# Incidence of dengue and socioeconomic and entomological indicators in Santos, São Paulo State, 2012-2016

**ABSTRACT** | Objectives: describe incidence of dengue in Santos/SP and relate dengue incidence coefficient (IC) with socioeconomic and entomological indicators from 2012-2016. Methods: epidemiological, descriptive, ecological study of confirmed cases of dengue, resident in Santos, from 2012-2016, of the Online-Notifiable Diseases Information System; six socioeconomic indicators were obtained from census sectors base of Brazilian Institute of Geography and Statistics-2010; the seventh from the São Paulo Index of Social Vulnerability-2010 and the entomological indicators from the Health Department; Spearman's Bivariate Correlation (SPSS-Statistics®) was applied. Approved by the Research Ethics Committee-CAAE n°79776017.1.0000.5479. Results: from 2012-2016 there were 16.451 cases, with IC from 117,4 (2012) to 2.122,8 (2013) cases/100.000 inhabitants, higher in females and between 15-29 years old; socioeconomic factors were more significant between 2015-2016; the Density Index of Aedes aegypti females showed a greater positive correlation. Conclusion: epidemiological/entomological profile of dengue was described, supporting managers in local control actions.
**Keywords:** Dengue; Epidemiology, Descriptive; Socioeconomic Factors; Entomology; Aedes.

**RESUMEN** | Objetivos: describir incidencia del dengue en Santos/SP y relacionar coeficiente de incidencia (CI) del dengue con indicadores socioeconómicos y entomológicos para 2012-2016. Métodos: estudio epidemiológico, descriptivo, ecológico de casos confirmados de dengue, residentes en Santos, desde 2012-2016, del Sistema de Información de Enfermedades de Notificación-Online; obtuvieron-se seis indicadores socioeconómicos desde base de sectores censales del Instituto Brasileño de Geografía y Estadística-2010, el séptimo del Índice de Vulnerabilidad Social de São Paulo-2010 y los indicadores entomológicos del Departamento de Salud. Aplicó-se Correlación Bivariada de Spearman (SPSS-Statistics®). Aprobado por el Comité de Ética en Investigación-CAAE n°79776017.1.0000.5479. Resultados: desde 2012-2016 hubo 16.451 casos, con CI de 117,4 (2012) a 2.122,8 (2013) casos/100.000 habitantes, mayor en mujeres y de 15-29 años; los factores socioeconómicos fueron más significativos entre 2015-2016; el Índice de Densidad de hembras Aedes aegypti mostró mayor correlación positiva. Conclusión: describió-se perfil epidemiológico/entomológico del dengue, apoyando a los gerentes en acciones de control local.
**Palabras claves:** Dengue; Epidemiología Descriptiva; Factores Socioeconómicos; Entomología; Aedes.

**RESUMO** | Objetivo: descrever incidência de dengue em Santos/SP e relacionar coeficiente de incidência (CI) de dengue com indicadores socioeconômicos e entomológicos de 2012-2016. Método: estudo epidemiológico, descritivo, ecológico dos casos confirmados de dengue, residentes em Santos, de 2012-2016, do Sistema de Informação de Agravos de Notificação-Online; foram obtidos seis indicadores socioeconômicos da base de setores censitários do Instituto Brasileiro de Geografia e Estatística-2010; o sétimo do Índice Paulista de Vulnerabilidade Social-2010 e os indicadores entomológicos da Secretaria de Saúde; foi aplicada Correlação bivariada de Spearman (SPSS-Statistics®). Aprovado pelo Comitê de Ética em Pesquisa-CAAE n°79776017.1.0000.5479. Resultados: de 2012-2016 ocorreram 16.451 casos, com CI de 117,4 (2012) a 2.122,8 (2013) casos/100.000 habitantes, maior no sexo feminino e de 15-29 anos; os fatores socioeconômicos foram mais significativos entre 2015-2016; o Índice de Densidade de fêmeas Aedes aegypti apresentou maior correlação positiva. Conclusão: descreveu-se perfil epidemiológico/entomológico da dengue, apoiando gestores nas ações locais de controle.
**Palavras-chaves:** Dengue; Epidemiologia descritiva; Fatores socioeconômicos; Entomologia; Aedes.

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## INTRODUCTION

Dengue is an acute febrile disease, caused by viruses of the family Flaviviridae, with four serotypes DENV-1, DENV-2, DENV-3 and DENV-4. It is systemic and has a broad clinical spectrum, from asymptomatic to severe cases, with the majority having a benign clinical evolution and part progressing to severe forms, including death.[1]

More than half of the world's population lives at risk of dengue transmission. Rapid and chaotic urbanization, globalization and climate change created a favorable environment for the development of the most important vector of dengue, Aedes aegypti (Linnaeus), mainly in tropical and subtropical regions. [2]

Dengue affects the whole of society, but the burden may be greater in poor communities, with conditions more favorable to the vector. [3] In Brazil, actions against Aedes aegypti include control strategies such as: sanitation of the envi-

ronment, educational actions to eliminate the vector and its breeding sites and the fight for biological and chemical control. However, for more than 30 years Brazil has dealt with the proliferation of the vector and the diseases transmitted by it, whose control actions have been inefficient. [4]

The Baixada Santista Metropolitan Region has a favorable climate for the development of the vector, high density and population movement. It houses the largest port in Latin America, where more than 4.000 ships dock annually, with a large flow of people and products. [5] In the port of Santos in 1980 it was detected the first outbreaks of the reintroduction of Aedes aegypti in the state, eliminated with effective control measures. [6]

In Baixada Santista, the municipality of Santos was the first to present dengue transmission, registering 893 cases in 1997. [7] From 1997 to June 2005, dengue cases residing in this region represented 43,7% of the state's cases. [5]

From 2012 to 2016, Baixada Santista remained among the regions with the highest occurrence of dengue cases in the State of São Paulo: Campinas (226.202), with 17,.7% of the cases in the State; São José do Rio Preto (107.735); Ribeirão Preto (87.169), with 6,8% of the cases; Piracicaba (86.791); Sorocaba (79.702); and Baixada Santista with 57.355 cases, 4,5% of the State's cases. [7]

In Santos, from 1997 to 2012, the curve of the historical series of dengue cases followed the curve of the State of São Paulo, with the municipality responsible for a significant portion of the total cases of the State, varying from 13,9% to 48,1% between the years 1997 to 1999, 2001 to 2002 and 2004 to 2005. 6 From 2012 to 2016 Santos registered 16.451 cases of dengue, 28,7% of cases in the region and 1,3% of cases in the State. In this period, its incidence coefficient was higher than that of the state from 2012 to 2014 [7], with medium to high incidence in all years, according to the National Dengue Control Program (PNCD - Programa Nacional de Controle da Dengue). [8]

From 2006 to 2016 the incidence coefficient of probable dengue cases showed an increasing trend in Brazil, ranging from 212,1 (2009) to 825,8 (2015), in the State of São Paulo, from 29,0 (2009) to 1.679,5 (2015), and in Santos, from 25,6 (2008) to 2.585,2 (2013) cases/100.000 inhabitants. [9]

Considering the importance of the Baixada Santista and Santos Metropolitan Region in the context of the State's dengue epidemics, it is essential to develop a study to characterize and analyze the epidemiological and entomological profile of the disease in the city, contributing to the improvement of local strategies for dengue prevention and control. Thus, the objective of this study is to describe the incidence of dengue in Santos, according to year, sex, age group and to relate the dengue incidence coefficient with socioeconomic and entomological indicators in the period 2012-2016.

**METHOD**

Descriptive and ecological epidemiological study, whose groups of variables listed include the incidence of confirmed dengue cases, socioeconomic variables and entomological variables. The study population consists of confirmed cases of dengue, resident in Santos, notified in the Online Notification Diseases Information System (SINAN-Online) in the period from 2012 to 2016. Confirmed suspected cases were considered confirmed cases: laboratory by IgM serology, NS1 rapid test or Elisa (enzyme-linked immunosorbent assay), viral isolation, RT-PCR (reverse transcription followed by polymerase chain reaction), immunohistochemistry; and by clinical-epidemiological criteria in epidemic periods (except the first cases of the epidemic in the area, which have laboratory confirmation).[1]

Located on the coast of the State of São Paulo, headquarters of the Baixada Santista, Santos has 281,0 km², 419.400 inhabitants e 1.494,26 inhabitants/km2. In 2017, the infant mortality rate was 9,0 deaths/thousand live births, with a Municipal Human Development Index of 0,840 [10] (2010). It has a hot and humid climate and an economy based on port, commercial and tourist activities. [6]

The database referring to dengue cases was extracted in 2017 from SINAN-Online by TabWin-Datasus V.3.6 (2010). The dengue incidence coefficient (IC) was calculated per 100.000 inhabitants, using the population living in Santos from 2012 to 2016 as the denominator, according to data available at the SUS Computer Department (DATASUS). [11] The population corresponding to the stratification by sex and age group was used. The ratio of the dengue ICs by year of symptom onset, according to age group and sex was calculated as follows: ratio between each IC by age group, sex and year and the IC of the age group over 60 years, sex and year (this last used as denominator because it is the age group with the lowest CI in the period, adopted as a reference for relative comparison). The PNCD parameters were adopted to classify the incidence of dengue (number of cases/100.000 inhabitants): Low ≤ 100; Mean> 100 and <300; Discharge ≥ 300. [8]

Six socioeconomic indicators were obtained from the base of census sectors in Santos, according to the 2010 Census of the Brazilian Institute of Geography and Statistics (IBGE - Instituto Brasileiro de Geografia e Estatística) [12] and aggregated by the 65 neighborhoods, being calculated as follows:

- Demographic density (inhabitants/km²): division of the population of the neighborhood by the area of the neighborhood in Km2 (calculated in TerraView V.4.2.2).
- Proportion of literate resident people aged greater than or equal (≥) 5 years: percentage of literate resident people aged greater than or equal (≥) 5 years in relation to the total population of the neighborhood.
- Proportion of households with per capita income up to half (½) mi-

nimum wage; Proportion of households with general water supply; Proportion of households with sewerage via the general sewage network; Proportion of households with garbage collected: percentage of each indicator in relation to the total of permanent private households in the neighborhood.

The seventh indicator was obtained from the São Paulo Social Vulnerability Index (IPVS - Índice Paulista de Vulnerabilidade Social) 2010/Fundação Sistema Estadual de Análise de Dados (Seade - Sistema Estadual de Análise de Dados), based on data on schooling, health, family arrangements, insertion in the labor market, goods and public services. [13]

The IPVS database was added by neighborhood, adopting the Proportion of people residing in census tracts with IPVS 4, 5 or 6 (medium, high or very high vulnerability) in relation to the total population of the neighborhood.

The entomological indicators for the period 2012 to 2016 were extracted in 2017 from the databases of vector infestation indexes of the Vector Control Section (SECOVE - Seção de Controle de Vetores) - Municipal Health Secretariat of Santos.

The Larval Density Index (LDI) is composed of the Breteau Index (BI), an indicator adopted for the evaluation of larval density in the State of São Paulo [6], thus being calculated [14]:

Breteau Index (BI) = number of positive containers X 100 / number of properties surveyed

In Santos, SECOVE evaluates the BI in January, April, July and October, with two exceptions: in April 2013 it was not evaluated due to the dengue epidemic; and in 2014 it was evaluated in February, April, July and October. In 2012, the municipality adopted "Intelligent Dengue Monitoring" (MI-Dengue) as a tool for continuous monitoring of Aedes aegypti infestation and directing control actions. MI-Dengue is composed of traps (Mos-quiTRAP®) that capture adult females of

Aedes aegypti (mainly pregnant females), associated with a computerized system for the collection, transmission and access of information. [15]

In January 2012, 461 traps were installed in the municipality, 250m apart, with an average distribution of 16 traps/km². Each endemic agent inspected 78 traps/week, counting the captured Aedes aegypti females.

The entomological indicators were aggregated by year and neighborhood, in January, April, July and October, being calculated as follows:

- Larval Density Index (LDI): ratio between the number of positive containers for Aedes aegypti and the number of properties surveyed multiplied by 100.
- Density index of Aedes aegypti females (DIF): ratio between the number of adult Aedes aegypti females captured and the number of traps.

Spearman's bivariate correlation with SPSS Statistics® 22.0.0.0 (2014) was used for the statistical analysis of the data and a significance level of 5% to relate the

dengue IC with socioeconomic indicators and entomological indicators in the period from 2012 to 2016. The dengue IC was added by month of onset of symptoms and by neighborhood (per 10.000 inhabitants), using the resident/neighborhood population as the denominator, according to the 2010 IBGE Census. [12]

The neighborhoods of the Port Area (without resident population) and Morros Cachoeira, Chico de Paula and Embaré were excluded because they had a population of less than 200 inhabitants; as well as the neighborhoods of the continental area, which has the lowest demographic density (13.5 inhabitants/km²) in the municipality. [12] Therefore, there are few cases of dengue in these neighborhoods/areas, but due to the small/absent resident population, only 1 case would generate high incidence, causing "outliers" in the statistical analysis.

Researchers are committed to keeping data confidential, in accordance with Resolutions 196/1996 and 466/2012. [16-17] The research project (CAAE nº79776017.1.0000.5479) was approved on 02/20/18 at the Research Ethics Committee of Santa Casa de Misericórdia de São Paulo.

**Figure 1 - Dengue incidence coefficient (per 100.000 inhabitants) per epidemiological year of onset of symptoms, Santos, São Paulo. 2012-2016.**
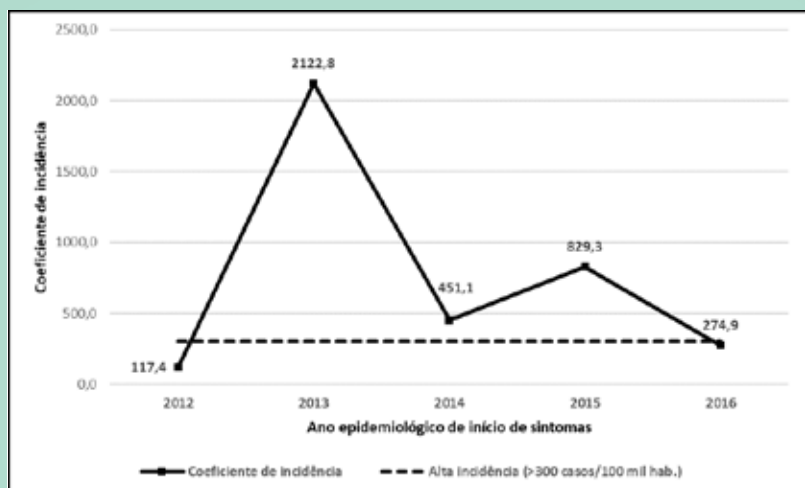


Sources: SINAN-Online, 2012-2016; DATASUS, 2012-2016.

**RESULTS**

From 2012 to 2016 there were 16.451 confirmed cases of dengue in Santos, with two epidemic peaks: in 2013 with 9.195 cases (2.122,8 cases/100.000 inhabitants); and in 2015 with 3.599 cases (829,3 cases/100,000 inhabitants) (Figure 1).

Regarding viral circulation, there was

a gradual change from serotype DENV-4 to DENV-1 over the period. In 2012, 100% of serotyped cases were DENV-4. In subsequent years, the proportion of the DENV-1 serotype began to increase until in 2015 it became 100,0% of the serotyped cases. In 2016, no serotypes were registered in SINAN-Online.

Over the long period studied, there was a general trend towards a higher

incidence of dengue in women, with the exception of the 0-14 age group in 2012 (Table 1).

The age group from 15 to 29 years old had a higher incidence over the period, followed by the age group from 30 to 59 years old, this pattern being similar for both sexes. The elderly (over 60 years old) constituted the group with the lowest incidence for both sexes throughout the period. When comparing the age groups with the highest incidence (15-29 years and 30 to 59 years) with the elderly, we show a risk for the former approximately 2 to 3 times greater. It is also worth noting that the risk is 4 times higher in the younger age groups (0 to 14 years and 15-29 years) in 2016 for males (Table 1).

According to Table 2, the investigation of the correlation between socioeconomic indicators and incidence coefficient by neighborhood in the period according to which for the years 2012 to 2014 there is no pattern of correlation between the variables. On the other hand, in 2015 and 2016, statistically significant correlations of strong and moderate intensity were identified, of which we highlight:

- Negative correlation with demographic density in 2016 (-0,389).
- Negative correlation with Literacy proportion of the population aged greater than or equal (≥) 5 years in 2015 (-0,435) and 2016 (-0,356).
- Positive correlation with Proportion of households with per capita income up to half (½) minimum wage in 2015 (0,384) and 2016 (0,324).
- Negative correlation with Proportion of households with sewage in 2015 (-0,352) and 2016 (-0,393).
- Positive correlation with proportion of people residing in census sectors with greater vulnerability - IPVS 4, 5 or 6 in 2015 (0,332).

The indicators of garbage collection and water supply did not correlate with

**Table 1 - Coefficients of dengue incidence (per 100.000 inhabitants) and ratio of coefficients of dengue incidence by epidemiological year of onset of symptoms, according to age group and sex, Santos, São Paulo. 2012-2016.**

| Sexo/Faixa Etária (anos) | | Ano epidemiológico de início de sintomas/Indicador | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|
| | | 2012 | | 2013 | | 2014 | | 2015 | | 2016 | |
| | | CI | RCI | CI | RCI | CI | RCI | CI | RCI | CI | RCI |
| Feminino | 0-14 | 94,4 | 2,0 | 1957,5 | 1,7 | 320,5 | 1,1 | 711,3 | 1,6 | 299,6 | 2,1 |
| | 15-29 | 153,9 | 3,2 | 3376,8 | 2,9 | 633,0 | 2,1 | 1570,0 | 3,6 | 415,4 | 3,0 |
| | 30-59 | 168,7 | 3,5 | 2548,8 | 2,2 | 660,9 | 2,2 | 1006,8 | 2,3 | 328,8 | 2,3 |
| | ≥ 60 | 48,2 | 1,0 | 1173,7 | 1,0 | 300,5 | 1,0 | 432,7 | 1,0 | 140,1 | 1,0 |
| Masculino | 0-14 | 128,0 | 2,6 | 1788,7 | 1,7 | 353,8 | 2,1 | 635,4 | 1,9 | 324,3 | 4,1 |
| | 15-29 | 133,3 | 2,7 | 2965,7 | 2,9 | 523,7 | 3,1 | 1233,0 | 3,7 | 349,2 | 4,4 |
| | 30-59 | 103,6 | 2,1 | 1804,5 | 1,8 | 394,8 | 2,4 | 673,8 | 2,0 | 246,0 | 3,1 |
| | ≥ 60 | 49,5 | 1,0 | 1025,3 | 1,0 | 166,6 | 1,0 | 330,5 | 1,0 | 79,9 | 1,0 |

CI = Incidence coefficient (Coeficiente de incidência); RCI = Incidence coefficient ratio (Razão do coeficiente de incidência)  Fontes: SINAN-Online, 2012-2016; DATASUS, 2012-2016.

**Table 2 - Spearman's correlation coefficient between dengue incidence coefficient (per 10,000 inhabitants) per year and socioeconomic indicators, by neighborhood, Santos, São Paulo. 2012-2016.**

| Indicadores socioeconômicos | Coeficiente de incidência de dengue | | | | |
|---|---|---|---|---|---|
| | 2012 | 2013 | 2014 | 2015 | 2016 |
| Densidade demográfica (habitantes/km²) | -0,104 | -0,176 | -0,051 | -0,261 | -0,389(*) |
| Proporção de alfabetização (idade ≥ 5 anos) | -0,262 | -0,296(*) | -0,057 | -0,435(*) | -0,356(*) |
| Proporção de renda per capita até ½ salário mínimo | 0,246 | 0,201 | 0,005 | 0,384(*) | 0,324(*) |
| Proporção de abastecimento de água da rede geral | 0,004 | -0,111 | 0,120 | -0,208 | -0,141 |
| Proporção de esgotamento sanitário da rede geral | -0,235 | -0,142 | -0,053 | -0,352(*) | -0,393(*) |
| Proporção de lixo coletado | -0,137 | 0,056 | -0,046 | -0,104 | 0,017 |
| Proporção de pessoas residentes em setores censitários com IPVS 4, 5 ou 6 | 0,151 | 0,210 | 0,028 | 0,332(*) | 0,237 |

* Significant correlations (p <0.05)
IPVS = Paulista Social Vulnerability Index  (Índice Paulista de Vulnerabilidade Social); CC = Correlation coefficient Sources: SINAN-Online, 2012-2016; Fundação Seade - São Paulo Social Vulnerability Index, 2010; IBGE Census, 2010.

the incidence coefficients (Table 2).

The study showed dengue seasonality in April. In the epidemic years, the peak in April was 700,3 (2013) and 434,9 (2015) cases/100.000 inhabitants. The DIF followed the IC peaks in April 2012 (3,3), 2015 (7,5) and 2016 (7,0) and its lowest values occurred in July (except in 2012 when the lowest DIF value was verified in January). The LDI followed the IC peaks in April 2012 (0,8), 2014 (3,0) and 2015 (1,9); and in July, their lowest values were recorded (with minimum values also in October 2012 and 2013) (Table 3).

According to and Table 4, the analysis of the correlation between entomological indicators (LDI and DIF) and the dengue IC by neighborhood showed few statistically significant correlations of moderate intensity. The DIF showed a greater positive correlation in relation to the IC when compared to the LDI, but not significant in most years. In short, the IC correlated with statistical significance with:

- LDI in the third quarter of 2012 (-0,330).
- DIF and LDI in the first quarter of 2013 (0,412 and 0,319, respectively).

- DIF in the last quarter of 2015 (0,390).

## DISCUSSION

The temporal pattern of the incidence of Dengue in Santos in the period studied was similar to the state pattern and the pattern of Baixada Santista. 7 No cyclical pattern has been identified (with outbreaks in certain years 18), and in the years 2013 to 2015 the incidence remained high, according to the PNCD 8, above 300 cases/100.000 inhabitants and with significant peaks particularly in the years

### Table 3 - Dengue incidence coefficient (per 100.000 inhabitants) per month/year of symptom onset, Density index of Aedes aegypti females per month/year of capture and Larval density index per month/year of evaluation, Santos, Sao Paulo. 2012-2016.

| Indicador | Mês/Ano de início de sintomas/captura/avaliação | | | | | | | | | | | | | | | | | | | |
| | 2012 | | | | 2013 | | | | 2014 | | | | | 2015 | | | | 2016 | | |
| | jan | abr | jul | out | jan | abr | jul | out | fev | abr | jul | out | jan | abr | jul | out | jan | abr | jul | out |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| CI | 0,5 | 32,0 | 10,3 | 1,2 | 50,5 | 700,3 | 1,4 | 0,2 | 4,8 | 69,1 | 10,3 | 4,3 | 2,9 | 434,9 | 8,6 | 1,0 | 5,2 | 105,9 | 0,7 | 1,0 |
| IDF | 0,8 | 3,3 | 1,7 | 1,8 | 3,1 | 2,9 | 2,0 | 2,0 | 3,4 | 2,9 | 2,5 | 3,5 | 5,4 | 7,5 | 3,0 | 3,3 | 5,1 | 7,0 | 1,7 | 1,8 |
| IDL | 0,7 | 0,8 | 0,4 | 0,4 | 1,5 | –* | 0,2 | 0,2 | 1,9 | 3,0 | 0,8 | 1,8 | 1,8 | 1,9 | 0,7 | 1,5 | 1,5 | 1,3 | 0,3 | 0,6 |

* In April 2013, LDI was not evaluated due to the dengue epidemic. CI = Incidence coefficient (Coeficiente de incidência);

IDF = Density Index of Aedes Aegypti females (Índice de Densidade de fêmeas de Aedes Aegypti); IDL = Larval Density Index (Índice de Densidade Larvária)

Sources: SINAN-Online, 2012-2016; IBGE Census, 2010; Vector infestation indexes - SECOVE/Santos Municipal Health Department, 2012-2016.

### Table 4 - Spearman's correlation coefficient between dengue incidence coefficient (per 10.000 inhabitants) and Density Index of Aedes aegypti females and Larval Density Index-months of January "jan", April "abr", July "jul" and October "oct", by neighborhood, Santos, São Paulo. 2012-2016.

| Indicador/Mês | | Coeficiente de incidência de dengue (jan, abr, jul, out) | | | | |
| | | 2012 | 2013 | 2014 | 2015 | 2016 |
|---|---|---|---|---|---|---|
| IDF | jan | 0,286 | 0,412(*) | 0,132 | -0,255 | -0,190 |
| | abr | 0,168 | -0,084 | 0,128 | 0,075 | 0,179 |
| | jul | -0,245 | 0,161 | 0,035 | -0,106 | 0,044 |
| | out | 0,152 | -0,082 | 0,177 | 0,390(*) | 0,046 |
| IDL | jan | 0,149 | 0,319(*) | 0,073 | -0,249 | -0,106 |
| | abr | 0,018 | -** | 0,202 | 0,199 | 0,171 |
| | jul | -0,330(*) | -0,199 | 0,127 | -0,201 | -0,191 |
| | out | -0,142 | -0,220 | -0,192 | -0,015 | 0,198 |

* Significant correlations (p <0,05) ** In April 2013, LDI was not evaluated due to the dengue epidemic.

IDF = Density Index of Aedes Aegypti females (Índice de Densidade de fêmeas de Aedes Aegypti); IDL = Larval Density Index (Índice de Densidade Larvária)

Sources: SINAN-Online, 2012-2016; IBGE Census, 2010; Vector infestation indexes - SECOVE/Santos Municipal Health Department, 2012-2016.

2013 and 2015. This pattern must be associated with the change in the predominance of the DENV-4 serotype to DENV-1 over the study period.

According to the literature, in Santos the serotype DENV-1 was identified in 1997 and the other serotypes in 1998 (DENV-2), in 2002 (DENV-3) and in 2012 (DENV-4). In 1998 there was an epidemic in Santos after the introduction of DENV-1 in 1997; in 1999, after the introduction of DENV-2 in 1998; and in 2002, when DENV-3 was registered. 6 In turn, the identification of a new serotype, DENV-4, in 2012 (100,0%) with a predominance in 2013 (96,6%) culminated in the 2013 dengue epidemic that presented the highest IC (2.122,8 cases/100,000 inhabitants) of the studied period.

Consistently, over this period, the incidence of Dengue in Santos was higher

in females and in the 15-29 age group. This is a pattern referred to in other studies, with emphasis on studies carried out in São José do Rio Preto, from 1990 to 2005 [19], and in Araraquara, from 1991 to 2015 [20], in which there was also a predominance of the disease in women.

The greater involvement of women may be related to the influence of the home/home environment on the transmission of diseases transmitted by Aedes aegypti [21], as well as the greater demand for medical assistance by women, resulting in a greater number of diagnoses and notifications, which can cause a bias in the comparisons between the rates found. [22]

The high incidence of dengue in the epidemic years brings an important disease burden to society. By mainly affecting the age groups that make up the economically active population (the IC was higher in the 15-29 age group, followed by the 30-59 age group), dengue impacts productivity and generates an economic burden in epidemic years. [2]

The analysis of the correlation of the socioeconomic indicators studied with the incidence of dengue at the neighborhood level in Santos revealed that there are statistically significant correlations but they are weak or moderate and that this pattern is not consistently verified throughout the period. In general, worse socioeconomic conditions correlated with higher dengue incidence coefficients. One hypothesis would be that in areas with the worst socioeconomic levels, the characteristics of infrastructure and basic sanitation offer better conditions for the proliferation of the vector. In São José do Rio Preto - in a study based on income, education, illiteracy and number of residents per household - there was an association between dengue risk and socioeconomic levels in 1994 and 1995. [23]

It is also worth mentioning the demographic density with some negative correlations with the IC. There are few studies in the literature on intra-urban

assessment of dengue for such a discussion, however, a hypothesis would be that, in Santos, the beachfront and its surroundings have the highest demographic densities as well as the best socioeconomic indicators. [12-13]

O estudo mostrou sazonalidade da dengue em abril. Em Araraquara, de 1991 a 2015, o CI teve pico entre março e maio. [20] Dengue cases were also registered in Santos in the other months, showing endemicity of the disease, occurring throughout the year. [24] Still, the identification of seasonality contributes to the planning of epidemiological surveillance and vector control activities, intensifying efforts before this period to minimize viral dispersion. [20]

The entomological indicators IDF and IDL demonstrated a behavior apparently associated with the temporal evolution of the dengue incidence coefficient following the IC peak in April in several years of the studied period. However, the correlations between entomological indicators and the dengue incidence coefficient by neighborhood did not express a well-defined pattern. In the twenty periods investigated, only in 2 for LDI and 2 for DIF the correlations were statistically significant. In a study in São José do Rio Preto, from 2012 to 2013, however, the increase in dengue cases occurred in parallel with the increase in the number of adult females of Aedes aegypti. [25]

Regarding LDI, it is necessary to consider the lag between the increase in the larvae population and the increase in cases, since only adult females transmit the virus. [25] In Araraquara, from 1991 to 2015, the curve of cases increased one or two months after the peak of the larval index. [20]

The weakness of the correlations of entomological indicators may be related to the choice of the neighborhood as a spatial unit, given its heterogeneity, thus being one of the limitations of the study. When presenting aggregated socioeconomic and health data in comprehensive areas, the analyzes can be limited to the

average situation of individuals, making it impossible to identify the existing heterogeneity. [26] The use of data from SINAN-Online is another limitation of the study, due to the bias generated by underreporting, coverage and data quality.

It is necessary to consider the ecological type study as another limitation, a design that raises hypotheses for analytical studies with greater power to prove causal relationships. Thus, it is suggested future studies with multivariate correlations and time-spatial cluster, and possible reduction of the spatial unit in order to identify more homogeneous areas, seeking a better understanding of the levels of risk to dengue in the intra-urban space.

## CONCLUSION

The study described the epidemiological profile of dengue in Santos, with similar patterns to the profiles of the state of São Paulo and Baixada Santista. It also showed intra-urban differentials - which contribute to the understanding of the local dynamics of epidemics - and related the disease to socioeconomic and entomological indicators, with unprecedented local analyzes of the Density Index of Aedes aegypti females (DIF).

In relation to the socioeconomic indicators considered for the aggregate level of the study (neighborhood), relations between areas with worse socioeconomic conditions and a higher coefficient of dengue incidence were pointed out, especially with regard to the years 2015 and 2016. The literature diverges on the association between socioeconomic conditions and the occurrence of dengue, thus highlighting the complexity of this relationship. However, the study related dengue to socioeconomic factors, meeting the theme of social inequalities in health and the epidemiological profile of different social groups, also pointing out the relevance of seeking ways of coping within the scope of social public policies.

In turn, although the study has shown relationships between entomological in-

dicators and the incidence of dengue, they are not able to efficiently explain or predict the variation in the incidence of the disease.

Even so, the results contribute to planning activities for epidemiological surveillance and vector control, with focal interventions in the period leading up to seasonality - aiming to reduce infestation - and effective epidemiological surveillance to recognize transmission early. In addition, the importance of monitoring the adult vector can validate the maintenance of "Intelligent Dengue Monitoring" in Santos. 🦟

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