Impact of the COVID-19 pandemic on the diagnosis of leprosy in Brazil: An ecological and population-based study

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Summary

Background The pandemic caused by COVID-19 has seriously affected global health, resulting in the suspension of many regular health services, making the diagnosis of other infections difficult. Therefore, this study aimed to assess the impact of the COVID-19 pandemic on the diagnosis of leprosy in Brazil during the year 2020.

Methods We evaluated the monthly incidence of leprosy and calculated the percentage change to verify whether there was an increase or decrease in the number of leprosy cases in 2020, considering the monthly average of cases over the previous 5 years. We used interrupted time series analysis to assess the trend in the diagnosis of leprosy before and after the start of COVID-19 in Brazil and prepared spatial distribution maps, considering the percentage variation in each state.

Findings We verified a reduction of 41.4% of leprosy cases in Brazil in 2020. Likewise, there was a reduction of leprosy notifications in children under 15 years-old (-56.82%). Conversely, the diagnosis of multibacillary leprosy increased (8.1%). There was a decreasing trend in the leprosy incidence in the general population between 2015 and 2020 in Brazil. Spatial distribution maps depicted a reduction of up to 100% in new cases of leprosy in some states.

Interpretation Along with COVID-19 spread there was a reduction in leprosy diagnosis in the general population and children under 15 years-old, and also an increase in multibacillary cases diagnosed, signalling a serious impact of the pandemic on leprosy control strategies in Brazil.

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Keywords: Leprosy; Pandemic; SARS-CoV-2; Health Services; Brazil

Introduction

The pandemic of the coronavirus disease 2019 (COVID-19) denotes the most important and severe public health problem of the 21st century until now. The disease is caused by the new severe acute respiratory syndrome coronavirus 2 (SARS-CoV-2), and the first cases were reported in December 2019 in the city of Wuhan, China.[1] COVID-19 was declared a pandemic by the World Health Organization (WHO) on March 11, 2020, and, to date, approximately 220 million cases and more than 4.55 million deaths have been registered worldwide.[2] In Brazil, there were more than 21 million cases and about 585 thousand deaths from COVID-19. The country is the second in the world ranking of deaths, staying behind only the United States of America (USA) and the third in the number of cases.[3]

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Research in context

Evidence before this study

The onset of the COVID-19 pandemic has become one of the greatest challenges on global public health and led to the suspension of regular health services worldwide. Furthermore, measures to reduce the spread of the virus can severely affect the diagnosis, treatment, and control of other infections, such as leprosy. Additionally, prior studies conducted by our group demonstrated the negative effect of the pandemic in the diagnosis of hepatitis C in Brazil, and also in the diagnosis of leprosy and tuberculosis in the state of Bahia, located in the Northeast region. In the light of the above, we hypothesized that the COVID-19 pandemic could have also affected the diagnosis and the strategies to control leprosy in Brazil.

Added value of this study

This is the first study to assess the impact of the COVID-19 pandemic in the diagnosis of leprosy in Brazil in 2020. Herein, we used the % change as a tool to analyse the variation of leprosy cases during the first year of the pandemic, taking as reference the average number of cases diagnosed over the last five years. Our analyses showed a significant reduction in leprosy coefficient detection in the general population, but especially among children under 15 years old. On the other hand, there was an increasing trend of the multibacillary form. Importantly, spatial analyses identified high-risk areas of leprosy in inland municipalities and demonstrated a reduction of up to 100% regarding new leprosy cases, mainly in the states of North, Northeast, and Central-West regions of the country.

Implications of all the available evidence

Leprosy is a millenary and still neglected disease and the implementation of measures to control the disease was already a challenge even before the pandemic in Brazil. Nevertheless, the irruption of the COVID-19 pandemic can severely impact leprosy control strategies throughout the country. This study can provide information on decreasing trends of leprosy cases to health managers and authorities, also pointing to the regions most affected. At last, we hope that our findings aid the public health efforts in maintaining care for ill patients and facilitating access to health services to improve the diagnosis and the timely treatment for patients, thereby reducing physical disabilities and reaching cure as fast as possible.

During most of 2020-early 2021 measures to contain the transmission of SARS-CoV-2 limited the population's access to public health services.[4–6] Notably, populations that are affected by Neglected Tropical Diseases (NTDs) already face considerable barriers to access health services such as proper diagnosis and treatment. Furthermore, NTDs mostly affect populations socially and economically vulnerable in low-income countries.[7]

Additionally, WHO issued interim guidelines and recommended the suspension of most NTD-related activities, including surveillance actions and community campaigns.[8] All measures implemented to contain the spread of COVID-19 and the social, economic, and health system impact impaired actions to control and diagnose several other diseases, especially the neglected ones, such as leprosy.[4]

Leprosy is a chronic and systemic infectious disease, with an insidious clinical course, caused by the intracellular bacillus *Mycobacterium leprae*.[9] The disease is one of the main causes of permanent disability and social stigma and stands out as one of the most important NTDs in undeveloped countries such as India and Brazil. In addition, WHO estimates that around 3 million people worldwide live with disabilities caused by leprosy.[10] Despite being an ancient and treatable disease, leprosy still represents an important health problem, mostly in vulnerable populations, reflected by the lack of research funding to develop vaccines or new therapies.[11,12]

Regardless the reduction of leprosy cases in recent decades, 202,185 new cases were reported in 150 countries during 2019. In Brazil, 27,863 new cases were reported in 2019, with a detection rate of 1.32 cases per 10,000 inhabitants. Of this total, 21,850 patients presented MB form and among those, 1,545 were children under 15 years old.[10] In this context, Brazil stands out as the only country in the Americas that has not reached the leprosy control goal (<1/10,000 inhabitants) and also holds second place in the number of new cases throughout the world.[13]

In light of the above, factors such as social distancing, measures to restrict urban mobility, fear of infection, and reduced access to health services during the pandemic can drastically affect diagnosis, treatment, and control of leprosy.[14] Therefore, this study aimed to assess the impact of the COVID-19 pandemic on the diagnosis of leprosy in Brazil during 2020.

Methods

Type and study design

A population-based and ecological-type study, using spatial analysis tools and all reported cases of leprosy in Brazil, between 2015 and 2020 was conducted herein. The expected number of cases for 2020 was assessed by calculating the average leprosy cases of 2015 to 2019, the last five years before the pandemic (2015 to 2019), and compared to those effectively detected in 2020. Herewith, it was possible to analyse the influence of the COVID-19 pandemic on the notification of leprosy in Brazil during 2020.

Study area

Brazil is located in South America and also the fifth largest country in the world, with approximately

211 million inhabitants, which makes it the 5th most populous country. The country is politically and administratively divided into 27 federative units (26 states and one Federal District) and 5,570 municipalities. For political and operational purposes, the states are grouped into five regions (North, Northeast, Southeast, South, and Midwest) with distinct geographic, economic and cultural characteristics (**Supplementary material 1**).[15] Importantly, despite being the 12th largest economy in the world (US$ 1.434 trillion in 2021), Brazil has serious social inequalities and it is endemic for several NTDs, such as Leishmaniasis,[16] Chagas Disease,[17] Schistosomiasis[18,19] and Leprosy.[20,21]

Data source

Data referring to leprosy cases were collected from the Notifiable Diseases Information System (SINAN) of the Brazilian Ministry of Health. The notification of leprosy is mandatory throughout Brazil. SINAN data are in the public domain and can be assessed at the website of the Information Department of the Unified Health National System (DATASUS). Furthermore, data on COVID-19 were obtained from the website created by the Brazilian Ministry of Health to share COVID-19 data and indicators with the public.[22] Lastly, the digital cartographic mesh of Brazil (divided by states and regions) in shapefile format, was extracted from the Geographical Projection System, from the website of the Brazilian Institute of Geography and Statistics (IBGE) (Geodetic Reference System, SIRGAS/2000).

Data analysis and percentage of change calculation

To assess the impact of the pandemic on leprosy cases reported in Brazil during 2020, the percentage of change (% change) was calculated based on the following variables: i) new cases of leprosy in the general population; ii) new cases of leprosy in children under 15 years old; iii) proportion of new multibacillary cases over the total of newly diagnosed cases.

Although % change was initially designed to assess disparities in the mortality rate of different health problems, it has also been used to analyse morbidity rates, as demonstrated in prior studies conducted by our group.[23−25] Considering the expected value and the one observed, it is possible to calculate the increase or reduction in the phenomenon occurrence in time and space.[26] The % change was calculated through the following equation:

$$\%\ \text{change} = \frac{\text{number of cases registered in 2020} - \text{number of cases expected in 2020}}{\text{number of cases expected in 2020}} \times 100$$

in which, the number of cases registered in 2020 corresponds to the official data monthly notified by the Brazilian Ministry of Health; and the number of cases expected for 2020 corresponds to the average of cases registered monthly in the five years prior to the pandemic year (2015 to 2019). As a result, positive percentage values indicate an increase in the number of cases while negative values point to a reduction in the number of cases compared to the expected values.[26] The % change was assessed by regions, states, and the country. Results were presented as bar graphs and timelines showing both observed and expected values for leprosy and COVID-19 monthly indicators in 2020. Microsoft Office Excel® software 2017 (©Microsoft) was used for graphs and % change analyses.

Interrupted time-series analyses

To evaluate whether the leprosy diagnosis in 2020, after the onset of the COVID-19 in Brazil, differ from the trend between 2015-2019, we conducted an interrupted time series analysis. The variables assessed were the monthly detection of leprosy in the general population, in children <15 years old, and the proportion of the MB form. The intervention model was the establishment of the COVID-19 pandemic in Brazil in March 2020. First, the graphs of residue and sample and partial autocorrelation function (ACF and partial ACF) were used to verify autocorrelation in the residue and properties of stationarity and normality, to select the most appropriate and statistically parsimonious models.[27] Next, the ARIMA models of serial dependence were identified. The selected preintervention model was an ARIMA (2,1,0). Finally, the Ljung-Box (Q) test was used to assess whether the residuals were white noise, that is, approximately normally distributed around zero.[28] The Ljung-Box test indicated that the models are appropriate to describe the linear dependence between successive repetitions. The analyses were performed using IBM SPSS Statistics 22 software and data were presented in time series graphics.

Temporal trend analyses

A segmented log-linear regression, using the joinpoint regression model, was used to assess the temporal trend of leprosy diagnosis considering different parameters/scenarios: leprosy cases in the general population, in children under 15 years old and the proportion of MB cases in Brazil and its regions, between 2015 and 2020. The Monte Carlo permutation test was applied to select the best model for inflexion points (applying 999 permutations), considering the highest residue determination coefficient (R2). Furthermore, to describe the temporal trends, we calculated the monthly percentage change (MPC) and its respective confidence interval (CI 95%).[29] Once more than one significant inflexion was detected during the studied period, the average monthly percentage changes (AMPC) were also calculated. Time trends were considered statistically significant when MCP or AMCP had a *p*-value <0.05 and their CI 95% did not include zero. Importantly, a positive and significant MCP or AMCP values indicate an increasing trend; alternatively, a negative and significant MPC or AMCP indicates a decreasing trend; and non-significant trends are described as stable, regardless of MPC or AMPC values.[29]

Spatial analyses and elaboration of choropleth maps

First, to evaluate the spatial distribution of the data, choropleth maps by state, displaying P-score percentage values, per month, for leprosy in Brazil during 2020 (January-December) were elaborated. The following parameters were used: i) the P-score concerning new leprosy cases per month in the general population; ii) the P-score of new leprosy cases per month in children under 15 years old; iii) and P-score of new MB leprosy cases per month. Additionally, choropleth maps were stratified into nine categories of equal intervals, according to P-score (positive or negative) percentages: -100 to -75%; -75 to 50%; -50 to -25%; -25 to -0.1%; 0%; 0.1 to 25%; 25 to 50%; 50 to 75%; >75%. QGis software version 3.18.3 (QGIS Development Team; Open-Source Geospatial Foundation Project) was used to prepare the maps.

Role of the funding source

No funding source was required for the completion of this work.

Results

The analyses showed a leprosy case number reduction of 11,357 in Brazil during 2020 (n = 16,073; % change = -41.4%) compared to the average number of cases in the last five years (2015 to 2019, n = 27,430) (**Figure 1A**). Likewise, all Brazilian states and regions showed a reduction in the leprosy diagnosis in the general population. More importantly, the reduction percentage was higher in patients under 15 years old in Brazil (-56.82%; expected = 1,823; observed = 787; -1,036 cases), in all regions and 6 states (**Figure 1B**). On the other hand, it was observed an increase in the proportion of MB cases notification in Brazil (increase percentage = 8,1%) and all states/regions. (**Figure 1C**).

Remarkably, there was an expressive reduction in the leprosy detection coefficient in the general population between 2015 (14.52 per 100,000 inhabitants) and 2020 (7.59) in Brazil (**Table 1**). Likewise, this reduction pattern was also observed in all Brazilian regions, especially on the North (30.63 to 16.64), Northeast (23.32 to 11.78), and Midwest (38.29 to 22.34) regions. Similar data were observed in children under 15 years old (Brazil = 4.86 in 2015 to 1.78 in 2020). Conversely, the proportion of MB cases increased from 2015 (68.86%) to 2020 (80.22%) in Brazil and all its regions.

Next, the interrupted time series analysis was applied to verify whether the onset of the COVID-19 impacted the diagnosis of leprosy in Brazil in 2020. Interestingly, we observed a not stationary trend and a progressive and significative reduction in the diagnosis of leprosy in the general population (stationary R^2 = 0.091; normalized BIC = 12.95; significance = 0.073; ARIMA estimate = -307.84; *p*-value = 0.045; **Figure 2A**) in Brazil, after the establishment of the COVID-19 pandemic in March 2020. Conversely, there was a stationary and decreasing trend in the diagnosis of leprosy in children under 15 years old (stationary R^2 = 0.108; normalized BIC = 8.301; significance = 0.303; ARIMA estimate = -13.29; *p*-value = 0.321; **Figure 2B**) and a stationary trend in the proportion of MB forms (stationary R^2 = 0.252; normalized BIC = 0.97; significance = 0.389; ARIMA estimate = -0.123; *p*-value = 0.687; **Figure 2C**).

Furthermore, there was a progressive reduction in the number of new leprosy cases in the general population, from March to December 2020 in Brazil. In the North, Northeast, Midwest, and Southeast regions, the highest reduction percentage took place in December (-80.83%, -86.86, -87.64, and -88.82%, respectively; **Supplementary material 2A-E**). In the South region, the highest reduction percentage occurred in April (-74,16%). Correspondingly, leprosy cases decreased in children under 15 years old in the North, Northeast, and Midwest regions between March and December 2020. The highest reduction percentage occurred in December (-73.05%, -93.06%, and -94.9%, respectively) (**Supplementary material 3A-B and 3E**). Alternatively, the Southeast region showed a reduction of leprosy notifications in most months, especially May and December (-100%) (**Supplementary material 3C**). In the South region, there was a reduction of leprosy cases in 7 months, with punctual increases in May (233.33%) and October (114.29%) (**Supplementary material 3D**). On the other hand, a stable trend was observed regarding the percentage of MB leprosy cases in 2020. Surprisingly, most percentages of change found were positive (**Supplementary material 4A-E).**

Additionally, we conducted temporal trend analyses of data and the MCP/AMCP of leprosy cases was calculated. Interestingly, there was no seasonal variation regarding leprosy detection rate in the general population in the years before the pandemic in Brazil. However, in 2020 there was a decreasing temporal trend (MPC = -6.66; *p*-value <0.05; **Supplementary material 5A**). Similar temporal patterns were observed in the regions of Brazil, especially Northeast (MPC = -6.78) and Central-West (MPC = -8.78) regions. Also, stable trends were observed concerning leprosy cases in

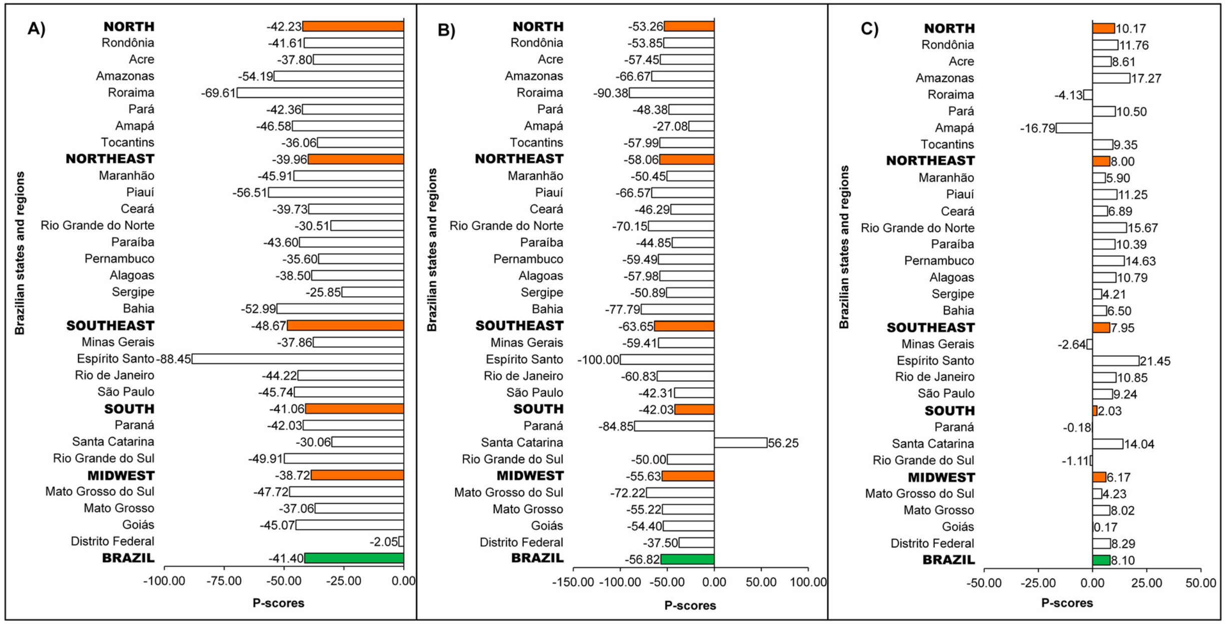

Figure 1. The % change of leprosy cases, according to data from Brazil, Brazilian regions, and states. **A**) P-score of new leprosy cases in the general population; **B)** P-score of new leprosy cases in children under 15 years old; **C**) P-score of new cases of multibacillary (MB) leprosy.

Variables/Indicators	Leprosy detection coefficient and proportion of MB cases	
	2015	2020
Total population		
Brazil	14.52	7.59
North	30.63	16.64
Northeast	23.32	11.78
Southeast	4.91	2.25
South	3.52	1.71
Central-West	38.29	22.34
Population under 15 years old		
Brazil	4.86	1.78
North	10.72	4.44
Northeast	8.57	2.99
Southeast	0.91	0.33
South	0.22	0.14
Central-West	9.43	3.43
Proportion of new multibacillary cases (%) †		
Brazil	68.86	80.22
North	66.41	82.07
Northeast	65.22	74.52
Southeast	64.42	75.62
South	79.32	83.27
Central-West	80.51	91.19

***Table 1*: Leprosy detection coefficient (per 100,000 inhabitants) in the general population and children under 15 years old, and the proportion (%) of multibacillary cases (MB) in Brazil and its regions between 2015 and 2020.**

† Proportion of multibacillary cases (MB) over total new cases, adjusted by 100. Leprosy detection coefficient per 100,000 inhabitants.

children under 15 years old from 2015 to 2019, in Brazil. Nevertheless, a decreasing and significant time trend was observed in 2020 (MPC = -6.56; *p*-value <0.05; **Supplementary material 5B**). On the other hand, and as expected, increasing trends were verified regarding the proportion of MB cases in Brazil (MPC = 0.22; *p*-value <0.05; **Supplementary material 5C**) and its regions.

Concerning the spatial distribution of leprosy cases in the general population (**Figure 3A**), after March, most states presented a reduction in the number of cases diagnosed. More importantly, 22 states exhibited a greater reduction of leprosy cases in December (-100% to -75%). Correspondently, there was a reduction in leprosy cases in patients under 15 years old in some states, even before the spread of COVID-19 in Brazil (January to March) (**Figure 3B**). Nevertheless, from April to December, there was an increase in the number of states with a marked reduction percentage. In addition, 23 states had a greater reduction of leprosy cases also in December (-100% to -75%), among which eight 21 showed a 100% reduction of leprosy notifications in children. Finally, regarding the spatial distribution of

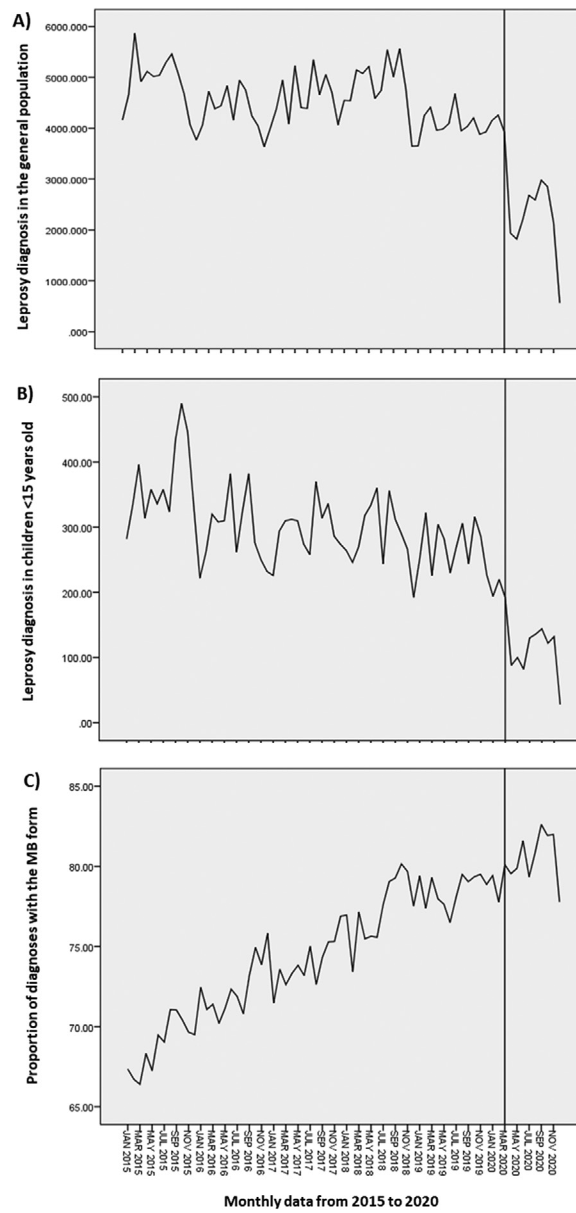

Figure 2. Interrupted time series analysis of leprosy cases in Brazil: A) leprosy diagnosis in the general population; B) leprosy diagnosis in children under 15 years old; and C) proportion of diagnosis of the multibacillary form (MB). The line that cuts each time series indicates the intervention in the series, in this case, the establishment of the COVID-19 pandemic in Brazil in March 2020.

MB leprosy cases, an increasing trend was verified throughout 2020: most states showed a positive percentage (**Figure 3C**). However, the states of Amapá, Roraima, Sergipe, São Paulo, and Rio Grande do Sul displayed greater negative % change (-100% to -75%) in May, June, November, and December.

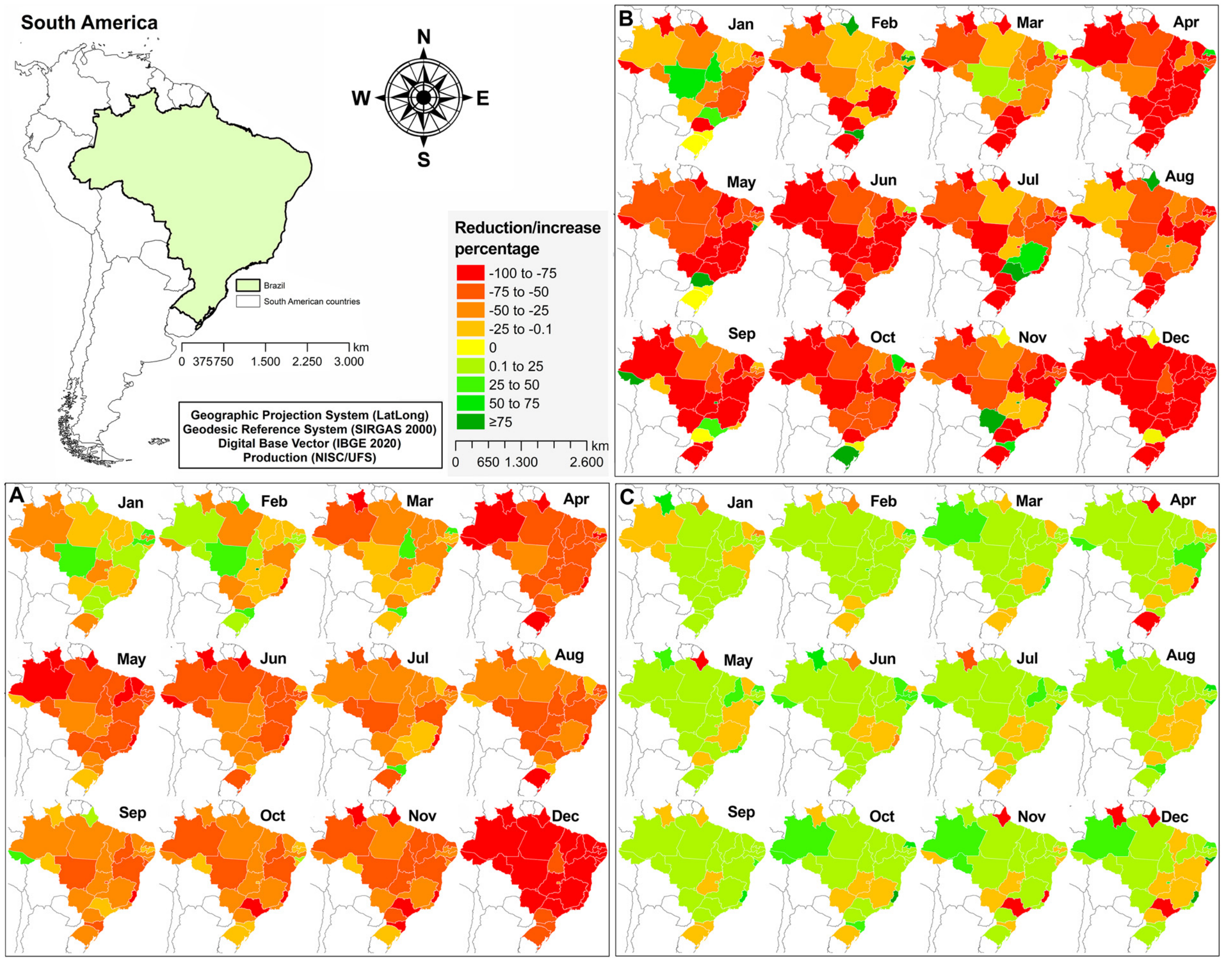

Figure 3. Spatial distribution of the percentage of change (% change) for leprosy cases (A) in the general population, (B) in children under 15 years old, and (C) the proportion of multibacillary (MB), per Brazilian state in 2020.

Jan = January; Feb = February; Mar = March; Apr = April; May = May; Jun = June; Jul = July; Aug = August; Sep = September; Oct = October; Nov = November; Dec = December.

Discussion

Herein, we assessed the impact of the COVID-19 pandemic on the diagnosis of leprosy in Brazil during 2020. Remarkably, this is the first study to use the % change as a tool to analyse the variation of leprosy cases in the first year of the pandemic, taking as reference the average number of cases over the last five years. The temporal trend analyses showed a significant reduction in leprosy detection rate in the general population, especially among children under 15 years old, after COVID-19 spread across the country. Conversely, there was an increasing trend of MB leprosy cases. Taken together, these results reveal a great impact on leprosy control strategies and indicate a worrying and insidious scenario regarding the evolution of the disease in the country, especially after the COVID-19 pandemic.

The COVID-19 pandemic has led almost all countries to implement unprecedented public health measures.[8] Among those, and particularly considering the need for physical and social distancing, WHO recommended postponing community-based research, active case-finding, and mass NTD treatment campaigns until the publication of new recommendations, considering the pandemic scenario.[8] As a result, it is expected delays in diagnosis, treatment, morbidity management, disability prevention and other health facility services, along with the discontinuation of disease monitoring activities, such as routine surveillance and population-based surveys. Nonetheless, the WHO also recommends that emergency interventions for patients that seek care in health centres to obtain a diagnosis, treatment, or to monitor NTD should be maintained.[8]

The negative effect of the pandemic on NTDs is evident and raise a concern about the ability to reach leprosy control goals in Brazil. At a national level, the situation can be even more alarming: Brazil is the only country that has not reached the disease control goal (<1/10,000) and it is the main responsible for this endemic in the American continent.[10,30] Furthermore, the country is the second in the number of cases throughout the world (staying behind only India), however, the disease indicators are expected to fall, due to underreporting of cases and hidden prevalence of the disease, linked to limited access to health facilities to diagnose it during the pandemic.[10] Even before the pandemic, the existence of a hidden prevalence of the disease had already been reported in studies carried out in the states of Alagoas and Bahia, North-eastern Brazil.[31,32] Thereby, we emphasize that with the pandemic, the underreporting of leprosy cases may be exacerbated across the country.

Notwithstanding, there was a significant reduction in the coefficient of diagnosis of *M. leprae* infection in children under 15 years old. Although leprosy is most prevalent among adults and the elderly, the detection of new cases in children under 15 years old indicates an active spread of the bacillus, with a continued transmission, and lack of disease control by health services.[33] Therefore, delays in the disease diagnosis in younger people increase the risk of developing MB leprosy and also physical disabilities, which can be even more worrying and stigmatizing among children and adolescents.[11]

On the other hand, it was denoted a relative increase in the number of MB leprosy cases diagnosed in 2020, probably reflecting the reduction in the number of paucibacillary (PB) leprosy diagnoses. MB leprosy is usually more severe, with a larger number of lesions, and a marked loss of sensation,[34] therefore the number of sick patients that seek health services is higher, considering the worsening of clinical condition.[11]

Alternatively, delays in PB leprosy diagnosis may increase the risk of clinical complications such as leprosy reaction, neurological damage, and physical disabilities. Furthermore, it can increase the risk of bacillus transmission to household contacts and preservation of the disease cycle in the community.[11]

As expected, leprosy has a greater impact on socially vulnerable populations.[35–37] In addition, factors such as low income, poor housing conditions, households clusters, nutritional deficiency, and poor education are considered social determinants of health-related to the transmission of *M. leprae*.[13,37,38] Northeast, North, and Midwest regions present the highest prevalence rates and represent the poorest areas of the country.[37,39,40]

Similarly, prior studies have already shown that the COVID-19 pandemic has a more severe effect on poorer populations, who live in suburbs and slums, areas with precarious water and sewage services.[41–43] In Brazil, COVID-19 had a catastrophic effect on the poorest areas, especially the ones located in the North region, which also exhibits the highest leprosy rate of the country.[44] The consequences of social distancing measures such as the increase in unemployment and poverty across the country, most likely aggravated leprosy epidemiological status in these areas, including indigenous communities. Likewise, previous studies conducted by our group have already demonstrated the negative effect of the pandemic in the diagnosis of hepatitis C, compromising the Brazilian hepatitis C eradication plan by the year 2030.[24] Moreover, the new coronavirus pandemic also has affected the diagnosis of leprosy[23] and tuberculosis[25] in the state of Bahia, located in the Northeast region.

Interestingly, the number of MB leprosy cases was already remarkably high reported before the pandemic in Brazil.[25] Nonetheless, even after WHO remarks on the diagnosis and treatment of NTDs such as leprosy, the pandemic will probably significantly affect the goals for the control of leprosy and other NTDs, as already previously stated for schistosomiasis.[45–47] Likewise, Barros and colleagues[4] assessed the availability of leprosy services during the COVID-19 pandemic in Bangladesh, India, Mozambique, and Zimbabwe. They reported that many leprosy-related health services remained open, providing leprosy diagnosis, multidrug therapy, and treatment for leprosy reactions. However, many patients were unable to go to health centres due to public health measures implemented to contain the spread of SARS-CoV-2.

Late diagnosis of leprosy, high proportions of MB leprosy cases, individuals diagnosed with a physical disability, and a poor treatment rate were already challenges in Brazil before the COVID-19 pandemic.[25] More importantly, the poorest segments of the population live mostly in clusters, especially slums. Social isolation measures lead to longer household contact, which could potentially increase the risk of *M. leprae* transmission. As a result, it is expected an increase in the number of cases and the burden of disabilities in the next years.[48] Further impacting the leprosy status is the lack of evaluation of household contacts that are usually diagnosed during clinical investigations and active case-finding actions.

Finally, the limitations for this study must be considered when interpreting the results. First, we carried out an ecological evaluation of secondary data obtained from DATASUS, therefore the possibility of bias exists, concerning the quantity and quality of information, that is, leprosy cases may be under, or even overreported in some regions, or even a registration delay in the system might be present. Second, as this is an ecological study, it is possible that the results observed between the groups do not occur at the individual level.[49] Lastly, data on COVID-19 cases may not be accurately reported, for instance, there might be registration delays altering the diagnosis date. Regardless of the limitations, our findings provide relevant data about the effect of the pandemic on the diagnosis of leprosy and for decision-making in dealing with leprosy in Brazil.

Taken together, the data and analyses indicate a serious and insidious impact of the COVID-19 pandemic in the battle against leprosy in Brazil. Maintaining care for ill patients and reducing barriers to access health services should be a priority for governments and health managers. Additionally, along with measures to reduce the spread of SARS-CoV-2, we recommend that practical emergency actions should be taken to control NTDs, such as leprosy. Finally, to interrupt the transmission cycle of *M. leprae*, reduce the number of new cases of leprosy reaction or physical disability, and at last to reach the disease control goal established by the WHO, health managers must reassess leprosy control programs and intensify active case-finding after the COVID-19 pandemic, to improve the diagnosis and early treatment for patients, reaching cure as fast as possible.

Declaration of interests

The authors report no conflict of interests.

Contributors

WSP: Conceptualization, Data curation, Investigation, Methodology, Software, Writing - review & editing, Project administration. MRS: Investigation, Validation, Writing - review & editing. DST: Validation, Writing - review & editing. AMJ: Validation, Writing - review & editing. ADS: Data curation, Investigation, Methodology, Writing - review & editing. RFC: Validation, Writing - review & editing. CDFS: Conceptualization, Data curation, Investigation, Methodology, Validation, Writing - original draft. MBS: Conceptualization, Data curation, Investigation, Methodology, Software, Writing - review & editing, Supervision, Validation.

Data sharing statement

The data sets related to leprosy analysed and that support the results of this study are registered in the Sistema de Informação de Agravos de Notificação (SINAN) and are available on the website of the Departamento de Informatica do Sistema Único de Saúde (DATASUS). http://tabnet.datasus.gov.br/cgi/tabcgi.exe?sinannet/cnv/hanswbr.def

Data related to COVID-19 cases are also available for anyone to access without the need to request any responsible agency. http://plataforma.saude.gov.br/

For the construction of spatial analysis maps, the cartographic base of Brazil was used, available in the electronic database of the Instituto Brasileiro de Geografia e Estatística (IBGE). https://www.ibge.gov.br/geociencias/organizacao-do-territorio/malhas-territorio/15774-malhas.html?=&t=o-que-e

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Editorial disclaimer

The Lancet Group takes a neutral position with respect to territorial claims in published maps and institutional affiliations.

Supplementary materials

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