REVISTA CIÊNCIAS EM SAÚDE
HEALTH SCIENCES JOURNAL e-ISSN 2236-3785

ORIGINAL ARTICLE

Bacilloscopy for leprosy in Brazil's public health system between 2013 and 2022

Baciloscopia para hanseníase no Sistema Único de Saúde do Brasil entre 2013 e 2022

Ricardo Barbosa-Lima[1,*], Geissiane Felizardo Vivian[2], Lincoln Max Rocha Alba[2], Kaisa Silva Nascimento de Gois[2], Vivian Aparecida Tomaz[3], Murilo Correzola Pinto[2], Flávia Freire Ramos-Silva[4], Glebson Moura Silva[5]

[1]*Metropolitan College of the State of São Paulo (FAMEESP), Ribeirão Preto, São Paulo, Brazil.*
[2]*Federal University of Sergipe (UFS), Department of Medicine of Lagarto (DMEL), Lagarto, Sergipe, Brazil.*
[3]*Fundação Universidade Regional de Blumenau (FURB), Blumenau, Santa Catarina, Brazil.*
[4]*State Department of Health of Pernambuco, Petrolina, Pernambuco, Brazil.*
[5]*Federal University of Sergipe (UFS), Department of Nursing of Lagarto (DENL), Lagarto, Sergipe, Brazil.*

Submitted 2023 Aug 1, 2023, accepted 2023 Nov 14, published 2023 Dec 28.

KEYWORDS

Epidemiology
Leprosy
Mycobacterium leprae
Unified Health System
Diagnostic techniques and procedures

ABSTRACT

Objective: To evaluate the annual number of skin smear microscopies for leprosy performed in the Unified Health System (SUS) in the last decade.
Methods: An ecological, longitudinal, retrospective, and quantitative study was conducted using data from the Ambulatory Information System (SIA/SUS). The number of skin smear microscopies for leprosy per 100,000 residents was estimated for Brazil and its five macroregions, between 2013 and 2022, with a significance level (a) of 5%.
Results: More than 1.3 million skin smear microscopies were reported in the last decade in the SUS. The median annual incidence was 67 skin smear microscopies for leprosy per 100,000 residents, with the maximum observed in 2013 (82) and the minimum in 2022 (46). Annual incidences in the North, Central-West, and Northeast macro-regions were significantly higher than the national estimate, whereas in the South and Southeast, they were lower ($p < 0.05$). The temporal trend was considered decreasing for the national estimate ($p = 0.002$), with an annual percentage variation of -5.6% (95%CI = -3.8%; -8.2%). However, after disregarding the years of the COVID-19 pandemic (2020-2022), the trend became stationary ($p = 0.181$). Furthermore, the incidence during the pre-pandemic period was significantly higher compared with the third year after the advent of the pandemic in all macro-regions of Brazil ($p < 0.05$).
Conclusion: It was possible to conclude that the SUS performed a significant number of skin smear microscopies for leprosy in the last ten years, but there are macro-regional disparities in Brazil and a significant impact of the COVID-19 pandemic.

*Corresponding author:
Addr.: Rua Augusto Carlos Brandão, 98, Centro. Petrolina, PE, Brasil. CEP: 56304-110.
E-mail: dentistaricardolima@gmail.com (Barbosa-Lima R).

This study was conducted at the Federal University of Sergipe.

https://doi.org/10.21876/rcshci.v13i4.1458

How to cite this article: Barbosa-Lima R, Vivian GF, Alba LMR, de Gois KSN Tomaz VA, Pinto MC, et al. Bacilloscopy for leprosy in Brazil's public health system between 2013 and 2022. Rev Cienc Saude. 2023;13(4):38-45. https://doi.org/10.21876/rcshci.v13i4.1458

PALAVRAS-CHAVE

Epidemiologia
Hanseníase
Mycobacterium leprae
Sistema Único de Saúde
Técnicas e Procedimentos Diagnósticos

RESUMO

Objetivo: Avaliar a quantidade anual de baciloscopias para hanseníase realizadas no Sistema Único de Saúde (SUS) nos últimos dez anos.
Métodos: Foi realizado um estudo ecológico, longitudinal, retrospectivo e quantitativo, utilizando dados do Sistema de Informações Ambulatoriais (SIA/SUS). A quantidade de baciloscopias para hanseníase a cada 100.000 residentes foi estimada para o Brasil e suas cinco macrorregiões, avaliada entre 2013 e 2022 com nível de significância (α) de 5%.
Resultados: Mais de 1,3 milhões de baciloscopias foram notificadas nos últimos dez anos no SUS. A mediana da incidência anual foi de 67 baciloscopias para hanseníase por 100.000 residentes, sendo a máxima observada em 2013 (82) e a mínima em 2022 (46). As incidências anuais nas macrorregiões Norte, Centro-oeste e Nordeste foram significativamente superiores à estimativa nacional, enquanto no Sul e Sudeste foram inferiores (p <0,05). A tendência temporal foi considerada decrescente para a estimativa nacional (p = 0,002), com variação percentual anual de -5,6% (IC95% = -3,8%; -8,2%). Entretanto, após desconsiderar os anos da pandemia de COVID-19 (2020-2022), a tendência tornou-se estacionária (p = 0,181). Além disso, a incidência durante o período pré-pandêmico foi significativamente maior quando comparada ao terceiro ano após o advento da pandemia em todas as macrorregiões do Brasil (p <0,05).
Conclusão: Foi possível concluir que o SUS realizou um número expressivo de baciloscopias para hanseníase nos últimos dez anos, mas existem disparidades macrorregionais no Brasil, bem como um impacto significativo da pandemia de COVID-19.

INTRODUCTION

Leprosy constitutes a global public health problem and a neglected tropical disease, mainly affecting underdeveloped or developing countries[1]. The disease is caused by an individual's infection with *Mycobacterium leprae*, which characterizes chronic mycobacteriosis with high infectivity and low pathogenicity[2]. Although advances have been achieved in treating leprosy with the introduction of polychemotherapy, in addition to the notable global efforts and strategies to contain the disease, endemic areas persist throughout the world, mainly related to the social vulnerability experienced in some countries, such as Brazil. From this perspective, there is concern about the late diagnosis of infected individuals when there is physical disability and reduced quality of life, reflecting the ineffectiveness of leprosy control actions[1,2].

Among the methods used to diagnose leprosy, laboratory tests and clinical examinations are available. The bacilloscopic exam, which evaluates a skin smear (intradermal) from the individual, is the most notable. Samples are processed to examine the presence of acid-fast bacilli (AFB) using modified Ziehl-Neelsen staining[1,2]. Individuals with positive skin smear microscopy are considered multibacillary, regardless of the number of skin lesions, although those with negative skin smear microscopy do not have the diagnosis of leprosy ruled out[3-5]. From a public health perspective, sputum skin smear microscopy is advantageous for diagnosing leprosy. It is easy to perform and has low operating costs, especially in complex cases where other tests are unavailable[6]. Furthermore, there is evidence that the outcome of sputum skin smear microscopy (positive or negative) may be associated with the development of leprosy reactions[5], demonstrating its applicability and relevance in the investigation and monitoring of suspected cases of leprosy.

A timely diagnosis of leprosy is a relevant objective for public health actions in countries such as Brazil. Although leprosy control actions, primarily operated by the Unified Health System (SUS), have reduced the burden of morbidity and mortality, there are disparities in macroregions related to the disease, including its endemic persistence in vulnerable regions. This outcome is influenced by socioeconomic, demographic, and environmental factors that result in late diagnosis[7,8]. Furthermore, there is a constant need to evaluate temporal trends related to leprosy and its outcomes and indicators in Brazil's macro-regions[7], in addition to strengthening actions that lead to timely diagnosis[8]. However, to the best of our knowledge, there has been no consistent investigation into the dynamics involving the performance of skin smear microscopy for leprosy in SUS.

Nevertheless, Barbosa-Lima et al.[9] demonstrated that the monthly number of skin smear microscopy for leprosy in the SUS was drastically reduced after the COVID-19 pandemic in all macro-regions of Brazil, considering the first and second years after the SARS-CoV-2 outbreak. This reduction was caused by the need to interrupt leprosy control actions and direct health efforts to contain the crisis associated with COVID-19, as well as occurring in parallel with the reduction in the number of leprosy diagnoses, demonstrating the negative and immediate impact of the scenario pandemic in the epidemiological scenario of the disease in Brazil. Still, it is necessary to monitor such outcomes, including the possibility of late impacts associated with the diagnosis of new cases of leprosy, seeking to define actions to reestablish pre-pandemic parameters[10,11].

Therefore, the objective of this study was to evaluate the annual number of skin smear microscopies for leprosy performed in the SUS in the last ten years (2013-2022), exploring the temporal trend, macro-regional disparities, and the late impact of the COVID-19 pandemic. Three hypotheses were examined: (H1) there was an increasing temporal trend in the annual number of sputum skin smears for leprosy; (H2) there were macro-regional disparities in the annual number of sputum skin smears for leprosy; and (H3) the annual number of sputum skin smears for leprosy during the third year after the start of the COVID-19 pandemic was equivalent to the pre-pandemic period (previous year).

METHODS

An epidemiological, ecological, longitudinal, retrospective, and quantitative study was conducted, characterizing a time series[12]. The observation location was Brazil, considering its five macroregions (North, Northeast, Southeast, South, and Center-West). The period was limited to the last ten years, between 2013 and 2022 (n = 10). Additionally, January, February, and March 2023 were included to measure the impact of the COVID-19 pandemic. The Strengthening the Reporting of Observational Studies in Epidemiology was adapted to guide the study report, enhancing scientific communication[13].

The primary variable of the study was the annual amount of skin smear microscopy for leprosy performed in the SUS between 2013 and 2022. To correct the effect of demographic changes throughout the time series, in addition to population differences between macroregions, the values were weighted by intercensal projections of inhabitants calculated by the Brazilian Institute of Geography and Statistics (IBGE) for each year, presented for every 100,000 residents in the national territory. The quantity of each macroregion in Brazil was considered a secondary variable. The values were approximated to become integers.

Data were collected from the SUS Ambulatory Information System (SIA/SUS) using the TabNet tool provided by the SUS Information Technology Department (DATASUS), linked to the Brazilian Ministry of Health[14]. The methodological procedures adopted were similar to those described by Barbosa-Lima et al.[9]. The annual number of skin smear microscopy for leprosy performed in the SUS was retrieved using the procedure code 02.02.08.005-6 (direct skin smear microscopy for AFB [leprosy]), using the filters available in the SIA/SUS for the period and location, considering productivity outpatient clinic approved each year.

Regarding the impact of COVID-19, the pre-pandemic period that acted as a control interval was limited between April 2019 and March 2020, while the third year after the start of the pandemic was limited between April 2022 and March 2020. 2023 (n = 12; monthly). The entire data collection and storage procedure was conducted in June 2023 by the same qualitative researcher trained in using the TabNet tool. Intercensal projections of the inhabitants were retrieved from the IBGE website[15].

Statistical analyses were performed using the JAMOVI (version 2.3.15, Sydney, Australia) and PAST (version 4.03, Oslo, Norway) statistical packages, with a significance level $\alpha = 0.05$. The distribution of the data sets was examined using a scatterplot (QQ *plot*), considering the nature of the variables. To express them, the median was the measure of central tendency, accompanied by the first and third quartiles (Q1 and Q3) as measures of dispersion, including the interquartile range (AIQ). When appropriate, the minimum and maximum values and sums were entered in addition to frequencies[16].

The temporal trend in the annual number of leprosy skin smear microscopy performed in the SUS between 2013 and 2022 was examined using the annual percentage variation (APV; %). The hypothesis of first-order serial autocorrelation was rejected when evaluating the national estimate using the Durbin-Watson test (DW coefficient = 1.85, p = 0.424). The value of the angular coefficient ($\beta 1$) was estimated in a bivariate linear regression model using the Ordinary Least Squares (OLS) method, considering a logarithmic transformation (log 10) of the dependent variable. VPA was estimated by the expression = $[-1+10\ (\beta 1)] * 100$. The 95% confidence interval of APV was estimated by the minimum and maximum values of $\beta 1$, obtained by the expression = [β 1 ± (t - critical value * β 1 -standard error)][17,18]. Between 2013 and 2019, removing the years of the COVID-19 pandemic (2020, 2021, and 2022), the temporal trend was examined using the Mann-Kendall test, considering the Sen angular estimator (S), due to the reduced number of observations (n = 7)16. The temporal trend was determined as stationary ($p \geq 0,05$), ascending ($p < 0.05$ and positive values in $\beta 1$ or S) or descending ($p < 0.05$ and negative values in $\beta 1$ or S).

The incidence ratios (IR) in the annual number of leprosy skin smear microscopy performed in the SUS between 2013 and 2022 in the macro-regions and the national parameter were estimated using a generalized linear model (GLM). After evaluating the distribution graphs, a quasi-Poisson distribution was observed, considering a robust variance. Therefore, a correction for data overdispersion was applied using a maximum likelihood estimator in the logarithmic function. Finally, the Spearman matrix was used to evaluate the correlation between annual incidences over the last ten years, considering the rho coefficient (ρ) to estimate significance, direction, and intensity[16].

Research Ethical Committee approval was unnecessary considering that all data collected and used are available in open access through DATASUS, as public domain[19].

RESULTS

Figure 1 and Table 1 show the annual amount of leprosy skin smear microscopy performed in the Unified Health System per 100,000 residents. Over the last decade, SUS has performed more than 1.3 million skin smear microscopy procedures for leprosy throughout the country. The Northeast macro-region had the highest absolute frequency, without considering population size, with more than 39% of exams. Proportionally to the population, the North macro-region had the highest relative frequency, with more than 135 annual skin smear tests per 100,000 residents, followed by the Central-West, with almost 110/100,000. Furthermore, it was possible to observe a marked variability in both macroregions between 2013 and 2022, whereas the others showed a more homogeneous behavior. All minimum annual values were recorded after the onset of the COVID-19 pandemic (from 2020 to 2022).

Table 2 presents the temporal trend in the annual amount of skin smear microscopy for leprosy in the SUS per 100,000 residents between 2013 and 2022. It was observed that the Northeast and South macro-regions showed a stationary trend over the last decade, whereas the others showed a significant decrease. Considering that 30% of the period evaluated was related to the

COVID-19 pandemic, Table 3 presents the temporal trend in the annual number of skin smear microscopy for leprosy in the SUS per 100,000 residents between 2013 and 2019 (before the outbreak). Only the Southeast macro-region maintained a significantly decreasing trend, whereas the others showed a stationary trend, highlighting the impact of the COVID-19 pandemic on the annual number of leprosy skin smear microscopy specimens in recent years.

Table 4 presents the incidence rates of skin smear microscopy for leprosy in the SUS per 100,000 residents between the pre-pandemic period and the third year after the start of the COVID-19 pandemic. In all macro-regions, the annual incidence was significantly higher in the pre-pandemic period than in the third year after its onset.

Table 5 presents the incidence rates of skin smear microscopy for leprosy in the Unified Health System per 100,000 residents between 2013 and 2022, comparing the five macro-regions with the national estimate. The North, Center-West, and Northeast macro-regions had a higher annual incidence, whereas the South and Southeast were lower, demonstrating macro-regional disparities in Brazil over the last ten years. Furthermore, the macro-regions North ($p = 0.008$, $\rho = 0.786$), Northeast ($p = 0.006$, $\rho = 0.817$), Southeast ($p = 0.009$, $\rho = 0.785$), and Central-West ($p = 0.001$, $\rho = 0.884$) showed a significant, positive, and strong correlation with the national estimate, demonstrating similar behavior over time, despite numerical differences. The South macro-region was not correlated ($p = 0.215$), demonstrating a different pattern from Brazil, corroborating the perspective demonstrated in Figure 1 between 2014 and 2018, in which there is an ascending and a descending parabola, respectively.

Table 1 — Annual number of skin smear microscopies for leprosy in the Unified Health System for every 100,000 residents.

Variable	North	North East	Southeast	South	Midwest	Brazil
Median	136	88	33	33	109	67
Q1	99	85	24	26	86	53
Q3	154	96	35	38	163	70
AIQ	55	11	11	12	77	17
Minimum (year)	87 (2021)	71 (2020)	21 (2022)	24 (2022)	63 (2021)	46 (2022)
Maximum (year)	189 (2017)	122 (2013)	39 (2013)	39 (2016)	178 (2019)	82 (2013)
Total	236,847	514,156	268,982	95,750	188,709	1,304,444
fr (%)	18.2	39.4	20.6	7.3	14.5	AT

Q1: first quartile. Q3: third quartile. AIQ: interquartile range. *fr*: relative frequency. N/A: not applicable.
Source: Outpatient Information System, Unified Health System, Ministry of Health - Brazil (2023).

Table 2 — Temporal trend in the annual number of skin smear microscopies for leprosy in the Unified Health System per 100,000 residents between 2013 and 2022.

Variable	β1	p-value	R^2	VPA (%)	Trend
North	-0.034 [-0.017, -0.047]	0.004	0.703	-7.5 [-3.8, -10.3]	Descending
North East	-0.013 [-0.017, 0.003]	0.054	0.386	NA	Stationary
Southeast	-0.030 [-0.019, -0.046]	<0.001	0.826	-6.7 [-4.3, -10.1]	Descending
South	-0.016 [-0.037, 0.006]	0.083	0.331	NA	Stationary
Midwest	-0.041 [-0.027, -0.068]	0.011	0.606	-9.0 [-6.0, -14.5]	Descending
Brazil	-0.025 [-0.017, -0.037]	0.002	0.731	-5.6 [-3.8, -8.2]	Descending

β_1: angular coefficient. [ ]: 95% confidence interval. R^2: coefficient of determination. VPA: annual percentage change (%). NA: not applicable. Source: Outpatient Information System, Unified Health System, Ministry of Health - Brazil (2023).

Table 3 — Temporal trend in the annual number of skin smear microscopies for leprosy in the Unified Health System per 100,000 residents between 2013 and 2019.

Variable	North	North East	Southeast	South	Midwest	Brazil
s	-9	-1	-14	6	-7	-6
p-value	0.119	0.500	0.015	0.191	0.190	0.181
Trend	Stationary	Stationary	Descending	Stationary	Stationary	Stationary

s: Sen's angular estimator. Source: Ambulatory Information System, Unified Health System, Ministry of Health - Brazil (2023).

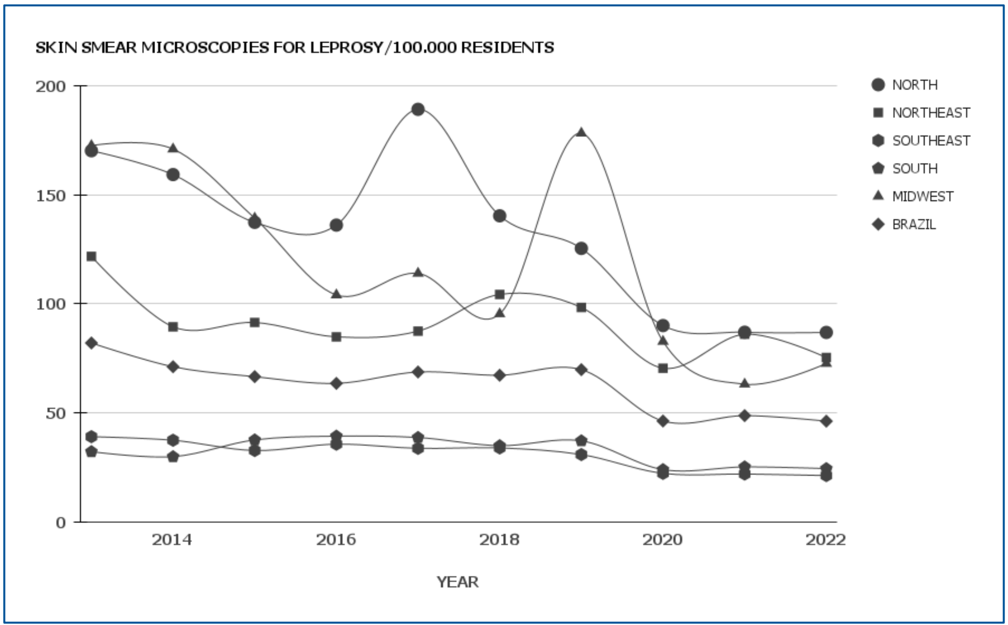

Figure 1 — Annual number of skin smear microscopies for leprosy in the Unified Health System for every 100,000 residents.

Table 4 — Incidence ratios of skin smear microscopies for leprosy in the Unified Health System per 100,000 residents between the pre-pandemic period and the third year after the start of the COVID-19 pandemic. All variables presented a *quasi*-Poisson distribution.

Region	Variable	IR	[95%CI]	p-value
North	Intercept	9	[8, 10]	<0.001
	Pre -pandemic *vs.* 3rd pandemic year	1.30	[1.12, 1.51]	0.003
North East	Intercept	7	[7, 7]	<0.001
	Pre - pandemic *vs.* 3rd pandemic year	1.27	[1.16, 1.39]	<0.001
Southeast	Intercept	2	[2, 2]	<0.001
	Pre - pandemic *vs.* 3rd pandemic year	1.43	[1.22, 1.69]	<0.001
South	Intercept	2	[2, 2]	<0.001
	Pre - pandemic *vs.* 3rd pandemic year	1.40	[1.23, 1.60]	<0.001
Midwest	Intercept	10	[6, 15]	<0.001
	Pre - pandemic *vs.* 3rd pandemic year	2.41	[0.93, 7.13]	0.097
Brazil	Intercept	5	[4, 5]	<0.001
	Pre - pandemic *vs.* 3rd pandemic year	1.44	[1.23, 1.68]	<0.001

IR: incidence ratio. [95%CI]: 95% confidence interval. Source: Outpatient Information System, Unified Health System, Ministry of Health - Brazil (2023).

DISCUSSION

This study evaluated the annual number of skin smear microscopy for leprosy performed in SUS in the last decade. Regarding the hypotheses investigated, H1 was rejected because no macroregion or national estimate showed an increasing temporal trend in the analysis with or without the COVID-19 pandemic period. On the other hand, concerning the number of new skin smear microscopy for leprosy, H2 was accepted, considering that the North, Central-West, and Northeast macro-regions were above the national estimate, while the South and Southeast were below. Finally, H3 was rejected because the number of new skin smear microscopy for leprosy during the third year after the start of the COVID-19 pandemic did not match the pre-pandemic period.

In the first analysis, it is possible to understand that the significant amount of skin smear microscopy for leprosy in Brazilian macro-regions is associated with the epidemiological scenario experienced. Miguel et al.[8], with data for 2008 and 2018, demonstrated that the North and Central-West macro-regions had the highest age-standardized mortality rates, whereas the South and Southeast had the lowest. In a previous study, with data between 2000 and 2011, Martins-Melo et al.[20] also demonstrated that the North, Northeast, and Central-West macro-regions had higher leprosy mortality rates

Table 5 — Incidence ratios of skin smear microscopies for leprosy in the Unified Health System per 100,000 residents between 2013 and 2022. All variables presented a *quasi*-Poisson distribution.

Variable	IR	[95%CI]	p-value
Intercept	67	[62, 72]	<0.001
North *vs.* Brazil	2.09	[1.68, 2.62]	<0.001
Northeast *vs.* Brazil	1.44	[1.14, 1.83]	0.004
Southeast *vs.* Brazil	0.49	[0.35, 0.67]	<0.001
South *vs.* Brazil	0.51	[0.37, 0.70]	<0.001
Midwest *vs.* Brazil	1.89	[1.51, 2.37]	<0.001

IR: incidence ratio. [95%CI]: 95% confidence interval.
Source: Outpatient Information System, Unified Health System, Ministry of Health - Brazil (2023).

than the South. Therefore, disparities between macroregions in Brazil are not restricted to leprosy outcomes, such as mortality, and manifest themselves concomitantly in aspects related to their diagnosis (such as the number of skin smear tests).

The more significant number of skin smear microscopy for leprosy observed in the North, Central-West, and Northeast macro-regions may reflect the demand for new cases, especially in endemic regions (more suspected cases, more tests to investigate them). However, considering the perspectives introduced by Silva et al.[21] and Pescarini et al.[22], it is also possible to question whether the greater number of skin smear microscopy observed is a reflection of the increased coverage of leprosy control actions developed by health services in these macro-regions, which raises the incidence of new cases, especially with the development of active searches and evaluation of household contacts. Therefore, the following question arises: do the North, Central-West, and Northeast macro-regions perform more skin smear microscopy for leprosy because they are endemic or because they perform a more significant number of leprosy control actions? Or both?

It is worth considering that data between 2011 and 2021 pointed to the North, Central-West, and Northeast macro-regions with the highest disease detection rates, whereas the South and Southeast had the lowest. Lima et al.[23] pointed out that such macro-regional differences can be attributed to several factors, from socioeconomic aspects, such as inequality in the distribution of resources, to weaknesses in the diagnosis and qualification of healthcare for leprosy, considering that the South and Southeast belong to the socioeconomic level considerably favorable (which does not apply to the others).

In contrast, Miguel et al.[8] identified that the rates of physical disability during diagnosis were high in the South and Southeast macro-regions, which reflects the ineffectiveness of leprosy control actions for timely diagnosis. Therefore, it is possible to understand that local demand can be a driver for performing skin smear microscopy for leprosy in SUS. However, its low incidence does not necessarily reflect satisfactory parameters related to timely diagnosis, which allows questioning of the leprosy control actions developed (even in regions with lower incidence). Finally, to the best of our knowledge, there are no studies on the availability of skin smear microscopy for leprosy in the SUS or training professionals and health services to use it. It is possible to question whether such variables are homogeneous across Brazilian macro-regions and how they are included in the care flows of individuals suspected of having leprosy.

Understanding the macro-regional dynamics related to skin smear microscopy for leprosy is vital because of the inclusion of this complementary test in the Clinical Protocol and Therapeutic Guidelines for Leprosy (PCDT), made available by the Brazilian Ministry of Health. Although the diagnosis of the disease is eminently clinical, PCDT includes positive skin smear microscopy as a cardinal sign of leprosy, recognizing its relevance within the criteria that allow diagnosis of the disease and guiding its availability in primary health care services. In the flowcharts proposed by the PCDT, bacilloscopy for leprosy is recommended in all potential circumstances, considering non-contact individuals or contacts with confirmed cases, in addition to the investigation of primary drug resistance (verification of the bacilloscopic index)[24].

Therefore, after analyzing the PCDT, the relevance of this examination to the epidemiological scenario of leprosy in Brazil becomes evident, from aspects related to its diagnosis to its treatment and monitoring in SUS health services, as well as introducing a broader view of the previously discussed macro-regional disparities, as they do not only translate into limitations in identifying new cases. In parallel, disregarding the impact of the COVID-19 pandemic, this study demonstrated that the annual number of leprosy skin smear microscopy showed a stationary temporal trend in Brazil and the North, Northeast, South, and Central-West macro-regions, decreasing only in the Southeast region. This outcome raises the question of whether the annual incidence is linked to the leprosy control actions that have been developed over the last ten years, seeking to understand whether a high or low incidence is closely related to demand or arises from limitations related to the SUS in providing and applying this complementary exam to assist individuals suspected or diagnosed with the disease.

Finally, considering the COVID-19 pandemic and corroborating the findings of Barbosa-Lima et al.[9], the annual number of skin smear microscopy for leprosy has not yet reached the level of the pre-pandemic period, even three years after the start of restrictive measures that culminated in the reduction of leprosy control actions in Brazil and around the world. The challenges in assisting people with leprosy after the advent of the COVID-19 pandemic were numerous, but it is worth noting that health services substantially modified the flow of care, reorienting health actions toward the health crisis caused by SARS-CoV-2. On the other hand, with the advancement of the epidemiological scenario, the introduction of vaccines, and the relaxation of health restrictions, a resumption of work processes was expected, thereby reestablishing assistance to individuals with leprosy[25,26].

However, it was observed that existing barriers were exacerbated, including difficulties for SUS users to access health services, underreporting of new cases, increased hidden prevalence, difficulties in scheduling complementary exams, and shortage of materials and medications to treat the disease, professional training, and educational campaigns. Furthermore, active search and contact assessment actions were also limited[25,27,28]. Therefore, even if no study has specifically addressed the topic of skin smear microscopy for leprosy, it is reasonable to hypothesize that its reduction over the years of the COVID-19 pandemic is part of this scenario.

Finally, it is crucial to consider the limitations of the method used. There may be underreporting in the number of skin smear microscopy for leprosy, considering that it depends on the health service professionals and administrators feeding the SUS productivity systems through production bulletins. Furthermore, Brazil was evaluated for the five macro-regions, but health regions (locals) may present different views from the macro-region to which they belong. Finally, considering the population approach, exploring, and correcting the outcomes based on characteristics related to individuals (SUS users) or health establishments was not possible. Future investigations can continue to monitor the spatio-temporal dynamics in notifications of skin smear microscopy for leprosy in the SUS, seeking to elucidate which factors determine their greater or lesser use in health care services and networks, especially in control actions and campaigns aimed at the disease.

CONCLUSION

Based on the observed scenario, it was concluded that SUS performed a significant amount of skin smear microscopy for leprosy in Brazil between 2013 and 2022. However, macro-regional disparities and a significant impact of the COVID-19 pandemic were observed.

REFERENCES

1. Chen KH, Lin CY, Su SB, Chen KT. Leprosy: a review of epidemiology, clinical diagnosis, and management. J Trop Med. 2022;2022:8652062. https://doi.org/10.1155/2022/8652062 PMid:35832335 PMCid:PMC9273393
2. Froes-Junior LAR, Sotto MN, Trindade MAB. Leprosy: clinical and immunopathological characteristics. An Bras Dermatol. 2022;97(3):338-47. https://doi.org/10.1016/j.abd.2021.08.006 PMid:35379512 PMCid:PMC9133310
3. Gilmore A, Roller J, Dyer JA. Leprosy (Hansen's disease): an update and review. Mo Med. 2023;120(1):39-44. PMid:36860602 PMCid:PMC9970335
4. Makhakhe L. Leprosy review. S Afr Fam Pract (2004). 2021;63(1):e1-6. https://doi.org/10.4102/safp.v63i1.5311 PMid:34797098 PMCid:PMC8603093
5. Santos MASD, Mercadante LM, Pegas ES, Kadunc BV. Relationship between bacilloscopy and operational classification of Hansen's disease in patients with reactions. Ann Bras Dermatol. 2018;93(3):454-6https://doi.org/10.1590/abd1806-4841.20186725 PMid:29924247 PMCid:PMC6001107
6. Belotti NCU, Nardi SMT, Paschoal VDA, Montanha JOM, Pedro HSP, Gazetta CE. Laboratory diagnosis of leprosy: two staining methods from bacilloscopy and rapid ml flow test. Int J Mycobacteriol. 2021;10(4):393-7. https://doi.org/10.4103/ijmy.ijmy_206_21 PMid:34916457
7. Lima LV, Pavinati G, Silva IGP, Moura DRO, Gil NLM, Magnabosco GT. Temporal trend, distribution and spatial autocorrelation of leprosy in Brazil: ecological study, 2011 to 2021. Rev Bras Epidemiol. 2022;25:e220040. https://doi.org/10.1590/1980-549720220040 PMid:36478213
8. Miguel CB, Mota PB, Afonso BO, Agostinho F, Cazzaniga RA, Abreu MCM, et al. Leprosy morbidity and mortality in Brazil: 2008-2018. Braz J Infect Dis. 2021;25(6):101638. https://doi.org/10.1016/j.bjid.2021.101638 PMid:34756836 PMCid:PMC9392197
9. Barbosa-Lima R, Ramos-Silva FF, Santos JCO, Santos DKC, Silva GM, Kameo SY. Leprosy bacilloscopy notifications in the Brazilian Unified Health System and COVID-19 pandemic: an ecological investigation. J Health Biol Sci. 2023 [cited 2023 Dec 14];11(1):1-5. Available from: https://periodicos.unichristus.edu.br/jhbs/article/view/4656
10. Marques NP, Marques NCT, Cardozo IM, Martelli DRB, Lucena EG, Oliveira EA, et al. Impact of the coronavirus disease 2019 on the diagnoses of Hansen's disease in Brazil. Rev Soc Bras Med Trop. 2021;54:e02512021. https://doi.org/10.1590/0037-8682-0251-2021 PMid:34320132 PMCid:PMC8313100
11. Deps P, Collin SM, Andrade VLG. Hansen's disease case detection in Brazil: a backlog of undiagnosed cases due to COVID-19 pandemic. J Eur Acad Dermatol Venereol. 2022;36(10):e754-5. https://doi.org/10.1111/jdv.18307 PMid:35680545 PMCid:PMC9347646
12. Merchán-Hamann E, Tauil PL. Proposal for classifying the different types of descriptive epidemiological studies. Epidemiol Serv Saude. 2021;30(1): e2018126. https://doi.org/10.1590/s1679-49742021000100026 PMid:33950133
13. Malta M, Cardoso LO, Bastos FI, Magnanini MM, Silva CM. STROBE initiative: guidelines on reporting observational studies. Rev Saude Publica. 2010;44(3):559-65. https://doi.org/10.1590/S0034-89102010000300021 PMid:20549022
14. Brasil, Ministério da Saúde. Departamento de Informática - Sistema Único de Saúde (DATASUS) [Internet]. Brasília (DF): Ministério da Saúde; 2023 [cited 2023 Jul 6]. Available from: https://datasus.saude.gov.br/
15. Brasil, Instituto Brasileiro de Geografia e Estatística [Internet]. Brasília (DF): Instituto Brasileiro de Geografia e Estatística; 2023 [cited 2023 Jul 7]. Available from: http://www.ibge.gov.br/
16. Pagano M, Gauvreau K, Heather M. Principles of bioestatistics. 3a. ed. Boca Raton: CRC Press; 2022. 620p.
17. Latorre MRDO, Cardoso MRA. Time series analysis in epidemiology: an introduction to methodological aspects. Rev Bras Epidemiol. 2001;4(3):145-52. https://doi.org/10.1590/S1415-790X2001000300002
18. Antunes JLF, Cardoso MRA. Using time series analysis in epidemiological studies. Epidemiol Serv Saude. 2015;24(3):565-76. https://doi.org/10.5123/S1679-49742015000300024
19. Brasil, Ministério da Saúde. Resolução n. 510 de 7 de abril de 2016 [Internet]. Dispõe sobre as normas aplicáveis a pesquisas em ciências humanas e sociais. Diário Oficial da União. 2016 mai. 24; Seção 1. p 44.
20. Martins-Melo FR, Assunção-Ramos AV, Ramos Júnior AN, Alencar CH, Montenegro Júnior RM, Oliveira MLW, et al. Leprosy-related mortality in Brazil: a neglected condition of a neglected disease. Trans R Soc Trop Med Hyg. 2015;109(10):643-52. https://doi.org/10.1093/trstmh/trv069 PMid:26354792
21. Silva CLM, Fonseca SC, Kawa H, Palmer DOQ. Spatial

distribution of leprosy in Brazil: a literature review. Rev Soc Bras Med Trop. 2017;50(4):439-49. https://doi.org/10.1590/0037-8682-0170-2016 PMid:28954063
22. Pescarini JM, Strina A, Nery JS, Skalinski LM, Andrade KVF, Penna MLF, et al. Socioeconomic risk markers of leprosy in high-burden countries: a systematic review and meta-analysis. PLoS Negl Trop Dis. 2018;12(7):e0006622. https://doi.org/10.1371/journal.pntd.0006622 PMid:29985930 PMCid:PMC6053250
23. Lima LV, Pavinati G, Silva IGP, Moura DRO, Gil NL, Magnabosco GT. Temporal trend, distribution and spatial autocorrelation of leprosy in Brazil: ecological study, 2011 to 2021. Rev Bras Epidemiol. 2022;25:e220040. https://doi.org/10.1590/1980-549720220040.2
24. Brasil, Ministério da Saúde. Protocolo Clínico e Diretrizes Terapêuticas da Hanseníase [Internet]. Brasília: Secretaria de Vigilância em Saúde, Departamento de Doenças de Condições Crônicas e Infecções Sexualmente Transmissíveis; 2022 [citado 7 jul 2023]. Available from: https://bit.ly/3GIT19k
25. Diniz SPMC, Pereira DLM, Aquino DMC, Oliveira BLCA, Rabelo PPC, Rolim ILTP. Impacto da COVID-19 na assistência às pessoas acometidas pela hanseníase. Rev Enferm Atual In Derme. 2023;97(2):e023078. https://doi.org/10.31011/reaid-2023-v.97-n.2-art.1627
26. Lopes JGCBS, Silva IM, Leal MGC, Ribeiro AMS, Leitão JCU, Sousa AFDS, et al. Subdiagnóstico de hanseníase no Brasil durante a pandemia da COVID-19. REAMed. 2022;20:e11172. https://doi.org/10.25248/reamed.e11172.2022
27. Reis ACNF, Oliveira JPM, Gomes HS, Cavalcante NV. Impact of the COVID-19 pandemic on the continued care of leprosy: an integrative review. RSD. 2022;11(14):e339111436490. https://doi.org/10.33448/rsd-v11i14.36490
28. Mendonça IMS, Eleres FB, Silva EMS, Ferreira SMB, Sousa GS. Impact of the COVID-19 pandemic on the care of patients with leprosy: an evaluative study from the perspective of the health professional. RSD. 2022;11(2):e4111225459

Conflicts of interest: No conflicts of interest declared concerning the publication of this article.

Individual contribution of the authors:
Study conception and design: RBL, FFRS, GMS
Data collection: RBL
Data analysis and interpretation: RBL, GFV, LMRA, KSNG, MCP, VAT, FFRS, GMS.
Manuscript writing: RBL, GFV, LMRA, KSNG, MCP
Critical review of the text: RBL, GFV, LMRA, KSNG, MCP, VAT, FFRS, GMS
Final approval of the manuscript: RBL, GFV, LMRA, KSNG, MCP, VAT, FFRS, GMS.
Statistical analysis: RBL
Overall responsibility for the study: RBL, FFRS, GMS
*All authors read and approved the final version of the manuscript submitted for publication by Rev Cienc Saude.

Funding information: not applicable.