Waterborne diseases and urban sanitation: a spatial relationship of arbovirus cases in Feira de Santana (BA)

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ABSTRACT
This work analyzed the spatial relationship of dengue, chikungunya and zika cases with urban sanitation problems, in the period 2014-2019, in the city of Feira de Santana. For this, after a literature review, a survey of pre-existing data on the occurrence of diseases was carried out, by neighborhood of the city and, after treating them through exploratory spatial data analysis (AEDE), it was possible to generate thematic maps in QGIS, showing a distribution of georeferenced cases in the urban area of the municipality.

Keywords: Aedes aegypti, Urban Sanitation, Health.

1 INTRODUCTION

Since the mid-1980s, the World Health Organization (WHO) has considered sanitation a priority measure in terms of public health (FRANCEYS, 1994). For the UN, basic sanitation has a direct impact on child mortality indicators, population health, disease eradication and environmental sustainability and is part of its millennium development goals.

Basic sanitation can be defined as a set of measures aimed at preserving and remedying environmental conditions in order to prevent disease and promote health, as well as to improve the quality of life of the population.

In Brazil, basic sanitation is a right guaranteed by the constitution, defined by Law No. 11.445/2007, as the set of services, infrastructure and operational facilities for water supply, sanitation, urban cleaning, urban drainage, solid waste management and rainwater, according to Trata Brasil. With the Basic Sanitation Law, it became valid for all municipalities to prepare the Municipal Basic Sanitation Plan - PMSB.

The concept of basic sanitation is set out in article 3, item I, of Law 11.445/2007 as a set of services, infrastructures and operational facilities for drinking water supply, sanitary sewage, urban cleaning and solid waste management and rainwater treatment and is essential for the hygiene of cities, for the well-being of the population, for the psychosocial development of individuals and for the maintenance of renewal conditions that guarantee the sustainability of the ecosystem.

For the World Health Organization (WHO), sanitation is a priority measure to ensure public health (FRANCEYS, 1994). The lack of sanitation in urban areas can lead to public health problems. Some of the most common are dengue, chikungunya and zika, which are diseases transmitted mainly by the Aedes aegypti mosquito, present in tropical regions. The virus generates major problems that involve the entire society and the country's economy.

This research aimed to correlate the occurrence of diseases - Zika, chikungunya and dengue - by urban sanitation problems, in the period 2014-2019, in the city of Feira de Santana. To this end, pre-existing data on the occurrence of diseases were collected by neighborhood of the city. After processing them through exploratory spatial data analysis (AEDE), thematic maps can be generated in QGIS, from the city's cadastral map and the spreadsheets created, generating a distribution of georeferenced cases in the urban area of the municipality.

The realization of this work is fundamental, as it benefits both the academic community and the general community. This is because, in addition to generating high costs for the public coffers, the Brazilian government's spending on the prevention and control of Aedes aegypti was R$ 152,103,611.63 in 2017, R$ 143,702,444.04 in 2016 and R$ 150,019,037.98 in 2015, according to the Ministry of Health. It also results in human suffering and health services at the limit. Thus, the prevention of these diseases can prevent high expenses, as well as the social burden of these diseases.

2 STUDY AREA

In Bahia, only 14.6% of municipalities declare having a Municipal Basic Sanitation Plan (PMSB). Feira de Santana (Figure 1), being the second most populous municipality in the state, estimated in 2017 by the Brazilian Institute of Geography and Statistics (IBGE), is no exception.

Figure 1 - Location map of the municipality of Feira de Santana, highlighting the urban area boundary.
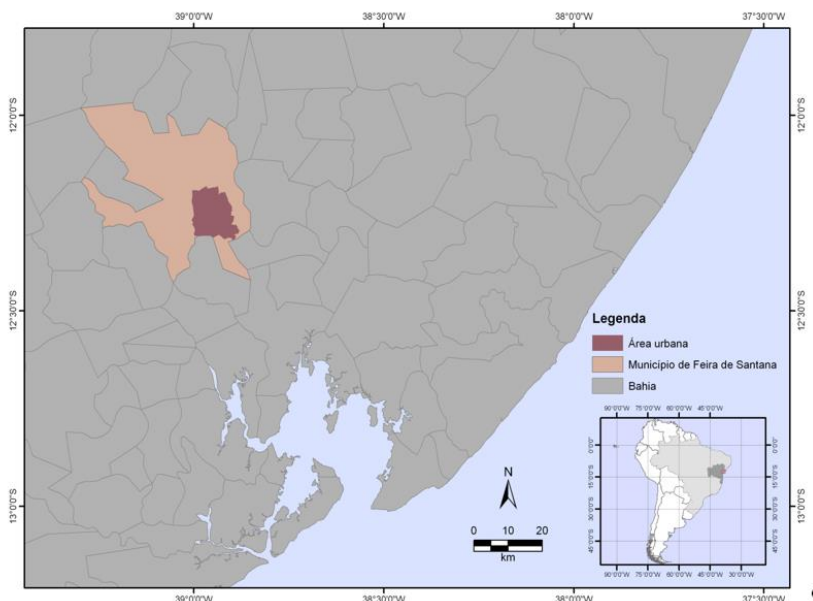
Source: SANTOS, B.S, 2012

According to the Trata Brasil Institute, most Brazilian municipalities - about 70% - still do not have a PMSB, and Feira de Santana is no exception. Located at the portal of the Bahian hinterland, with more than 600,000 inhabitants estimated in 2017 by the Brazilian Institute of Geography and Statistics (IBGE), Feira de Santana is the second most populous municipality in the state, occupying the first position not only in the interior of Bahia, but also in all other states in the northeast, north and center-west of the country (Table 1).

Table 1 - Evolution of the population of Feira de Santana (BA)

| ANO	POPULAÇÃO RESIDENTE	
	URBANA	RURAL
1940	19.660	63.608
1950	34.277	72.928
1960	69.884	71.873
1970	131.720	55.570
1980	233.905	57.599
1991	348.973	56.875
2000	431.730	49.219
2010	510.637	46.007
2020	603.981	43.002

Source: IBGE Cities

For Santo (2002), the expansion of Feirense took place without a greater concern for the environment, like any city without planning, and only in 1968, the first Integrated Local Development Plan was carried out in the municipality. It is noteworthy that the water and sanitation service provider in the municipality is EMBASA - Empresa Baiana de Águas e Saneamento.

Figure 02 shows the types of water supply, by household, by census tract and by neighborhood. With emphasis on (a) households connected to the public network (EMBASA); (b) households supplied by artesian well water; (c) households supplied by rainwater stored in cisterns or other containers and (d) households supplied with water in other ways.

Figure 2 - Types of water supply, per household, per census tract and per neighborhood
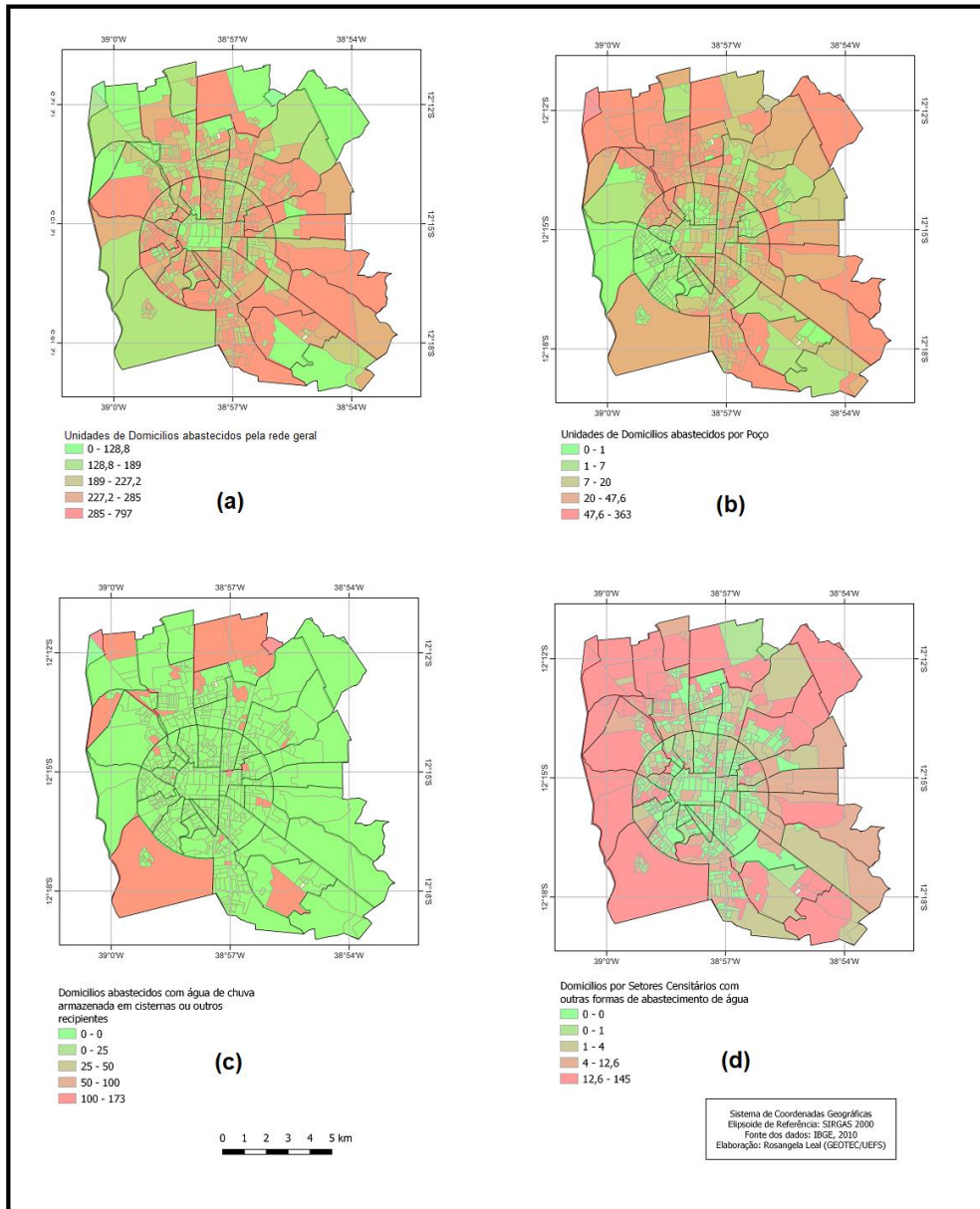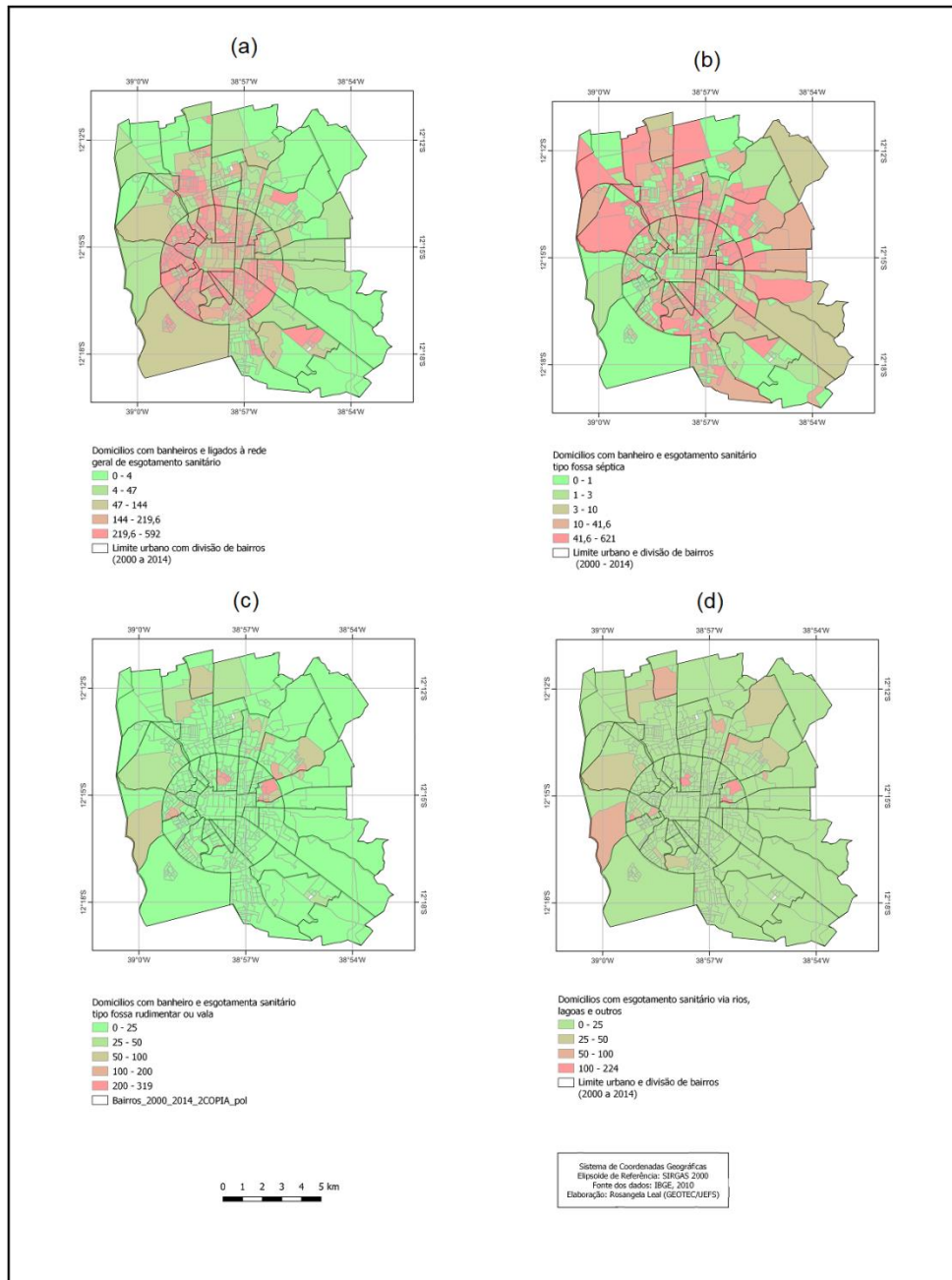

Source: IBGE, 2010

Figure 3 shows the types of sewage disposal in Feira de Santana, by census tract, aggregated by neighborhoods. With emphasis on (a) households with individual toilets connected to the public sewage system; (b) households with individual toilets with septic tank type sewage; (c) households with individual toilets with rudimentary pit or ditch type sewage; (d) households with individual toilets with sewage via rivers, ponds or other.

Figure 3 - Sanitary sewage in Feira de Santana, by census tract, aggregated by neighborhoods.
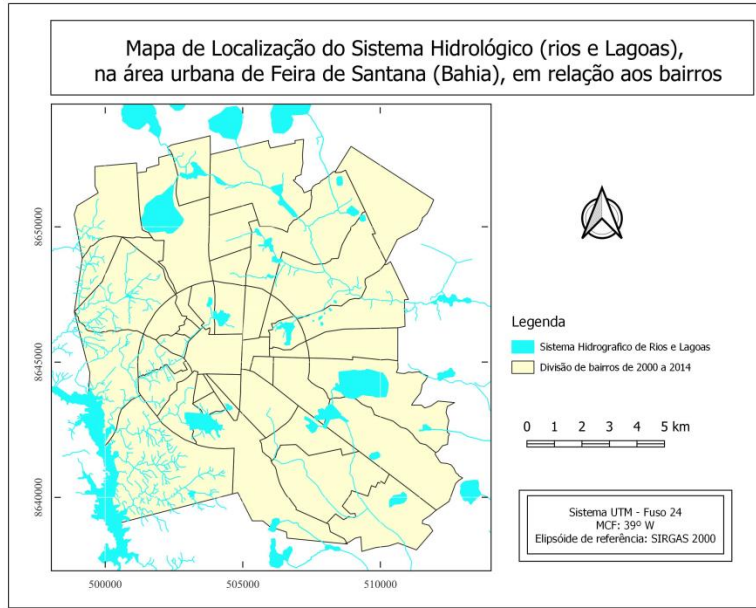

Source: IBGE, 2010

Another aggravating factor in the city is the water structure itself, with a system of lagoons throughout the urban area (Figure 4). Most of them were occupied in a disorderly manner, with the installation of irregular housing.
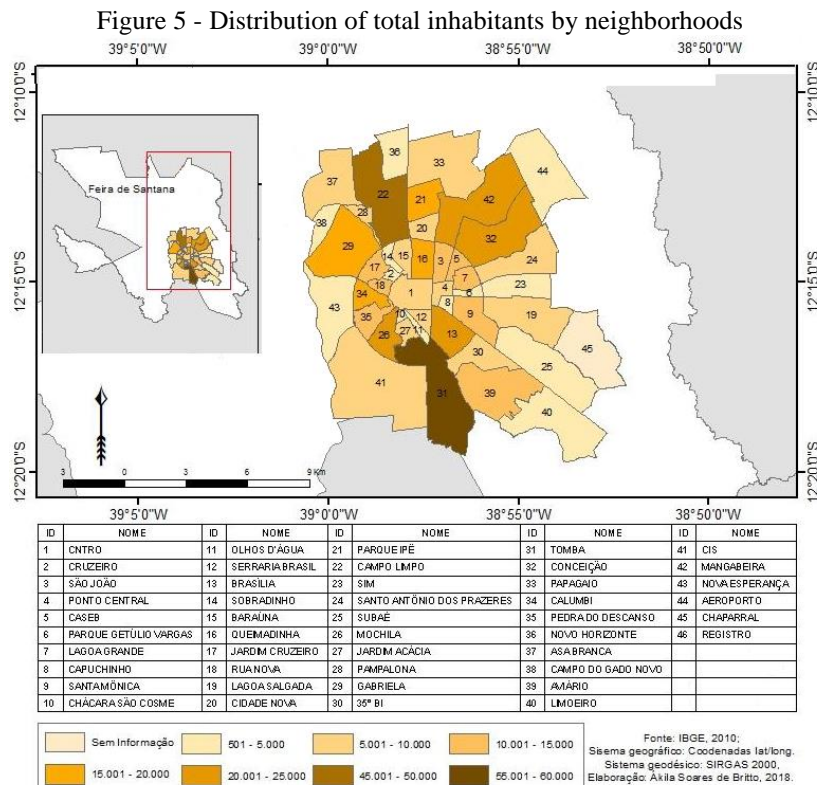
Figure 4 - Distribution of the hydrographic network and lake system in the urban area of Feira de Santana (BA)

Source: IBGE (2010), EMBASA (2000)

Regarding the resident population in the municipality of Feirense, figure 5 shows the distribution of the total number of inhabitants by neighborhood.

Figure 5 - Distribution of total inhabitants by neighborhoods

ID	NOME	ID	NOME	ID	NOME	ID	NOME	ID	NOME
1	CNTRO	11	OLHOS D'ÁGUA	21	PARQUE IPÊ	31	TOMBA	41	CIS
2	CRUZEIRO	12	SERRARIA BRASIL	22	CAMPO LIMPO	32	CONCEIÇÃO	42	MANGABEIRA
3	SÃO JOÃO	13	BRASÍLIA	23	SIM	33	PAPAGAIO	43	NOVA ESPERANÇA
4	PONTO CENTRAL	14	SOBRADINHO	24	SANTO ANTÔNIO DOS PRAZERES	34	CALUMBI	44	AEROPORTO
5	CASEB	15	BARAÚNA	25	SUBAÉ	35	PEDRA DO DESCANSO	45	CHAPARRAL
6	PARQUE GETÚLIO VARGAS	16	QUEIMADINHA	26	MOCHILA	36	NOVO HORIZONTE	46	REGISTRO
7	LAGOA GRANDE	17	JARDIM CRUZEIRO	27	JARDIM ACÁCIA	37	ASA BRANCA		
8	CAPUCHINHO	18	RUA NOVA	28	PAMPALONA	38	CAMPO DO GADO NOVO		
9	SANTA MÔNICA	19	LAGOA SALGADA	29	GABRIELA	39	AMÁRIO		
10	CHÁCARA SÃO COSME	20	CIDADE NOVA	30	35º BI	40	LMOEIRO		

Source: Adapted from BRITO and FREITAS (2019) Data source: IBGE (2010).

ARBOVIROSES

Arboviruses are diseases caused by arboviruses (ARthropod BOrne VIRUS) and transmitted by arthropods, that is, insects and arachnids. Currently, the most relevant arboviruses in Public Health are Dengue, Zika Virus, Chikungunya Fever and Yellow Fever (FREITAS; ZUBEN; DONALISIO, 2017).

The Aedes aegypti mosquito is the main vector of these diseases. It is not native to the country, being of African origin and was already eliminated from Brazil in 1955, but returned in 1976 due to coverage failures of control actions and possibly had its reintroduction across borders and ports (BRASIL, 2020).

Dengue is considered the most widely circulating arbovirus in Brazil, characterized by a seasonal pattern and a recurrent history of epidemics (TEXEIRA; BARRETO, 2008).

In 2014, a new arbovirus began to circulate in the country with a potentially epidemic profile, and the following year, in addition to this, Zika Virus also began to spread in some municipalities and with proof of an association between congenital ZIKA infection and microcephaly. These diseases have clinical similarities, diverse complications, enormous social and economic impacts, especially in tropical regions (BRASIL, 2016; BRASIL, 2017).

According to the Ministry of Health (2019), the number of probable dengue cases in the country in January 2019 more than doubled compared to the same period last year, as there was a 149% increase in cases and the three arboviruses together showed an average increase of more than 200%.

The control of these diseases is very complex, as several environmental, educational, social and cultural factors contribute to this context. Climate change, disordered urbanization, as well as natural and man-made disasters also have strong influences on the process of spreading diseases (NATAL et al., 2015). Associated with this framework is the problem of basic sanitation in the city, which has configured a serious framework for the spread of the vector of these diseases and their rapid contamination.

3 MATERIAL AND METHODS

The development of the work in reference was based on a bibliographic review on the subject in question, in addition to the collection of information from complementary studies carried out on the municipality of Feira de Santana (BA).

Based on the bibliographic review, a theoretical foundation was made with the themes involved in the research, data were collected and processed, considering data provided by the Department of Informatics of the Unified Health System (DATASUS), National Sanitation Information System (SNIS), Municipal Basic Sanitation Plan (PMSB) and the Health Department of the Municipality of Feira de Santana.

Thus, a survey was conducted on the current situation of basic sanitation and the incidence of waterborne diseases such as cholera, typhoid, hepatitis and leptospirosis, for each neighborhood,

respectively. Thus, a database on the number of cases of Dengue, Chikungunya and Zika, by neighborhoods, can be developed for quantitative analysis and association with rainfall, urban sanitation (presence/absence) and sewage system.

With the cadastral plan of the city in hand, associated with the number of cases indicated in the database referring to Dengue, Zika and Chikungunya, it was possible to group the data of the respective occurrences of the diseases, which allowed the elaboration of tables and graphs, for analysis and creation of the maps. The tool used to group the data and create the spreadsheets and graphs was Excel.

After formatting the data in the spreadsheets, they were inserted into the QGIS application, transforming the information provided into a variety of thematic maps, showing the distribution of georeferenced cases in the urban area of the municipality, as well as their spatial correlation with the variables adopted.

4 RESULTS AND DISCUSSION

Between 2014 and 2019, the most critical period for the number of dengue cases was in 2019 (1,564 probable) and the year with the lowest number of notified cases was 2017 (277 probable). The incidence profile is consistent with the number of cases, since the estimated population, in the period studied, varied only about 5% more (Graph 01).

In the same period, the behavior of a new arbovirus responsible for Chikungunya fever was observed. The year 2014, in which the first cases were registered, presented at the end about 1,265 probable cases, in the following year this number was even higher (3,745 cases), while the three subsequent years showed a consecutive decline, but in 2019 this disease again gained prominence in the epidemiological scenario of the municipality, with an approximate increase of 30% of the cases.

In 2015, the circulation of a new arbovirus called Zika virus was identified in the country and in the municipality of Feira de Santana. Unlike the other arboviruses mentioned, Zika virus did not present an oscillating pattern of cases annually, behaving as a temporal decrease within the worked interval. In its first year, 1,329 cases were recorded, in the following year 271, then 174 and in 2018 and 2019, respectively, 88 and 34 cases.
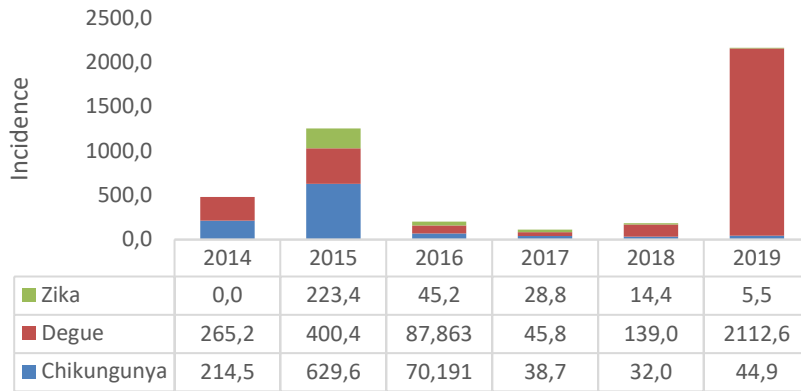
The average incidence per 100,000 inhabitants for the period studied was 171.6 for chikungunya, 505.5 for dengue and 52.9 for Zika. The incidence of dengue was prevalent in most years, the exception being in 2015, when Chikungunya predominated with 629.6 cases per 100,000 inhabitants. It is noted that in the municipality of Feirense there is a greater risk of illness in relation to dengue.

The years 2015 and 2019 were the ones that most reported cases of these diseases, while between the years 2016 and 2018, the picture is of decreasing incidence with some discrete oscillations, as can be seen in Graph 01.

Graph 1: Chikungunya, Dengue and Zika incidences, between 2014 and 2019, Feira de Santana-BA.

|	2014	2015	2016	2017	2018	2019
■ Zika	0,0	223,4	45,2	28,8	14,4	5,5
■ Degue	265,2	400,4	87,863	45,8	139,0	2112,6
■ Chikungunya	214,5	629,6	70,191	38,7	32,0	44,9

Source: Health Department of Feira de Santana

Faced with the analysis of the ranking of the 20 neighborhoods with the highest number of cases for Chikungunya, Dengue and Zika, it appears, according to data presented in Graph 02, that 13 of them were common for the three arboviruses, being them: Tomba, Santo Antônio dos Prazeres, Sobradinho, SIM, São João, Santa Monica, Rua Nova, Queimadinha, Ponto Central, Pedra do Descanso, Parque Ipê, Papagaio and Pampalona.

This frequency of cases in these locations signals the risk of circulation and demonstrates that strategic planning is needed to focus on the most critical areas.

Graph 2: Distribution of the 20 neighborhoods with the highest frequency of cases of (A) Chikungunya, (B) Dengue and (C) Zika, between 2014 and 2019, Feira de Santana-BA.
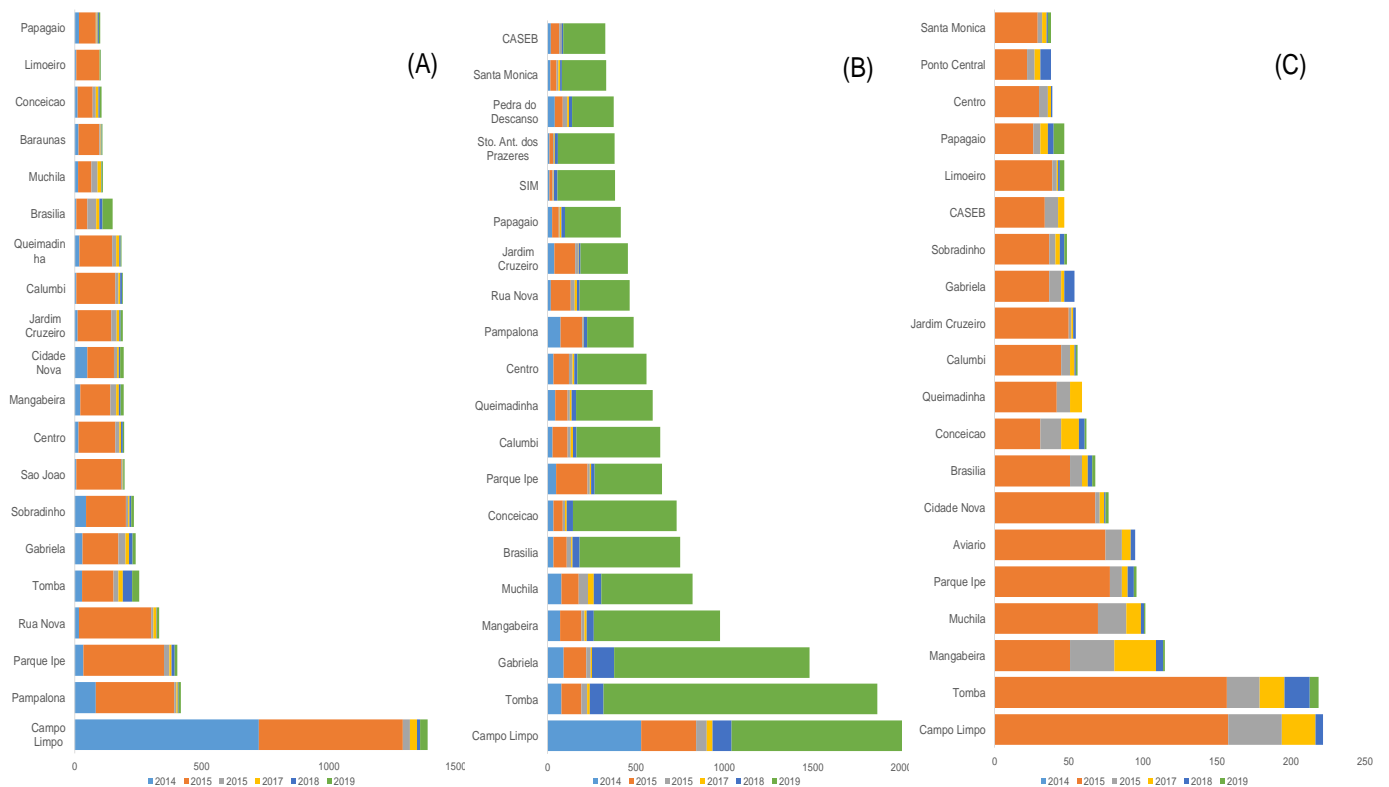

Source: Survey data

Between Chikungunya and dengue, 15 neighborhoods showed a higher prevalence of cases, while when analyzing Chikungunya and Zika, 16 neighborhoods coincide among the 20 listed. On the other hand, when comparing Dengue and Zika, 15 neighborhoods are more frequent. It is important to know the profile of circulating arboviruses, understanding the space in which it is inserted, in order to assist in epidemiological and clinical conduct. However, although the vector is the same, it is not every Aedes aegypti mosquito that transmits these arboviruses, only the infected ones, which implies strategic and constant action in order to make timely blockade, avoiding epidemics.

Feira de Santana, despite having 59.7% of households with adequate sanitary sewage, only 17.7% of urban households have adequate urbanization (presence of culvert, sidewalk and paving) (IBGE, 2010), thus hindering the drainage of rainwater and increasing the possibility of standing water, which is the main means of dissemination of Aedes aegypti.

Figure 6 - Thematic maps of dengue, zika and chikungunya cases, respectively, in 2019.
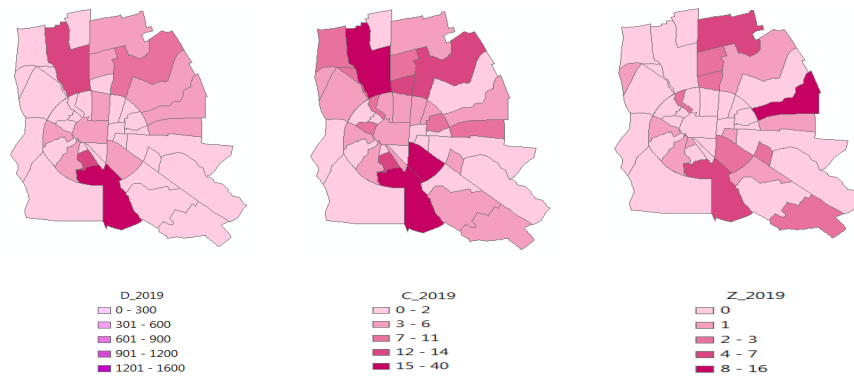
The thematic maps in Figure 6 refer to 2019. In the other years under analysis, the case dispositions are similar, with Campo Limpo having a higher incidence of dengue in all years, which also happens in relation to Zika and Chikungunya cases - except for 2019 for Zika, since the number of cases in Campo Limpo was zero.

It is necessary, in the municipality of Feira de Santana, a greater attention to the number of cases, mainly of dengue, which has not decreased as those of Zika and Chikungunya, but increased, which generates high expenses for public coffers, besides being a public health issue. It is noteworthy that the sanitation situation in the city is precarious, facilitating the spread of the transmitter. Therefore, it is urgent to implement measures to contain this problem.

5 FINAL CONSIDERATIONS

This study aimed to analyze the spatial relationship between dengue, chikungunya and Zika cases and urban sanitation problems in the period 2014-2019 in the city of Feira de Santana. Based on

the analysis of a variety of thematic maps generated with the QGIS application, associated with the city's cadastral map, it was possible to generate a distribution of georeferenced cases in the urban area of the municipality .

It is important to highlight the characterization presented in relation to the types of water supply, by household, by census tract and by neighborhood, in addition to the types of sewage that integrate the urban space of the municipality, which has a low level of adequate urbanization, especially regarding the presence of manhole, sidewalk and paving, a factor that hinders the drainage of rainwater and allows the occurrence of standing water, which is the main means of dissemination of Aedes aegypti.

Thus, it is concluded that the investigation of the transmission of these diseases, Dengue, Zika and Chikungunya, at the local level, associated with urban structuring, becomes an essential factor for the formulation of effective control strategies, which can contribute not only to the containment of exorbitant public spending, but also to benefit the population effectively, since it is a public health issue.

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