



Notifications of Leptospirosis in the State of Ceará - Brazil, from 2013 to 2019: Profile of Cases and Factors Associated with the Incidence

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Authors' contributions

This work was carried out in collaboration among all authors. All authors read and approved the final manuscript.

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ABSTRACT

Objective: This study proposes an epidemiological analysis and distribution of human cases of leptospirosis reported in the State of Ceará, from 2013 to 2019.

Methods: Descriptive study, with data on leptospirosis accidents reported in the Notifiable Diseases Information System between 2013 and 2019.

Results: 344 cases and 24 deaths were reported, with emphasis on the second two months (41%), corresponding to an average annual incidence of 0.54/105 inhabitants and a fatality rate equal to 2.2% per year, directly related to rainfall rates. Of those affected by the disease, 72% were aged 20

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to 59, 76% were men, 88% considered themselves black, 39% were residents of urban areas and 59% did not report their education; 87% were diagnosed using clinical-laboratory criteria and 76% were cured.

Conclusion: There was an increase in reports of leptospirosis associated with rainfall, mainly affecting the economically active population, most of whom live on the social margins.

Keywords: *Leptospira*; descriptive epidemiology; neglected diseases; socioeconomic factors.

1. INTRODUCTION

Leptospirosis is an infectious disease caused by aerobic gram-negative spirochete-shaped bacteria belonging to the genus *Leptospira* [1]. This pathology is a zoonosis of socioeconomic relevance due to the high expenses to public coffers related to the cost of treatment, which may eventually be fruitless, since the pathology has a high lethality. Its worldwide distribution affects people every month of the year, especially in the rainy months, which can trigger outbreaks [2].

The most relevant reservoir of *Leptospira* spp. in urban areas it is the *Rattus norvegicus*, popularly known as the brown rat or vole, which can permanently store the *Icterohaemorrhagiae* serogroup of bacteria and transmit it through urine. In addition to this serotype, others are also capable of causing diseases, although of a milder magnitude [3]. Although rats are the main source of transmission, dogs also have a major impact, as they live in the same space as humans and can be asymptomatic reservoirs of leptospire, just like rats. Transmission occurs through the penetration of the bacteria into the body through damaged skin tissue and the entire skin when exposed for long periods to mud, contaminated water or another humid environment infected by spirochetes [4,5].

In Brazil, large urban centers are fragile in epidemiological terms due to high rates of population agglomeration, especially those communities located on the margins of urban areas, often without geographic organization and/or health system. As a result of these unfavorable conditions, there is an increased risk of rodent infestations, in addition to environments that favor the spread of water contaminated with bacteria, in periods of high rainfall, thus causing public health problems, which favor diseases such as leptospirosis [6].

The diagnosis of this infection is carried out through serological tests, such as the serum

agglutination reaction. The recommended treatment consists of antibiotic-based control and prevention therapy, requiring health education actions, especially for high-risk groups according to sanitary conditions, improvements in sewage systems, water treatment and monitor the reservoirs found in the microorganism cycle. It is also worth highlighting the importance of using multivalent vaccines, which contain more serotypes of *Leptospira* sp., providing the individual with an extensive spectrum of protection against possible carriers of the bacteria [7].

In accordance with the above, the present study analyzes the epidemiological profile of *Leptospira* sp. infection, justified by the endemic condition in the country, mainly among more vulnerable groups, such as those who live in spaces with precarious basic sanitation conditions. In addition to being a public health problem, the economic loss stands out, as the most affected population belongs to the economically active group [1].

Therefore, the study aimed to analyze the distribution of leptospirosis, according to temporal (years and months), epidemiological, clinical and sociodemographic characteristics in the State of Ceará, in the period 2013-2017.

2. METHODOLOGY

This is a descriptive study with a quantitative approach of cases of infection caused by *Leptospira* sp., occurring in the State of Ceará, from January 2013 to December 2019.

The State of Ceará is located in the northeast of Brazil, its population is estimated at 9.1 million inhabitants, with a demographic density of 56.76 inhabitants/km², according to research carried out in 2019, executed by the Brazilian Institute of Geography and Statistics [8].

The area corresponding to the State has 184 cities, divided into a territorial extension of

148,894.441 km². The region is nationally known for its religiosity and tourism, which is characterized as one of the most important sources of income for local families. In addition to this, the tertiary sector of services and commerce also stands out, replacing agricultural activities that for a long time remained the main form of financial income. The State is in the northeastern hinterland sub-region, giving it climatic characteristics classified as semi-arid, called "Polígono das Secas" [9].

The following variables were investigated:

a) Temporal:

- Year (2013; 2014; 2015; 2016; 2017; 2018; 2019);
- Bimester (first; second; third; fourth; fifth; sixth).

b) Sociodemographic:

- Age group (in years: <1-9; 10-19; 20-39; 40-59; 60-64; 65-69; 70 ≤);
- Education (ignored/not informed; illiterate; incomplete primary education; complete primary education; incomplete secondary education; complete secondary education; incomplete higher education; complete higher education; not applicable);
- Ethnic group (ignored/not informed; white; black; yellow; indigenous [we chose to combine 'brown' and 'black'] [10];
- Sex (female; male);

c) Clinical-epidemiological:

- Area of residence (urban; rural; peri-urban, ignored/blank).
- Confirmation criteria (clinical-laboratory; clinical-epidemiological; ignored/blank);
- Evolution (cure; death from the reported condition; death from another cause; ignored/blank).

The information was analyzed using measures of central tendency (average), incidence (per 100 thousand inhabitants), and lethality rate (%), using the population projection of the Brazilian Institute of Geography and Statistics [9], for each year of interest.

To calculate incidence and lethality, the following formulas were used:

incidence =

$$\frac{\text{Number of new cases of the disease in the year} \times 100,000}{\text{Population in the year}}$$

Lethality =

$$\frac{\text{Number of deaths from the disease in the year} \times 100}{\text{Number of sick people per year}}$$

The rainfall rates verified on the Cearense Foundation of Meteorology and Water Resources website [11].

The variables were obtained by consulting the Notifiable Diseases Information System NET/TabWin32 [12] and the information was presented in the form of graphs created in the Microsoft Excel® program.

The data analyzed are in the public domain, that is, they are secondary, therefore, it was not necessary to submit or approve the study by the Ethics Committee or Local Scientific Committee in accordance with Resolution No. 510 of 2016 of the National Health Council [13].

3. RESULTS

In the period from January 2013 to December 2019, 344 cases of leptospirosis were reported in the State of Ceará, giving an average annual incidence of 0.54 cases per 100,000 inhabitants. The year with the highest percentage was 2019 (35%) and the period with the lowest percentage of registered cases occurred in 2017 (8%). 53 deaths were recorded during the time period analyzed, with a total fatality rate of 15.4%. In 2019, 17 deaths were reported, giving a mortality rate of 4.9%, on the other hand, in 2013 and 2015 there were only two lethal episodes, with a mortality rate of 0.6% in both years (Table 1).

Infections with *Leptospira* sp. were recorded in every two months, with an average of 57 cases per two months. From the first to the fourth two months, an incidence above or close to the average is observed, especially in the second (March and April), with 41% cases reported, resulting in a value almost five times higher than the average. The last two months reported lower values compared to the others (Table 1).

Between the years 2013 and 2019, an increase in leptospirosis notifications was observed when, in the same year, there was an increase in the amount of rainfall in the State. This proportion was also notable in relation to lethality, shown in Fig. 1.

Table 1. Number according to the two months, deaths and lethality of leptospirosis cases according to the year of occurrence, territory of the State of Ceará, 2013-2019

Year	Two months						Total N (%)	Deaths N (%)
	First	Second	Third	Fourth	Fifth	Sixth		
2013	5	7	11	3	5	1	32 (9)	2 (0,6)
2014	5	14	12	12	4	3	50 (15)	6 (1,7)
2015	1	11	5	9	2	1	29 (8,0)	2 (0,6)
2016	9	25	5	5	1	4	49 (14)	11 (3,2)
2017	3	12	5	3	3	2	28 (8)	4 (1,2)
2018	9	21	8	7	1	4	51 (15)	11 (3,2)
2019	11	53	23	12	5	-	105 (35)	17 (4,9)
Total N (%)	43 (13)	143 (41)	69 (20)	51 (15)	22 (6)	16 (5)	344 (100)	53 (15,4)

Source: Notifiable diseases information system (Sinan)

Table 2. Sociodemographic characteristics of cases and deaths from leptospirosis, in the State of Ceará, 2013-2019

Sociodemographic data	Cases		Deaths N	Lethality %
	N	%		
Age range (in years)				
≤1-9	11	3	-	-
10-19	39	12	2	0,6
20-39	135	39	15	4,4
40-59	113	33	24	7,0
60-69	26	8	5	1,4
≥70	20	5	7	2,0
Total	344	100	53	100
Education				
Ignored/not informed	201	59	31	58
Illiterate	14	4	-	-
Incomplete elementary education	56	17	13	25
Complete primary education	15	4	2	4
Incomplete high school	15	4	1	2
Complete high school	27	8	5	9
Incomplete higher education	5	1	1	2
Complete higher education	5	1	-	-
Not applicable	6	2	-	-
Total	344	100	53	100
Ethnic group				
Ignored/not informed	17	5	2	4
White	23	6	4	7
Black (black + brown)	303	88	46	87
Yellow	1	1	1	2
Total	344	100	53	100
Sex				
Masculine	263	76	35	66
Feminine	81	24	18	44
Total	344	100	53	100
Occurrence zone				
Ignored/not informed	159	46	-	-
Urban	134	39	51	96
Rural	46	13	2	4
Peri-urban	5	2	-	-
Total	344	100	53	100

Source: Notifiable diseases information system (Sinan)

Table 3. Clinical characteristics of leptospirosis cases, in the State of Ceará, 2013-2019

Epidemiological/clinical data	Cases	
	N	%
Confirmation criteria		
Clinical-laboratory	300	87
Clinical-epidemiological	37	11
Ignored/not informed	7	2
Evolution		
Cure	262	76
Death due to notified injury	53	15
Death from another cause	6	1
Ignored/not informed	63	18

Source: Notifiable diseases information system (Sinan)

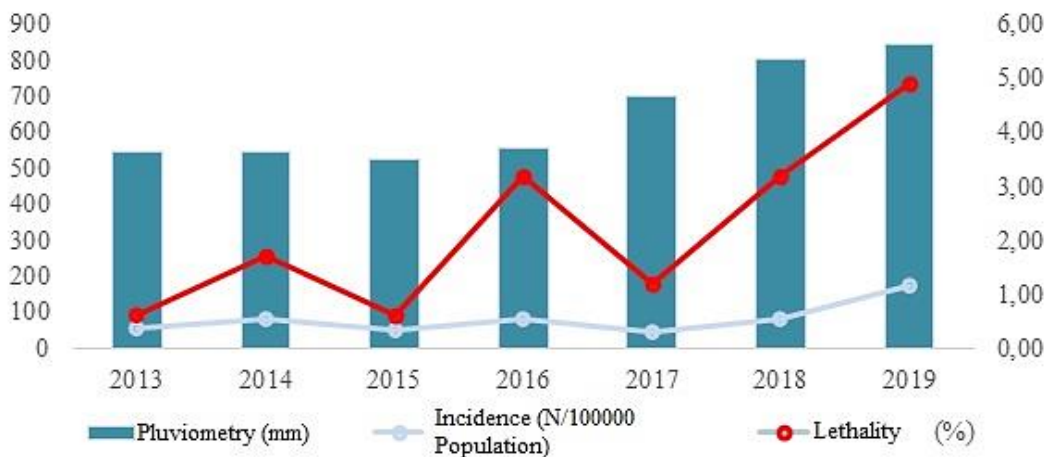


Fig. 1. Incency of leptospirosis per year related to rainfall and fatality rate. State of Ceará, 2013-2019

The age groups of 20-39 years and 40-59 years were most reported in the notifications, consequently, the majority of deaths occurred in the population within these age ranges. Regarding education, 59% of the forms were not filled out. Among those infected, 88% declared themselves black, with 87% of deaths belonging to this population. As for gender, males were the most affected, with 76% of notifications and 66% of lethal episodes, as shown in Table 2.

According to Table 3, the majority of cases did not inform the area of residence, representing 46% of the records, followed by those residing in urban areas, with 39% of the notifications. The predominant confirmation criterion was clinical-laboratory (87%), which involves analysis of the patient's clinic and tests responsible for helping to confirm the infection. Regarding the evolution of individuals, cure was achieved in 76% of cases after treatment, however, 15% of patients died as a result of leptospirosis.

4. DISCUSSION

In the years 2013 to 2019, there was an irregular distribution in the incidence rate of leptospirosis notifications in the State of Ceará, however an increase was observed compared to the years 2013 and 2019, thus seeing an increase of 0.36 cases/100,000 inhabitants to 1.15 cases/100,000 inhabitants, respectively. The variations presented demonstrate similarity between the study carried out in Fortaleza, which found a peak in notifications in 2014, and another research carried out in the Northeast, demonstrating a similar arrangement of cases between 2013 and 2016 [14,15].

The average lethality found in another study was equal to 11.4% for Porto Alegre-RS, from 2007 to 2013, concluding that the death rate in Ceará is lower compared to other regions, as well as compared to the national average of 9% [13,16].

In relation to precipitation, especially when it tends to generate floods, it is closely related to epidemic outbreaks of leptospirosis in developing countries and with tropical climates, especially when it occurs in locations without adequate sanitation, resulting in the presence of rodents [6]. This relationship can be verified through research that demonstrates the correlation between the increase in incidence and lethality as a result of high rainfall, as well as the decrease in notifications due to the reduction in rainfall [2].

By analyzing the variables, it is possible to observe the high rate of infection in individuals aged 20 to 59 years. This group is possibly more prone to infection as a result of their work activities, thus belonging to the economically active group. As a result, the illness or death of these individuals has a socioeconomic impact [17,18].

In relation to this, the low incidence in children and the elderly can be justified by the limitation of contact with contaminated water and soil, especially during adverse environmental events, which can cause outbreaks. Among those infected, individuals under ten years of age present less serious events, which reduces the possibility of deaths in this population. Elderly people have the advantage of immunological development resulting from previous exposure to the etiological agent [18].

Although information regarding education is absent in most questionnaires (59%), studies link leptospirosis with poor basic sanitation conditions and low economic power [19,20]. Consequently, in most occurrences *Leptospira* sp. affect people with lower educational levels, as can be seen in 17% of cases, where individuals stated that they had incomplete primary education. The absence of information in more than 50% of the notification forms makes it impossible to compare with other studies, as happened in other studies [20], demonstrating the need to raise awareness among professionals to completely fill out the notification forms.

The ethnic group most affected by the pathology was black, who also represent the largest portion of Ceará inhabitants [8], as well as those who suffer most from social inequality. This situation is a reflection of the irregular distribution of income between races, giving black people less privileges, consequently resulting in a greater portion of marginalization on the part of this

population that lives in locations with precarious basic sanitation conditions [22].

In terms of gender, it was observed that males presented the highest percentage. It is assumed that this high number is related to the greater exposure of these individuals to risk areas, especially during extreme natural episodes, such as floods [16,21,23].

Among the years analyzed, the largest portion (46%) of patients did not report their area of residence, followed by those living in urban areas (36%). This occurs because leptospirosis is associated with urbanization, which occurs in a disorganized manner, mainly on the margins of cities [24]. As a consequence, low-income population agglomerations occur without sanitation policies, necessary to reduce transmission sources and reduce residents' exposure to streams and sewage [25,26].

Confirmation of suspected infection by *Leptospira* sp. occurred predominantly through laboratory diagnostic criteria, in line with two other research carried out [16,21]. The Ministry of Health also advises that the epidemiological criterion should be used when the individual demonstrates physiological changes (hepatic, renal or vascular), correlated with previous descriptions of suspected cases and in situations that make it impossible to carry out laboratory tests or when they have carried out the collection of a single sample for testing before seven days of illness and the result was non-reactive [6].

It is also noteworthy that rapid detection and timely initiation of treatment for the pathology increases patient survival, reducing lethality. In this way, the initiation of pharmacotherapy can be considered even before laboratory results, when the local epidemiological history is favorable to the emergence of cases [24].

The percentage of cured patients was recorded in 76% of cases, representing a quarter of the population that contracted the pathology, corroborating the literature. Despite the high cure rate, the lethality of leptospirosis is still worrying, as death rates can reach 40%, depending on the region, mainly affecting individuals aged 20-59 years, who represent the population in that age group. classified as productive [21,25].

Another problem is that infections cause high treatment costs, especially for those who present

a severe form of the disease, who can remain hospitalized, on average, for 7.5 days [5].

Studies with secondary data are important for ecological analysis, however time series analyzes have some limitations, such as filling out and recording individuals' information on the website, which over time can cause errors in their evaluation and dissemination of unreliable results. It is important to highlight that the notifications are mostly completed by hospitals, where the most serious cases are found, and this fact may be related to the high lethality presented [21].

5. CONCLUSION

The data evaluated make it possible to characterize the profile of leptospirosis cases/deaths in the State of Ceará, over a period of seven years, referring to a set of variables, as well as to determine the relationship between incidence, lethality, rainfall and socioeconomic characteristics. The research presented helps in the adoption of specific intervention strategies and allocation of resources to reduce factors that favor the proliferation of *Leptospira* sp., as well as early diagnosis and treatment of individuals who contract the disease.

COMPETING INTERESTS

Authors have declared that no competing interests exist.

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