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Short Communication

Urban Leptospirosis and Rainfall in the City of Rio De Janeiro/RJ, Brazil, 2007 To 2017

Isabela Pereira de Oliveira Souza[1], and Wagner de Souza Tassinari[1,2]*

[1]Postgraduate course in Veterinary Sciences, Federal University Rural of Rio de Janeiro, Brazil
[2]Department of Mathematics, Federal University Rural of Rio de Janeiro, Brazil

*Corresponding author

Wagner de Souza Tassinari, Rua Bernardo Taveira, 235, Bloco 03 apto 310, Rio de Janeiro, Rio de Janeiro, Brazil

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• Leptospirosis; Urban epidemics; Epidemiology; Climate

Abstract

The aim of this paper is investigate the effects of rainfall in urban leptospiroses cases in a one the most largest city in the world, Rio de Janeiro/Brazil, in 2007 to 2017 period. Urban Leptospirosis study is relevant to public health because of its severity and mode of dissemination, being its occurrence greater in places with socio-environmental and climatic vulnerability, as Rio de Janeiro city. To evaluate the correlation between the time series of the human leptospirosis cases and rainfall, were used exploratory graphical analyzes and regression models. It was possible to observe that leptopirose cases are significantly associated with the monthly mean rainfall of the previous month (RR = 1.11 [95% CI: 1.08 - 1.15]), the increases of lepstopirosis cases in this urban setting happens according to rainfall. The monitoring not only of cases of leptospirosis, but also climatic variables, need to be taken into account in epidemiological surveillance. The implementation of public policies for basic sanitation, mainly in urban areas, are necessary for the maintenance and prevention of most neglectable infectious diseases.

INTRODUCTION

Leptospirosis is relevant to public health because of its severity and mode of dissemination, being its occurrence greater in places with socio-environmental and climatic vulnerability. Leptospirosis is relevant to public health because of its severity and mode of dissemination, being its occurrence greater in places with socio-environmental and climatic vulnerability. It is a globally distributed and high lethality in regions with precarious urban environments conditions [1-5]. Infection may occur through contact with infected reservoir animals urine and tissues or with Leptospira contaminated, soil or water [3]. Severe disease develops in 5-10% of symptomatic infections and causes multisystem complications such as acute renal failure and pulmonary hemorrhage [6].

Leptospirosis transmission is driven by a complex interaction of environmental, socioeconomic, demographic and individual determinants which result in considerable geographical and temporal variation in infection risk [7,8].

In recent decades, leptospirosis has been considered a emerging infectious disease due to changes in its epidemiology. This infections disease has emerged to become a health threat in urban centres [9-11]. Rapid and spatially disorganized process of urbanization throughout the developing world has created unhealthy physical and social urban environments [10]. At present more than one billion of the world's population resides in slum settlements [12]. The lack of adequate sewage systems, trash deposits and poor housing favour high rodent densities which in turn lead to environmental contamination with pathogenic Leptospira and high level transmission of leptospirosis in these communities [12-14].

Leptospirosis cases occur throughout the year in this setting [15], indicating that there is endemic transmission. However, large outbreaks have been reported during seasonal periods of heavy rainfall and flooding [9,13,14,15,16,17]. Leptospirosis is well-known to occur in disaster situations such as hurricanes and monsoons [18] and is increasingly recognized as an emerging infectious disease with cyclic climatic events [19].

The urban plan of Rio de Janeiro was defined by decades of public investment in urban infrastructure, prioritizing neighbourhoods in the southern areas adjoining the ocean beaches, while neglecting the poorer regions in the north and west sectors of the city, generating an expressive spatial segregation and social inequality with an increase in the number of cases of infectious diseases in poorer [20].

Considering the epidemiology of this re-emerging zoonotic infection disease in world's largest cities, this article discusses the evolution of leptospirosis in the city of Rio de Janeiro, Brazil, from 2007 through 2017, investigating how much rainfall effect can influence the occurrence of leptospirosis cases.

MATERIALS AND METHODS

It is a descriptive ecological study carried out in the city of Rio de Janeiro, Brazil, during from 2007 to 2017. Rio de Janeiro is considered the fourth largest city in South America (population 6.3 million) [21], with a large diversity of geographic, environmental and socioeconomic characteristics. The city boundaries include swamps and mountains as high as 800 m; densely populated areas as well as unpopulated forests and slum communities in close proximity to upper and middle class neighbourhoods. Slum communities (*'favelas'*) are distributed throughout the city and occupy diverse geographic settings, which include most mountains and swamp regions in the city. The accumulated annual rainfall volume is around 1,000 mm, and the seasonal heavy tropical rainfall and flooding occur during the summer period between December and March and affects regions with inadequate water drainage.

The leptospirosis cases in city of Rio de Janeiro, during the study period, were collected from the Municipal Health Department of Rio de Janeiro [22] through the SINAN (National System of Notifiable Diseases). Between 2007 and 2017, 1,297 leptospirosis suspected cases and 589 confirmed cases were reported to the Municipal Health Secretary of Rio de Janeiro according to clinical, epidemiological and laboratory criteria of the Brazilian Ministry of Health [23]. Cases are reported on the basis of having signs and symptoms compatible of leptospirosis, such as jaundice, acute renal insufficiency and hemorrhage; reported history of contact with potential risk factors such as flooding and reservoirs and laboratory evidence for the diagnosis obtained during microscopic agglutination test, culture isolation evaluations.

The data of accumulated monthly precipitation in millimeters of the rainfall statistics of the city of Rio de Janeiro from January 2007 to December 2017, were obtained from the National Institute of Meteorology [24]. To evaluate the possible association between the positive cases of leptospirosis and rainfall, was taken into account the day average rainfall occurred in the month prior to the month of onset of the first lepitospirosis symptoms.

The exploratory analysis of the data was performed by a line graphs regarding time series comparing lepitospirosis cases and rainfall throughout the study period. Boxplot graphics were made to compare the monthly distribution of confirmed cases of leptospirosis and monthly rainfall during the 10-year study period. The trend curves were done by smoothing spline nonlinear function [25].

Due to the non-existence of autocorrelation temporal model in the case numbers (Durbin-Watson Test, p-value = 0.277) [26], the generalized linear regression model with negative binomial distribution was used to test and measure the relationship between leptospirosis cases and the effect of rainfall [27]. To treat seasonality, the month of the first symptoms of the leptospirosis cases were incorporated into the model, considering the latency time of the disease. As observed that the months of August were those that had less reports of cases of leptopirose, it was chosen to be the base category in the regression model.

All statistical analyzes were performed using software R, version 3.4.4 [28].

RESULTS AND DISCUSSION

In mostly times, leptospirosis can be difficult to diagnose, mainly when it is in a early stage because it shares symptoms with many other more common infections, such as influenza or arboviruses diseases [29]. With varying symptoms and problematic diagnostics, can make the diagnosis of confirmed leptospirosis cases difficult. Even so, in figure 1 it is possible to observe the occurrence curves of suspected and confirmed cases of leptospirosis are quite similar, even though the positive cases occur to a lesser extent. The same figure shows, that the highest rainfall rates during the study period occurred between January and April, this distribution coincides both for the occurrence of suspected cases and for confirmed cases of leptospirosis. There is a direct relationship between rainfall and cases of leptospirosis, where we observed that rainfall peaks are continuously followed by an increase in the number of cases.

When analyzing the distribution of cases month to month, a seasonal pattern of the ocurrence of leptospirosis cases is observed, with a higher summer concentration, during which period there is also an increase in rainfall (Figures 1 and 2). In Figure 3, it was possible to observe that both the trend curve of the confirmed cases of leptospirosis and the trend curve of rain of the month before the date of the first symptoms show similar behavior. Although in cases of drought occur cases of the disease, torrential rains and consequent floods increase the occurrence of the disease. Through the trend curve, we verified that the cases of leptospirosis and rainfall rates, did not show any tendency during the study period. However, it is possible to observe that when there is an increase in cases of leptospirosis, they coincide with an increase in rainfall in the month preceding the first symptoms of leptospirosis. During the studied period, the highest number of cases occurred in 2010. In this period, the Rio de Janeiro suffered the greatest episode flood of the last 80 years, which can be attested by the peaks of rainfal rates presented. This relationship could also be verified by Guimarães et al. [16], where the authors indicate the monthly mean of precipitation as a risk factor for leptospirosis and as an alert indicator to the surveillance system.

The first model, in negative binomial regression analysis (table 1) shows that the relative risk estimate (RR = 1.11 [95% CI, 1.08 - 1.15]), indicated that for every one mm more in the mean rainfall there is an 11% increase in human positive cases of leptospirosis in the following month. The second model was able to capture the effect of seasonality between the months of the year, with a statistically significant relative risk for the months of January (RR = 2.21 [IC 95%:1.29; 3.78]), February (RR = 2.57 [IC 95%:1.54; 4.27]), March (RR = 1.79 [IC 95%:1.04; 3.08]) and April (RR = 1.18 [IC 95%:1.18; 3.33]). All relative risks were estimated using the month of August as a reference. It should be noted that this period corresponds to the period identified in the seasonality and and with more cases during the years of the studied period.

It is worth mentioning that the torrential rain associated with the lack of adequate sanitary infrastructure is the real factor triggering the increase in the number of cases, since the occurrence of floods is strongly related to the precarious system of sewage and urban water drainage. Thus, the high density of inhabitants of the municipality of Rio de Janeiro and the high production of garbage, combined with the problems of sanitation and the occurrence of heavy rains accompanied by floods, have been considered as precursors of epidemic outbreaks [16,30,31].

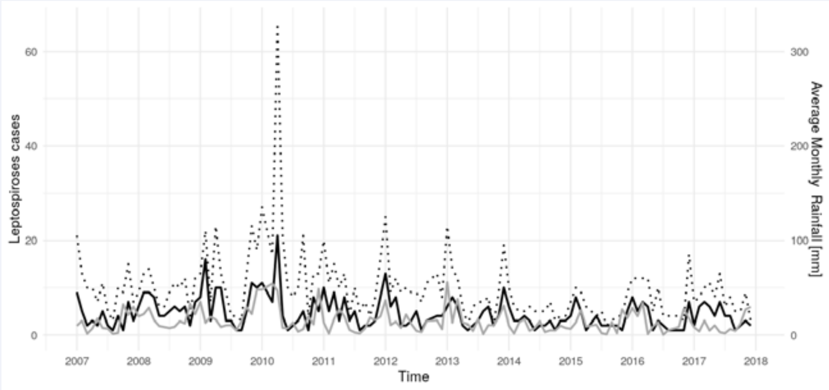

Figure 1 The recorded of leptospirosis suspected (dotted line) and confirmed (black line) cases, climate time series (grey line) month average precipitation (measured in mm) from the month prior to the date of the first symptoms of the leptospirosis cases in the Rio de Janeiro city, in january 2007 to dezember 2017 period.

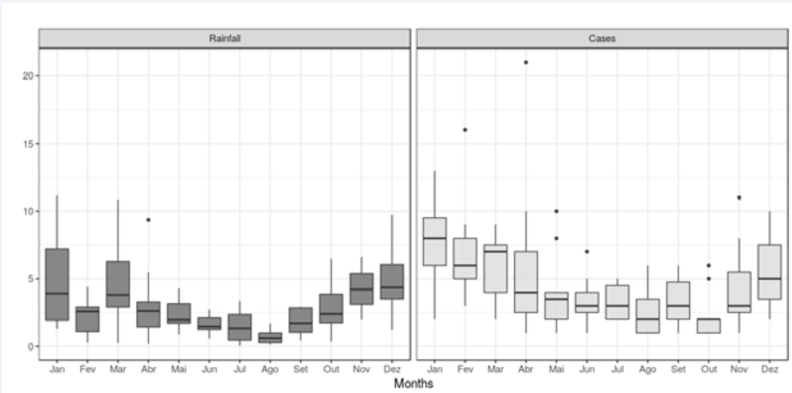

Figure 2 Seasonality of month average rainfall (measured in mm) (dark grey boxplots) and positive cases of leptospirosis (light grey boxplots) in the Rio de Janeiro city, 2007 - 2017.

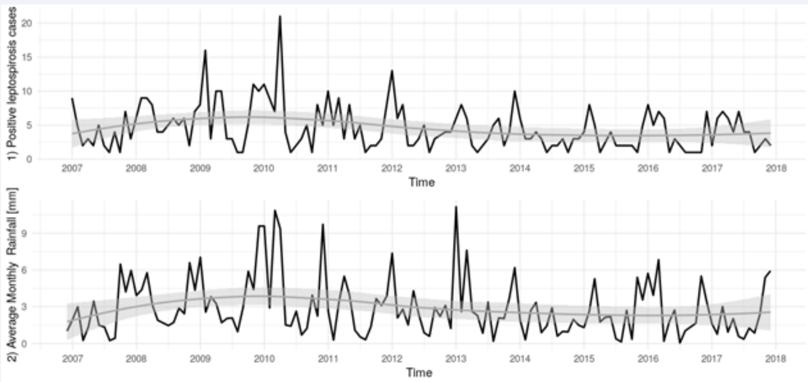

Figure 3 Trend curve (grey line) of the leptospirosis confirmed cases (figure 2.1) and the month average rainfall (measured in mm) from the month before to the date of the first symptoms of the leptospirosis cases (figure 2.2) in the Rio de Janeiro city, in january 2007 to dezember 2017 period.

CONCLUSION

The occurrence of Leptospirosis is intimately related to the rainy season of summer, because with increasing water volume, Leptospira is transported more quickly through contact with urban floodwaters.

According to some authors [31,32], confirmed cases of leptospirosis can be directly related to situations of socio-environmental vulnerability, and is therefore an indicator of the effect of this vulnerability, as observed in the present study. In the big in urban centers, the intense and disorderly process of urbanization caused by rapid growth, lack of basic sanitation

Table 1: Risk analysis for the occurrence of leptospirosis cases using negative binomial regression models. Relative risk estimates (RR) and their respective confidence intervals at 95% of the precipitation exposure variables and the months of the year in the Municipality of Rio de Janeiro, 2007-2017.

Exposure	Model 1	Model 2
Variables	**RR [CI 95%]**	**RR [CI 95%]**
Railfall	1.12 [1.07; 1.16]*	1.08 [1.03; 1.12]*
Months		
January	-	2.21 [1.29; 3.78]*
February	-	2.57 [1.54; 4.27]*
March	-	1.79 [1.04; 3.08]*
April	-	1.98 [1.18; 3.33]*
May	-	1.41 [0.81; 2.44]
June	-	1.25 [0.72; 2.17]
July	-	1.23 [0.71; 2.14]
August (ref.)	-	1.00 [1.00; 1.00]
September	-	1.20 [0.68; 2.12]
October	-	0.79 [0.43; 1.46]
November	-	1.36 [0.79; 2.36]
December	-	1.70 [0.98; 2.94]

* Significant at 5%.

and inadequate collection of garbage favorable environmental conditions for reproduction of the rodent population, the main disease. As a powerful factor, strong rainfall in tropical regions, causing floods, favorable condition for exposure to the agent of disease by means of water transmission and may lead to epidemics of leptospirosis in urban places.

The monitoring of leptospirosis cases is not enough to create measures for the prevention of urban leptopirosis, understanding the role of climate is fundamental, since it facilitates the analysis of the risk of epidemics and assists preventive measures. This study indicates that the average monthly rainfall may constitute an important indicator that enables the execution of actions in order to prepare the health sector for the probable increase in cases of this disease. Therefore, it is necessary to implement the interaction between the work of epidemiological surveillance and the risk management teams of environmental surveillance, to increase the response capacity to natural disasters in the city of Rio de Janeiro.

The population of Rio de Janeiro is vulnerable to climate variations, mainly due to the socioeconomic factors, lack of infrastructure, lack of urban planning and slum areas, as the city has a topography and climate that enhance this vulnerability. Thus, the implementation of public policies for basic sanitation, mainly in urban areas, are necessary for the maintenance and prevention of most neglectable infectious diseases.

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