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Original Article

Epidemiological characteristics and spatial analysis of leprosy cases in an endemic municipality

Características epidemiológicas e análise espacial dos casos de hanseníase em um município endêmico

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Objective: to analyze the epidemiological characteristics and spatial distribution of leprosy cases in an endemic municipality. **Methods:** epidemiological, retrospective study with spatial analysis techniques developed with data from the National System of Compulsory Notification. Leprosy cases were georeferenced using a Geographic Positioning System receiver for the spatial location of the households. Spatial analysis was performed by the Kernel method. **Results:** one hundred new cases of leprosy were reported, and there was predominance of males and patients with low education. The Virchowian clinical form was predominant (32.0%) and 48.0% of the cases presented some degree of disability at the time of diagnosis. There was an increasing temporal trend in the detection rate. The spatial analysis identified critical areas for occurrence of leprosy, which was concentrated in the urban area (71.0%). **Conclusion:** the municipality presented high endemicity for leprosy, with heterogeneous distribution of cases and risk cluster in the urban area.
Descriptors: Leprosy; Epidemiology; Spatial Analysis.

Objetivo: analisar as características epidemiológicas e a distribuição espacial dos casos de hanseníase em um município endêmico. **Métodos:** estudo epidemiológico, retrospectivo com técnicas de análise espacial desenvolvido a partir de dados do Sistema Nacional de Notificação Compulsória. Os casos de hanseníase foram georreferenciados utilizando-se um receptor *Geografic Positioning System* para a localização espacial dos domicílios. A análise espacial se deu pelo método de Kernel. **Resultados:** Foram notificados 100 casos novos de hanseníase com predomínio do sexo masculino e baixa escolaridade. A forma clínica Virchowiana foi a predominante (32,0%) e 48,0% dos casos apresentaram algum grau de incapacidade no momento do diagnóstico. A tendência temporal da taxa de detecção apresentou-se crescente. A análise espacial identificou áreas críticas para ocorrência da hanseníase e concentrando-se na zona urbana (71,0%). **Conclusão:** o município apresentou alta endemicidade para a hanseníase com distribuição heterogênea dos casos e cluster de risco na área urbana.
Descritores: Hanseníase; Epidemiologia; Análise Espacial.

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Introduction

Leprosy is considered one of the major infectious diseases and it is manifested in different clinical forms. The disease mainly affects skin cells and peripheral nerves, and its severity is related to the interaction of its causative agent, *Mycobacterium leprae,* and the immunity of the carrier[1].

Data from the World Health Organization indicate that 143 countries reported a total of 214,783 new cases of leprosy in 2016, corresponding to a detection rate of 2.9 cases per 100,000 inhabitants. In the same year in Brazil, 25,218 new cases were reported, reflecting a detection rate of 12.2 cases per 100,000 inhabitants, taking the country to the second position in the world among those with the highest number of new cases[2].

Although some Brazilian municipalities achieved the goal of eliminating leprosy, the figures of the incidence of the disease remain high in the Northeast of the country[2]. In 2015, the state of Sergipe had a detection rate of 16.23 cases per 100,000 inhabitants, totaling 364 new leprosy cases and being the 5th state in the northeast region with the highest incidence rate of the disease[3].

Epidemiological studies of infectious diseases have advanced greatly in recent years. Studies on leprosy have addressed the geographic distribution of this endemic disease in Brazil and worldwide, seeking to fill gaps about the factors that influence its spread[4].

The use of health geoprocessing techniques through Geographic Information Systems allows the identification and delimitation of potential risk areas for disease transmission[5]. In parallel to spatial distribution, temporal analyses allow to understand the behavior of disease indices in the studied period[6]. In this context, the identification of priority areas has a positive impact on prevention and control measures.

Although the literature shows a close relationship between socioeconomic factors and leprosy, there is a clear the need for further studies to portray the pattern of geographic distribution of the disease through the identification of endemic clusters. The objective of this study was to analyze the epidemiological characteristics and spatial distribution of leprosy cases in an endemic municipality.

Methods

This is an epidemiological, retrospective study with spatial analysis techniques, using secondary data from the National System of Compulsory Notification, of the Department of Informatics of the Unified Health System. The study used notification forms of new cases of leprosy in the municipality of Simão Dias/SE, Brazil, from 2006-2017, adopting the definition of the International Classification of Diseases, 10th revision, code A30[7].

The municipality of Simão Dias is located in the extreme west of the state of Sergipe (latitude: -10.7323, longitude: -37.8145, 10°43'56'' South and 37°48'52'' West), 110 km from the capital Aracajú, with a territorial area of 564,702 km^2 and a current population of approximately 41 thousand people[8].

Data collection took place between October and November 2018 through the notification forms of the National System of Compulsory Notification in the Municipal Health Department of Simão Dias. The study variables included: number of cases, sex, education, age group, address, operational classification, clinical form, case evolution and degree of disability at the time of diagnosis.

Incidence rates were calculated per 100,000 inhabitants, using as denominator the general population of Simão Dias. Data from the 2010 demographic census of the Brazilian Institute of Geography and Statistics[8] and data available from the Department of Informatics of the Unified Health System (DataSUS)[9] were used.

In the spatial analysis, the addresses of the residences of new leprosy cases were georeferenced, with registration of latitude and longitude geographic

coordinates obtained through a Geografic Positioning System receiver and provided by Google Maps[10]. Of the 100 cases notified in the period, five were excluded due to lack of address in the notification forms.

Choropleth maps were made using the TerraView 4.2 software using the municipal database and digital grid. The Kernel intensity estimator was adopted. Through statistical smoothing, this estimator generated an intensity surface for visual detection of hotspots, indicating clustering in a spatial distribution and continuous surface. This data interpolation is suitable for application to point-location data. The point distribution was transformed into a smoothed surface and presented as a continuous map, representing different levels of intensity of cases. The amount of smoothing, i.e. the radius width of the influence was set to 1,000 meters, as this value generated an adequate representation of the distribution of leprosy cases in the municipality, minimizing overlapping bias or the occurrence of subdistribution patterns[11].

The cartographic base of the municipality of Simão Dias was provided by the Brazilian Institute of Geography and Statistics[8]. The cartographic projection corresponded to the Universal Transverse Mercator (UTM) System, using the Earth Datum Model Geocentric Reference System for the Americas 2000.

The temporal trends of the series were calculated considering the number of leprosy cases as the dependent variable and the year as the independent variable. We used the Joinpoint software version 4.2.0 to calculate the annual change in notifications from 2006 to 2017. This software performs a segmented linear regression (join join regression) to estimate the percentage of annual change and identify points where a trend changes. To this end, a logarithmic linear model was fit, adding Joinpoints and calculating the difference up to a statistically significant value, using the Monte Carlo permutation test. Then, the Annual Percentage Change (APC) was estimated and tested from the definition of the segments.

The program used its own defined models to better represent the trend, using a smaller number of inflection points for the analysis. Considering a statistically significant trend when $p<0.05$, it was possible to demonstrate growth (positive APC), reduction (negative APC) or maintenance (zero APC) of the trend in the historical series (2006-2017).

Descriptive data were tabulated and analyzed using the GraphPadPrism version 5.01 and Microsoft Office Excel 2016 softwares. The TerraView 4.2.2 and QGIS 2.14.11 softwares were used for spatial analysis.

The study followed the ethical standards established in Resolution 466/12 of the National Ethics Council on Research involving human beings, and was approved by the Ethics and Research Committee of the Federal University of Sergipe according to Opinion nº 2,830,183/2018 and Certificate of Presentation for Ethical Appreciation nº 92517118,1,0000,5546.

Results

The study data indicate that in the interval from 2006 to 2017, 100 new cases of leprosy were reported in the municipality of Simão Dias. The incidence rate ranged from 25.70 in 2006 to 22.03 cases per 100,000 inhabitants in 2017. The highest incidence was observed in 2012 (37.47) and the lowest in 2016 (9.83).

Most cases were male (52.0%), aged between 30 and 45 years, with one to four years of schooling (45.0%), and residing in urban areas (71.0%). It was also observed the presence of cases of people younger than 15 years (3.0%). Operatively, the number of paucibacillary and multibacillary cases were equal and the Virchowian form was predominant (32.0%), followed by the Undetermined (29.0%), Tuberculoid (25.0%) and Dimorphic (10.0%) forms. Regarding the evolution of the case, more than 90.0% reached cure and 48% presented some degree of disability.

The spatial analysis showed a higher concentration of cases in the urban area of the municipality, as shown in Figure 1.

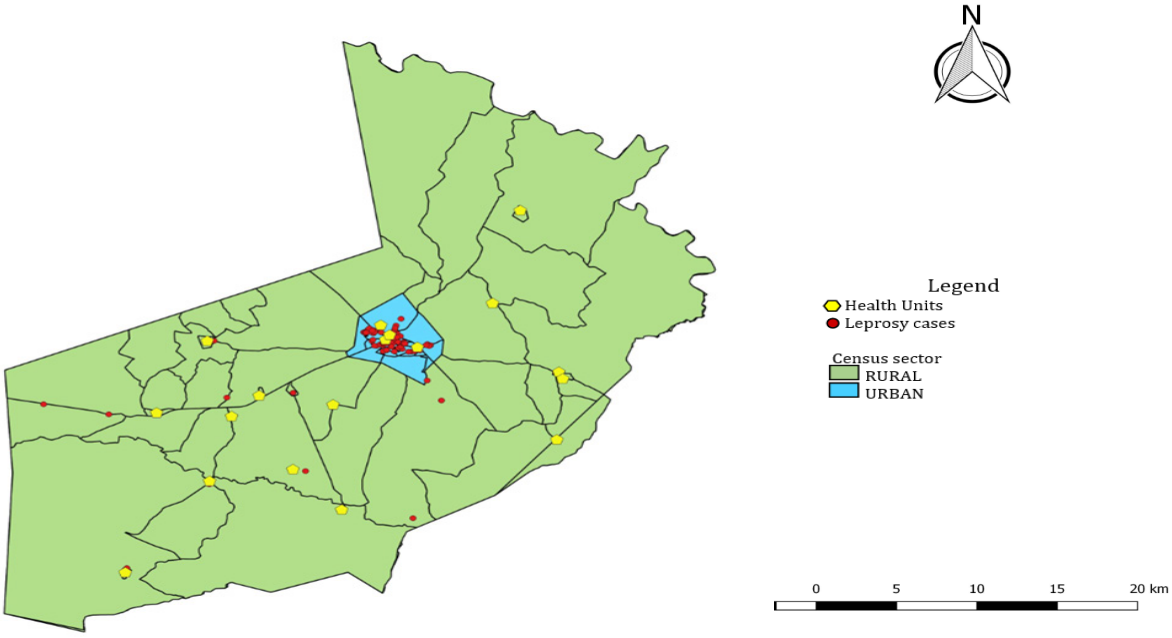

Figure 1 – Geographic distribution of leprosy cases

Figure 2 depicts the concentration of human cases through spatial Kernel estimation. The scale is divided into 10 grayscale slices. Thus, the areas of greatest intensity on the map are represented by the darker colors. It was noticed that the largest cluster of cases coincided with the most urbanized areas of the municipality.

Figure 3 demonstrates that the municipality of Simão Dias showed an increasing temporal trend in the detection rate, although not significant (p=0.667).

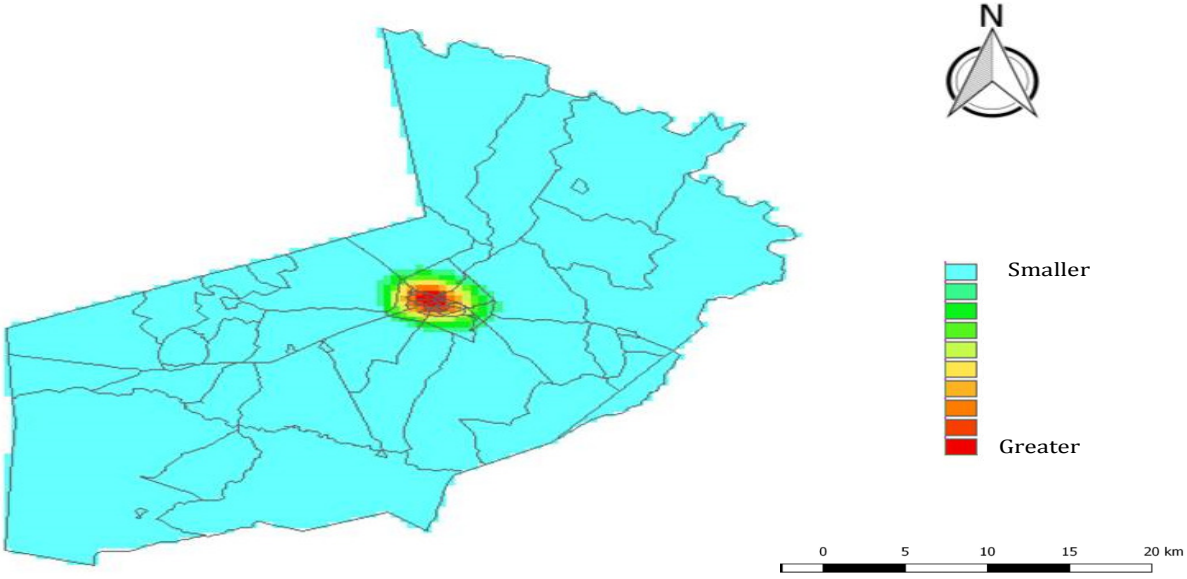

Figure 2 – Kernel map of leprosy cases

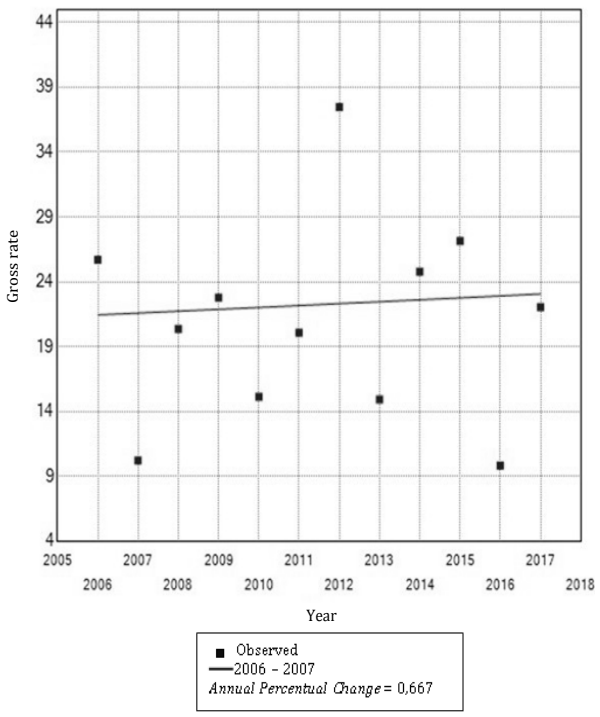

Figure 3 – Temporal trend of detection rate of leprosy cases

Discussion

The study had limitations due to the use of secondary data, which does not allow the researcher to control possible errors resulting from typing and records. Moreover, the study was conducted at the level of municipality, thus preventing the extrapolation of the results to the national reality.

The findings of this study contribute to the knowledge on the theme, pointing out the development of the clinical practice mainly in the context of Primary Care. The study also had a positive impact on the health care of users through innovative strategies such as geoprocessing techniques for epidemiological analysis due to the incorporation of Geographic Information Systems using Global Positioning System to identify and delimit the potential risk areas for transmission of diseases[3,5-6,11].

The general coefficients of detection of leprosy in the municipality of Simão Dias oscillated, but a pattern of high endemicity of the disease was noticeable, according to the epidemiological parameters of the Ministry of Health (between 10 and 20 cases per 100 thousand inhabitants)[12]. It is worth mentioning that 2012 was the year with the highest detection rate in the studied period, indicating a situation of vulnerability of the municipality regarding the control of the disease, since these cases may occur due to the continuous transmission of the disease[2,12]. It is also suggested that this increase in the detection rate may be associated with the intensification of active search and diagnosis of cases in the municipality.

In 2016, there was a drop in the detection rate, indicating that the disease is a dynamic event in this municipality. There is also a possibility of underreporting of cases as well as problems in the processing of the information mainly due to the poor development of epidemiology services and data records, especially in small municipalities. Underreporting and loss of information is commonplace throughout the country and this compromises the functioning of the reporting system in force in the country[13].

Considering the magnitude of the problem, the reduction in the detection of leprosy cases in Brazil has been the subject of agreements in the last decade, but Simão Dias remains with a higher incidence than the goal established by the Ministry of Health to eliminate the disease. It is therefore evident that the municipality has difficulties to meet the national goal[12], indicating that the disease is a serious public health problem in this place, as well as in several other Brazilian municipalities.

The disease was observed to be prevalent in males with low education, corroborating the findings of other studies that suggest the influence of social determinants on the process of illness of the population, as they directly influence the understanding of the guidelines provided by health professionals as to self-care[2,14-15].

Most of the individuals were in the economically active age group. This indicates an exposure of the municipality of Simão Dias to potential social and

economic risks, because the different degrees of disability generated by the disease force patients to leave their daily activities. This scenario ends up interfering in the work and social life of individuals, causing economic losses and psychological trauma, characterizing leprosy as a disease of extreme impact from the socioeconomic perspective[1]. It is also inferred that the presence of some degree of disability may indicate failure in early diagnosis, increasing active and recent transmissions. This hypothesis is reinforced by the diagnosis of the disease in children under 15 years old. All these aspects make it difficult for the municipality to reach the national goals of fight against leprosy[12].

To combat this transmission dynamics, the municipality should strengthen the active search of new cases through home visits and investigation of communicable cases, as well as increase the provision of treatment for confirmed cases. The intensification of public policies to combat leprosy in the population is important, with early diagnosis and treatment, so as to avoid the advance of the disease to its chronic form and the development of functional complications[14].

Besides these strategies, a study conducted in Indonesia[16] showed positive results of the implementation of occupational and income strategies for people undergoing treatment for leprosy. The strategies helped people of working age to seek health services early. For this, managers must seek allies in other spheres of government, in public and private entities.

In the temporal trend analysis, an increasing but non-significant trend was detected in the detection rate of new leprosy cases. This data differ from those of a study conducted in Fortaleza, Ceará[17], where there was a downward trend in the joinpoint graph during the study period, explained by the greater control of multibacillary cases[18].

In this context, notification of new leprosy cases may contribute to early identification and treatment to prevent the occurrence of clinical complications such as physical disability and reaction episodes. Notification may also favor the breakdown of the transmission chain, fulfilling what is expected of primary care in its prevention and health promotion strategies[19]. However, a general analysis of the data allows us to infer that there was a growing trend of transmission, with high detection rates in the municipality.

The spatial distribution analysis revealed that most cases in the municipality were concentrated in the urban area, which was also found in a study conducted in the municipality of Tucano, Bahia[15], where over 85.0% of the population diagnosed with leprosy lived in the urban area. The visualization of the kernel map showed the concentration of cases in urban agglomerations, pointing to the identification of priority areas to combat this endemic disease by their managers.

Another factor that possibly contributes to such a disparate number of cases in the urban and rural areas is the preference of the population to concentrate in urban centers because of the supply of productive activities and health services. Urbanization then becomes a feature that diffuses the disease, because it facilitates the transmission through intimate and prolonged contact with infected people[20].

It is noteworthy that the municipality of Simão Dias has a particular geographical feature that, despite not having a large territory, some communities are located far from its headquarters. Althoug leprosy is a predominantly urban endemism in the municipality, the punctual distribution shows an inequality of the disease within the municipality, indicating the presence of cases in more distant areas and with lower population density. The existence of areas with confirmed cases and which do not have health facilities nearby should receive more attention from the competent agencies to actively search for underreported cases and improve access to health care.

Thus, the identification of cases in a municipality with such heterogeneous distribution and risk cluster in the urban area will allow further analysis of the transmission and occurrence of the leprosy, allowing to reformulate more effective strategies to combat, control and eradicate it in the municipality. To this

end, the health surveillance and information system, including geographic information systems, should be strengthened to monitor leprosy control[13].

In addition to health surveillance actions, it is necessary to increase educational actions with the population as a way to combat misinformation and strengthen community awareness regarding leprosy, contributing to early diagnosis and treatment. Therefore, access to health services and social inclusion programs should be promoted in order to strengthen the capacity of active participation of people affected by leprosy in spaces of social control[12,19].

Conclusion

The municipality of Simão Dias presented a detection rate that point to high endemicity throughout the study period. Furthermore, it was found that the most affected population was male, with low education, in conditions of social vulnerability. The spatial distribution of the cases was heterogeneous in the municipality, with concentration in the urban area.

Collaborations

Jesus MS, Sandes TA and Lima ACR contributed to the design of the project and analysis and interpretation of data. Souza KOC, Góes JAP and Santos AD contributed to the writing of the article, relevant critical review of the intellectual content, and final approval of the version to be published.

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