

Analysis of the Incidence of Leprosy in the Northeast Region of Brazil: 2011 to 2021

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Leprosy is a pathology known to mankind for centuries. The clinical manifestations of leprosy depend on the patient's immune reaction against *Mycobacterium leprae*, ranging from small hypochromic lesions and hypoesthesia to progressive and diffuse infiltrations of the skin, involvement of upper airway mucosa and involvement of cutaneous as well as nerve trunks. In some cases, and especially during reactions there are several manifestations and signs and symptoms of systemic involvement. The objective of the present study was to analyse the incidence of leprosy and the epidemiological parameters in the period from 2011 to 2021, in the Northeast of Brazil. The Notifiable Diseases Information System-SINAN of Brazil was consulted and is being reported on the detected cases of leprosy. The various parameters being discussed in the present study include sociodemographic aspects, types of injuries, clinical form, treatment regimen, degree of disability and clinical evolution. We were all during a global pandemic in 2020-21. The 2020-21 global pandemic of COVID-19 compromised the monitoring and recording of several diseases, which were left in the background. This fact may have contributed to the drop in the number of leprosy cases registered between 2020 and 2021 in the present study. There were 168,848 reported cases, of which 55.57% were males 62.87% were multiracial, most with low education level, until primary education, 35.63% had multiple skin lesions, 68.51% received treatment for the multibacillary type of disease, 26.83% (24.468) had neuronal impairment and, 71.74%, were considered cured. Despite the drop in the global number of cases observed in the region, several factors are still worrying, these require actions that contribute to the eradication of leprosy in the region, and these include programs that eradicate poverty, implementation of health programs that favour early diagnosis and treatment of leprosy cases, reduction of stigma and social exclusion of affected patients.

Keywords : Leprosy, Brazilian Northeast, Incidence

Introduction

Leprosy is a disease known to humanity for centuries, having been named in honor of Gerhard-Henrik Armauer Hansen, a researcher at Noguera, who discovered *Mycobacterium leprae* in the 19th century. It is classified as an infectious disease (Carrol et al 2015, Makhakhe 2021, WHO 2018).

The clinical manifestations of leprosy depend on the patient's immune reaction against *Mycobacterium leprae*. World Health Organization (WHO) classifies leprosy into paucibacillary (PB) and multibacillary (MB) based on the number of skin/nerve lesions (WHO 2018, Massone & Brunasso 2022). These are described as: Indeterminate; Tuberculoid; Dimorphic and

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Virchowian (VV) in Brazilian classification (Araujo 2003, Pimental et al 2018). These range from small hypochromic patches and hypoesthesia to progressive and diffuse infiltrations of the skin, involvement of upper airway mucosa, single or multiple nerves and other systemic involvement like eyes, joints lymph nodes etc (Araújo 2003, WHO 2018, Prakoeswva et al 2022).

Leprosy has a chronic course and predominantly affects the skin and peripheral nerves, resulting in neuropathy and associated long-term consequences, including deformities (associated with stigmatization of the disease) and disabilities. The later are associated with the involvement of the peripheral nervous system, resulting in loss of sensitivity and muscle changes - atrophy, paresis and paralysis (Barbosa et al 2018, Lau 2019, Graille et al 2020).

The disease is endemic in some countries, with the highest incidences being reported from Bangladesh, Brazil, the Democratic Republic of Congo, Ethiopia, India, Indonesia and Madagascar

(Pego et al 2020, Ramos et al 2016, Sarode et al 2020). In the Brazil leprosy is a public health problem and leads to socioeconomic worsening, since the clinical evolution of the disease contributes to stigmatization and consequent low self-esteem and segregation of patients. In addition, neurological injuries and muscle impairments can lead to motor disabilities, making work and day-to-day activities difficult and unfeasible, with consequent negative impacts on the patient and family members (Lau 2019, Gouvea et al 2020, Castro et al 2016).

In this sense, studies on the incidence of leprosy are important, especially in regions such as the Brazilian Northeast (09 states; 1.5 million km²; 57,071,654 inhabitants and HDI = 0.659), characterized by several socially disadvantaged locations (Bigs2 2022, Oliveira & Ferreira 2020). Identifying, debating and addressing the needs of the subject population may lead to creating public policies to control leprosy in these áreas and also provide lessons/ ideas for other

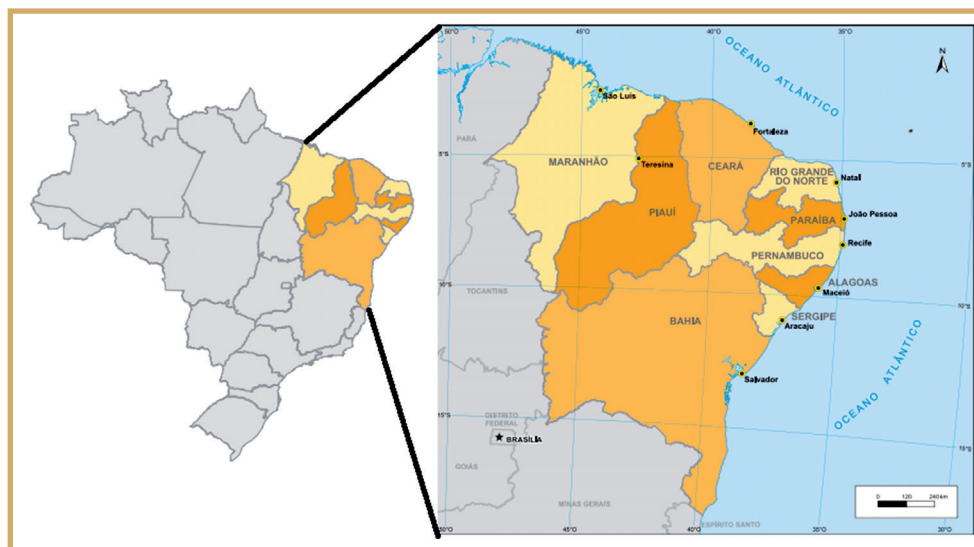


Fig. 1 : Representation of the Brazilian Northeast. Source: Bigs1, 2022.

countries still battling leprosy and trying to eliminate/ eradicate it. Therefore, the objective was to evaluate the incidence of leprosy in the Brazilian Northeast between 2011 and 2020 (non Covid period) and also between 20-21 the Covid pandemic period.

Material and Methods

The present study is an exploratory and retrospective study in which data from the SINAN database - National System of Diseases and Notifications, related to leprosy cases between 2011 and 2021 has been analyzed. SINAN is a database system with information and registration in the public domain, in which there is no confidential personal record of data, for which permission from the Ethics Committee is required for publication in Brazil.

Methodology

Local characterization

The Brazilian Northeast has a population

of approximately 57,071,654 inhabitants, distributed in 09 states. It has a human development index of 0.699 and a territory of 1.5 million km². Most of its territory in this região is semi-arid and is adjoining the Atlantic Ocean – Fig. 1 (Bigs1 2022).

Data collection and analysis

The SINAN system was accessed regarding for records of leprosy cases for the period corresponding to the years 2011 to 2021. The variables assessed were the sociodemographic features of reported cases, types of lesions, clinical form, therapeutic regimen, degree of disability and clinical evolution. Data were recorded in Excel software and analyzed descriptively.

Results

The present study used data collected at SINAN, with the occurrence of 168,848 cases of leprosy notified in the Northeast of Brazil, between the

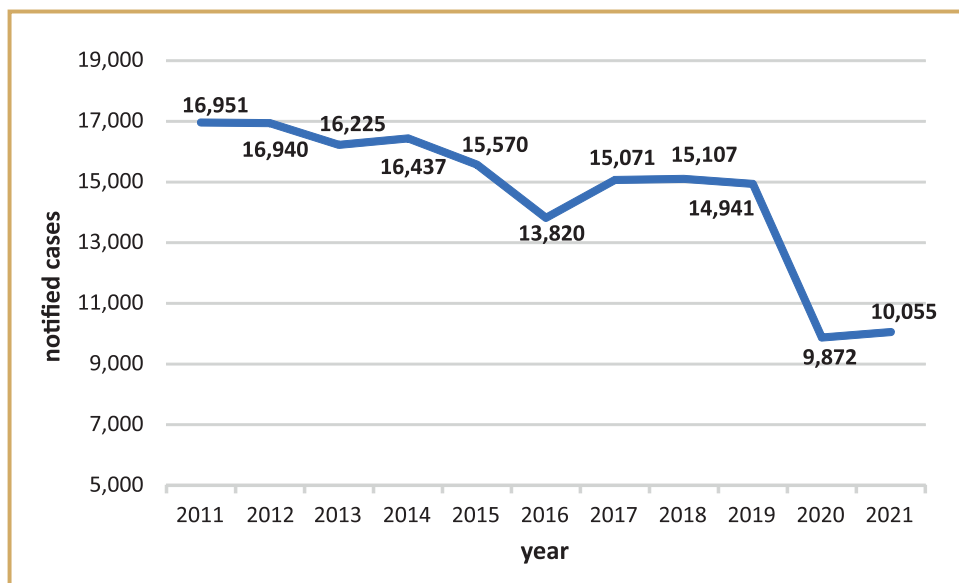


Fig. 2 : Annual incidence of leprosy cases in Northeast Brazil (2011–2021).

Table 1 : Socio-demographic profile of reported leprosy cases in Northeast Brazil from 2011 to 2021

Variable	Number N	Percentage %
Sex		
Man	90,487	55.57
Woman	72,342	44.42
* Not registered	19	00.01
Schooling		
Illiterate	18,845	11.57
Elementary school	44,282	27.19
Middle school	29,864	18.34
High school	27,193	16.69
<i>Bachelor's degree or more</i>	5,640	03.46
* Not registered/others	37,024	22.74
Ethnicity		
White	26,546	16.30
Black	22,696	13.94
Asian	1,478	00.91
Brown	1,02,387	62.87
Indigenous	557	00.34
* Not registered	9,184	05.64
Age		
01 - 09 years	4,191	02.57
10 - 19 years	14,891	09.16
20 - 29 years	19,187	11.78
30 - 39 years	27,460	16.86
40 – 49 years	29,134	17.89
50 – 59 years	28,859	17.72
60 years or older	39,126	24.03

* Information not registered in the system.

years 2011 and 2021. As can be seen in Fig. 2, there was a drop of 6,096 annual cases between 2011 and 2021. Maximum drop occurred from 2019 to 2020/2021.

As for the sociodemographic variables, there was a predominance among the reported cases of leprosy in the Brazilian Northeast among men (55.57%); had low schooling – Basic (27.19%),

Elementary (18.34%) and Illiterate (11.57%); most were brown (62.87%) and predominantly aged between 20 and 49 years (46.53%), as described in Table 1.

The first clinical aspect analyzed referred to the number of skin lesions, with the highest frequency (35.63%) of multiple lesions, five or more, as illustrated in Fig. 3.

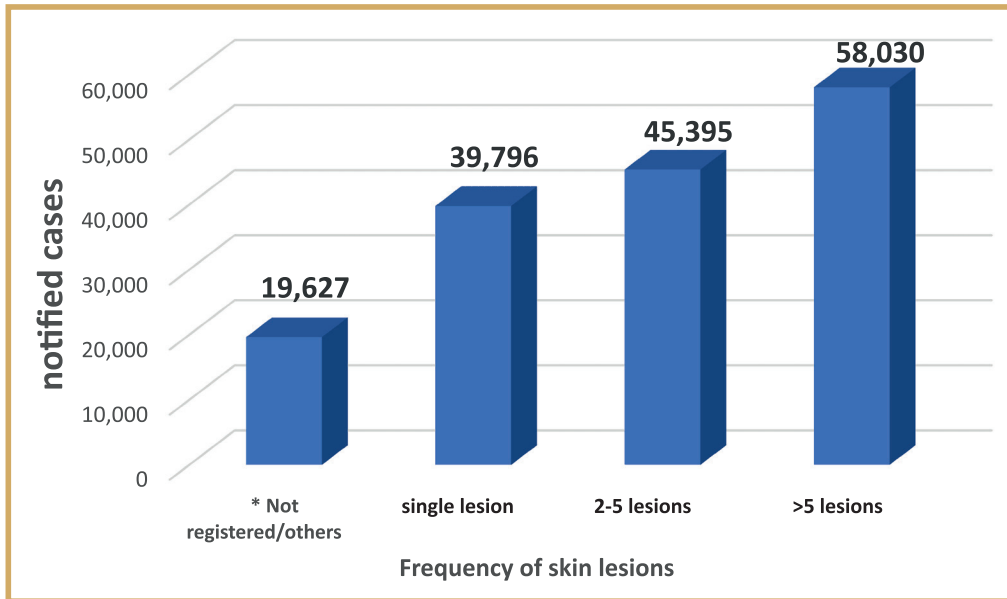


Fig. 3 : Classification of cases according to number of skin lesions in reported cases of leprosy in Northeast Brazil - 2011 to 2021.

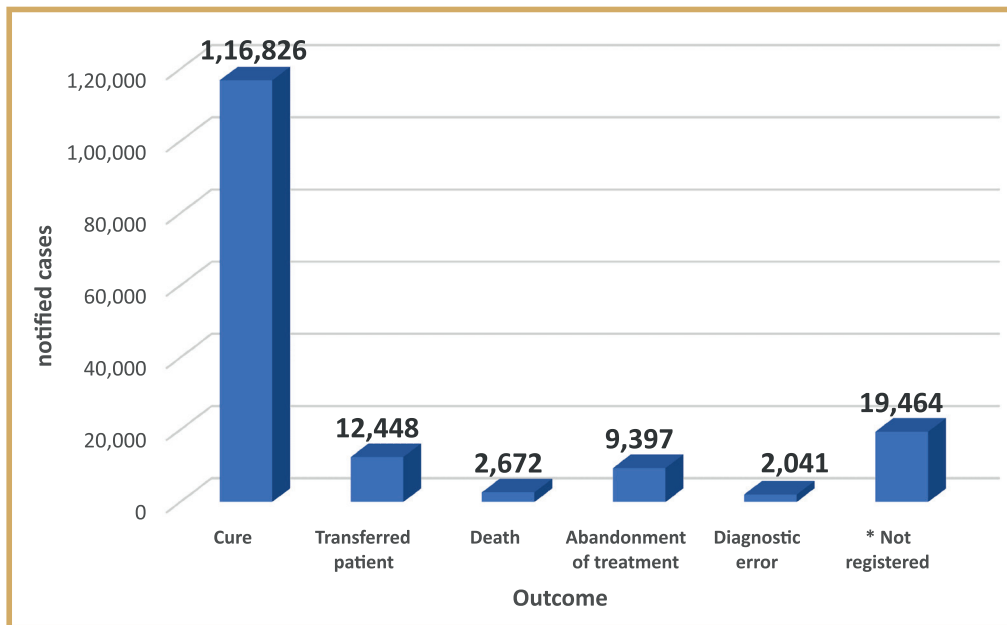


Fig. 4 : Final outcome of leprosy cases reported in Northeast Brazil - 2011 to 2021.

Table 2 : Socio-demographic profile of reported leprosy cases in Northeast Brazil from 2011 to 2021.

Classification	Caracteristics	Reported cases
Indetermined	* It is the first manifestation of leprosy, whose lesions (few in number and in any region of the body) can appear on average after three years of infection. The appearance of hypochromic spots and hypoesthesia occurs. smear is negative.	23,088
Tuberculoid	* Lesions (trichophytoid or sarcoid) are well-defined, few in number, asymmetry in distribution and anesthetic. The smear is negative.	26,410
Borderline	* Varied clinical manifestations are observed, affecting the skin, nerves or internal organs. The skin lesions are numerous and their morphology is varied. There are infiltrations on the face and ears, in addition to lesions on the back of the head and neck, suggestive findings for the clinical diagnosis. The smear can be positive or not.	64,053
Virchowiana	*It is a multibacillary form, recognized for corresponding to the low resistance pole, within the immunological spectrum of the disease. in the chronic course, it is characterized by progressive and diffuse infiltration of the skin, mucous membranes of the upper airways, eyes, testes, nerves, and may also affect the lymph nodes, liver and spleen. On the skin, papules, nodules and macules are described. Early signs of VH are nasal obstruction, serosanguineous rhinorrhea and lower limb edema. Smear is positive.	27,708
Not classified or not registered	Cases that were not classified or information not recorded in the system.	21,319

Adapted de: Araújo (2003); Pimentel et al (2018)

* The Brazilian leprosy notification health system uses the classification according to the bacilloscopic index, if less than 2+, undetermined and tuberculoid leprosy are included; On the other hand, the bacilloscopic index greater than or equal to 2+, involve the borderline and Virchowian forms (Pimentel et al 2018).

Furthermore, information was recorded on the result of the smear (intra-dermal scraping) this laboratory test contributes to assist in the classification of leprosy, being positive, it characterizes a strong indication of the Multibacillary group, while a negative result does not exclude the diagnosis of the disease (Taggart et al 2020, Ploemacher et al 2020). In addition, it may favor the diagnosis of other skin diseases

and recurrences. In the present study, the results were: In 17,229 this information was not recorded; 40,541 were positive; 48,944 negative; 56,134 did not take the skin smear test.

Thus, based on the clinical analyzes and laboratory findings, previously described, leprosy can be classified into subtypes, as described in Table 2, with borderline being the most frequent (39.33%) in the present study.

Discussion

As shown in Table 2, SINAN (Brazilian National Disease Notification System) does not present data by subgroups as per Ridley & Jopling classification, which involves clinical, bacteriological, immunological and histopathological criteria, but uses the above system as referred by Pimentel et al (2018). Thus, the characterizations of the groups were described in the table for a better understanding of the readers. Furthermore, data from unregistered or unclassified items was added, in order to draw attention to the importance of correctly recording these data, for proper mapping of leprosy cases in the region. Better training and awareness of health teams on this topic is needed.

As observed, the most frequent cases were borderline (64,053), which can be explained, in part, because it belongs to the multibacillary form (lepromatous and borderline), mainly by the respiratory system, when close and lasting contacts occur.

The clinical evolution can be understood as explained by Bucater & Dias (2020): The disease begins with a hypochromic lesion, with altered thermal, tactile and painful sensitivity and may present with alopecia and/or anhidrosis at the site. The polarization for the tuberculoid form appears in people who have cellular immunity resistant to the bacillus and a maximum of five lesions with delimited borders appear, in this form it is already observed that the nerves are compromised, generating disabilities. The borderline or borderline form, on the other hand, develops in people who have intermediate cellular immunity and present more than five lesions with a tuberculoid aspect and others with a lepromatous aspect.

The diagnosis of a case of leprosy is carried out through a general physical and dermatoneurological examination to identify

lesions or areas of the skin with altered sensitivity and/or impairment of peripheral nerves, with sensory and/or motor and/or autonomic alterations. Cases with suspected neural involvement, without skin lesion (suspected primary neural leprosy), and those with an area with doubtful sensory and/or autonomic alterations and without evident skin lesion, should be referred to more complex health units for confirmation. diagnosis. It is recommended that, in these units, such patients are submitted again to a careful dermatoneurological examination, to the collection of material for laboratory tests (smear smear or histopathology of the skin or of the sensory peripheral nerve) and to electrophysiological and/or other more complex tests to identify impairment. discrete cutaneous or neural and perform differential diagnosis with other peripheral neuropathies (Miguel et al 2021, Chen et al 2022).

The diagnosis of the disease must be followed by the classification in paucibacillary (PB) or multibacillary, this is essential for the definition of multidrug therapy (MDT). The treatment of the clinical paucibacillary form includes the use of rifampicin and dapsone for 6 months (Ghosh & Chaudhuri 2015, Khunafa et al 2019, Nyamogoba et al 2019), with 49,288 registered for this therapeutic regimen. As for the treatment of the multibacillary clinical form, lasting 12 months (Ghosh & Chaudhuri 2015, Khunafa et al 2019, Nyamogoba et al 2019), there is the use of rifampicin, dapsone and clofazimine, with 111,562 registered under this therapeutic regimen. Another 1,998 cases did not have the information recorded.

Furthermore, it is important to analyze the levels of involvement of peripheral nerves leading to different grades of disabilities as per WHO system of grading, which can be classified as: Grade 0 (No

neural involvement); Grade 1 (Sensitive changes in feet, hands and eyes); Grade 2 (More severe impairments in the feet, hands and eyes and/or visible deformities) – (Morais & Furtado 2018, Lau 2019). In the present study, we observed: 91,200 cases of Grade 0; 33,369 Grade 1 cases; 11,953 Grade 2 cases and 26,326 unrecorded/evaluated cases.

Despite observing a majority of cases in Grade 0, it was found that 26.83% of the registered cases have some degree of neuronal impairment. This can be attributed to the delay of the patient or the health system in diagnosing the cases, similar to what was observed by Nyabogoba et al (2019) in Kenya, leading to prolonged treatment and negative consequences for the patient. Finally, the final outcomes of the reported cases were analysed, and it was observed that most cases (71.74%) progress to cure, as described in Fig. 4.

Observing the data presented in Fig. 1, there was a drop in the notified cases of leprosy in Brazil. However, the goal of eliminating leprosy, defined in the 1990s by the World Health Organization (WHO), was not reached by Brazil, with the occurrence of thousands of cases of the disease per year, with Brazil being the second responsible country, for more cases of leprosy in the world, behind India and ahead of Indonesia, this reality goes against what it claims.

Globally, to date, an average of 250,000 new patients are reported annually. The incidence and prevalence of this condition differs considerably by country, noting that developing countries suffer the greatest impact from both new cases and patients undergoing treatment.

Concerning the years 2020-2021, respectively, 9,872 and 10,055 cases of Hanseniasis were reported in Brazil in those years. In this period there was a considerable drop in notifications of this pathology, which can be explained in

part by the occurrence of the global pandemic of COVID-19 which compromised the reporting, monitoring and recording of several diseases including leprosy, which were in the background.

The majority of cases recorded among men, 90,487 reported, can be explained, according to Pego et al (2020), by the fact that men are more exposed to infection in their day-to-day activities, prevention, thus favouring a greater occurrence of cases.

The high number of leprosy cases, described in Table 01, demonstrates a predominance among socially disadvantaged people. The Northeast region of Brazil has several geographic disparities, with more developed sectors along the coast and socially disadvantaged areas in the interior of the region, which influences sanitary conditions, health education programs and types of health service provision. These disparities are partly explained by income concentration, as indicated by Oliveira & Ferreira (2020): *“In Brazil, poverty is mainly due to the great inequality and concentration of income, which leads to an excluding and centralized “development”. Most of the population in socially disadvantaged conditions in this region has low schooling and is of mixed or black ethnicity”*.

This social contextualization partly explains the greater occurrence of those infected by *Mycobacterium leprae* being brown and with low education, since as explained by Castro et al (2018) the social factors are directly related to the occurrence of leprosy in population groups, including race, ethnicity or skin colour. The authors indicate that people in social vulnerability are more exposed to contact with leprosy, and the difficulty in accessing prevention and health care programs contributes to late diagnosis, favouring intra-household transmission. This aspect could be complementary information data to be

considered for registration in SINAN, favouring a better understanding of the socioeconomic dynamics of leprosy.

About the clinical aspects analysed in the present study, the first aspect addressed in Fig. 3, presented data on the occurrence or not of skin lesions. 58,030 cases of multiple lesions were observed. The number of lesions, their characteristics and the level of neuronal involvement contribute to the diagnosis of the type of leprosy, which can be divided into Paucibacillary, characterized by few skin lesions, occurring between 1 and 5 lesions; and Multibacillary, with 6 lesions or more observed (Sasakawa Health Foundation 2019; Taggart et al 2020, Pego et al 2020). This is important for correct medical guidance and chemotherapy treatment, seeking to control the spread of the disease and negative consequences associated with its clinical evolution especially occurrence of disabilities which can be prevented and or better managed.

The large number of cured patients can be explained by the monitoring system in Brazilian communities, through health teams, which despite budgetary limitations in several locations, are committed to solving various health problems, accompanying the treatment including leprosy. Despite this data, 5.55% of cases abandoned treatment, this can be explained according to Gouvea et al (2020), by the adverse effects that the medication causes, by social exclusion, by the lack of information from health professionals and even by the sanitary conditions.

One of the limitations of the present study referred to the failure to record some information in the public health system by health professionals. Despite this, the relevance of the present survey on leprosy in the Brazilian Northeast contributed to the construction of knowledge about this public health problem,

requiring appropriate public policies to reduce the occurrence rates of this pathology, as well as to reinforce the continuing education programs of health professionals to monitor cases and record information.

Aspects related to stigma and discrimination promote social exclusion and, at the same time, can produce negative consequences that result in uncomfortable social interactions, limiting social interaction, psychological suffering and, consequently, can interfere with the diagnosis and adherence to leprosy treatment, perpetuating a cycle of social and economic exclusion (Alecrin et al 2021, Chen et al 2022). Situations in which stigma and discrimination occur can occur in the family, at school, at work and even in health services. This can be reduced with greater monitoring of health teams, monthly returns to the health service for guidance on adverse effects and prevention measures. All these aspects should be studied in-depth and accordingly interventions/strategies planned.

Sharing of these experiences can be mutually beneficial for ultimate eradication of leprosy from the world.

Conclusions and way forward

In the present study, based on the data analyzed on leprosy in the Brazilian Northeast, it was observed: a drop in cases, predominance among men; brown-skinned people with low education. These factors, associated with socioeconomic issues, are possibly related to the occurrence of leprosy. This, added to the lack of adequate access, guidance or monitoring by the health services, explains the majority of cases having multiple lesions and a large number of cases with neural involvement.

Therefore, early diagnosis and adequate treatment of the disease and its complications, as well as guidance on self-care, are the main ways of preventing physical disabilities resulting from leprosy. The prevention of physical

disabilities includes a set of measures to avoid the occurrence of physical, emotional, spiritual and socioeconomic damages.

Thus, social programs to combat poverty must be articulated with health actions to eradicate leprosy in the region, such as: health education, active search for cases, early diagnosis and treatment, monitoring of treatment abandonment, actions to reduce stigma and social exclusion, reinforcement of epidemiological analysis and continued qualification of health professionals. The latter, especially with regard to the correct recording of information in the health system, in a way that contributes to the correct design of studies on this pathology.

References

1. Araujo MG (2003). Leprosy in Brazil. *Rev Soc Bras Med Trop.* **36**: 373-382.
2. Alecrin ES, Oliveira ALG, Guimarães NS et al (2022). Factors associated with the development of leprosy in Brazilian contacts: a systematic review. *Rev Inst Med Trop São Paulo.* **64**: e55.
3. Barbosa CC, Bonfim CV, Brito CMG (2018). Spatial analysis of reported new cases and local risk of leprosy in hyper-endemic situation in Northeastern Brazil. *Trop Med Int Health.* **23(7)**: 748–757.
4. Bigs1 – Brazilian Institute of Geography and Statistics - Political map of the Brazilian northeast region. 2022. Available in: <https://portaldemapas.ibge.gov.br/portal.php#100>.
5. Bigs2 – Brazilian Institute of Geography and Statistics. Brazilian cities and states. 2022. Available in: <https://www.ibge.gov.br/cidades-e-estados>.
6. Bucater EP, Dias MAC. (2020). Prevalence of hanseniasis cases in the municipality of votuporanga (sp) in the period 2014 to 2018 / Prevalência de casos de hanseníase no município de Votuporanga (SP) no período de 2014 a 2018. *Revista brasileira multidisciplinar* **Vol. 23, n.2.**: Available in: <https://reOvistarebram.com/index.php/revistauniara/article/view/748>.
7. Carrol KC, Brooks GF, Butel J et al (2015). Mycobacteria. In : Jawetz, Melnick and Adelberg's Medical Microbiology (Geo F. Brook. Editor), 27th edition, McGraw-Hill, pp313-326.
8. Castro SS, Santos JPBG, Oliveira VR (2016). Leprosy incidence, characterization of cases and correlation with household and cases variables of the Brazilian states in 2010. *An Bras Dermatol.* **91(1)**: 28-33.
9. Chen KH, Lin CY, Su SB et al (2022). Leprosy: A review of epidemiology, clinical diagnosis, and management. *J Trop Med.* 2022: 8652062. Doi: 10.1155/2022/8652062.
10. Ghosh S, Chaudhuri S (2015). Chronicles of Gerhard-Henrik Armauer Hansen's life and work. *Indian J Dermatol.* **60(3)**: 219-221.
11. Graille J, Blaizot R, Darrigade AS et al (2020). Leprosy in French Guiana 2007-2014: a re-emerging public health problem. *Br J Dermatol.* **182(1)**: 237-239.
12. Gouvea AR, Martins JM, Poscla C (2020). Interruption and abandonment in the treatment of leprosy - Interrupção e abandono no tratamento da hanseníase / Braz. *J Healt Rev.* **3(4)**: 10591-10603. Available in: <https://ojs.brazilianjournals.com.br/ojs/index.php/BJHR/article/view/15141/12491>
13. Khunafa A, Prasetyo A, Wiyono TH et al (2019). Knowledge and actions of leprosy patients on the incidence of leprosy in Brengkok Village, Brondong Public Health Care of Lamongan Regency, Indonesia. *Pub Healt Indonesia.* **5(4)**: 99-104.
14. Lau KHV (2019). Neurological complications of leprosy. *Semin Neurol.* **39(04)**: 462-471.
15. Makhakhe L (2021). Leprosy Review. *S Afr Fam Pract* (2004).. 2021 Oct 29; **63(1)**: e1-e6. doi: 10.4102/safp.v63i1.5311.
16. Massone C, Brunasso AMG (2022). Classification of Leprosy. *Leprosy and Buruli Ulcer* pp 49–53 https://link.springer.com/chapter/10.1007/978-3-030-89704-8_6
17. Miguel BC, Mota PB, Afonso BO et al (2021). Leprosy morbidity and mortality in Brazil:

- 2008–2018. *Braz J Infect Dis.* **25(6)**, November–December.
18. Morais JR, Furtado ÉZL. Gr (2018). The level of physical inability of patients with leprosy. *Rev enferm UFPE on line.*, Recife, **12(6)**: 1625–32, jun., 2018. <https://periodicos.ufpe.br/revistas/revista-enfermagem/article/view/231049/29244>.
 19. Nyamogoba HDN, Mbuthia G, Mulambalah C (2019). Endemicity and increasing incidence of leprosy in Kenya and other world epidemiologic regions: A review. *African J Health Sci.* **32(3)**: 38–62.
 20. Oliveira LMGT, Ferreira MO (2020). An essay on inequality and poverty in the Brazilian Northeast in the light of the Kuznets hypothesis. *Revista Pesquisa e Debate* v. 33, n. 2(58).
 21. Pêgo AF, Eleutério D, Procópio JPM et al (2020). Hanseníase: correlação entre o número de lesões hansênicas, nervos afetados e o diagnóstico precoce no estado de Minas Gerais. *Revista Eletrônica Acervo Saúde*, 12(9). <https://revistas.pucsp.br/index.php/rpe/article/view/49982/40552>
 22. Pimentel LS, Viana NAN, Assunção AM et al (2018). Immunopathogenic, clinical and pharmacological aspects of leprosy: a literature review. *Rev. Ciênc. Saúde, São Luís.* **20 (2)** :33–40. <https://periodicoseletronicos.ufma.br/index.php/rcisau-de/article/view/10101/9397>
 23. Ploemacher T, Faber WR, Menke H et al (2020). Reservoirs and transmission routes of leprosy; A systematic review. *PLoS Negl Trop Dis.* **14**: 1–27.
 24. Prakoeswva C, Reza N, Alina M et al (2022). Pediatric leprosy profile in the post elimination era: a study from Surabaya, Indonesia. *Amer J Trop Med Hyg.* **106(3)**: 775–778.
 25. Ramos JM, Romero D, Belinchón I (2016). Epidemiology of leprosy in Spain: The role of the international migration. *PLoS Negl Trop Dis.* **10(3)**. <https://doi.org/10.1371/journal.pntd.0004321>.
 26. Sarode G, Sarode S, Anand R (2020) Epidemiological aspects of leprosy. *Disease-a-Month.* **66(7)**. <https://doi.org/10.1016/j.disamonth.2019.100899>.
 27. Sasakawa Health Foundation (2019). Tóquio - Novo atlas de hanseníase.
 28. Taggart M, Kelly A, Stell R (2020). Multibacillary leprosy with an incubation period exceeding 50 years. *BMJ Case Reports.* <http://dx.doi.org/10.1136/bcr-2022-250835>
 29. World Health Organization - WHO (2018). Guidelines for the diagnosis, treatment and prevention of leprosy.

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