GEOGRAPHIC ACCESS TO HEALTH AND LEPROSY DISTRIBUTION IN SANTARÉM-PA: ANALYSIS OF THE COVERAGE OF PRIMARY CARE UNITS IN A HYPERENDEMIC AREA OF THE AMAZON

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ABSTRACT

The objective of this study was to spatially analyze the distribution of leprosy cases and their relationship with the areas covered by the Basic Health Units (BHU) in Santarém-Pará. An epidemiological, descriptive and retrospective study was carried out based on data from the Brazilian Institute of Geography and Statistics, the Notifiable Diseases Information System (SINAN), and the Municipal Health Department of Santarém. For the elaboration, comparison, and analysis of the spatial distributions of the cases, data from the 2022 census and the QGIS were used. The most prevalent clinical form was dimorphic (49.62%), followed by virchowian (26.31%). Regarding the operational classification, most patients (78.19%) were multibacillary. It was observed that the UBSs in the Jaderlândia, Matinha

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and Maracanã neighborhoods are located on the borders of their coverage areas, making it difficult for the population to access them. It is concluded that the spatial analysis revealed a heterogeneous distribution of leprosy cases in the city, also highlighting a discrepancy in the distribution of the UBSs in relation to their areas of operation. This imbalance can generate difficulties in accessing health services in some areas of the city, evidencing the need to review the location of the UBSs. The study highlights the challenge represented by the positioning of the UBSs on the borders of their areas of operation. In view of these findings, it is imperative to strengthen leprosy surveillance and control actions, concentrating efforts on early diagnosis, appropriate treatment, and health education, in order to reduce the incidence of the disease and ensure equitable access to health services for the entire affected population.

Keywords: Leprosy. Spatial analysis. Basic Health Unit.

INTRODUCTION

Leprosy is a chronic and infectious-contagious condition, caused by *Mycobacterium leprae*, characterized by its slow progression and affecting mainly the peripheral nerves, with transmission occurring through prolonged contact between a susceptible person and an untreated multibacillary patient (Brasil, 2017; Véloso et al., 2018).

In this direction, one of the strategies of the Ministry of Health (MH) consists of the integration of leprosy diagnosis and treatment actions in primary care, involving teams from the Family Health Program (PSF), Community Health Agents (CHA) and all units of the Unified Health System (SUS), aiming to facilitate universal access to diagnosis and treatment (Silva et al., 2018). In addition, it is crucial to know the epidemiological characteristics of the disease to understand the relationship between the bacillus and the patients treated in health services, as well as to know the spatial distribution of basic health units, enabling strategic and rational investments, taking into account the particularities of each region (Barbosa; Almeida; Santos, 2014).

According to Baia (2021), the organization and distribution of Basic Health Units (UBS) and the availability of health professionals are crucial elements to face the current epidemiological situation of leprosy. The location of the UBSs and their proximity to their areas of demand are essential to ensure effective service delivery to the population. In addition, the epidemiological surveillance of leprosy plays a crucial role in the interpretation and analysis of the data collected in health services, using epidemiological and operational indicators to guide the actions to be taken (Cunha et al., 2007; Cunha et al., 2019).

In this sense, spatial analysis has been used as an operational tool to identify geographic areas that are more vulnerable to the appearance of new cases and to intensify strategies to combat leprosy in these areas, allowing better monitoring of the distribution of the disease at local, regional and national levels. The distribution of leprosy cases is heterogeneous, with the most socioeconomically developed states in the south and southeast regions achieving the goal of eliminating leprosy as a public health problem, while clusters with a high burden of the disease persist in the north, central-west, and northeast regions of Brazil (Freitas; Duarte; Garcia, 2017).

In the Pará region, in addition to the hyperendemic condition of leprosy, there is a low coverage rate of the Family Health Strategy (ESF) program, indicating the presence of undiagnosed active foci of transmission and a low rate of evaluation of household contacts. It is notable that the analysis of the distribution of cases of the disease by year reveals a significant reduction in 2020, with a drop of 46% compared to 2019, from 38.1/100,000 inhabitants to 20/100,000 inhabitants. This temporal decline can be attributed, in part, to the

COVID-19 pandemic and the isolation measures implemented to control it, which may have influenced the lower demand for health services (Rocha; Noble; Garcia, 2020).

In this context, the present study sought to employ spatial analysis to map the distribution of leprosy cases reported between 2014 and 2019, correlating them with the areas covered by the UBSs in the municipality of Santarém, Pará.

METHODOLOGY

The study was of an epidemiological nature, being descriptive and retrospective. It used data from important sources, including the Brazilian Institute of Geography and Statistics (IBGE) for geographic and demographic information, the Notifiable Diseases Information System (SINAN) for data on leprosy cases, and the Municipal Health Department of Santarém (SEMSA) for specific data related to health in the municipality.

The choice of the city of Santarém as the place for the study of leprosy is due to its significance and representativeness in the context of the disease problem in the state of Pará. The city has an important classification of endemicity and is strategically located in the region. Located in the western region of the state of Pará, Santarém has geographic coordinates of 2º 24" 52" S and 54º 42" 36" W, with an average altitude of 35 meters. It belongs to the Lower Amazon mesoregion and the microregion of the same name. It is located on the banks of the Tapajós River, at its confluence with the Amazon River (IBGE, 2013).

Santarém is divided into 50 neighborhoods in the urban area and 354 census tracts. According to the IBGE, the census tract is the smallest territorial unit, formed by a continuous area, entirely contained in an urban or rural area, with a certain size and number of households that allow a single interviewer who is an IBGE employee (census agent) to apply all the necessary questionnaires there. The network of census tracts made available by the IBGE covers the fragmentation of the entire national territory, thus ensuring complete coverage of the country. This detailed geographic structure allows for an accurate and comprehensive analysis of the distribution of leprosy in the municipality under study, facilitating the planning and implementation of disease control and prevention measures (IBGE, 2013).

Data collection was carried out in the database of the Notifiable Diseases Information System (SINAN), with prior authorization from the Health Department of the Municipality of Santarém, ensuring compliance with privacy and data security policies.

To correlate and analyze the spatial distributions of leprosy cases, data from the 2022 census and *shapefiles* corresponding to the census tracts were used, allowing a detailed analysis of the geographic distribution of cases in the urban area of Santarém.

The georeferencing of the addresses of the leprosy cases was carried out using the *Open Street View* application, ensuring accuracy in locating the cases on the map. The geographic coordinates obtained were then transcribed into an Excel spreadsheet to facilitate data manipulation. The QGIS software was used to create the maps and analyze the results. As a cross-platform Geographic Information System (GIS) application, QGIS enables the visualization and analysis of spatial data efficiently.

In addition, the visualization of the distribution of each UBS by neighborhood through the creation of new *shapes* identifying the respective areas covered by these UBSs, allowed a more detailed analysis of the coverage of health services in the city.

The survey considered only cases of leprosy that occurred between 2014 and 2019, excluding records before or after this time interval, even if they were eventually registered in the Notifiable Diseases Information System (SINAN) during the period. In addition, leprosy cases that occurred in cities neighboring the municipality where the research was conducted and registered in SINAN were excluded, in order to maintain the focus on the defined study area.

The study followed the ethical recommendations established in Resolution 466/12 of the National Health Council (CNS), ensuring respect for the norms and guidelines for research involving human beings. The recommendations of autonomy, beneficence, non-maleficence, justice and equity were adopted throughout the research process. In addition, the study was submitted to the evaluation of the Research Ethics Committee of the State University of Pará, and was approved under opinion No. 6,116,994.

To analyze the results, descriptive statistical techniques were used, including the absolute and relative frequency of leprosy cases. In addition, a spatial analysis was performed to investigate the relationships between the data of the patients evaluated and the areas covered by the UBSs. This spatial analysis made it possible to identify geographic and spatial patterns in the distribution of leprosy cases in relation to the UBSs, helping in the planning and implementation of strategies for the prevention and control of the disease.

RESULTS AND DISCUSSION

During the period from 2014 to 2019, SINAN data revealed the occurrence of 266 cases of leprosy in the urban area of Santarém. However, 51 of these cases (19.17%)

could not be located due to the change of residence or the lack of address information on the notification form. Of the cases identified, the distribution by variables such as gender, age, clinical form, operational classification and degree of physical disability can be seen in Table 1. The analysis of the table indicates that 165 cases (62.03%) were confirmed in males, while 101 (37.97%) occurred in females.

Table 1 - Sociodemographic and clinical characterization of leprosy cases reported in the city of Santarém, from 2014 to 2019.

Variable		Leprosy Cases (SINAN)	
		N	%
Gender	Male	165	62,03
	Female	101	37,97
	Total	266	100
Age	15-29 years	30	11,27
	30-49 years	**86**	**32,33**
	50-69 years old	**94**	**35,33**
	>70 years	56	21,05
	Total	266	100
Clinical Form	Undetermined	28	10,52
	Tuberculoid	30	11,27
	Dimorphous	**132**	**49,62**
	Virchowiana	**70**	**26,31**
	Not Rated	6	2,25
	Total	266	100
Operational Classification	Paucibacillary	58	21,80
	Multibacillary	**208**	**78,19**
	Total	266	100
Degree of Physical Disability	0	131	49,25
	1	61	22,93
	2	31	11,65
	3	43	16,16
	Total	266	100

SOURCE: Ministry of Health – Notifiable Diseases Information System (SINAN). Prepared by the authors, 2023.

During the period analyzed, the age group most affected by leprosy was 50 to 69 years old, corresponding to 35.33% of the registered cases, followed by individuals from 30 to 49 years old, representing 32.33% of the cases, and the elderly aged 70 years and over, with 21.05% of the cases. Finally, the age group from 15 to 29 years old was the least affected, with only 11.27% of the cases. It is important to highlight that no cases were identified in individuals under 15 years of age during the period investigated.

The analyses in this study reveal that leprosy tends to predominantly affect the adult population, with the age group of 50 to 69 years presenting the highest rate of cases (35.33%). In contrast, the younger age groups have a lower incidence of the disease, with the 15 to 29 age group being the least affected, with only 11.27% of cases.

According to the Madrid classification, in the present study there was a higher prevalence of the borderline form of leprosy, with 49.62% of the cases, followed by the lepromatous form, which affected 26.31% of the patients. In third place, the tuberculoid form was found to be present in 11.27% of the cases, while the indeterminate form was the least frequent, registering 10.52% of the cases.

Regarding the operational classification, the data in the table indicate that 21.80% of the patients were classified as paucibacillary, while 78.19% were identified as multibacillary. In addition, the analysis reveals that 49.25% of the studied population has Physical Disability Grade 0, 22.93% are in grade I, 11.65% in grade II, and in 16.16% of the cases the assessment of the degree of disability was not performed.

The study found support in the works of Goiabeira (2018) and Cunha (2019) in relation to the gender variable, highlighting the prevalence of leprosy cases in men. This predominance can be explained by the greater exposure of men to the triggering factors of the disease, possibly related to their work environments. In addition, it is suggested that men sometimes show less concern with the aesthetic and physical changes caused by the disease, which can lead to a delay in seeking health services and increase the risk of complications and deformities (Carvalho; Gonçalves, 2022).

As highlighted by Silva (2020), leprosy is more commonly identified in adults due to its long incubation period, which usually ranges from 2 to 7 years. The impacts of leprosy go beyond physical health, causing economic and social losses due to the reduced ability to perform daily activities. It is also important to highlight the occurrence of the disease in the elderly population, defined by the Ministry of Health as individuals aged 60 years or older. Due to the aging process and the presence of other health conditions, leprosy illness in this group increases the risk of complications, such as disabilities and deformities. In addition, the delay in diagnosis and initiation of treatment contributes to the increase in the number of cases as age advances (Sales *et al*, 2020).

The results indicate a late detection of leprosy cases, since the predominant clinical forms were Dimorphic (49.62%) and Virchowian (26.31%), which are disseminating stages of the disease in the municipality. In addition, the prevalence of these clinical forms contributes to a higher risk of developing high degrees of physical disabilities and to maintaining the chain of transmission of the disease (Quaremas *et al*, 2019; Olive tree; Barbosa; Carrijo, 2019).

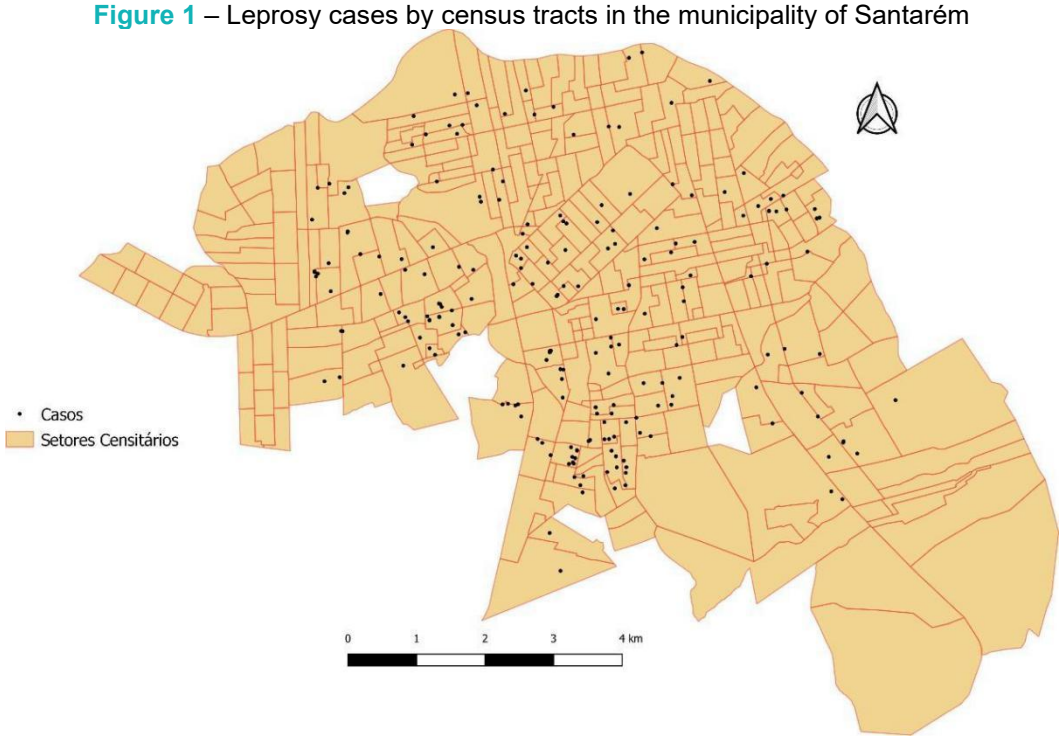
The multibacillary form stands out due to its relevance in the spread of the disease. Multibacillary individuals represent the main source of transmission, since they release a large amount of bacilli into the environment, favoring the contamination of healthy people

with whom they have frequent and prolonged contact. In addition, the predominance of multibacillary forms suggests a delay in the diagnosis of leprosy (Sales et al., 2020).

The study by Uchôa (2017) highlights that many patients develop some degree of disability even after drug treatment for leprosy. In addition, a worrying issue is highlighted: there is a considerable number of patients diagnosed with the disease who do not undergo evaluation regarding the Degree of Physical Disability (GIF), suggesting a possible negligence on the part of the professionals responsible for neurological evaluation. The lack of this evaluation can result in underreporting of severe cases and, consequently, in inadequate interventions.

To describe the correlation between census tracts and leprosy cases in the urban area of Santarém, information from the 2022 Population Census was used. These data allowed the identification of 354 census tracts in the region. Then, these tracts were correlated with leprosy cases, resulting in the elaboration of the map shown in Figure 1.

Figure 1 – Leprosy cases by census tracts in the municipality of Santarém

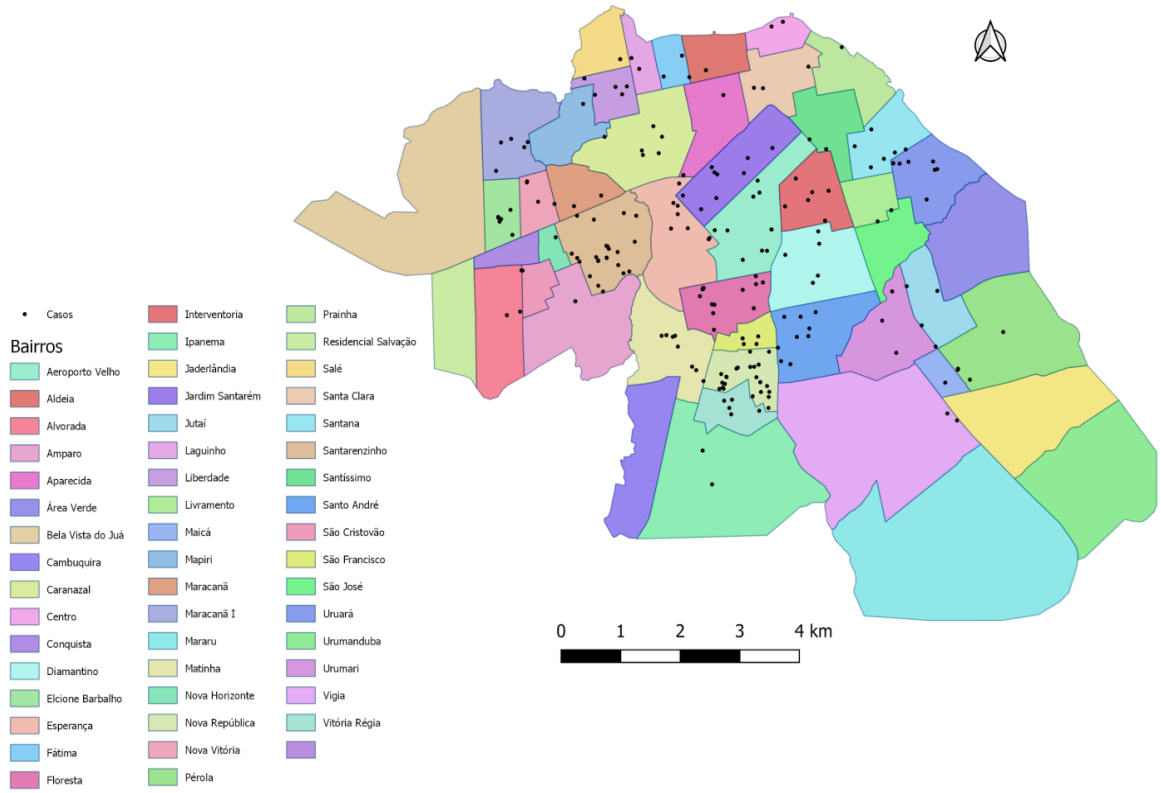


SOURCE: Brazilian Institute of Geography and Statistics (IBGE). Prepared by the authors themselves, 2023.

Through the identification of the census tracts corresponding to their respective neighborhoods, the occurrence of cases by neighborhoods was identified, Figure 2. The map in Figure 2 shows a significant concentration of leprosy cases in the census tracts of the Nova República neighborhood, located in the southern region. During the period from 2014 to 2019, 24 cases of leprosy were reported in this neighborhood, 21 of which were classified as multibacillary. These data are worrisome, as they suggest a continuity in the

chain of transmission of the disease and indicate possible delays in diagnosis. As highlighted by Fernandes (2022), although there is a good cure rate, it is crucial to invest in Primary Health Care to promote the early detection of cases and ensure adequate follow-up. These measures are essential to control the spread of leprosy and reduce its impact on the community.

Figure 2 – Leprosy cases by neighborhoods in the Municipality of Santarém



SOURCE: Brazilian Institute of Geography and Statistics (IBGE). Prepared by the authors themselves, 2023.

As established by Ordinance 2.488/2011 of the Ministry of Health, the delimitation of the coverage area is essential to quantify the population residing in the areas surrounding a UBS. This delimitation aims to establish territorial limits that meet the parameters of primary care coverage, facilitating patients' access to the services offered by the UBSs (Brasil, 2011).

In the municipality of Santarém, with its 50 neighborhoods and 28 UBSs to meet the demand of the urban area, challenges are faced due to the reduced number of UBSs in relation to the population. In addition, the location and scope of these UBSs play a crucial role in the accessibility of health services.

After locating and mapping the leprosy cases notified by SINAN in the municipality of Santarém, during the period from 2014 to 2019, the data were superimposed on the

previously generated maps. Figure 3 shows the overlapping of the mappings of the UBSs and their respective areas of coverage, together with the georeferencing of leprosy cases in the period studied.

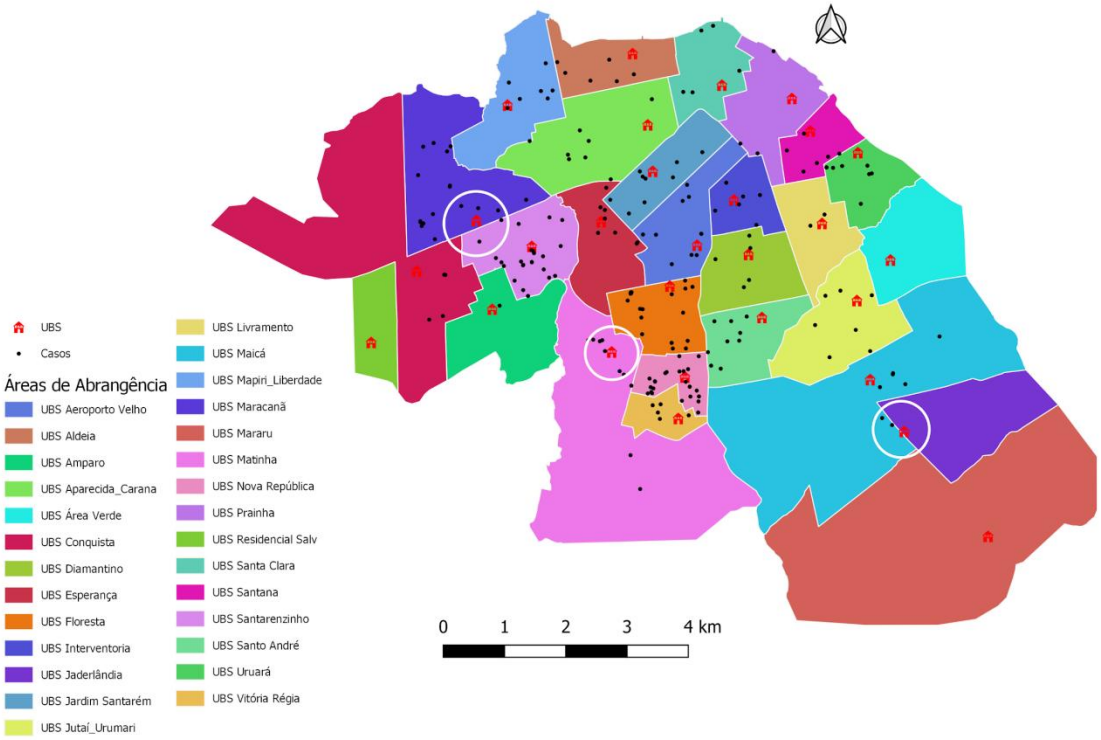
In Figure 3, it can be observed that some UBSs are not strategically located to cover the entire area under their responsibility in an equitable manner . This is indicated by the blank circle, suggesting areas that may not be adequately covered by the health services provided by the UBSs. This lack of equitable coverage can make it difficult for local residents to access health care, highlighting the need for review and adjustment in the distribution of UBSs to better meet community needs.

The examples provided illustrate the challenges faced by the population in relation to access to health services in the UBSs in Santarém. In the UBSs Jaderlândia, Matinha and Maracanã, the location of these units on the borders of their areas of coverage can make it difficult for the local population to access health services. This situation can result in inadequate access to health care for residents of these areas, especially those who live at the edges of the areas covered by the UBSs.

On the other hand, the UBS of Conquista faces the challenge of a large area of responsibility, which includes the new Bela Vista do Juá neighborhood, the result of the expansion of the municipality. This can overwhelm the health services of the UBS da Conquista, as it now has to deal with an additional population without necessarily having the resources or capacity to meet the increased demand.

These examples highlight the importance of a careful assessment of the location and scope of PHUs, ensuring that they are strategically positioned and can effectively meet the health needs of the local population. Periodic review of these aspects is essential to ensure equity in access to health care and efficiency in service delivery.

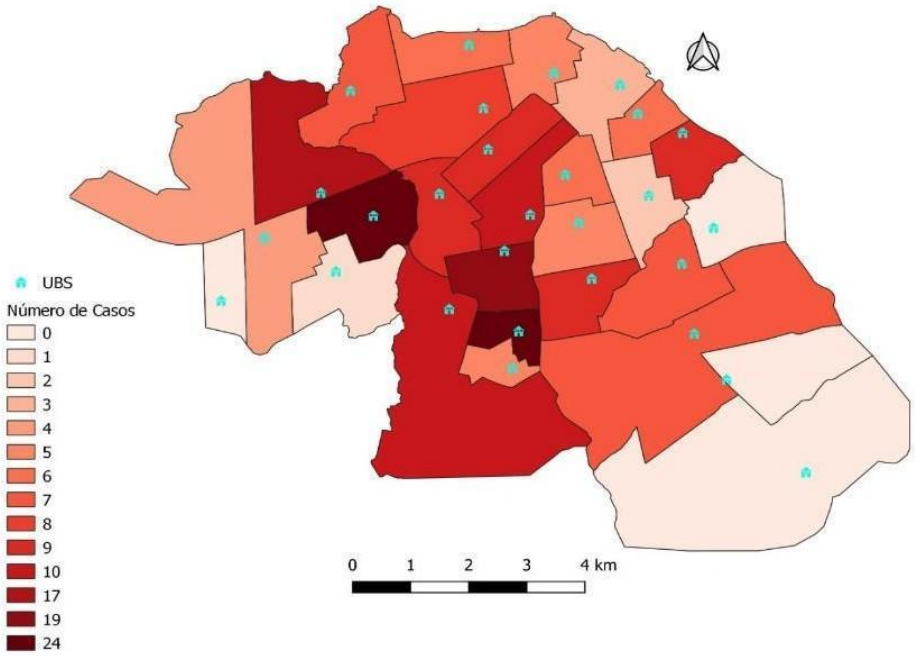
Figure 3 – Distribution of leprosy cases in relation to the areas covered by the UBSs in the municipality of Santarém



SOURCE: BRAZIL. Ministry of Health. Health Surveillance Secretariat – Notifiable Diseases Information System (SINAN) and Brazilian Institute of Geography and Statistics (IBGE). Prepared by the authors themselves, 2023.

Based on the data in Figure 3, it was possible to apply spatial analysis to calculate the density of cases by area covered by the UBSs, resulting in the map represented in Figure 4. This map provides a visualization of the number of leprosy cases in relation to the coverage areas of the UBSs, allowing a more detailed analysis of the spatial distribution of the disease within the municipality.

Figure 4 – Number of cases by area covered by the UBSs in the municipality of Santarém



SOURCE: Brazilian Institute of Geography and Statistics (IBGE). Prepared by the authors themselves, 2023.

The discrepancy observed in the distribution of leprosy cases in relation to the expectation based on previous studies, such as that of Azevedo (2021), is a significant finding. While Azevedo[20] suggests that the concentration of cases is closely linked to less socioeconomically favored regions, the absence of cases in peripheral neighborhoods such as Residencial Salvação and Mararu contradicts this expected association.

In addition, when analyzing the number of cases by area covered by the UBSs, it is interesting to note that the Santarenzinho and Nova República neighborhoods stand out with a higher number of cases, with 24 each, followed by 19 cases at the UBS da Floresta and 17 cases at the UBS Maracanã. On the other hand, some UBSs, such as those in the neighborhoods of Livramento, Mapiri Liberdade, Maicá, Prainha and Conquista, registered only 1 case. Notably, the UBSs Área Verde, Jaderlândia, Mararu and Residencial Salvation, the latter being a housing project of the Minha Casa, Minha Vida program, did not register any cases of leprosy.

These observations highlight the complexity of the distribution of leprosy and highlight the importance of considering factors beyond socioeconomic status when analyzing the occurrence of the disease. Factors such as access to health services, migration patterns, population density, and housing quality can play significant roles in the dynamics of leprosy transmission in a community.

CONCLUSION

The study revealed, through the spatial analysis of leprosy cases in the urban area of the city and the characteristics of the UBSs and their areas of coverage, a heterogeneous distribution of cases of the disease. The spatial analysis allowed us to see that leprosy cases are unevenly distributed in the urban area of the municipality, indicating variations in the incidence of the disease in different regions.

In addition, a disproportionate distribution of the UBSs was observed in relation to their respective areas of coverage. Some units serve a significant portion of the population, which can result in difficulties in accessing health services for certain areas of the city. These findings underscore the importance of evaluating and adjusting the distribution and supply of health services to ensure adequate and equitable coverage for the population.

The study shows that the positioning of the UBSs on the borders of their areas of coverage was identified as a significant problem. This configuration makes it difficult for the population enrolled in these units to access health services, generating additional challenges for the diagnosis and early treatment of diseases such as leprosy. This directly reflects the difficulty in detecting the disease in areas of recognized social vulnerability, evidencing problems in the operational capacity of the health service to identify new cases early. The inadequate location of the UBSs can result in underutilization of health services by the most vulnerable communities, contributing to the persistence and worsening of health problems in these areas.

In view of these findings, it is essential to strengthen surveillance and epidemiological control actions for leprosy, focusing on early diagnosis, appropriate treatment, active search for absent patients, testing of contacts of carriers, and health education, with a view to reducing the incidence of the disease and improving access to health services for the affected population.

In addition, the importance of continuous training of health professionals and the use of technologies, such as spatial analysis, to assist in supporting the decision of health teams in combating the spread of the disease, further reinforcing the fight against leprosy, is highlighted.

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