Spatial distribution and epidemiological profile of leprosy cases in Brazil between 2012 and 2021

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Abstract— *Leprosy is a chronic infectious disease considered one of the oldest diseases in history, which mainly affects the skin and peripheral nerves. In Brazil, there is a need to evaluate and characterize the number of leprosy cases, as well as their distribution throughout the national territory. Thus, the present study aimed to carry out an analysis of the spatial distribution and trace the epidemiological profile of leprosy cases in Brazil between the years 2012 and 2021. For this, data available in the Sistema de Informação de Agravos de Notificação (SINAN) were collected and analyzed. The variables evaluated were: Gender, Age group (years), race, education, Type of Output, Classification of leprosy and clinical form. The most affected individuals were men (56.92%), aged between 40 and 59 years (37.68%), mixed race/color (57.89%) and elementary school (48.66%). The states of Maranhão, Mato Grosso and Pará had the highest numbers of leprosy cases in Brazil. Fortunately, most patients have progressed to a cure. Based on the clinical form, there was a predominance of the Dimorphic form, followed by the Virchowian form. In turn, in relation to operational classification, most cases were classified as multibacillary. In conclusion, we emphasize that future studies are needed to assess the impact of the COVID-19 pandemic on SINAN notifications and confirm whether the reduction in leprosy cases in Brazil is the result of better public policies or due to underreporting. We also present valuable information from states and strategic groups for health campaigns aimed at combating leprosy.*

I. INTRODUCTION

Leprosy is a chronic infectious disease caused by the bacillus *Mycobacterium leprae* (Niitsuma, 2021), being considered one of the oldest diseases in history (Silva Santos, 2017). This pathology mainly affects the skin and peripheral nerves, and if not treated correctly, it can lead to physical disabilities (Carneiro, 2017). Fortunately, for its treatment, we rely on the administration of combined antibiotics, multidrug therapy (MDT), which consists of rifampicin, dapsone and clofazimine (Ribeiro, 2017).

Despite efforts, data from 2017 point to an increase in its prevalence at a global level, which highlights the need

for a series of more effective measures to treat this disease (Silva Santos, 2017). Brazil has a decline in the number of leprosy cases, in contrast to the global increase, but remains among the countries with the highest number of new cases detected in the world (Gracie, 2017). The limitation in its control is associated with difficulty in surveillance of contacts and limited knowledge about transmission (Niitsuma, 2021). In turn, early detection and reduction of disabilities seem to be related to the efficiency of primary health care services (Ribeiro, 2018). Furthermore, the treatment of patients with leprosy is considered essential to interrupt the chain of transmission of the disease, being, therefore, strategic in controlling the disease (Ribeiro, 2017).

Brazil has goals for the elimination of leprosy, through the implementation of outpatient treatment policies, campaigns and guidelines for disease control. Furthermore, it counts on the collaboration of each state to promote its elaborate actions (Ribeiro, 2018). Thus, to assess the impact of this policy, there is a need to assess and characterize the number of leprosy cases, as well as their distribution throughout the Brazilian territory. Based on this, the present study aims to carry out an analysis of the spatial distribution and trace the epidemiological profile of leprosy cases in Brazil between the years 2012 and 2021.
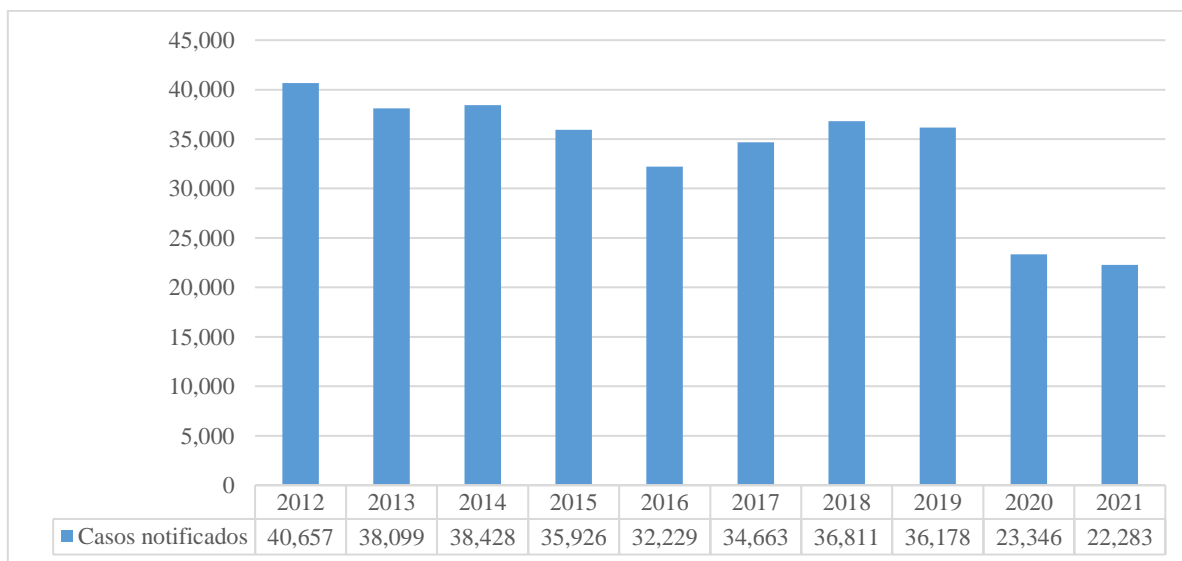
II.   METHODOLOGY

The present study was carried out with secondary data in the public domain, thus not requiring submission to an ethics committee. This is a descriptive and quantitative population-based study, carried out with data collected on the DataSUS website, from the Notifiable Diseases Information System (SINAN). Initially, the information was obtained from the health information section (TABNET) (https://datasus.saude.gov.br/informacoes-de-saude-tabnet/), selecting the option "epidemiology and morbidities". In the analysis, "Leprosy cases - Since 2001" notified throughout the Brazilian federative unit, in the period from 2012 to 2021, were verified and clinical form. Descriptive statistics were applied in tables and graphs, and the data were analyzed in Microsoft Excel® software, available as absolute and relative frequencies.

III.   RESULTS AND DISCUSSION

Diagnosed cases of leprosy are considered compulsory notification, therefore, they must be notified by the health professional, through the Notification/Investigation form of the Notifiable Diseases Information System (SINAN) (Silva Santos, 2017). Based on these data, we identified that in the period from 2012 to 2021, 338,620 individuals with leprosy were registered in Brazil, being shown in graph 1 that the years from 2012 to 2019 there was a small oscillation in the number of cases, which began to decline from 2020, showing a reduction of 45.2% in 2021 when compared to 2012. Data for 2020 and 2021 showed a significant reduction in leprosy cases, however, this was a period of COVID-19 pandemic, which may have generated sub-notifications in the system. Furthermore, this global health problem has caused difficulties in the Brazilian health system, directly impacting leprosy patients due to the closure or reduction of care in treatment centers (Pernambuco, 2022). It is also important to cite, as pointed out by Pernambuco (2022), that even in places that remained in operation, many people were unable to travel to these centers due to travel restrictions.

Graph 1- Number of leprosy cases from 2012 to 2021, Brazil.

	2012	2013	2014	2015	2016	2017	2018	2019	2020	2021
Casos notificados	40,657	38,099	38,428	35,926	32,229	34,663	36,811	36,178	23,346	22,283

Source: Ministry of Health/ Notifiable Diseases Information System (SINAN)

To understand factors that may be associated with the number of leprosy cases, we surveyed epidemiological variables for the period from 2012 to 2021, as seen in table 1. A greater number of cases were recorded in males (56.92%), as also pointed out in previous studies in different states of Brazil (Campos, 2005; Amaral, 2008; Barbosa, 2014). Regarding age, the age group from 40 to 59 years (37.68%) was the most affected. These individuals belong to the Economically Active Population (EAP) class, which can harm the economy, since individuals affected by this disease and who are not diagnosed early can develop deformities and physical disabilities (Silva Goes, 2018).

Table 1- Absolute and relative frequencies of probable leprosy cases by gender, age group, race and education, from 2012 to 2021, Brazil.

Variable	N	%
Sex		
Male	192,757	56.92
Female	145,832	43.07
Not informed	31	0.01
Age range (years)		
< 1	2	0.0006
1 a 4	762	0.23
5 a 9	6,127	1.81
10 a 14	13,173	3.89
15 a 19	14,959	4.42
20 a 29	38,602	11.40
30 a 39	58,574	17.30
40 a 49	63,699	18.81
50 a 59	63,895	18.87
60 a 69	47,434	14.01
70 a 79	23,577	6.96
≥ 80	7,816	2.30
Race		
White	82,330	24.31
Black	42,598	12.58
Yellow	3,180	0.94
Brown	196,019	57.89
Indigenous	1,473	0.44
Not informed	13,020	3.84
Education		
Illiterate	30,760	9.08
Elementary School	164,765	48.66
High school	62,511	18.46
University education	14,979	4.42
Not applicable	2,329	0.69
Not informed	63,276	18.69

N = number of dengue cases, % = percentage

Source: Ministry of Health/ Notifiable Diseases Information System (SINAN)

Table 1 also shows that there was a predominance of the disease in mixed ethnicity/color (57.89%) and in elementary school (48.66%). Brown ethnicity/color is already well reported in the literature, identified as a predominant variable in different studies related to leprosy (Costa, 2019; Andrade Goiabeira, 2019; Morais & Ézl, 2018). However, it is important to take into account that brown color is the prevalent ethnicity in Brazil, due to its miscegenation or how individuals identify themselves, which explains most of the cases being concentrated in this population (Silva, 2020). Also, low schooling is pointed out by Pereira, Oliveira & Oliveira-Filho (2018) as a risk factor for contamination and transmission of a series of neglected diseases such as schistosomiasis, which also extends to leprosy (Santos Lages, 2018).

The study conducted by Ribeiro et al. (2018) highlights that an analysis carried out in 2015 revealed that the number of leprosy cases is not homogeneous among the different regions of Brazil. Therefore, we carried out an analysis of the spatial distribution of the disease (figure 1), which shows that the states of Maranhão (n=40,147), Mato Grosso (n=39,614) and Pará (n=34,426) have the highest number of cases of leprosy, with Mato Grosso, in the Centro-Oeste and Maranhão, in the Northeast, already mentioned with high rates of prevalence of the disease (Ribeiro, 2018). The South region was the least affected, as also reported (Ribeiro, 2018).
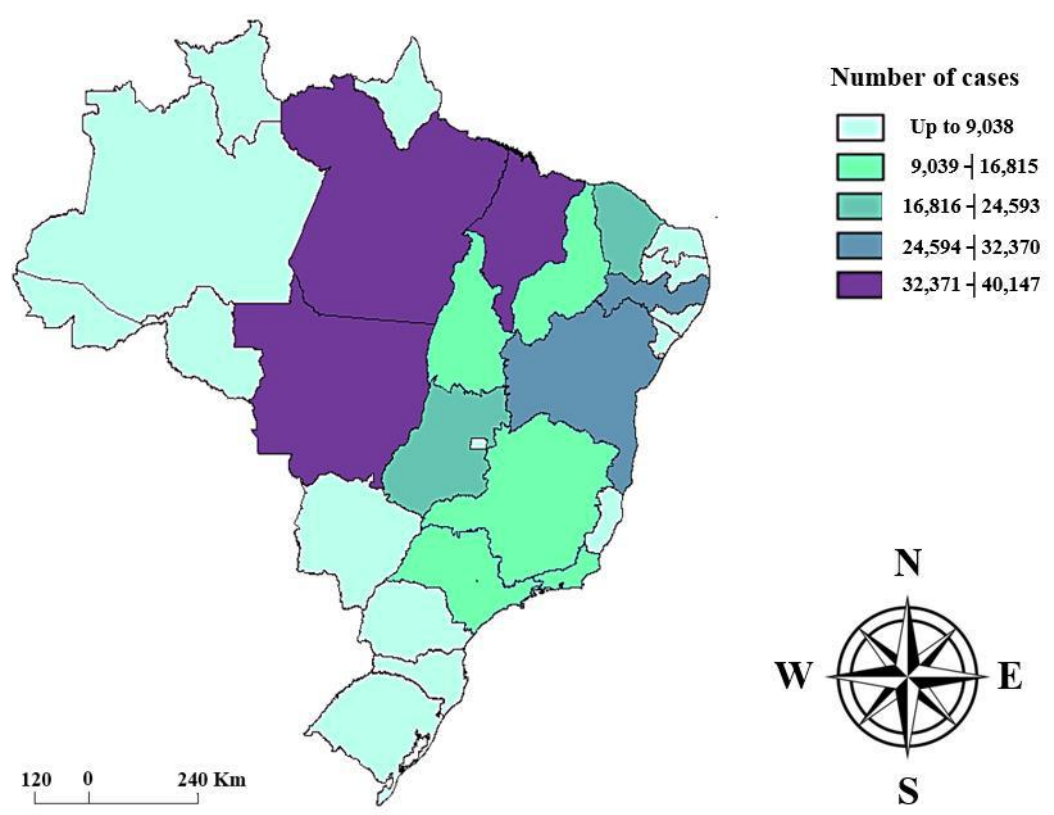

Fig.1 – Spatial distribution of leprosy cases from 2012 to 2021, Brazil

Source: Ministry of Health/ Notifiable Diseases Information System (SINAN)

Based on **table 2**, it is observed that most cases (70.7%) progressed to cure, which is the condition in which the patient, initially infected with *Mycobacterium leprae* and diagnosed as a case of leprosy, started and completed the treatment within the timeframe estimated by the World Health Organization (WHO) (Sousa, 2019). The disease was lethal for 1.62% (n=5,473) of patients, and a rate of treatment abandonment and follow-up was also reported in 19,775 individuals (5.84%). The study conducted by Calçada (2022) determined standards in the treatment of

leprosy in a Brazilian state, pointing out that with a lower abandonment of treatment, there are fewer deaths and, consequently, a higher rate of cured individuals. For Quaresma (2019), the lower treatment abandonment is related to the reception and adequate counseling that the patient receives, as well as a bond between the patient and the health team, which leads to an increase in the patient's motivation to complete his treatment. Transfers of patients to other states or municipalities totaled 27,864 cases. SINAN has special documentation to avoid double

registration and linking of leprosy cases, in which there may be a situation in which the same patient was notified more than once by different health units in the same period of time. This is important to ensure that no more cases are reported than there actually are, as well as to ensure that funds are distributed fairly among the health spheres in the transfers of financial resources from the Primary Care Floor (BRASIL, 2007). Finally, the diagnostic error occurred in

only 1.51 (n=5,115) of the cases. The study conducted by Neves (2021) showed that diagnostic errors in leprosy are not related to the level of endemicity in Brazil, but rather to the characteristics of patients and clinical manifestations. This brings to light the need to train health professionals in carrying out complementary exams to establish a correct diagnosis in more complex situations.

Table 2 – Frequency by Type of Output in the period from 2012 to 2021 in Brazil.

Type of Output	N	%
Cure	239,423	70.70
Death by the notified injury	5,473	1.62
Abandonment	19,775	5.84
Transfers*	27,864	8.23
Diagnostic error	5,115	1.51
Not informed	40,970	12.10

Caption: *Transfer to the same municipality, to another municipality, to another state or to another country. **Source:** Ministry of Health/ Notifiable Diseases Information System (SINAN)

The classification of the disease based on the clinical form, according to the Madrid classification, is: indeterminate, tuberculoid, lepromatous and borderline. Still, there are patients who do not have visible lesions on the skin and may have lesions only on the nerves (pure neural leprosy) (Menezes, 2019). In the present study, most patients had the borderline form (n=158,916; 46.93%),

followed by the Virchowian form (60,802; 17.96%), as reported in **table 3**. Similar results were reported by Silva (2020) and Pêgo (2020). Also, according to Campos (2018), the lower proportion of indeterminate leprosy, compared to borderline and tuberculoid forms, indicates that most patients were diagnosed late.

Table 3 – Frequency by Clinical Form Notified from 2012 to 2021 in Brazil.

Clinical Form	N	%
Undetermined	42,167	12.45
Tuberculoid	45,512	13.44
Borderline	158,916	46.93
Virchowiana	60,802	17.96
Not classified	19,312	5.70
Not informed	11,911	3.52

Source: Ministry of Health/ Notifiable Diseases Information System (SINAN)

In addition to the classification based on the clinical form, there is the operational classification adopted for treatment purposes, with leprosy classified as paucibacillary, with the presence of up to five skin lesions and negative intradermal smear, when available, or multibacillary, with the presence of six or more skin lesions or positive intradermal smear (Lopes, 2021). In the present

study, 83,471 cases (24.65%) were categorized as paucibacillary and 254,619 cases (75.19%) as multibacillary, with a total of 530 cases (0.16%) classified as Not informed. These data are worrying, since the multibacillary form has a high power of transmissibility and disability, being related to greater chances of sequels (Lira,

2019). Furthermore, the prevalence of multibacillary forms indicates a delay in diagnosis (Sales, 2020).

IV. CONCLUSION

The data presented here show that there was a reduction in leprosy cases in 2020 and 2021. However, we emphasize that future studies are needed to assess the impact of the COVID-19 pandemic on SINAN notifications and confirm whether this reduction is the result of better policies public or due to underreporting. Also, the states of Maranhão, Mato Grosso and Pará had the highest numbers of leprosy cases, being strategic states for health campaigns aimed at combating leprosy.

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