicated that the dengue cases followed a seasonal pattern of occurrence: they began in December and January and reached greatest incidence in February and March, coinciding with the period of higher temperatures, before falling in May. Seasonal patterns such as this, with increased case occurrence in the early months of the year, have been found in municipalities in the states of São Paulo,[9,14,15] Piauí, [16] Rio de Janeiro[17] and Santa Catarina.[18]

Increased mean temperature and relative humidity of the air were, together, capable of predicting 59.4% of infestation by the vector. In the two years following the epidemic, the *Aedes* breeding grounds were found to have reached similar levels to those of the epidemic, although transmission of the virus was practically zero.

The relationship between rainfall and *Ae. aegypti* breeding grounds or dengue cases occurs due to association of different mechanisms,[19] and may vary according to the region studied. The lack of significant association between rainfall and number of *Ae. Aegypti* breeding grounds found in this study can be explained by constant rainfall all year round in the region.

In view of the above, it is appropriate to emphasize that increased dengue incidence and dissemination is a complex process, influenced by multiple social, environmental and climatic factors which, through synergy, can generate an epidemic scenario.[17,20] Standing out among these factors is disorderly urbanization, precarious sanitation conditions, lack of effective control of the mosquito, economic globalization, vector propagation and infestation in the urban environment, human mobility and climate changes.[12,17-22]

The main limitations of this study relate to its secondary sources of information. The possibility of underreporting and existence of incomplete dengue case records may compromise the analysis of some of the variables.

It is appropriate to mention that climate information can be used to forecast increases in the mosquito population and, consequently, to locate risk areas for arbovirus outbreaks. This early warning can be used by municipal Public Health authorities, especially in the early months of the year, to plan and direct measures that are more efficacious in controlling the *Aedes* mosquito and thus reduce the danger of dengue and other arboviruses transmitted by this vector.

Knowledge of the epidemic process and use of this information can assist with assessing the health situation for decision making, with the aim of guiding intersectoral, educational and social awareness raising actions. In order to reduce the burden of dengue, Public Health policies need to be continuous and need to take specific local needs into consideration, with regard to vector control and dengue surveillance. Finally, the priority of prevention actions must be highlighted, involving the active participation of the population and being articulated with intersectoral public policies.

Authors' contributions

Andrioli DC, Busato MA and Lutinski JA contributed to the study concept and design, result analysis and interpretation, drafting and critically reviewing the contents of the manuscript. All the authors have approved the final version of the manuscript and state that they are responsible for all aspects thereof, guaranteeing its accuracy and integrity.

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