

## LEPROSY AND HEALTH VULNERABILITY IN BELO HORIZONTE, MINAS GERAIS

### HANSENÍASE E VULNERABILIDADE DA SAÚDE EM BELO HORIZONTE, MINAS GERAIS

### LA LEPROA Y LA VULNERABILIDAD DE LA SALUD EN BELO HORIZONTE, MINAS GERAIS

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## ABSTRACT

The aim of this study was to analyze the spatial distribution of leprosy and its association with the Health Vulnerability Index (IVS in Portuguese). This is an ecological study of multiple groups and analytical character, held in Belo Horizonte, Brazil, using census sectors as analysis units. Data from leprosy cases notified between 2004 and 2013 were obtained in the Notifiable Diseases Information System. In order to reflect the adverse living conditions the IVS 2012, a composite indicator elaborated by the Municipal Health Department of Belo Horizonte, was used. The smoothed rate was obtained through empirical global Bayesian method. The results indicate that the medians of leprosy detection rates tended to be higher as the vulnerability increased according to the IVS, and in the sectors belonging to the very high risk category or high risk category the medians of the rates were significantly higher compared to the sectors classified as low and medium risk ( $p < 0,001$ ). Evidences show the need to intensify methods aimed to improve the living conditions of the population, because leprosy in that city follows a pattern built under the mark of inequalities, as confirmed by the association with IVS.

**Keywords:** Leprosy; Epidemiology; Health Vulnerability; Spatial Analysis.

## RESUMO

O objetivo deste estudo foi analisar a distribuição espacial da hanseníase e sua relação com o Índice de Vulnerabilidade da Saúde (IVS). Trata-se de estudo ecológico de múltiplos grupos de caráter analítico, realizado em Belo Horizonte, Brasil, utilizando os setores censitários como unidades de análise. Os dados dos casos de hanseníase, notificados entre 2004 e 2013, foram obtidos do Sistema de Informação de Agravos de Notificação. Para refletir as condições de vida adversas, utilizou-se o IVS 2012, indicador composto elaborado pela Secretaria Municipal de Saúde de Belo Horizonte. Por meio do método bayesiano empírico global, obteve-se uma taxa suavizada. Os resultados revelam que as medianas das taxas de detecção de hanseníase tenderam a ser maiores à medida que se aumentava a vulnerabilidade segundo o IVS, sendo que nos setores pertencentes à categoria de risco muito elevado e elevado risco as medianas das taxas foram significativamente superiores às dos setores classificados em baixo e médio risco ( $p < 0,001$ ). As evidências oferecidas demonstram a necessidade de se intensificar medidas que visem à melhora das condições de vida da população, pois a hanseníase no município está diante de um padrão construído sob a marca de desigualdades, como atesta sua relação com IVS.

**Palavras-chave:** Hanseníase; Epidemiologia; Vulnerabilidade em Saúde; Análise Espacial.

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## RESUMEN

El objetivo de este estudio fue analizar la distribución espacial de la lepra y su relación con el Índice de Vulnerabilidad en Salud (IVS). Se trata de un estudio ecológico de múltiples grupos de carácter analítico realizado en Belo Horizonte, Brasil, utilizando secciones censales como unidades de análisis. Los datos de los casos de lepra, notificados entre 2004 y 2013, se obtuvieron en el Sistema de Información sobre Enfermedades de Notificación Obligatoria. Para reflejar las condiciones de vida adversas utilizamos el IVS 2012, indicador compuesto preparado por la Secretaría de Salud Municipal de Belo Horizonte. La tasa suavizada se obtuvo mediante el método Bayés empírico global. Los resultados indican que las medianas de las tasas de detección de la lepra tienden a ser mayores a medida que aumenta la vulnerabilidad de acuerdo con el IVS, mientras que en los sectores pertenecientes a la categoría de riesgo muy alto o de categoría alto las medianas de las tasas son significativamente más altas en comparación con los sectores clasificados como riesgo bajo o medio ( $p < 0,001$ ). Las evidencias muestran la necesidad de intensificar las medidas para mejorar las condiciones de vida de las personas ya que en esta ciudad la incidencia de la lepra está vinculada a la desigualdad socioeconómica, confirmada por su relación con el IVS.

**Palabras clave:** Lepra; Epidemiología; Vulnerabilidad en Salud; Análisis Espacial.

## INTRODUCTION

Leprosy is an infectious disease that affects the skin and peripheral nervous system and can cause irreversible physical damage. Although it has cure and access to treatment is free, its control remains challenging.<sup>1</sup>

Statistics from the World Health Organization (WHO) show that, in 2015, 210,758 new cases of leprosy were reported in 136 countries. In this scenario, we highlight India, Brazil and Indonesia, responsible for 81% of this total.<sup>2</sup>

Among the premises associated with the spatial distribution of the disease, there are socioeconomic factors,<sup>3</sup> those related to problems in health services<sup>4</sup> and specific factors of the host, such as immunological<sup>5</sup> and genetic<sup>6</sup> determinants.

It has long been discussed that high-risk conditions for the distribution and spread of the endemic leprosy are mostly related to poverty.<sup>7</sup> High rates of malnutrition,<sup>8</sup> house agglomeration<sup>9</sup> and low schooling<sup>10</sup> are some of the factors already identified.

With regard to populous municipalities, such factors are commonly observed in the township lines. These places are characterized by uncontrolled growth and disorganized settlement, resulting mainly from the migratory movements.<sup>11</sup> This hinders the sanitary structuring of the city,<sup>12</sup> besides leading to a rapid increase in the demand for health services.

Although there is a consensus on the relationship between adverse living conditions and the occurrence of leprosy, there has been a growing need to identify specific indicators of living conditions that allow them to be associated. In addition, indicators capable of analyzing space in heterogeneous parts, in which actions must be developed according to criteria of needs and priorities at the local level, are consistent with the principles of the Brazilian Health System (SUS).

This is the case of the Health Vulnerability Index (IVS), prepared by the Municipal Health Secretariat of Belo Horizonte (SMSA-BH), and composed of socioeconomic and sanitation variables extracted from the Demographic Census of the Brazilian Institute of Geography and Statistics (IBGE in Portu-

guese). The IVS is already in its third update (IVS 1998, 2003 and 2012) and has as great quality portraying areas with maximum urban homogeneity (census sector).<sup>13</sup>

It is imperative to understand that space is ambiguous and that the disaggregation of health information allows knowing the territorial inequalities present in the local reality, making the analysis of the determining or conditioning factors for the occurrence of diseases more precise. This represents a reduction in the intrinsic distortions of aggregations, unlike what occurs in the analysis of countries, states and municipalities, which is based on large averages and ends up homogenizing different realities. In an intra-urban area, the census sector, which is the smallest territorial unit contained in urban or rural areas, represents a more adequate scale, especially when analyzing populous municipalities.

In the light of this discussion and considering the lack of studies that evaluate the adequacy of IVS in portraying the reality of the occurrence of leprosy, the present study proposed to analyze the spatial distribution of leprosy in Belo Horizonte, Minas Gerais, and its relationship with IVS. Belo Horizonte is the sixth most populous city in Brazil<sup>14</sup> and has epidemiological relevance to leprosy both in the detection rate<sup>15</sup> and due to its strategic position in the state.

## MATERIAL AND METHOD

This is an ecological study of multiple analytical groups carried out in the city of Belo Horizonte, capital of the state of Minas Gerais, Brazil. The census sector was adopted as a unit of analysis. Belo Horizonte currently has 3,936 census sectors, of which 41 do not have a population. These, in turn, are distributed in nine administrative regions, which correspond to what the SMSA-BH has designated as sanitary districts, namely: *Barreiro*, *Centro-Sul*, *Leste*, *Nordeste*, *Noroeste*, *Norte*, *Oeste*, *Pampulha* and *Venda Nova*.

Considering that epidemiological information related to leprosy is extremely responsive to the operational capacity of

the control services and programs, data were obtained from the period between 2004 and 2013. Longer historical series may allow dilution of operational variations, providing conditions for a better approximation of the reality of the endemic disease. Also, data from the SINAN presented improvement in its consistency as of 2001.

Only new cases of leprosy of Belo Horizonte dwellers on the date of diagnosis were included in the study, and the cases that were discharged due to misdiagnosis were excluded. These data were obtained from SINAN, made available by the State Coordination of Sanitary Dermatology (CEDS), of the Minas Gerais State Health Department (SES-MG). The population disaggregated by census sector was taken from the databases of the 2010 IBGE Census.

In order to identify the places of residence of individuals with leprosy on the map, the geographical coordinates of each case were consulted. Data were taken from SISVE provided by GEEPI of the SMSA-BH. In the case of house numbers not accurately found in the cartographic base, the SMSA-BH recommends approaching up to 100 numbers of distance and maintaining the even or odd classification.

The SMSA-BH adopts the metric numbering system for house addressing. The house number represents the distance, in meters, from the starting point of the axis of the street in which the plot is located. The area closest to the center of the city is taken as the beginning, and the buildings on the right side of the street take the even numbers and the buildings on the left, the odd ones. This criterion seeks to increase the possibility of positioning the individual in the census sector where he/she lives.

Risk classification of the census sectors according to the IVS 2012 was obtained from the GEEPI of the SMSA-BH, which was categorized according to the following cut-off points: medium risk – census sectors with IVS values with  $\frac{1}{2}$  standard deviation around the mean (mean  $\pm$  0.5 standard deviation); low risk - sectors with values lower than the mean IVS; high risk – sectors with values above the mean IVS up to the limit of 1.5 standard deviation above the mean (upper limit of the mean IVS + 1 standard deviation); very high risk - sectors with values above the IVS.<sup>13</sup>

The cartographic base in digital and georeferenced format was made available by SMSA-BH. The maps used the Universal Transverse Mercator (UTM) projection system and the South American Datum 1969 (SAD 69) as a geodetic reference system.

For the treatment of data, the software Statistical Package for the Social Sciences (SPSS) for Windows version 19 was used, which contemplated the structuring of a database and the construction of the indicator rate of detection of new cases of leprosy per 100 thousand inhabitants. The methodology for constructing the indicator was carried out in accordance

with the recommendations of the Ministry of Health, set out in the Guidelines for Surveillance, Attention and Elimination of Leprosy as a Public Health Problem.<sup>16</sup>

The indicator used was based on the mean rate of new cases reported from 2004 to 2013. The global empirical Bayesian method<sup>17</sup> was implemented to correct the rates, which tend to present great instability, given the small populations in census sectors at risk of becoming ill. "This method, by estimating the risk of a small area, has as its central idea the use of information from the other areas that compose the study region, in order to reduce the effect of random fluctuations not associated with risk".<sup>18</sup> Thus, the maps produced are smoother and informative.

The spatial autocorrelation of the adjusted rates was evaluated by the Moran's I Global Index.<sup>19</sup> This method refers to a test whose null hypothesis is spatial independence, represented by the expected and observed index equality. The expected index equals  $a-1/(n-1)$ , where  $n$  is the number of areas. Positive values (between 0 and +1) indicate direct autocorrelation, that is, greater similarity between neighbors; and negative values (between 0 and -1) indicate reverse autocorrelation, indicating dissimilarity. The index value was tested using 999 random permutations for a "Queen" spatial weighting scheme, that is, considering as neighbors the polygons that are contiguous in at least one point. Value of  $p < 0.05$  was considered significant. These analyzes and the making of the maps were done in software R, version 3.2.1, using *rgdal*, *spdep*, *ggplot2* and *ggsn* packages.

The adjusted detection rates of the four IVS risk categories (low, medium, high, very high) were compared from the non-parametric Kruskal-Wallis statistical test.<sup>20</sup> The level of significance was 5% ( $p < 0.05$ ). This test was used because of the non-normality of the data found by the Kolmogorov-Smirnov test.

As the Kruskal-Wallis test only identifies that there is difference between the groups, several Mann-Whitney tests with Bonferroni correction were used to check where the difference was. These analyzes were performed using SPSS software, version 19.

The research project was submitted to the Research Ethics Committee (REC) of the Federal University of Minas Gerais (UFMG) and of the SMSA-BH, being approved according to the Certificate of Presentation for Ethical Appreciation number 16762513.3.0000.5149. This was carried out in compliance with the provisions of Resolution 466/2012 of the National Health Council, which establishes directives and norms regulating research involving human beings.<sup>21</sup>

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## RESULTS

Between 2004 and 2013 816 new cases of leprosy were reported in Belo Horizonte, resulting in a mean detection of 3.44 cases per 100,000 inhabitants. Of this total, 87.4% (n = 713) could be associated with their respective census sectors.

Considering the quality of the georeferencing presented in SISVE, 74.5% (n = 608) of the addresses were exactly located; 12.9% (n = 105) had the house number approximated in up to 100 distance numbers; and 12.6% (n = 103) were expurgated, since they were not found in the cartographic base of the municipality or lacked the necessary information for the geocoding process.

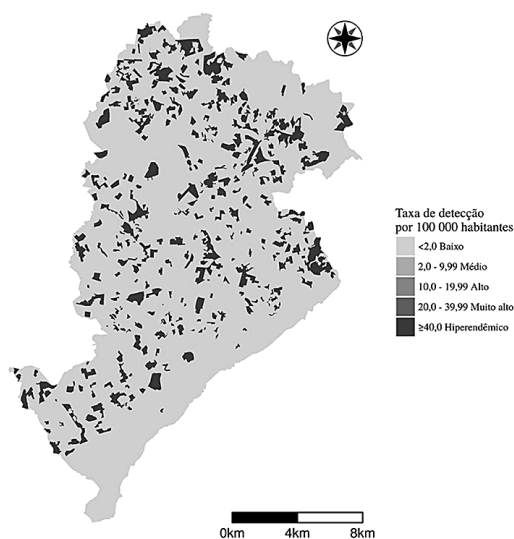


Figure 1 - Average detection rate of leprosy (per 100,000 inhabitants) for the period from 2004 to 2013 by census sector of Belo Horizonte.

The crude detection rates for that period ranged from zero to 2,277.8 cases per 100,000 inhabitants (Figure 1), while the rates adjusted by the global empirical Bayesian method ranged from 15.35 to 161.54 cases per 100,000 inhabitants (Figure 2).

With the adjusted rates, the test for verifying spatial autocorrelation was applied. The result presented a positive value (Morans' I = 0.05059), indicating a greater similarity between neighbors, being statistically significant (p-value = 0.001).

Regarding the distribution of census sectors, 15.3% had rates compatible with hyperendemic areas, which equals 442,934 (18.6%) inhabitants exposed in these areas. In terms of proportion, these sectors were located mainly in the districts Venda Nova and Norte, with 22.2 and 22.0%, respectively (Table 1).

The medians of the adjusted rates tended to be greater as the vulnerability according to IVS was increased. The Kruskal-Wallis test revealed that the medians of detection rates were statistically different among the four risk groups (p < 0.05) (Table 2). In order to identify in which group the difference was, six Mann-

Whitney tests were performed using a critical value of 0.008, according to the Bonferroni correction (0.05 divided by 6 = 0.008).

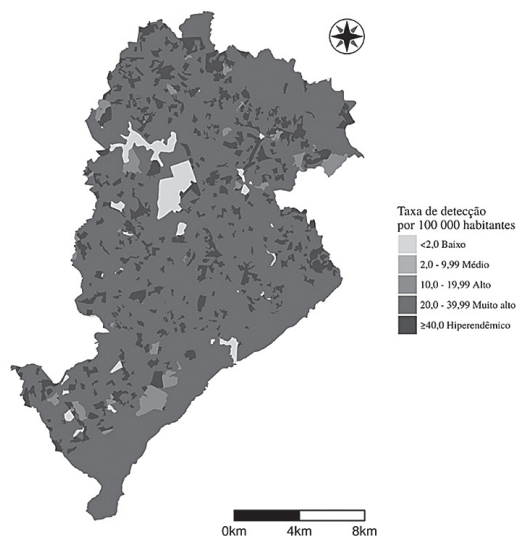


Figure 2 - Adjusted average detection rate of leprosy (per 100,000 inhabitants) for the period from 2004 to 2013, by census sector of Belo Horizonte.

Table 1 - Distribution of the census sectors of Belo Horizonte classified as hyperendemic, according to health district – period 2004 to 2013

Districts	Total number of census sectors	Number of hyperendemic census sectors	
		n	%
Barreiro	432	73	16.9
Centro-Sul	516	50	9.7
Leste	392	60	15.3
Nordeste	456	73	16.0
Noroeste	461	59	12.8
Norte	323	71	22.0
Oeste	534	58	10.9
Pampulha	412	61	14.8
Venda Nova	410	91	22.2
Total	3,936	596	–

Source: SINAN/CEDS/SES-MG; SISVE/GEEPI/SMSA-BH.

Table 2 - Comparison of the medians of the adjusted detection rates of leprosy in the four risk categories of the IVS. Belo Horizonte, 2004 to 2013

Risk Category	Median	Percentile 25	Percentile 75	p-value
Low	24.81	23.56	26.51	<0.001 <sup>a</sup>
Medium	24.78	23.09	28.50	
High	26.17	23.53	29.12	
Very high	26.34	24.11	29.01	

Note: <sup>a</sup>p-value obtained in the Kruskal-Wallis test.

The results showed that the medians of the detection rates in the very high risk and high risk categories were significantly higher than the low and medium risk sectors ( $p < 0.001$ ). There was no statistically significant difference between the medians in the low and medium risk sectors ( $p = 0.377$ ), as well as in the sectors classified as high and very high risk ( $p = 0.378$ ).

## DISCUSSION

The mean detection rate found for Belo Horizonte allows classifying it as an medium endemic area, according to the parameters established by the Ministry of Health.<sup>16</sup> When comparing the results found with the mean detection rates of all federal capitals for the same study period, Belo Horizonte is the fifth city with the lowest rate.<sup>22</sup>

The analysis of the spatial distribution of the occurrence of cases from the detection rate was better performed using smoothing techniques. The degree of variability found in Figure 1 is associated with the small risk populations living in the sectors, which leads to very unstable estimates. This means that the addition or decrease of a single case in the census sector causes drastic changes in values.<sup>18</sup> In statistical terms, rates are not comparable, since they have very different variances.<sup>18</sup>

The Moran's I test showed the existence of spatial autocorrelation. This indicates a similarity between the rates of the geographically closer sectors, characterizing the formation of agglomerates.

The study of the spatial distribution of leprosy provided information that would not be visualized only with tabular data. The graphic representation emphasizes epidemiological surveillance should be increasingly focused on the sub-municipal scale, since there are plots of its territory that shelter population segments exposed to different risks of contracting the disease, not always revealed in aggregate indicators at the municipal level.

In this way, accurate analysis and identification of subregions should be fostered. SINAN, for example, could specify other municipal subdivisions, such as census sectors. This would contribute to more specific interventions for the context of the area.<sup>23</sup>

In addition, managers need to be convinced that models focusing on medical care alone are not sufficient to eliminate leprosy as a public health problem. The results of this study indicate that census sectors with higher vulnerability, as measured by the IVS, have higher rates of detection of the disease, emphasizing the need to transcend from predominantly individual and biological actions to a collective approach, developing intersectoral actions to improve living conditions. Investments in education, basic sanitation, housing, job opportunities and leisure activities can help minimizing the effects of inequalities and improving the standard of living of the population, thereby reducing the magnitude of the disease.

Studies have even shown the association between leprosy and socioeconomic factors, suggesting that improvement of these factors could contribute to reduce the occurrence of the disease.<sup>3,8</sup> This fact is corroborated when analyzing the spatial distribution of leprosy in the world. In developed countries, few new cases are recorded and, when detected, they are found mainly among immigrants from countries where the disease is still endemic.<sup>24</sup>

Thus, socioeconomic and sanitation factors involve a complex of associated variables and, therefore, it is difficult to evaluate the one of greater relevance. Therefore, it is important to use indicators that go beyond the single-cause conception for a health event and that contemplate the idea that they are influenced by networks.

Synthetic indicators started to gain more expression in Brazil during the 90's, when several indicators appeared in the country with the objective of understanding the social reality through a unique measure, achieved by combining the multiple measurements of their quantifiable analytical dimensions.<sup>25</sup>

Among the limitations of this study, the use of secondary data can often result in inconsistencies in the estimated rates. Despite of this, the choice for this type of source reduces operational costs and does not impair the analysis.

## CONCLUSIONS

The evidence provided by this study highlights the need to intensify measures aimed at improving the living conditions of the population, since leprosy in Belo Horizonte is facing a pattern built under the mark of inequalities, as evidenced by its relation with IVS. From this perspective, using this indicator as one of the elements for planning and prioritizing actions to control leprosy in the municipality is appropriate.

Thus, this study is considered important because it can contribute to the planning of inclusive public policies oriented to the most vulnerable areas with the objective of intervening in reality to minimize existing inequalities, which are determinants of the health-disease process and often trivialized and neglected.

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