Analysis of Seasonality, Tendencies and Correlations in Human and Canine Visceral Leishmaniasis

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ABSTRACT

Background: Leishmaniosis are a chronic disease complex, which may vary from simple cutaneous lesions to a fatal visceral form, with elevated expansion within the urban centers. Fortaleza is an endemic area for VL and it has been presenting registers of human death in the past decade. The HVL seasonality, the HVL and CVL tendencies have been evaluated, along with the correlation and influence of the seroreactive dogs, of the euthanized dogs, of the abiotic environmental factors and the human and canine population over the coefficient of the HVL incidence, in the Fortaleza town between 2006 and 2012.

Materials, Methods & Results: The experimental protocol was approved by the Ethics Committee for the State University of Ceará Animal Use (CEUA/UECE), protocol nº 08622833-1. As a data source for the analysis of HVL and CVL, the monthly quantitative of notified and registered cases in the State of Ceará Health Secretariat (SESA) and in the Fortaleza Zoonosis Control Center (CCZ) was utilized respectively from 2006 to 2012. Fortaleza’s population estimate during and after the census period, the rainfall average monthly rate (mm), the air relative humidity (%) and the temperature (°C), were provided, at the same period, by the Brazilian Institute of Geography and Statistics (IBGE)., The data were analyzed by ANOVA followed by Tukey, linear regression and Spearman correlation test. The monthly average of HVL registered cases, between 2006 and 2012, did not differ significantly between the months of the year. The HVL incidence coefficient, per 100.000 inhabitants, presented a negative tendency, while the human lethality and mortality coefficients and the percentage of seroreactive dogs presented a positive, stationary and negative tendency, respectively. The percentage of euthanized dogs presented a slight correlation and did not influence the HVL incidence coefficient. On the other hand, the percentage of seroreactive dogs presented correlation and positive influence over the HVL incidence coefficient. The human population presented negative influence over the HVL, Furthermore, the canine population also presented negative influence over the number of visceral leishmaniasis (VL) human cases over the evaluated period. The average monthly values of the rainfall rate, of the air humidity and of the temperature demonstrate correlation, having the rainfall rate not presenting influence over the HVL incidence coefficient. On the other hand, the relative air humidity and the average temperature negatively influenced the LVH incidence coefficient.

Discussion: In this study, a direct dependency between the canine and human cases according to the percentage of seroreactive dogs, a non-relation with the percentage of euthanized dogs and an inverse relation with the human and canine populations and the abiotic environmental factors (relative air humidity and average temperature) were observed. Therefore, it was concluded, that the seroreactive canine population control has influence over the HVL. This research creates perspectives for the identification of other factors that may influence the incidence of canine and human cases, such as vector density and the participation of other possible reservoirs within the domestic disease cycle. Furthermore, a deeper evaluation of the native vegetation, appointed by human action, is suggested.

Keywords: human visceral leishmaniasis, canine visceral leishmaniasis, seasonality, tendencies analysis, correlation analysis.
INTRODUCTION

Leishmaniosis are a chronic disease complex with elevated expansion within the urban centers [22]. They are among the most relevant diseases in all over the world and Brazil is among the Latin American countries which presents most human cases, about 90% of the current registered [20].

The vertebrate hosts acknowledged as reservoirs are the mammals belonging to the Canidae family and the humans, and due to domesticated dogs circulating among the domiciliary areas, they are incriminated of sustaining the epidemiology chain [5,24].

Studies conducted in Belo Horizonte [8] and in São Paulo [15] demonstrate that the prevalence of visceral leishmaniasis (VL) varies from 20% to 40% of the canine population. Fortaleza city has registered, in the past years, an elevated number of canine and human cases of VL (Tables 1 and 2), including an elevated registered number of human deaths.

Landscape changes have been imputed by the human being along the years, with the removal of primary vegetation, which reduced the natural ectopic of the disease, exposing the human and canine population to its etiological agents in Brazilian urban centers [3,12,19,28]. Fortaleza city is not different. However, few studies were made with epidemiological and temporal approach involving the canine visceral leishmaniasis (CVL) and its relation with the human visceral leishmaniasis (HVL).

The aim of this paper was to evaluate the HVL seasonality, to determine the HVL and the CVL tendencies and to evaluate the HVL incidence coefficient concerning the influence of the seroreactive dogs, the euthanized dogs, the abiotic environmental factors and the canine and human population in the city of Fortaleza between the years of 2006 and 2012.

<table>
<thead>
<tr>
<th>Year</th>
<th>Canine Population*</th>
<th>N° of Samples</th>
<th>N° of Total of Seroreactive Euthanized Not Removed</th>
</tr>
</thead>
<tbody>
<tr>
<td>2006</td>
<td>212,689</td>
<td>14,761</td>
<td>1,258 8.52 1,042 82.83 216 17.17</td>
</tr>
<tr>
<td>2007</td>
<td>213,964</td>
<td>46,179</td>
<td>7,132 15.44 3,138 44.00 3,994 56.00</td>
</tr>
<tr>
<td>2008</td>
<td>217,678</td>
<td>80,058</td>
<td>5,204 6.50 2,528 48.58 2,676 51.42</td>
</tr>
<tr>
<td>2009</td>
<td>220,488</td>
<td>126,307</td>
<td>6,514 5.17 4,197 64.16 2,344 35.84</td>
</tr>
<tr>
<td>2010</td>
<td>215,792</td>
<td>114,583</td>
<td>6,791 5.42 4,423 65.13 2,368 34.87</td>
</tr>
<tr>
<td>2011</td>
<td>217,939</td>
<td>113,527</td>
<td>5,024 4.42 3,005 59.81 2,019 40.19</td>
</tr>
<tr>
<td>2012</td>
<td>220,754</td>
<td>98,180</td>
<td>3,462 3.53 2,442 70.54 1,020 29.46</td>
</tr>
</tbody>
</table>

*Estimate canine population for the year of 2012.
MATERIALS AND METHODS

Study location

Fortaleza is an urban area located between 3º43’02”S and 38º32’35”, situated in the state of Ceará coastal area, in the northern region of Brazil. It presents a medium annual temperature of 26°C, it has a complex maritime area vegetation and a maritime evergreen swampy forest. The rain season happens between the months of January and May, with an average annual rainfall rate of 1.338mm. The human population is of approximately 2.500.195 inhabitants, distributed among six administrative regions, known as Regional Executive Secretariats. (SER I, SER II, SER III, SER IV, SER V and SER VI).

Data collection

As a data source for the analysis of HVL and CVL, the monthly quantitative of notified and registered cases in the State of Ceará Health Secretariat (SESA) and in the Fortaleza Zoonosis Control Center (CCZ) was utilized respectively from 2006 to 2012. Fortaleza’s population estimate during and after the census period, the rainfall average monthly rate (mm), the air relative humidity (%) and the temperature (°C), were provided, at the same period, by the Brazilian Institute of Geography and Statistics (IBGE).

Statistical analysis

A descriptive ecological, observational epidemiological study of the chronological series of the 2006 to 2012 VL was made at the town of Fortaleza. The seasonality analysis was made based on the box-plot, through ANOVA (one-way), followed by the Tukey test. The tendency analysis of the incidence coefficients, of the mortality and lethality, of the HVL, and of the percentage of seroreactive dogs was made by linear regression. The percentage of euthanized dogs and of seroreactive dogs, along with the number of samples of canine serum analyzed by CCZ are expressed in Table 2.

The percentage of seroreactive dogs, euthanized dogs and unremoved dogs, along with the number of samples of canine serum analyzed by CCZ are expressed in Table 2.

The monthly average of HVL registered cases, between 2006 and 2012, did not differ significantly between the months of the year. (P < 0.05).

The HVL incidence coefficient, per 100.000 inhabitants, presented a negative tendency (y = 854.3 – 0.42x, r² = 0.28) (Figure 1A), while the human lethality and mortality coefficients and the percentage of seroreactive dogs presented a positive, stationary and negative tendency, respectively (y = -1077 + 0.54x, r² = 0.102; y = 15.57 – 0.007x, r² = 0.008; y = 2703 – 1.342x, r² = 0.52) (Figures 1B, 1C and 1D).

The percentage of euthanized dogs presented a slight correlation (ρ = -0.28) and did not influence the HVL incidence coefficient (y = 11.54 – 0.04x, r² =0.09) (Figure 2A). On the other hand, the percentage of seroreactive dogs presented correlation (ρ = 0.50) and positive influence over the HVL incidence coefficient (y = 7.67 + 0.20x, r² =0.230) (Figure 2B).

The human population presented negative influence over the HVL (y = 1908 – 683x, r² = 0.33) (Figure 2C), furthermore, the canine population also presented negative influence over the number of VL human cases (y = 2197 – 908.6x, r² = 0.72) (Figure 2D) over the evaluated period.

The average monthly values of the rainfall rate, of the air humidity and of the temperature are expressed on the figures 3A, 3B and 3C, respectively. These variables demonstrate correlation (ρ = -0.119, ρ = -0.459, ρ = -0.476, respectively), having the rainfall rate not presenting influence over the HVL incidence coefficient. (y = 20.34 – 0.004x, r² = 0.03) (Figure 3D). On the other hand, the relative air humidity and the average temperature negatively influenced the LVH incidence coefficient (y = 36.55 – 0.22x, r² = 0.19; y = 59.55 – 1.47x, r² = 0.22, respectively) (Figures 3E and 3F).
Figure 1. HVL incidence coefficients tendency per 100,000 inhabitants (A), of lethality (B), of mortality (C), and of the seroreactive dogs (D), between 2006 and 2012, in the Fortaleza town, Ceará, Brazil.

Figure 2. Correlation and influence of the euthanized dogs percentage (A), seroreactive dogs (B), human population (C) and canine population (D) over the HVL incidence coefficient, between 2006 and 2012, in the Fortaleza town, Ceará, Brazil.

Figure 3. Average rainfall monthly rate (mm) (A), average air humidity (%) (B), average temperature (°C) (C), correlation and influence of the rainfall rate (mm) (D), of the relative air humidity (%) (E) and of the average monthly temperature (°C) (F) over the HVL incidence coefficient, between the years of 2006 and 2012, in the Fortaleza town, Ceará, Brazil.

DISCUSSION

As of 1980, VL has been expanding towards the great urban centers of Brazil. Several factors contributed for this situation, among them, the great mobility of people, environmental changes, and the densification of people, which favor the contact between human beings, vectors and animals [27]. In the attempts to contain the advances of the disease in Brazil, the Health Ministry launched the Visceral Leishmaniasis Control Program (PCLV), in which one of the goals involve the elimination of domestic dogs affected by VL, because in the urban environment, it is considered the main reservoir host of the disease [5].

In this study, the HVL annual cumulative incidence per 100,000 inhabitants demonstrated a negative tendency during the six year period of 2006-2012. These information diverge from the data reported in the city of Belo Horizonte [16], between the years of 1994 and 2007, and from the data in the city of Bauru [26], between the years of 2003 and 2008, which reported a series of crescent tendencies records.

In a study conducted in the city of Jacobina, Bahia, it was established that for every infected human, there should be at least 18 subclinical bearers or asymptomatic [1]. Therefore, the values of incidence described in Table 1, of this research, may present themselves underestimated, since the data available are based in the passive detection of the cases. Similar fact has been reported in studies conducted in Sabará, Minas Gerais [21], Fortaleza, Ceará [13] and Belo Horizonte, Minas Gerais [8].

The data between 2006 and 2012 demonstrates that CVL has been presenting a reduction in its rates (Table 2), which may be attributed to the prevention and control actions in the city of Fortaleza, such as the combat to the vector insect and the diagnosis and
capture of the seroreactive dogs. This fact can be confirmed through the lineation of the historical series, which presented negative tendencies in the percentage of seroreactive dogs (Figure 1D). This information is not in agreement with the ones acquired in the city of Belo Horizonte, where the annual tendency of VL affected dogs presented a positive tendency [16].

As consequence to the still elevated incidence of HVL, positive and stationary tendencies from the mortality and lethality rates were demonstrated (Figure 1C). This fact may be associated to the population’s difficult access to health services, to diagnosis and to early treatment, especially in cases of subclinical and/or asymptomatic infections, which are quite frequent in human patients. A similar scenario was reported in Jacobina, Bahia [1], Belo Horizonte, Minas Gerais [3] and in the state of Bahia [12], which presented an elevated human lethality, mainly due to late diagnosis and treatment.

The direct dependency between the percentage of euthanized dogs and seroreactive dogs associated to the null (Figure 2A) and positive (Figure 2B) influences in the HVL incidence, is in accordance to the findings obtained at the city of Feira de Santana, Bahia [7] and, these findings are based in the existence of vector insects in the region and in the intense cutaneous canine parasitism [4,11], which favor the transmission to the human being.

Other data confirm these findings, since the main risk factor for the occurrence of the human disease is the prevalence of the canine disease, superior to 2%, associated to the presence of the vector insect, and because the canine enzooty precedes spatiotemporally the occurrence of the human cases [3,4,6,7]. This way, the importance of the domestic dog in the maintenance of VL in the domiciliary perimeter and in the possible inference of risk areas for the human infection is clear.

Another important point would be the analysis of the human and canine population density, towards the number of human cases of VL. And, by what is shown in table 2, the canine population density observed can be considered high, but it does not represent an indicator of susceptibility to the infection (Figure 2D). On the other hand, it was already demonstrated that areas with high canine demographic densities contribute to the occurrence of epidemic outbreaks [10].

Studies conducted in the towns of Belo Horizonte [3,17] and Fortaleza [14] show that the increase of CVL prevalence and the higher number of domiciliary dogs were directly associated to the increment within the HVL rates. In relation to the human demographic density, in the present study, it was demonstrated that it has negative influence over the HVL incidence (Figure 2C), and it is able to be explained by the negative tendency of HVL (Figure 1A). This fact is in accordance to what was shown by Marzochi & Marzochi [18] and Cunha et al. [9], which demonstrated to have positive correlation between this variable and the increase on the number of human cases.

In this same study, it was possible to evaluate the seasonality, by the monthly average of registered HVL cases. When confronted with the average rainfall rate, with relative air humidity and the monthly average temperature (Figures 3A, 3B and 3C) during the same period, the non-influence of the rainfall rate and the negative influence of the other variables over the HVL incidence (Figures 3D, 3E and 3F) was observed.

These findings are in accordance to what was shown in studies conducted in the states of Bahia [12,25], Minas Gerais [23], Rio Grande do Norte [29] and São Paulo [26], which reported strong correlation of the relative air humidity and of the average temperature with the incidence of the human and canine disease, by the likely increase of the phlebotomines density. Furthermore, results similar to those of this research were shown in studies conducted in the state of Minas Gerais [2,16], which described that the rainfall rate had no influence over the dynamics of the disease, despite the higher phlebotomines density over the pluvious periods.

It is worth highlighting that, the population of phlebotomines and its distribution within the city of Fortaleza was not the objective of this present research.

CONCLUSIONS

In this study, a direct dependency between the canine and human cases according to the percentage of seroreactive dogs, a non-relation with the percentage of euthanized dogs and an inverse relation with the human and canine populations and the abiotic environmental factors (relative air humidity and average temperature) were observed. Therefore, it was concluded, that the seroreactive canine population control has influence over the HVL.

This research creates perspectives for the identification of other factors that may influence the incidence of canine and human cases, such as vector density and the participation of other possible reservoirs within the domestic disease cycle. Furthermore, a deeper evaluation of the native vegetation, appointed by human action, is suggested.
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Declaration of Interest. The authors declare that there is no conflict of interest.

Ethical approval. The experimental protocol was approved by the Ethics Committee for the State University of Ceará Animal Use (CEUA/UECE), protocol nº 08622833-1.

REFERENCES


