Minireview Article

ECOLOGICAL STUDIES AND EPIDEMIOLOGICAL ASPECTS OF LEPTOSPIROSIS IN THE NORTHEAST REGION OF BRAZIL

ABSTRACT

Introduction: Leptospirosis, a globally prevalent zoonotic infection, affects approximately one million people annually. Originating from the bacterium *Leptospira*, it is transmitted through contact with the urine of reservoir animals, such as rodents. In Brazil, it is endemic, especially in the Northeast region, where poor sanitary conditions contribute to its dissemination. The objective of this study is to analyze the main determining factors for the increase in leptospirosis cases in the Northeast region of Brazil, with an emphasis on rainfall patterns and deficiencies in basic sanitation. **Methodology:** The methodology consisted of a qualitative exploratory-descriptive bibliographic review of articles published between 2014 and 2024 in Portuguese, English, and Spanish. Inclusion criteria were relevance to the topic, while exclusion criteria involved duplicated articles or those that did not highlight the content of interest. The search was conducted in databases such as LILACS, SciELO, and PubMed, using specific descriptors. The analysis involved careful selection and exhaustive reading for the categorization of results. **Results and Discussion:** Leptospirosis impacts urban and poor areas, with over one million annual cases globally. Factors such as precipitation and disordered urbanization contribute to its spread, especially in tropical regions. Low-income populations are vulnerable due to the lack of basic sanitation. The unequal distribution reflects socio-economic disparities, with densely populated urban areas being more affected. **Conclusion:** Leptospirosis poses a challenge to public health, especially in regions with poor sanitary conditions. Effective control requires a comprehensive approach, including improvements in sanitation infrastructure, health education, and rodent control.

Keywords: Leptospirosis, Zoonosis, North East of Brazil, Sanitation, Surveillance.

INTRODUCTION

Worldwide, the most prevalent zoonotic infection is Leptospirosis, with approximately 1 million cases per year, which is caused by a spiral-shaped bacterium with particular characteristics that aid in its differentiation, such as the presence of hooks at one or both ends. This pathogen belongs to the family *Leptospiraceae* and genus *Leptospira*, and through studies on serological and molecular analyses, over 300 serovars grouped into 30 serogroups have been

discovered, determining the species from which different groups are formed, dictating the infecting agent's evolution and severity of the disease, namely: saprophytic, intermediates, and pathogenic [1, 2].

The infection by this pathogen occurs through direct or indirect contact with contaminated urine from reservoir animals, mainly rodents. After the bacterium enters the organism, the patient's clinical picture develops according to the species involved in the process, presenting signs and symptoms similar to flu-like syndromes, such as fever, myalgia, headache, nausea, among others. In more severe manifestations, there is a possibility of involvement of various systems, leading to jaundice, hemorrhage, organ enlargement, breathing difficulties, and progression of initial signs and symptoms. This disease can also present asymptomatically, but this is not the only factor that challenges its diagnosis, as the clinical presentation by the agent does not describe pathognomonic signs that lead to early identification of the disease [3].

In Brazil, a compulsory nature is attributed to the number of annual cases of the disease. Leptospirosis exhibits alarming numbers that attribute to it an endemic and neglectful characteristic, where in periods of rain, with a higher probability of flooding, the epidemiological situation worsens due to risk factors that contribute to its emergence. Between the period from 2019 to 2023, approximately 13,673 cases were confirmed in the country, of which 20.6% correspond to the Northeast region, being one of the most affected by infection cases, ranking only behind the South and Southeast regions. It represents the second region with the most precarious sanitary conditions, serving as a parameter for the emergence of waterborne infections [4, 5].

The epidemiology of this infection can be potentiated by environmental and social factors that culminate in a greater risk for affected areas. The pathogen of leptospirosis is present in the urine excreted by reservoir animals and, after being excreted in areas of water accumulation, contaminates water, soil, or even food, which in places with precarious sanitary conditions become determining factors for the emergence of numerous cases of the disease. In addition, some professions demonstrate risks considering direct contact with possible infection areas, such as: firefighters, street sweepers, cleaning workers, waste pickers, butchers, fishermen, farmers, veterinarians, among others [6].

The present study aims to analyze the main determinants for the increase in cases of leptospirosis in the Northeast region of Brazil, questioning how the

pluviometric behavior and the deficiency in basic sanitation interfere in the prevalence of the infection. Therefore, a high number of cases is observed during the winter, which highlights the waterborne nature of the disease, since in this period the region presents the highest precipitation rates. Floods become one of the main means of leptospirosis contamination, highlighting problems related to the increasing urbanization without structural planning, concomitant with this, the deficiency in basic sanitation as a factor aggravating the resident population [7, 2].

METHODOLOGY

This was a bibliographic study of the exploratory-descriptive type with a qualitative approach, and these data were used for the elaboration of the scientific article. According to Gil (2022): bibliographic research is developed based on material already prepared, consisting mainly of books and scientific articles, that is, it is one that carries out the theoretical survey of a certain subject from the collection of information about what different authors report on the subject [8].

An exploratory study has a nature involving bibliographic survey, interviews with people who have (or have) practical experience with the researched problem, and analysis of examples that stimulate understanding. It also has the basic purpose of developing, clarifying, and modifying concepts and ideas for the formulation of subsequent approaches. Thus, this type of study aims to provide greater knowledge to the researcher about the subject so that they can formulate more precise problems or create hypotheses that can be researched by subsequent studies.

According to Gonçalves (2003), descriptive research records, analyzes, classifies, and interprets the observed facts, often establishing relationships between them. Regarding the approach, this study is qualitative. Minayo (2001) describes qualitative research as one whose concern of the researcher is not directed to the quantitative profile of the data but rather to the value of the information that can be collected, correlating the phenomena and variables to reality, in order to understand this experience in deeper dimensions, encompassing creativity and directing towards the construction of scenarios and new perspectives within the same reality [9, 10].

Data collection was carried out from the bibliographic survey conducted through searches of scientific productions on the proposed theme, from 2014 to 2024. The inclusion criteria for the selection of contents were those published in full

according to the theme, documents, regulations, norms of health entities on the subject, articles published in Portuguese, English, and Spanish.

The exclusion criteria were articles that were not relevant to the theme, duplicated, incomplete materials, debates, reviews, summaries, and materials unavailable in full. Literature searches were performed in the following databases: Latin American and Caribbean Literature in Health Sciences (LILACS), Scientific Electronic Library Online (SciELO), and PubMed. It is noteworthy that the LILACS, and BDENF databases were consulted through the Virtual Health Library (VHL). Searches were conducted using the Health Sciences Descriptors (DeCS) from the Regional Medicine Library (Bireme): Leptospirosis, Epidemiology, and Virulence Factors in Portuguese, English, and Spanish with the help of boolean operators "AND" and "OR" (Table 01).

	DESCRIPTOR 01	**DESCRIPTOR 02**	**DESCRIPTOR 03**
KEYWORD	Leptospirosis	Epidemiology	Virulence Factors
ALTERNATIVE TERM	Cane Cutter Fever Cane-Cutter Fever Canicola Fever Fever, Canicola Fever, Mud Fever, Rice-Field Fevers, Cane-Cutter Infection, Leptospira Infection, Leptospira Canicola Infections, Leptospira Infections, Leptospira Canicola Leptospira Canicola Infection Leptospira Canicola	Epidemiologies, Social Epidemiology, Social Social Epidemiologies Social Epidemiology	Factor, Pathogenicity Factor, Virulence Factors, Pathogenicity Factors, Virulence Pathogenicity Factor Pathogenicity Factors Virulence Factor

	Infections Leptospira Infection Leptospira Infections Leptospiroses Leptospirosis Canicola Leptospirosis Canicolas Mud Fever Rice Field Fever Rice-Field Fever Stuttgart Disease Swineherd's Disease Swineherd's Diseases		

Table 1 - Table referring to the descriptors used.
Source: Own Author

Therefore, through the mentioned descriptors, an initial collection of articles was carried out, applying exclusion parameters to reduce the number of materials found, including the exclusion of duplicate articles and observing the publication dates to ensure that they were covered during the period of interest in the research. In the first database used, the Virtual Health Library (VHL), 655 articles were found available with the search using the descriptors, of which 45 were selected for further analysis and only 9 were used, indicating the exclusion of 646 materials. In PubMed, 358 articles were collected and after applying the initial exclusion parameters, 52 were selected, but only 9 of these met the remaining criteria, with the remaining 349 articles being excluded. Finally, in the last database used, the Scientific Electronic Library Online (SciELO), 346 articles were found, of which 124 were selected and ultimately 9 articles were used in the development of the project, totaling 337 excluded (Figure 1). After this first step, the titles of the articles were thoroughly analyzed to verify their relevance to the proposed research topic. Following this selection, the articles underwent a floating reading to assess the available content and deliberate on their relevance to the research.

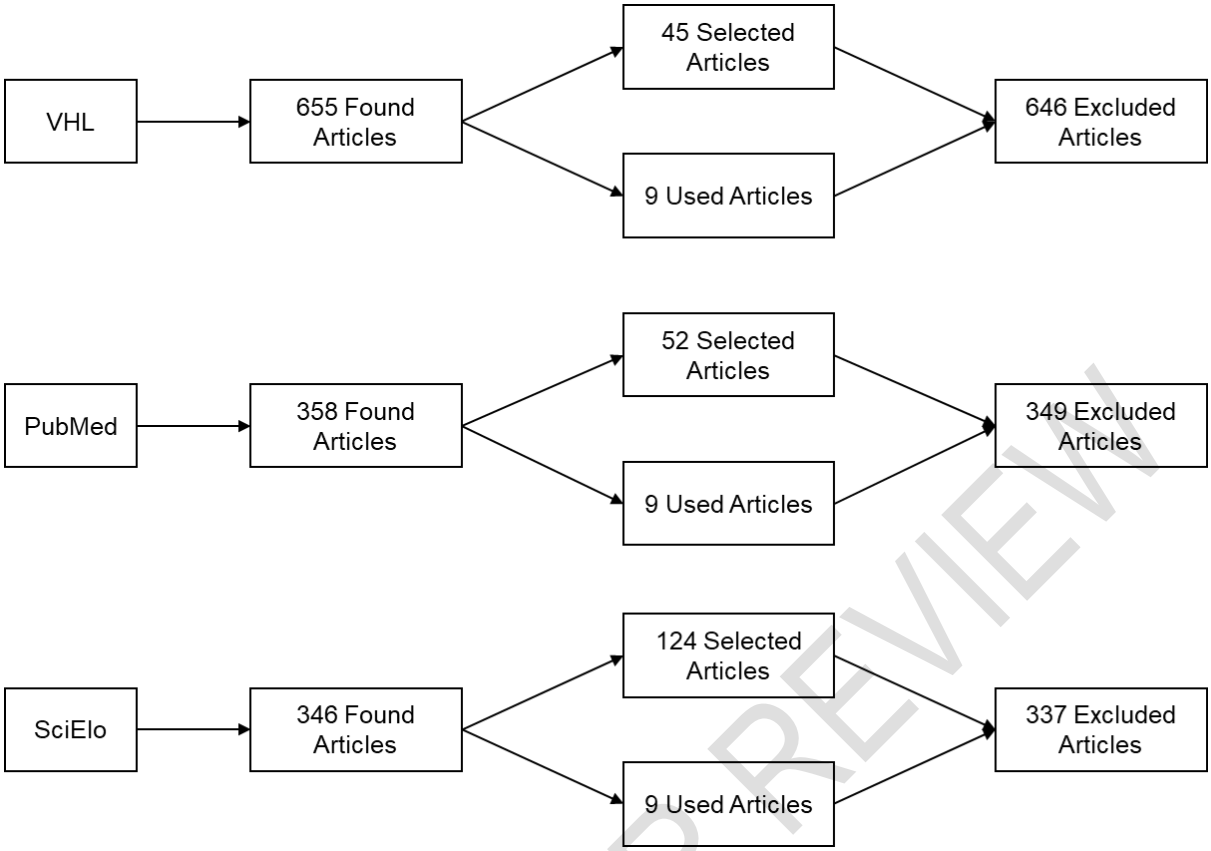


Figure 1 - Flowchart related to the databases used and the respective quantities of articles found, selected, used, and excluded.
SOURCE: Own Author

Subsequent to this, the chosen articles were used for a thorough and detailed reading, enabling the evaluation of their content. This analysis was of paramount importance for the construction of a results table, containing questions based on the specific objectives of the work. These questions, based on the information found in the previous reading on the subject and in the research problem, were answered to construct the categories in order to improve the data analysis. This model of result elaboration allows for a methodological and systematic approach aiming at the thorough evaluation of the information provided in scientific papers, assisting in the development of an article that is informative and scientifically grounded.

RESULTS AND DISCUSSION

Leptospirosis, a prevalent bacterial zoonosis in urban and poor areas, presents significant socioeconomic impacts influenced by a complex interaction with environmental factors resulting from its high incidence, with over one million

people infected annually and 60,000 deaths. These alarming numbers reflect the close relationship between these conditions and the spread of the disease, with these areas often suffering from lack of resources for the control of reservoir animals, which play a crucial role in the dissemination of leptospirosis, mainly through contact with water contaminated by the urine of infected animals, especially rodents [11, 12, 13].

Other factors such as environmental variables like precipitation and temperature, resulting in more frequent and severe floods, and unplanned urbanization, characterized by the absence of urban planning and deficiencies in sanitary conditions, are equally crucial for the emergence of more infection cases, considering they create conducive environments for leptospirosis proliferation. These outbreaks are heightened in impoverished communities in densely populated urban areas, where exposure and disease transmission are facilitated, especially during these extreme weather events and in regions with tropical climates [14, 15, 16].

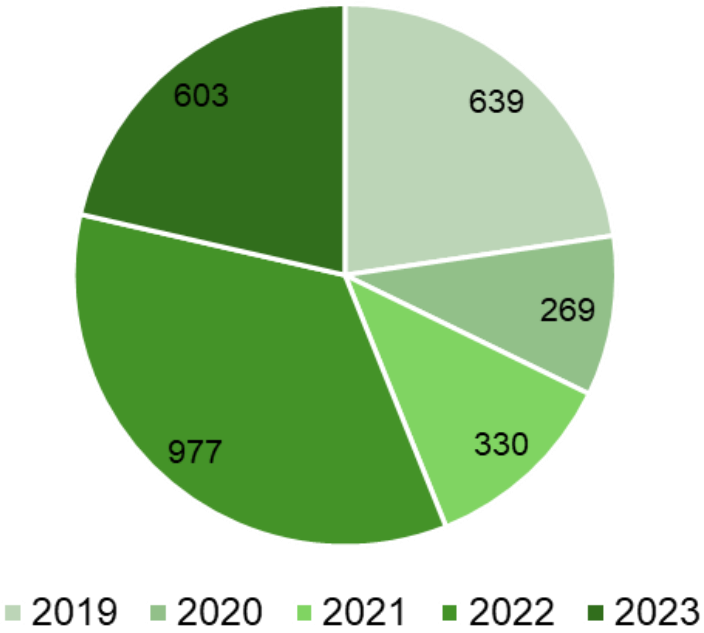
The unequal distribution of leptospirosis reflects existing socioeconomic disparities. Low-income populations are particularly vulnerable due to precarious housing conditions and lack of basic sanitation, as shown in Table 2 [17], which relates sewage collection service in each region and in Brazil to the income of residents in those locations, making it possible to observe the position of the Northeast region, which ranks second in terms of lack of basic sanitation for the population, with an alarming percentage of 69.1% of underserved people regarding this basic need. The vicious cycle of the disease is fueled by the absence of assistance and maintenance of infection sources, as well as by the lack of effective public policies to improve the sanitary infrastructure of affected communities [18, 19, 20, 21].

Sanitation Panel Brazil		
Locality	**Sanitation**	**Income**

Sanitation Panel Brazil			
	Percentage of the total population (%) without access to sewage collection service (SNIS, 2022)	Income of individuals (R$/month) with basic sanitation (IBGE, 2022)	Income of individuals (R$/month) without sanitation (IBGE, 2022)
North Region	85,7%	2.779,63	2.040,15
Northeast Region	69,1%	2.533,28	1.531,33
South Region	50,4%	3.429,04	2.862,53
Central-West Region	38,2%	4.041,33	2.633,00
Southeast Region	19,2%	3.460,50	2.222,54
Brazil	44,5%	3.359,12	2.103,59

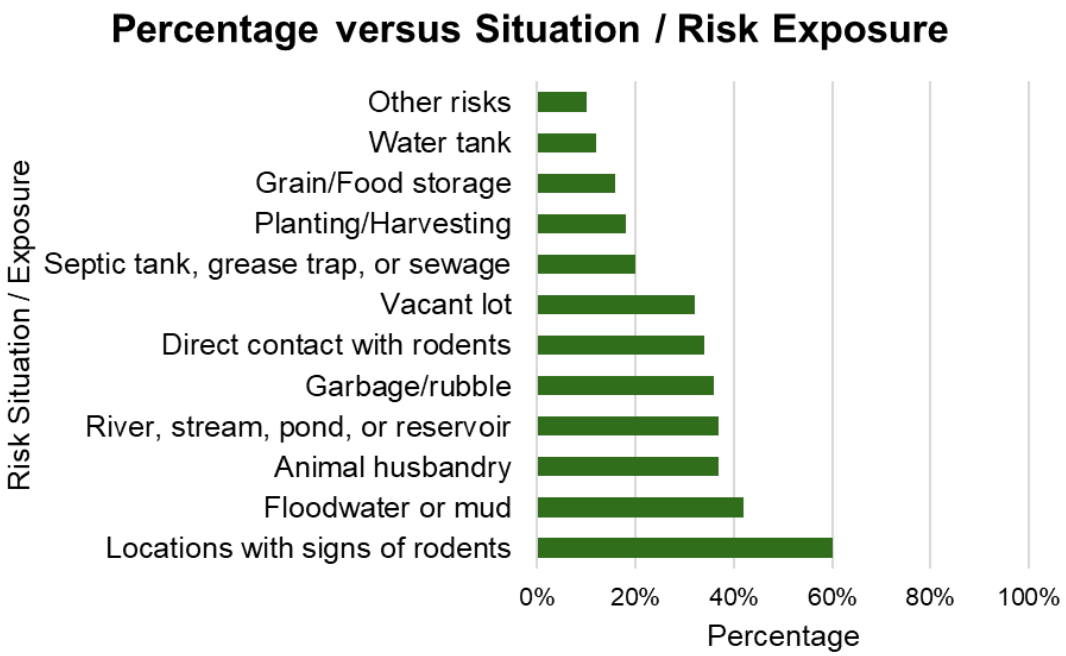
Table 2 - Sanitation Panel in Brazil and Each Region relating Sewage Collection Service and Monthly Income.
SOURCE: Instituto Trata Brasil, 2022

Based on the epidemiology presented by the Sistema de Informação de Agravos de Notificação (Sinan), according to graph 1 in the highlighted period, the Northeast region showed a disparity in the number of reported cases each year. In 2019, 639 cases were registered, while in the years 2020 and 2021, these numbers decreased significantly, with 269 and 330 infectious cases confirmed by *Leptospira*, respectively. This decrease can be explained by the global situation faced during this period, the COVID-19 pandemic, which limited the movement of people in cities and halted a significant portion of services provided to the population, resulting in a decrease in pathogen transmission. However, after this period, in the years 2022 and 2023, the number of cases increased, with 977 and 603 cases respectively, affected by this bacterium, considering the resumption of occupational and leisure activities, which, in contact with suitable locations for the pathogen's emergence, can become risk factors for individuals.



Graph 1 - Notified cases of leptospirosis in the Northeast region of Brazil from 2019 to 2023 according to Sinan/SVS data.
SOURCE: Own Author

The quantity of leptospirosis cases attributes to it the classification of a global public health problem, resulting from structural and environmental interferences as presented in Graph 2 [5]. In this context, Castiblanco-Valencia et al. (2016) discussed one of the factors contributing to the spread of the disease, emphasizing that the absence of control of this medium enables its dissemination, considering that the presence of a bacterial reservoir is necessary for the infection to emerge [22]. Moreover, the transmission of this pathogen can be favored by sanitary deficits in communities underserved by responsible public agencies, which also neglect the infrastructure of the localities, leading to environmental disasters such as floods and prolonged periods of rainfall [23]. Thus, Grillová et al. (2021) concluded that, based on the mentioned issues, socioeconomically vulnerable populations become susceptible due to their current conditions [24].



Graph 2 - Percentage of exposure to leptospirosis risk situations recorded in confirmed cases in Brazil from 2010-2023.
SOURCE: Brazil, 2024

The survival of *Leptospira* in various environments, such as water and soil, is a fundamental factor for its dissemination, as highlighted by Casanovas-Massana et al. (2018) [25]. This characteristic of the bacterium makes it capable of persisting in unfavorable conditions and serves as an additional challenge for the control of leptospirosis. Additionally, as mentioned by Picardeau (2017), it is essential to conduct environmental studies to understand the relationship between the ecosystem, climate change, and the epidemiology of the disease, including the identification of factors that promote biofilm formation, a survival mechanism of the bacterium in the environment [14].

In addition to understanding the ecology of the etiological agent of leptospirosis, it is necessary to know the biology of the microorganism and how it responds to environmental pressures. The analysis of whole-genome sequencing of *Leptospira*, as pointed out by Teixeira et al. (2015), reveals a genetic complexity that influences the pathogen's virulence factors, especially its surface proteins [26]. However, many of these proteins still have unknown functions, highlighting the need for further research to better understand the interaction between the bacterium and it’s host. Understanding these adaptive and genetic mechanisms is of paramount importance for the development of effective prevention and control strategies for

leptospirosis. These measures are essential to mitigate the impact of leptospirosis on vulnerable communities and promote public health [27].

The public health problem related to *Leptospira* goes beyond quantifying the disease, as it has the ability to survive for long periods in unfavorable conditions in aquatic and muddy environments. However, despite the advancement of science, little is known about the mechanisms and structure that contribute to virulence, making infection with this pathogen a challenge in both control and diagnosis [28, 29]. Additionally, according to Picardeau (2017), studying the interaction of the ecosystem with the bacterium is crucial to understanding and improving knowledge about its development since it still has unknown mechanisms to identify the connection of the pathogen with its respective host [14].

In addition to the ecological and molecular issues of the etiological agent, other factors are of paramount importance in the control of leptospirosis. Among these factors, the lack of preventive measures and the negligence of public health authorities contribute to the persistence of leptospirosis as a health threat in developing countries, where sanitation deficiencies are particularly pronounced [30, 31]. To mitigate the risks associated with leptospirosis, it is essential to implement policies that address both environmental and socioeconomic aspects, promoting health education, improvements in sanitation infrastructure, and effective rodent control, as suggested by Hernández-Rodríguez, Gómez, and Villamil (2017). These measures are essential to protect public health and reduce the incidence of this significant zoonotic disease [32].

Thus, leptospirosis is a neglected disease due to multiple factors, considering the risks of population contagion and disorderly occupation of urban space, public authorities must promote more efficient policies [33]. According to Higino and Azevedo (2014), the segment of the population most affected by cases of infection is those residing in developing countries, which face difficulties regarding sanitation conditions [34]. Therefore, to provide improvements in the health scenario and initiate prophylactic measures, a conscious approach to contamination risks and structural development projects that support communities and preserve individuals' integrity is necessary [35].

CONCLUSION

Considering the results, the socioeconomic profile of populations most affected by the pathogen is determined by some variables, such as income and employment, access to basic services, housing, and health conditions. From this perspective, areas that present precarious sanitation tend to influence the epidemiology of the infection, as they represent a risk factor for the emergence of more reservoirs and thus more cases of the disease; environmental aspects also act as an aggravating factor in the situation, considering that increased rainfall creates a conducive environment for the survival of the bacterium, especially in floods or inundations. In summary, to improve public health in these most affected areas, the responsible authorities must act according to the needs in order to promote adequate sanitation and structural conditions. Additionally, investment in research will enable scientific advancements through genetic and molecular studies of the pathogen, contributing to the development of prophylactic measures that assist in leptospirosis prevention.

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DEFINITIONS, ACRONYMS, ABBREVIATIONS

SNIS - National Sanitation Information System

IBGE - Brazilian Institute of Geography and Statistics

LILACS - Latin American and Caribbean Literature in Health Sciences

SciELO - Scientific Electronic Library Online

VHL - Virtual Health Library

DeCS - Health Sciences Descriptors

Bireme - Regional Medicine Library