Analysis of reported leptospirosis cases at the national, state, and municipal levels in Governador Valadares, MG

Análise dos casos notificados de leptospirose no âmbito nacional, estadual e do município de Governador Valadares-MG

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Abstract

Human leptospirosis is a disease caused by a spirochete of the genus Leptospira. Although it is potentially lethal, its impact on the health of the population is still underestimated. The objective of this work was to evaluate the occurrence of leptospirosis cases at the national level, in the state of Minas Gerais (MG) and the municipality of Governador Valadares (GV), based on data obtained from the information system for notifiable diseases (SINAN), in order to carry out a dynamic diagnosis of this infection in the three spheres. An observational, retrospective study was carried out considering the period from january 2007 to december 2020. The data obtained for Brazil (BR) and MG were compared with those for GV, considering age group, race, sex, education, diagnostic criteria, evolution of the disease, among others. 50,912 cases of Leptospirosis were observed in BR, 1,876 (3.7%) in MG and 33 (0.064%) in GV. Leptospirosis affects a population, predominantly, of working age, male and with low education. The majority of cases occurred in urban areas, in the home environment and mainly during periods of greatest rainfall and flooding. The clinical-laboratory criterion was the most used to confirm cases, which, in the majority, progressed to cure. This work highlighted the need for investment in public policies that promote better sanitary conditions for the population, better drainage and management of rainwater with a reduction in flooding during rainy periods and information for the population regarding preventive measures and control of this disease.

Keywords: Leptospirosis; Health Information Systems; *Leptospira interrogans*.

Resumo

A leptospirose humana é uma doença causada por uma espiroqueta do gênero Leptospira. Embora potencialmente letal, seu impacto na saúde da população ainda é subestimado. O objetivo deste trabalho foi avaliar a ocorrência de casos de leptospirose no âmbito nacional, do estado de Minas Gerais (MG) e do município de Governador Valadares (GV), a partir de dados obtidos do Sistema de Informação de Agravos de Notificação (SINAN), visando um diagnóstico dinâmico desta infecção nas três esferas. Foi realizado um estudo observacional, retrospectivo, considerando o período de janeiro de 2007 a dezembro de 2020. Os dados obtidos para o Brasil (BR) e MG foram comparados com os de GV, considerando faixa etária, raça, sexo, escolaridade, critério diagnóstico, evolução da doença, entre outros. Foram observados 50.912 casos de leptospirose no BR, sendo 1.876 (3,7%) em MG e 33 (0,064%) em GV. A leptospirose afeta uma população, predominantemente, em idade produtiva, do sexo masculino e com baixa escolaridade. A maioria dos casos ocorreu em áreas urbanas, no ambiente domiciliar e, sobretudo, no período de maior ocorrência de chuvas e inundações. O critério clínico-laboratorial foi o mais usado para a confirmação dos casos, que, em sua maioria, evoluíram para a cura. Este trabalho evidenciou a necessidade de investimento em políticas públicas que promovam melhores condições sanitárias para a população, melhor drenagem e manejo das águas pluviais com redução das inundações nos períodos chuvosos e a informação da população a respeito de medidas preventivas e de controle desta doença.

Palavras-chave: Leptospirose; Sistemas de Informação em Saúde; *Leptospira interrogans*.

INTRODUCTION

Human leptospirosis is a zoonotic disease that most frequently occurs in tropical climate regions. It is caused by a spirochete of the genus *Leptospira*—an aerobic, Gram-negative bacterium with more than 250 known serovars.[1-3] Each year, this infection affects over 1 million people worldwide, with an incidence rate ranging from 10 to 100 cases per 100,000 inhabitants and approximately 58,900 deaths.[3,4] In Brazil, on average, more than 3,600 individuals are affected annually, with an incidence rate of 1.9 cases per 100,000 inhabitants and around 375 deaths.[5,6]

Transmission to humans occurs accidentally, typically when the microorganism—present in soil or water contaminated with the urine of infected animals—enters the host through mucous membranes or skin abrasions or lesions.[1] Mammals serve as reservoir hosts, most commonly rats, cattle, dogs, and cats.[7]

The incubation period ranges from 2 to 26 days, and both transmission and clinical manifestation appear to vary depending on environmental and socioeconomic conditions. Incidence rates can be up to ten times higher in countries located in tropical and low-income regions, which are characterized by a combination of factors such as high humidity, elevated temperatures, heavy rainfall, and inadequate sanitation infrastructure.[2,8]

In humans, clinical manifestations range from subclinical infection and self-limiting anicteric febrile illness, with or without meningitis, to pulmonary hemorrhagic syndrome and a severe, potentially fatal condition known as Weil's syndrome, characterized by hemorrhage, renal failure, and jaundice, and associated with a high mortality rate.[1,4,9] However, due to its nonspecific symptoms—such as fever, headache, and myalgia, which mimic those of more commonly recognized illnesses—leptospirosis is frequently underdiagnosed and underreported, often misclassified as dengue, chikungunya, or fever of unknown origin. Other symptoms such as nausea, vomiting, abdominal pain, and diarrhea are commonly associated with gastrointestinal tract infections.[8-10]

Leptospirosis outbreaks are typically associated with flooding, as humans become more exposed to potentially contaminated water sources.[4] Certain occupations increase the risk of infection, including individuals working in sewer cleaning and maintenance, street cleaning, recyclable materials collection, farming, and fishing.[6]

Although potentially fatal, its impact on public health remains underestimated. From both political and media perspectives, the disease receives little to no visibility, rendering it marginalized and largely unknown to the general public. Given its close association with poverty, the lack of public interest in its resolution, and the possible need for costly permanent or long-term treatments following infection, leptospirosis has been classified in the international literature as a Neglected Tropical Disease—a category referring to diseases prevalent in impoverished populations that lack the economic and infrastructural capacity to mobilize investments in addressing their health conditions and that fail to attract the attention of major pharmaceutical companies or governments for the development of medicines and vaccines.[11]

No vaccine is currently available; thus, prevention relies directly on sanitary control measures, which can be difficult to implement, particularly in developing countries.[12]

Mandatory notification of leptospirosis must be performed by healthcare professionals or those responsible for public or private health services providing patient care. The analysis of data available from the Notifiable Diseases Information System (SINAN) enables a dynamic diagnosis of the occurrence of events within the population, offering support for causal explanations of notifiable diseases and identifying potential risks to which individuals may be exposed. This contributes to understanding the epidemiological reality of a given geographic area. Its systematic and decentralized use promotes the democratization of information, allowing healthcare professionals and researchers to access and disseminate data to the broader community. Therefore, it is a valuable tool to support health planning, define intervention priorities, and assess the impact of implemented actions.[13]

The objective of this study was to evaluate the occurrence of leptospirosis cases at the national level, in the state of Minas Gerais (MG), and in the municipality of Governador Valadares (GV), based on data obtained from SINAN, in order to conduct a dynamic diagnosis of this infection across these three levels.

MATERIALS AND METHODS

An observational, retrospective study was conducted based on secondary data obtained from the SINAN, available through the electronic platform of the Department of Informatics of the Unified Health System (DATASUS), accessible

at https://datasus.saude.gov.br/acesso-a-informacao/doencas-e-agravos-de-notificacao-de-2007-em-diante-sinan/. The aim was to gather information from the period between January 2007 and December 2020. The occurrence of leptospirosis was assessed at the national level and within the state of Minas Gerais, and the data were compared with those from the municipality of Governador Valadares, considering age group, race/ethnicity, sex, education level, cases in pregnant women, area and setting of occurrence, time of year with the highest frequency, diagnostic criteria, and disease outcome. Governador Valadares has a territorial area of 2,342.376 km², a population of 257,172 inhabitants according to the 2022 Census conducted by the Brazilian Institute of Geography and Statistics (IBGE), and a Municipal Human Development Index – 2010 (MHDI 2010) of 0.727.

In this study, the research subjects consisted of public data obtained through remote access to the SINAN platform. There was no contact between researchers and patients, no biological material was collected, and no personal identification of patients was accessed.

Incidence rates were calculated for each variable and compared using incidence rate inference testing with the BioEstat 5.3 software. Statistical significance was set at $p \leq 0.05$ in relation to the municipality of Governador Valadares.

RESULTS

During the evaluated period, 50,912 cases of leptospirosis were reported nationwide, with 1,876 (3.7%) recorded in the state of Minas Gerais and 33 (0.064%) in the municipality of Governador Valadares. Most cases in Brazil involved individuals aged 20 to 39 years (40.2%). In Minas Gerais, the most affected age group was 40 to 59 years (38.2%), whereas in Governador Valadares—similarly to the national level—the 20 to 39 age group accounted for the highest case occurrence (45.5%).

Males were the most affected across all three levels, accounting for 79.9%, 83.0%, and 87.9% of cases in Brazil, in the state of Minas Gerais, and in the municipality of Governador Valadares, respectively. White individuals were the most affected racial group in Brazil (45.9%) and in Minas Gerais (46.9%). In contrast, in Governador Valadares, the most affected group was individuals who self-identified as mixed-race, accounting for 42.4% of cases.

When analyzing the reported cases by educational level, it was observed that, across all three levels, the majority of cases affected individuals who had not completed middle school (Grades 6–9). However, it is important to note the large number of individuals for whom both educational level and race/ethnicity were not recorded, listed in the SINAN database as "Ignored/Blank," with a significantly higher proportion of missing educational data observed in Governador Valadares (Table 1).

A total of 282 cases of leptospirosis were reported among pregnant women in Brazil, accounting for 0.6% of the total number of notified cases. Most of these occurred during the second trimester of pregnancy. In the state of Minas Gerais, 7 cases were recorded, representing 0.4% of the state's total, also predominantly in the second trimester. However, no cases were reported in the municipality of Governador Valadares.

In most leptospirosis cases, infection occurred in urban areas: 54.7% in Brazil, 43.8% in Minas Gerais, and 60.6% in Governador Valadares. The household environment was the site of infection for 40.5%, 34.7%, and 63.6% of individuals in these three levels, respectively, with a significantly higher rate in Governador Valadares (Table 2).

Most cases occurred during the first quarter of the year across all three levels, with January standing out as the month with the highest number of reported cases in Brazil (14.0%), Minas Gerais (20.3%), and Governador Valadares (42.4%).

The most commonly used criterion for diagnostic confirmation was the clinical-laboratory method in all three scopes, accounting for 86.4% of cases in Brazil, 89.4% in Minas Gerais, and 84.8% in Governador Valadares (Table 3).

Most individuals progressed to recovery in all three contexts. However, a considerable number of cases resulted in death due to the severity of the disease, with fatality rates of 8.9% in Brazil, 10.7% in Minas Gerais, and 18.2% in Governador Valadares (Table 4).

Table 1

Demographic data of individuals with leptospirosis from January 2007 to December 2020.

Demographic Data	Governador Valadares (n/%)	Minas Gerais (n/%)	Brazil (n/%)
Race/ethnicity			
Unknown/ Blank	11 (33.3%)	248 (13.2%)	5,621 (11%)
White	8 (24.2%)	879 (46.9%)	23,350 (45.9%)
Black	-	133 (7.1%)	2,822 (5.5%)
Asian	-	10 (0.5%)	322 (0.6%)
Mixed-race	14 (42.4%)	603 (32.1%)	18,646 (36.4%)
Indigenous	-	3 (0.2%)	151 (0.3%)
Total	33	1.876	50,912
Sex			
Unknown/ Blank	-	-	4 (0.007%)
Male	29 (87.9%)	1,558 (83%)	40,695 (79.9%)
Female	4 (12.1%)	318 (17%)	10,213 (20.1%)
Total	33	1,876	50,912
Educational Level			
Unknown/ Blank	28 (84.8%)	913 (48.7%)*	18.283 (35.9%)*
Illiterate	-	6 (0.3%)	779 (1.5%)
Incomplete Primary School (Grades 1–5)	-	144 (7.7%)	4,951 (9.7%)
Complete Primary School	-	114 (6.1%)	3,044 (6%)
Incomplete Middle School (Grades 6–9)	2 (6.1%)	200 (10.7%)	8,264 (16.2%)
Complete Middle School	2 (6.1%)	102 (5.4%)	3,657 (7.1%)
Incomplete High School	1 (3%)	123 (6.6%)	3,528 (6.9%)
Complete High School	-	191 (10.2%)	5,821 (11.4%)*
Incomplete Higher Education	-	21 (1.1%)	664 (1.3%)
Complete Higher Education	-	47 (2.5%)	1,004 (2%)
Not applicable	-	15 (0.8%)	917 (1.8%)
Total	33	1,876	50,912
Age Group			
Unknown/ Blank	-	1 (0.1%)	12 (0.02%)
<1 year	-	6 (0.3%)	293 (0.6%)
1-4 years	-	2 (0.1%)	259 (0.5%)
5-9 years	1 (3%)	23 (1.2%)	1,204 (2.4%)
10-14 years	3 (9.1%)	52 (2.8%)	2,848 (5.6%)
15-19 years	-	115 (6.1%)	4,704 (9.2%)
20-39 years	15 (45.5%)	715 (38.1%)	20,484 (40.2%)
40-59 years	11 (33.3%)	717 (38.2%)	16,485 (32.4%)
60-64 years	-	100 (5.3%)	2,055 (4%)
65-69 years	-	67 (3.6%)	1,251 (2.5%)
70-79 years	2 (6%)	67 (3.6%)	1,111 (2.2%)
80 and older	1 (3%)	11 (0.6%)	206 (0.4%)
Total	33	1.876	50.912

*$p \leq 0.05$ compared to Governador Valadares.

Table 2

Area and environment of leptospirosis occurrence from January 2007 to December 2020.

	Governador Valadares (n/%)	Minas Gerais (n/%)	Brazil (n/%)
Area of occurrence			
Unknown/ Blank	5 (15.2%)	371 (19.8%)	10,159 (20%)
Urban	20 (60.6%)	821 (43.8%)	27,851 (54.7%)
Rural	7 (21%)	603 (32.1%)	11,190 (22%)
Peri-urban	1 (3%)	81 (4.3%)	1,712 (3.4%)
Total	33	1.876	50,912
Environment of occurrence			
Unknown/ Blank	6 (18.2%)	536 (28.6%)	14,527 (28.5%)
Household	21 (63.6%)	651 (34.7%)*	20,633 (40.5%)*
Workplace	3 (9.1%)	407 (21.7%)	9,133 (17.9%)
Leisure	2 (6.1%)	148 (7.9%)	3,378 (6.6%)
Other	1 (3%)	134 (7.1%)	3,241 (6.4%)
Total	33	1.876	50,912

*$p \leq 0.05$ compared to Governador Valadares.

Table 3

Criterion for confirmation of leptospirosis cases from January 2007 to December 2020.

Confirmation criterion	Governador Valadares (n/%)	Minas Gerais (n/%)	Brazil (n/%)
Unknown/ Blank	-	42 (2.2%)	577 (1.1%)
Clinical-laboratory	28 (84.8%)	1,678 (89.4%)	43,977 (86.4%)
Clinical-epidemiological	5 (15.2%)	156 (8.3%)	6,358 (12.5%)
Total	33	1.876	50,912

Table 4

Outcomes of leptospirosis cases from January 2007 to December 2020.

Outcome	Governador Valadares (n/%)	Minas Gerais (n/%)	Brazil (n/%)
Unknown/ Blank	-	122 (6.5%)	3,819 (7.5%)
Cure	27 (81.8%)	1,524 (81.2%)	42,131 (82.8%)
Death due to the reported condition	6 (18.2%)	201 (10.7%)	4,531 (8.9%)
Death from another cause	-	29 (1.5%)	431 (0.8%)
Total	33	1,876	50,912

DISCUSSION

Leptospirosis is a zoonosis with a high incidence in Brazil and constitutes a major public health concern. Due to its history of frequent flooding, the municipality of Governador Valadares may present an increased risk for the development of this disease among its inhabitants. In this study, the age groups most affected by leptospirosis across all three levels align with data from the Brazilian Ministry of Health, which indicate a higher occurrence of the disease among individuals in the productive age range—between 20 and 49 years.[14]

In the study by Notobroto et al.[7] conducted in Indonesia, most confirmed leptospirosis cases involved individuals aged 41 to 60 years, predominantly male, who accounted for 80% of all cases. This trend is understandable given that most men around the age of 40 in that region work as farmers, cattle breeders, or sand miners in rivers.[7] Similarly, in the present study, a higher infection rate was observed among males in all three geographic levels. Martins and Spink[11] also concluded that men (78.6%) are more affected by leptospirosis than women (21.3%) in their analysis of Brazilian cases from 2007 to 2015. In the study by Gonçalves et al.[15] conducted in Belém, Pará, from 2007 to 2013, the majority of infected individuals were also male (68.9%). According to the authors, this may be due to greater exposure of men to risk factors, such as spending more time outside the home and engaging in hazardous occupational activities in informal, low-skilled work environments like streets or open-air markets—conditions that favor infection.

In this study, white individuals were the most affected by leptospirosis in Brazil and in the state of Minas Gerais, accounting for 45.9% and 46.9% of cases, respectively—similar to the findings of Martins and Spink,[11] who reported that 46% of infected individuals also self-identified as White. In Governador Valadares, those most affected were individuals who self-identified as mixed-race. According to data from the *Cidades* portal of the Brazilian Institute of Geography and Statistics, the population of Governador Valadares is predominantly mixed-race, which may explain the higher rates of leptospirosis in this group. In the epidemiological study by Oliveira et al.[16] on leptospirosis cases in Brazil from 2010 to 2019, the highest number of cases involved individuals of mixed-race (38.3%) and White (45.0%) ethnicity. Similarly, in the study by Araújo Filho et al.[17] conducted in Pará from 2012 to 2017, mixed-race individuals were the most affected (79.7%), followed by Whites (7.8%), Blacks (3.9%), and individuals of other skin colors (8.6%).

Regarding educational level, across all three levels of analysis, the vast majority of affected individuals had not completed middle school (Grades 6–9). This suggests that a significant proportion of cases may be associated with low educational attainment, which could reflect a limited understanding of the risks, transmission, and consequences of the disease itself.[7,12] Rodrigues,[18] in a quantitative study of confirmed leptospirosis cases in the state of Acre in 2017, found that most infected individuals had not completed primary school (35.9%). Furthermore, individuals with incomplete or completed higher education accounted for only 2% of reported cases. In a similar study, Oliveira et al.[16] found a higher frequency of leptospirosis among individuals with incomplete primary education (Grades 1–5) (15.8%) and those who had completed high school (Grades 10–12) (12.2%), whereas the frequency was lower among those with incomplete higher education (1.41%).

Leptospirosis infection during pregnancy is associated with increased morbidity and mortality for both the pregnant woman and the fetus.[5] In the present study, cases of leptospirosis in pregnant women were observed only at the national and state levels (Brazil and Minas Gerais), predominantly during the second half of pregnancy.

In this study, most cases occurred in urban areas, which present various public health challenges, such as inadequate sanitation and waste accumulation. These conditions favor the proliferation of animal populations that act as vectors of the disease and increase human exposure to the pathogen, often disseminated through floodwaters.[7,19,20]

The occurrence of leptospirosis is closely linked to environmental factors that influence both the survival of the bacterium in the environment and human exposure.[4] The disease is most commonly acquired during rainy seasons with flooding, when rat urine from sewers and storm drains mixes with runoff and mud from the floodwaters.[21]

Poor household sanitation conditions—including open sewage disposal, surrounding waste, and the presence of rats—are also associated with increased leptospirosis incidence, as is high household population density.[7] In the present study, the household environment was the most frequent site of infection across all three geographic levels, with a significantly higher rate in Governador Valadares, possibly due to the frequent flooding events that occur in the municipality during the rainiest time of the year.[22]

Coelho et al.[23] conducted a study in the Metropolitan Region of Baixada Santista (São Paulo) and found that among the probable infection settings, the household environment

stood out the most (55.83%). Populations facing worse socioeconomic conditions, precarious housing, and high vulnerability to flooding during rainy periods exhibited the highest infection risks.[23] Similarly, in the study by Lima et al.,[24] conducted in Belém, Pará, from January 2006 to December 2011, the household setting was also identified as the primary site of infection, accounting for 45.1% of total cases.

Most leptospirosis cases occurred during the first quarter of the year across all three levels, with January being the month with the highest incidence. In Governador Valadares, this pattern may be explained by the increased occurrence of rainfall and flooding between October and March.[22] In the study by Guimarães et al.,[21] it was observed that, in the city of Rio de Janeiro, rainfall is concentrated between December and March, affecting areas with poor water drainage, which leads to flooding and facilitates the spread of the bacterium responsible for leptospirosis.[21]

However, the number of cases may vary depending on the rainy season in each region. The rainy season—particularly in warm climate areas—triggers peaks in disease incidence by enabling the pathogen to persist in the environment, thereby preventing its desiccation.[19] Moreover, warm weather is directly associated with increased exposure to activities involving contact with water that may be contaminated with the urine of infected animals.[4]

The clinical diagnosis of leptospirosis involves an analytical process of disease detection through the collection of epidemiological data and clinical and laboratory evaluation of the patient. Laboratory testing serves as a complementary diagnostic tool to either confirm or rule out a clinical suspicion. In this study, the clinical-laboratory criterion was the most commonly used method for confirming leptospirosis cases in Brazil, in Minas Gerais, and in Governador Valadares. Serological testing is the method of choice for leptospirosis diagnosis, with ELISA-IgM and the Microscopic Agglutination Test (MAT) being the most widely used. These tests allow for differentiation of the early phase of leptospirosis from other diseases with similar symptoms, such as dengue, influenza-like illness, malaria, and rickettsioses. They are also useful in diagnosing the late phase of leptospirosis, which may mimic acute viral hepatitis, dengue hemorrhagic fever, hantavirus infection, yellow fever, severe malaria, typhoid fever, endocarditis, rickettsioses, acute Chagas disease, pneumonia, acute pyelonephritis, acute appendicitis, and sepsis.[14] In the study by Gonçalves et al.,[15] most cases were confirmed through clinical-laboratory criteria (83.8%), with only 14.5% confirmed through clinical-epidemiological criteria. Similarly, Oliveira et al.[16] reported that 86.8% of cases were confirmed by clinical-laboratory criteria and 12.0% by clinical-epidemiological criteria.

In this work, most individuals with leptospirosis progressed to recovery. However, a significant number of deaths due to the reported condition were observed across all levels, which may be attributed to the misdiagnosis of another disease. This could have occurred because leptospirosis presents signs and symptoms similar to those of other illnesses, as previously described, underscoring the need for improved monitoring and diagnostic strategies.[11] In the study by Araújo Filho et al.,[17] 73.3% of patients progressed to recovery, while 11.5% died. In the clinical-epidemiological study conducted by Calado et al.,[25] the notified cases of leptospirosis in Brazil's Northern Region showed an increase in the recovery rate from 89.5% in 2012 to 93.4% in 2015, whereas the percentage of deaths due to the condition decreased from 4.5% to 2.6% during the same period, indicating a possible improvement in disease management.

This study presents some limitations, such as the use of secondary notification data. It is evident that the disease notification system remains flawed, with underreporting of cases and a large number of incomplete or missing data, revealing the need for improvements.

CONCLUSION

This study revealed that leptospirosis is a prevalent disease across all levels evaluated, primarily affecting individuals of productive age, predominantly male, and with low educational attainment. The majority of cases occurred in urban areas, within the household environment, and particularly during periods of heavy rainfall and flooding. The clinical-laboratory criterion was the most frequently used method for confirming cases, most of which progressed to recovery.

The knowledge generated by this study highlights the need for investments in public policies that promote improved sanitary conditions for the population, better drainage and rainwater management to reduce flooding during the rainy season, and efforts to educate the public about preventive and control measures for this disease.

This study also underscored the need for professional training focused on the accurate and thorough completion of SINAN notification forms, with the aim of reducing underreporting and the high number of incomplete or missing data.

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