Relevance of socioeconomic factors to the management of Leptospirosis in Brazil.

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Abstract. Leptospirosis, a febrile infectious disease caused by Leptospira bacteria, remains endemic in Brazil, particularly affecting regions with poor sanitation and significant socioeconomic inequality. This study investigates the epidemiological and socioeconomic factors influencing leptospirosis cases in Brazil from 2014 to mid-2024, based on data from the Information System for Notifiable Diseases (SINAN). Over the study period, 33,963 cases were reported, with the South and Southeast regions exhibiting the highest numbers of infections. A rising trend in cases since 2022 is noted, likely due to environmental factors such as increased flooding, driven by climate change. The disease primarily affects populations aged 20 to 59, particularly those in occupations and environments prone to exposure to contaminated water and waste. Despite the South recording the highest number of cases, the Northeast region has a disproportionately high mortality rate, highlighting the critical role of socioeconomic conditions in disease outcomes. The study emphasizes the need for targeted public health policies to address sanitation infrastructure and social inequalities, particularly in vulnerable regions, to manage and reduce the incidence of leptospirosis in Brazil effectively.

Keywords. Leptospirosis, Socioeconomic, Inequality, Environment, Health, Public health policies, Brazil.

1. Introduction

T Leptospirosis was first described in the mid-1800s by Adolf Weil and is characterized as a febrile infectious disease caused by bacteria of the genus Leptospira, which belong to the order Spirochaetales and the family Leptospiraceae. This disease is mainly found in tropical and subtropical regions, such as the Americas, where it is endemic in Latin America and the Caribbean. [1]

Currently, there are 10 pathogenic species of Leptospira, with Leptospira interrogans being the most frequent cause of leptospirosis in humans. The main reservoirs and thus the primary sources of transmission to humans in Brazil are rodents, specifically Rattus norvegicus, Rattus rattus, and Mus musculus. These animals do not develop the disease upon contact with Leptospira bacteria but rather harbor the pathogenic microorganisms in their kidneys, excreting them through urine, and contaminating water, soil, and food. [1]

It is believed that the disease was introduced to Brazil via rodents that inhabited the ships used to transport African slaves during the colonial period. However, the first cases of leptospirosis in Brazil were only described in 1917. One likely reason for this delay in identifying the disease is that cases prior to that time were possibly misdiagnosed as yellow fever, due to their similar symptoms. [2]

In Brazil, there is no vaccine available for human immunization against leptospirosis, and contamination is mainly caused by exposure of the skin (whether injured or not) or mucous membranes to the urine of infected rodents. Additionally, infection can occur through the ingestion of food and water contaminated by these animals. Interpersonal transmission is also possible through direct contact with the bodily fluids of infected individuals. [2]

It is important to highlight that certain factors facilitate leptospirosis infection in Brazil, the primary one being living or working in areas with inadequate sanitation infrastructure, such as insufficient or absent garbage collection and poor sewage system maintenance. Additionally, certain occupations pose a higher risk of exposure to environments contaminated by Leptospira, such as garbage collectors, recyclers, farmers, veterinarians, animal handlers, and firefighters. Another significant risk factor for leptospirosis infection is

the contamination of individuals during rainy seasons and/or natural disasters, such as floods, through contact with contaminated water and mud. [2]

According to the Brazilian Ministry of Health, neglected diseases are those that primarily affect the most vulnerable populations, such as those living in poverty, which perpetuates social inequality. Therefore, leptospirosis is considered a neglected disease in Brazil, and due to this status, it requires increased investment in research for more effective treatment and diagnostic methods.

To address neglected diseases in the country, Brazil created the Research and Development Program for Neglected Diseases, which aims to promote the development of medications for use in the public health system. By 2020, the program had already received over 39 million reais in funding for health innovation. However, leptospirosis has not been recognized as a neglected disease by the government, and thus, it has not received any dedicated investment for research or intervention. [5]

Despite this, leptospirosis is a notifiable disease in Brazil, and reporting is carried out through the SINAN (Information System for Notifiable Diseases), which is a crucial tool for monitoring diseases in a country with continental dimensions. The SINAN system aims to standardize the collection and processing of data on notifiable diseases across the national territory, allowing for the analysis of the health and disease processes of the Brazilian population, thereby serving as a guide for public policy decisions aimed at managing the public health system in Brazil. The system's data source consists of standardized notification forms distributed within the public health system, completed by professionals who diagnose the health condition, containing important information for characterizing the disease of interest, its geographical distribution, and its behavior in space and time. [3]

Thus, public policies aimed at combating leptospirosis are necessary for disease prevention. This study aims to characterize the most relevant socioeconomic aspects of leptospirosis epidemiology in Brazil, which are necessary to better guide the establishment of public health measures for its control.

2. Methodology

Ecological, time-series, descriptive study. In this study, all confirmed cases of leptospirosis in Brazil from 2014 to June 2024, as recorded in the Information System for Notifiable Diseases (SINAN), were selected. Population data, estimated by the Brazilian Institute of Geography and Statistics (IBGE), were obtained from the Department of Informatics of the Unified Health System (DATASUS) website.

The variables of interest in this study were: region of residence of the infected individual, age group, race/color, and outcome of the disease (lost to follow-up, cure, death due to leptospirosis, and death from other causes).

The data used in this research are secondary and publicly available and therefore do not require approval from an ethics committee, by Resolution No. 466/12 of the Ministry of Health.

3. Results

Between 2014 and June 2024, 33,963 cases of leptospirosis were reported in Brazil. Overall, a consistent and significant decline in confirmed cases of the disease was observed during the study period, decreasing from 4,757 in 2014 to 1,744 in 2021, as shown in **Fig.1**

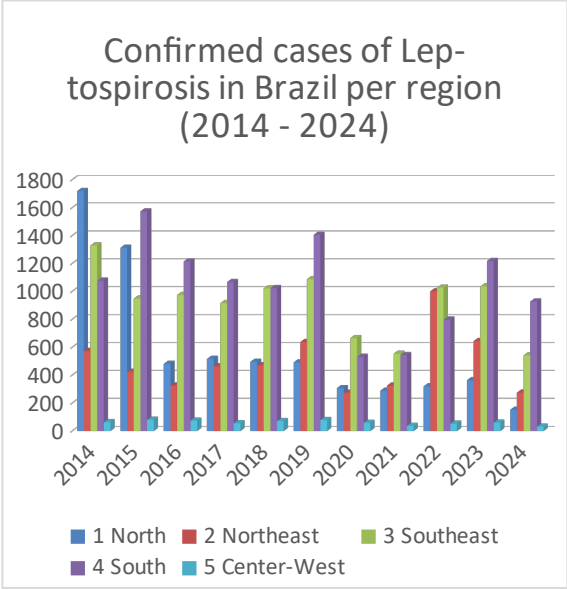

Fig. 1 – Confirmed cases of Leptospirosis in Brazil between 2014-2024.

However, there was a marked increase in cases in 2022 and 2023, reaching 3,194 and 3,318 infections, respectively. The first half of 2024 recorded 1,924 cases, indicating the persistence of this upward trend in infections.

From a geographic perspective, the most affected regions in descending order were the South (11,372 cases), Southeast (10,092), North (6,441), Northeast (5,406), and Center-West (652). It is worth noting that, despite the general increase in infections across the country in 2022 and 2023, the Northeast region saw a 200% growth compared to 2021, rising from just over 300 cases to around 1,000 infections in 2022. Similarly, a significant rise was observed in the Southeast (from 553 to 1,026 cases) during the same period. The South region also deserves attention, with 1,217 confirmed cases in 2023, surpassing the 1,076 cases reported in 2014,

and representing a 124% increase compared to 2021.

The most affected region in absolute numbers by leptospirosis in Brazil was the South, and among the states in this region, Rio Grande do Sul reported the highest number of cases (4,772), with a population of about 11.2 million. It was followed by Paraná, which reported 3,514 cases since 2014, with an estimated population of over 11.8 million. However, the state of Santa Catarina, with just over 8 million inhabitants, recorded 3,070 cases during the period.

Regarding the racial distribution of infections, it was observed that two major groups were the most affected: white and brown individuals. These two population groups accounted for 84% of all cases in the Brazilian population. It is important to highlight that white and brown people comprise 88.8% of the Brazilian population.

Regarding the age distribution of the affected population, it was found that individuals aged 20 to 39 accounted for 13,032 confirmed cases of leptospirosis in Brazil, representing the highest incidence of the disease across different age groups, as shown in **Fig.2.** Adults aged 40 to 59 also stood out, comprising 11,748 of the total infected individuals. Together, these two age groups account for more than 70% of the confirmed cases of leptospirosis in Brazil.

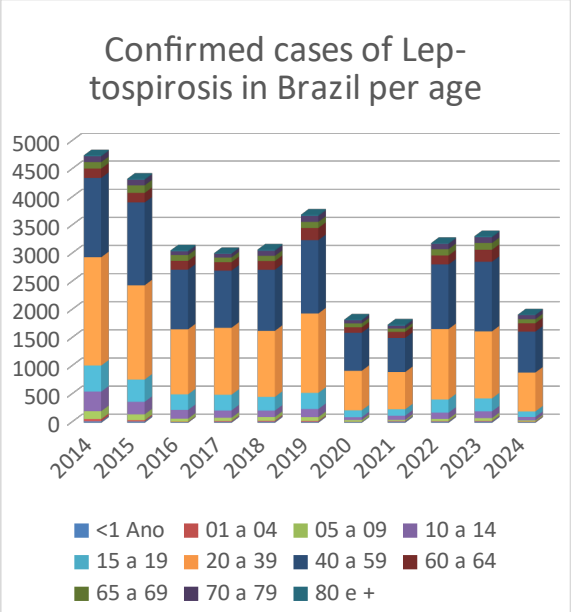

Fig. 2 – Confirmed cases of Leptospirosis in Brazil per age group

In terms of outcomes, most cases (81.7%) resulted in recovery and restoration of the individual's health. However, a significant number of deaths were recorded (3,011), corresponding to 8.86% of all reported cases. Additionally, there was a considerable number of cases with lost follow-up, making it impossible to determine the exact outcome for these individuals.

When analyzing leptospirosis outcomes by region, the Northeast region recorded the second-highest number of deaths (733), despite being only the fourth in terms of absolute case numbers, surpassing even the South, which had the highest number of cases overall but ranked third in fatalities (649 cases).

4. Discussion

The decline in leptospirosis cases in Brazil between 2014 and 2024 may be attributed to increased investments in basic sanitation during this period, including the expansion of sewage systems and improved waste collection from Brazilian households.

However, a rising trend in infections was observed in recent years, particularly in 2022 and 2023. One potential explanation for this pattern is the worsening of global warming, which among other consequences, intensifies the rainy season, leading to flooding, a condition directly associated with increased incidence of leptospirosis. [6,7, 13]

When examining the number of leptospirosis infections in the Brazilian region, the South appears to be the most affected. This likely stems from the significant number of farms in the states within this region, as a substantial part of their economy relies on agricultural and livestock production.6 Studies conducted in the state of Rio Grande do Sul have identified higher incidence rates of the disease in coastal areas of low altitude and predominantly agricultural land use, particularly in regions with irrigated crops. [8]

The high number of infections in the Southeast region may be linked to the significant urban concentration in this area and, consequently, to the disorganized urban growth that contributes to conditions favorable for the proliferation of leptospirosis transmission vectors, such as the accumulation of waste and open sewage. [7]

In the North region, climate factors play an important role in explaining the high number of reported cases. It is well-known that bacteria of the genus Leptospira thrive in hot and humid climates, making tropical and subtropical regions conducive to their proliferation. The combination of heavy rainfall and hot, humid weather prevalent in this part of Brazil, alongside historical levels of poverty, governmental neglect, and social inequality, contributes to the region's disease landscape. [5, 6, 7, 9]

Previous studies have highlighted that although the Brazilian government has improved its strategies for managing natural disasters, healthcare interventions tend to be limited to emergencies, without concrete follow-up plans once the crisis has passed. Therefore, a recommendation for controlling leptospirosis and other diseases that

benefit from such scenarios is the establishment of sectors focused on strategic prevention and damage reduction, with particular attention to flood and inundation control. [11]

In the Northeast region, socioeconomic factors emerge as the most significant contributors to the spread of leptospirosis, such as low human development levels, high dropout rates, significant social inequality, inefficient income distribution, and poor or non-existent basic sanitation in many parts of cities and towns. Additionally, there is a lack of state interest in investing in the region's development. [5, 7, 10] It is important to note that the available data from the Northeast may not fully reflect the true situation, as factors like delayed reporting, underreporting, and misdiagnosis could account for the lower number of reported cases. [2]

The distribution of leptospirosis infections among Brazilian ethnic groups mirrors the overall population distribution, with the highest number of cases occurring among the two largest ethnic groups—white and mixed-race individuals—who together account for 88.8% of Brazil's population. [10] It is important to emphasize that in Brazil, race is a self-reported characteristic, typically based on phenotype, and therefore, this result may differ from research conducted in other regions.

Regarding the distribution of leptospirosis cases across age groups, as shown in **Fig.2**, the highest concentration of infections was found in the economically active population, between 20 and 59 years of age. Work-related factors, depending on the labor activity and the work environment, may increase the risk of leptospirosis. [10] Furthermore, this portion of the population is more vulnerable to contamination during commutes between home and work, as they may come into contact with open sewage, contaminated mud, infected puddles, and floodwaters. [5, 6]

Concerning the outcomes of leptospirosis in Brazil, the fatality rate remains high, with nearly 9% of cases resulting in death, a figure that may be underestimated due to a considerable number of individuals lost to follow-up, whose outcomes were not identified. This elevated mortality rate may be associated with the disease's pathophysiology, which can lead to life-threatening conditions such as coagulopathies and shock. However, other factors must also be considered, including delayed diagnosis due to public unawareness of the disease and its severe signs, large areas without adequate healthcare services, especially in rural zones, and misdiagnosis, as leptospirosis may be mistaken for other endemic diseases, such as yellow fever, delaying appropriate treatment. [5, 7]

Finally, when analyzing the disease's outcomes in different Brazilian regions, it becomes apparent that, although the South records the highest number of leptospirosis cases, it ranks third in terms of deaths caused by the disease, in stark contrast to the Northeast, which has the second-lowest number of cases yet the second-highest mortality rate, surpassed only by the Southeast, which has more than double the number of infections. This scenario supports the hypothesis that the socioeconomic conditions of the Northeastern population are among the primary, if not the greatest, risk factors for leptospirosis infections and poor outcomes, even surpassing climatic predispositions. [5, 7]

Throughout the development of this research, a notable lack of studies on leptospirosis in the North, Northeast, and especially the Central-West regions of Brazil [6], compared to the South and Southeast, became apparent. This highlights the need for increased investment in the investigation, characterization, diagnosis, and treatment of leptospirosis in Brazil. Although already considered a neglected disease in the country, those infected may face even more desperate circumstances depending on where they live.

5. Conclusion

Based on the findings of this research, it is clear that the Brazilian government needs to invest in urban infrastructure, primarily focusing on efficient waste collection and sewage systems, rodent population control strategies, plans to address the rainy season and prevent flooding risks, stricter oversight of employers to ensure the proper provision and use of personal protective equipment for workers exposed to leptospirosis, and public education to raise awareness about disease prevention methods.

Additionally, more resources should be allocated to research on leptospirosis, both for diagnostic and preventive purposes, with one approach being the inclusion of leptospirosis in the Brazilian government's Research and Development Program for Neglected Diseases. Moreover, incentives for research into the epidemiology and behavioral patterns of the disease in the country's most neglected regions—North, Northeast, and Central-West—are needed.

Finally, effective action is required to combat social inequality in Brazil, as this condition has proven to be the principal risk factor affecting the health of the Brazilian population.

6. References

[1] Governo da Bahia. Leptospirose. Secretaria da Saúde do Estado da Bahia. Retrieved from https://www.saude.ba.gov.br/suvisa/vigilancia-epidemiologica/doencas-de-transmissao-vetorial/leptospirose/

[2] Marteli, A. N., Genro, L. V., Diament, D., & Guasselli, L. A. (2020). Análise espacial da leptospirose no Brasil. Saúde Em Debate,

44(126). https://doi.org/10.1590/0103-1104202012616

[3] Schramm, J. M. A., & Mendes, G. (n.d.). Sistemas de Informação de Agravos de Notificação: ferramenta para vigilância epidemiológica. Revista Epidemiologia e Serviços de Saúde. Retrieved from https://www.scielo.br/j/ress/a/K8Bh4JKPmdqySDZBj6JBPxn/?format=pdf#:~:text=O%20Sinan%20foi%20criado%20com,de%2012%2F08%2F1976

[4] Simões, L. S., Sasahara, T. H. de C., Favaron, P. O., & Miglino, M. A. (2016). Leptospirose – Revisão. Pubvet, 10(02). https://doi.org/10.22256/pubvet.v10n2.138-146

[5] Martins, M. H. da M., & Spink, M. J. P. (2020). A leptospirose humana como doença duplamente negligenciada no Brasil. Ciência & Saúde Coletiva, 25(3). https://doi.org/10.1590/1413-81232020253.16442018

[6] Portela, F. C., Kobiyama, M., & Goerl, R. F. (2020). Panorama brasileiro da relação entre leptospirose e inundações. Geosul, 35(75). https://doi.org/10.5007/1982-5153.2020v35n75p711

[7] Lacerda, F. B., Pereira, P. S., & Protti, L. M. L. (2021). Fatores determinantes na caracterização da leptospirose como doença negligenciada: revisão integrativa. Revista Eletrônica Acervo Científico, 19. https://doi.org/10.25248/reac.e6256.2021

[8] Barcellos, C., Lammerhirt, C. B., Almeida, M. A. B. de, & Santos, E. dos. (2003). Distribuição espacial da leptospirose no Rio Grande do Sul, Brasil: recuperando a ecologia dos estudos ecológicos. Cadernos de Saúde Pública, 19(5). https://doi.org/10.1590/s0102-311x2003000500007

[9] Gonçalves, N. V., de Araujo, E. N., Sousa Júnior, A. da S., Pereira, W. M. M., Miranda, C. do S. C., Campos, P. S. da S., Matos, M. W. de S., & Palácios, V. R. da C. M. (2016). Distribuição espaço-temporal da leptospirose e fatores de risco em Belém, Pará, Brasil. Ciencia e Saude Coletiva, 21(12). https://doi.org/10.1590/1413-812320152112.07022016

[10] Coelho, V. de A., Santos, M. C. dos, & Jesus, E. E. V. de. (2024). PERFIL EPIDEMIOLÓGICO DA LEPTOSPIROSE HUMANA E SUA ASSOCIAÇÃO COM OS INDICES PLUVIOMÉTRICOS NA REGIÃO METROPOLITANA DE SALVADOR-BAHIA: 2013 A 2022. Revista Ibero-Americana De Humanidades, Ciências E Educação, 1(2), 436–445. https://doi.org/10.51891/rease.v1i2.11012

[11] Londe, L. de R., da Conceição, R. S., Bernardes, T., & Dias, M. C. de A. (2016). Flood-related leptospirosis outbreaks in Brazil: perspectives for a joint monitoring by health services and disaster monitoring centers. Natural Hazards, 84(2). https://doi.org/10.1007/s11069-016-2493-8

[12] Bradley, E. A., & Lockaby, G. (2023). Leptospirosis and the Environment: A Review and Future Directions. In Pathogens (Vol. 12, Issue 9). https://doi.org/10.3390/pathogens12091167