J. Health Biol Sci. 2018; 6(2):128-132 doi:10.12662/2317-3076jhbs.v6i2.1755.p128-132.2018

ORIGINAL ARTICLE

Visceral Leishmaniasis hospitalizations and seasonality in Fortaleza, Ceará, Northeast Brazil between 2003 – 2012

Hospitalização por leishmaniose visceral e sazonalidade em Fortaleza, Ceará, Nordeste do Brasil entre 2003 e 2012

Robério Dias Leite[1,2], Renata Leal Meneses[3], Thais Fontes de Magalhães[4], Mauricio Yukio Ogawa[5], Hayssa de Oliveira Falcão[3], Anastácio de Queiroz Sousa[2,6]

1. Docente do Departamento de Saúde Materno-Infantil da Faculdade de Medicina da Universidade Federal do Ceará (UFC), Fortaleza, CE, Brasil. 2. Hospital São José de Doenças Infecciosas (HSJ) da Secretaria de Saúde do Estado do Ceará, Fortaleza, CE, Brasil. 3. Médica da Unidade de Pronto Atendimento (UPA) do Canindezinho, Fortaleza, CE, Brasil. 4. Programa de Pós-graduação em cirurgia pela Universidade Federal do Ceará (UFC), Fortaleza, CE, Brasil. 5. Discente do Curso de Medicina da Universidade Federal do Ceará (UFC), Fortaleza, CE, Brasil. 6. Docente do Departamento de Medicina Clínica e do Departamento de Patologia da Faculdade de Medicina da Universidade Federal do Ceará (UFC), Fortaleza, CE, Brasil.

Abstract

Introduction: The knowledge of the relationship between Visceral Leishmaniosis and climatic aspects is already well established in the literature of other countries, but lack data of this relationship in Brazil. **Objective:** This study aimed to describe the seasonal distribution of hospitalizations for Visceral Leishmaniosis (VL) in a referral hospital for infectious diseases located in an endemic area of the semiarid in the Northeast of Brazil. **Methods:** The number of monthly hospitalizations between 2003 and 2012 was recorded retrospectively and was correlated with climate variables. **Results**: During this period 1,302 patients were hospitalized. We observed an inverse relationship with the monthly amount of precipitation (r = - 0.725; p = 0.008), the number of days per month with precipitation (r = - 0.683; p = 0.0144) and relative humidity (r = - 0.746; p = 0.005) when compared with the monthly number of hospitalizations due to VL. Inversely, there was a direct relationship with the maximum monthly mean temperature and the number of hospitalizations due to VL (r = 0.643; p = 0.024). **Conclusions**: The rainy season, characterized by more rainfall and higher humidity, was correlated with fewer hospitalizations for VL. Conversely, in months with higher temperatures the number of hospitalizations for VL was higher.

Key words: Climate. Hospitalization. Leishmaniasis. Visceral.

Resumo

Introdução: O conhecimento da relação entre Leishmaniose Visceral e aspectos climáticos já é bem estabelecido na literatura em outros países. Entretanto, esse tipo de avaliação carece de mais evidências no Brasil. **Objetivo**: Descrever a distribuição sazonal das internações por Leishmaniose Visceral (VL) em um hospital de referência para doenças infecciosas localizadas em uma área endêmica do semiárido no Nordeste do Brasil. **Métodos**: o número de internações mensais entre 2003 e 2012 foi registrado retrospectivamente e correlacionado com as variáveis climáticas. **Resultados**: Durante esse período, 1.302 pacientes foram hospitalizados. Observou-se uma relação inversa entre o volume mensal de precipitações (r = - 0.725; p = 0,008), o número de dias por mês com precipitação (r = - 0.683; p = 0,0144) e a umidade relativa (r = - 0.746; p = 0,005) quando comparados com o número de hospitalizações mensais devido à VL. Inversamente, houve uma relação direta com a temperatura média mensal máxima e o número de internações por VL (r = 0,643; p = 0,024). **Conclusões**: a estação chuvosa, caracterizada por maior precipitação e maior umidade, foi correlacionada com menos internações por VL. Por outro lado, em meses com temperaturas mais elevadas, o número de hospitalizações por VL foi maior.

Palavras-chave: Clima. Hospitalização. Leishmaniose Visceral.

INTRODUCTION

Visceral Leishmaniasis (VL) is a zoonosis of significant burden that was first described by Leishman and Donovan in 1903[1], hence the name of its causing protozoal parasite: *Leishmania donovani*. It is transmitted to humans through the bite of an infected female phlebotomine sandflie of the *Phlebotomus* genus, in the Old World; and of the *Lutzomiya* genus, in the New World[2-5]. In Brazil, VL has mammals of the *Canidae* family as its main reservoir hosts[6]. Clinical presentation includes prolonged fever, fatigue, weight loss, liver and spleen enlargement and increased risks of hemorrhage and bacterial infections. Its incidence is arising in urban areas representing the second most common cause of death among all parasitic diseases and one of the most relevant diseases worldwide[7, 8]. VL is considered endemic in 98 countries and, according to the World Health Organization (WHO) estimates, there are 350 million people at risk of infection, another 12 million people currently infected and 2 million new cases occur annually[2]. In Latin America, Brazil is the country with the highest incidence of the disease, mostly concentrated in its Northeastern area[7, 9].

In the municipality of Fortaleza, state of Ceará, Brazil, 5,606 cases of VL were registered between 2003 and 2012, when 316 (5.6%) of which resulted in death[10]. Difficult access to health care system, diagnosis and treatment delays may contribute to

Correspondence: Maurício Yukio Ogawa. Rua Coronel Nunes de Melo, 1315 - Rodolfo Teófilo, Fortaleza – CE, CEP: 60430-160. E-mail: yukiogawa@gmail.com

Conflito de interesse: Não há conflito de interesse por parte de qualquer um dos autores.
Recebido em: 10 Set 2017; Revisado em: 19 Dez 2017; 4 Jan 2018; Aceito em: 9 Jan 2018

such high mortality rates[11].

The dynamics and incidence of VL transmission is considered to be closely related to social and economic factors[2, 12, 13], as well as environmental[13, 14] and climatic ones[2, 15, 16]. The latter includes use of land, soil coverage, topography, rainfall indexes, relative humidity, temperature and vegetation. Temperature and humidity play a major role on the vector mosquito's survival, development and activity; being sensitive to temperature changes, they prefer areas where thermal amplitude is smaller[15, 17]. Although a few species live inside trees and trunks, species geographically close to human houses live inside walls, especially breathable ones, which retain humidity during the night and gradually lose it during the day[3, 5]. Additionally, climate also influences host distribution and local vegetation[16]. Moreover, rainfall may increase disease distribution by allowing phlebotomine transportation to new areas[18].

Several studies[15,17,19-22] performed in different countries have found an association between climatic variables and VL incidence. Little is known on this issue in the state of Ceará, although VL's urbanization process is relatively new in our country and climatic factors may have played a role in such phenomenon[23]. Furthermore, we are currently going through a process of climate change worldwide, which to some extent may have an impact on the distribution of seasonal distribution of infectious diseases[24]. The aim of our study is to investigate if there is similar correlation of climate and seasonality on the number of patients admitted with VL in Fortaleza, Ceará, Northeast Brazil between 2003 – 2012.

MATERIAL AND METHODS

Data collection – We performed a retrospective, descriptive study using the data available in Hospital São José for Infectious Diseases, the reference hospital for infectious diseases in Fortaleza, Ceará, Brazil. Our study included every patient diagnosed with VL admitted in this hospital between January 1, 2003 and December 31, 2012, coming to a total of 1.302 patients. Patients are referred from different municipalities of Ceará, most of them from Fortaleza and neighboring cities (80.0%, according to the hospital's Epidemiological Surveillance Unit). We used the public domain data provided by the National Meteorology Institute (INMET) regarding monthly maximum, mean and minimum temperatures; monthly rainfall distribution and monthly relative air humidity in Fortaleza during that period. There is no data regarding the climatic variables representative of all municipalities in the state of Ceará.

Study area – Fortaleza is an urban area located on the seaside of the Atlantic Ocean, in Northeastern Brazil, within the latitude of 3º43'02"S and 3º32'35"S. It has a mean altitude of 21 meters (68 feet) and 34km (21 miles) of urban beaches. The city has an area of 313,8 km² (121 mi²) and, according to the 2012 census, is populated by 2.5 million people (25). The mean overall year temperature is around 26º C and the rainy season goes from January to May.

Data analysis – Spearman's rho coefficient test was used to determine possible correlations between the number of monthly hospital admissions of patients with VL and climatic variables (monthly mean temperature, relative air humidity and rainfall) over the 10 years of the study. (IBM© SPSS© Statistics Version 20)

Ethics – Ethical Committee approval was obtained (CAAE 27736914.4.0000.5044).

RESULTS

Between 2003 and 2012, 302 patients with VL were admitted in our hospital, representing 22.1% (1,302/5,884) of the reported cases in Ceará, Brazil[10]. The mean (range) annual and monthly number of hospitalizations due to VL was 108.5 (92 – 131) and 10.9 (3.6 – 17) respectively. During that period, the average number of yearly hospitalizations due to VL increased from 98.4 to 162.0 (64.6%) when we compare 2003-2007 and 2008-2012. The mean (range) annual and monthly number of days with: a) precipitations were 152.4 (116.0 – 175.0) and 12.7 (7.2 – 19.0) days; total precipitation were 1661.1 (1,033.3 – 2,369.5) and 138.8 (86.1 – 196.6) mm; maximum temperature were 31.2 (30.3 – 32.1) and 31.2 (30.5 – 32.2) ºC; minimum temperature were 23.7 (20.6 – 25.3) and 23.7 (21.4 – 24.6) ºC and relative humidity were 77.2 (70.4 – 85.1) and 77.2 (73.7 – 80.9) %. (Table 1).

Table 1. Climate variables between 2003 and 2012, Fortaleza-Ce, Brazil

Climate variable	Annual Mean (range)	Monthly Mean (range)
Days with precipitations	152.4 (116.0 – 175.0)	12.7 (7.2 – 19.0)
Total precipitation	1661.1 (1,033.3 – 2,369.5)	138.8 (86.1 – 196.6)
Maximum temperature (ºC)	31.2 (30.3 – 32.1)	31.2 (30.5 – 32.2)
Minimum temperature (ºC)	23.7 (20.6 – 25.3)	23.7 (21.4 – 24.6)
Relative humidity (%)	77.2 (70.4 – 85.1)	77.2 (73.7 – 80.9)

The number of days with precipitations, total precipitations and relative humidity were higher between January and June than between July and December 19.1 (13.9 – 23.8) days, 248.3 (135.5 – 394.7) mm, 81.4 (78.4 – 84.4) % vs 6.8 (4.9 – 9.5) days, 27.1 (8.3 – 68.1) mm, 73.2 (70.9 – 76.9) % respectively. Mean maximum temperatures ≥ 31º C were observed between August and February and mean minimum temperatures ≥ 24º C occurred between November and February. During that period, all those climate variables remained stable, without any tendency of increase or decrease. There was an inverse relationship with the monthly amount of precipitation (r = - *0.725*; p = *.008*), the number of days in the month with precipitations (r = - *0.683*; p = *.0144*) and relative humidity (r = - 0.746; p = *.005*) when compared with the number of hospitalizations due to VL (Figure

1, Figure 2 and Figure 3).

Figure 1. Mean monthly Viceral Leisshmaniasis hospitalizations and average rain fall between 2003 and 2012, Fortaleza, CE, Brazil.

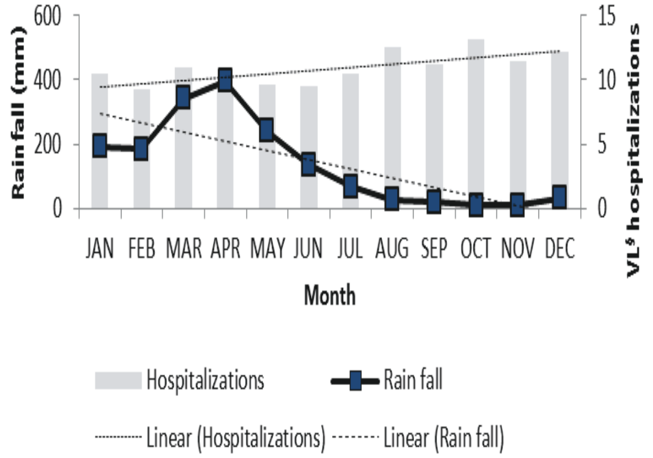


Figure 2. Mean monthly Viceral Leisshmaniasis hospitalizations and average days with precipitations between 2003 and 2012, Fortaleza, CE, Brazil.

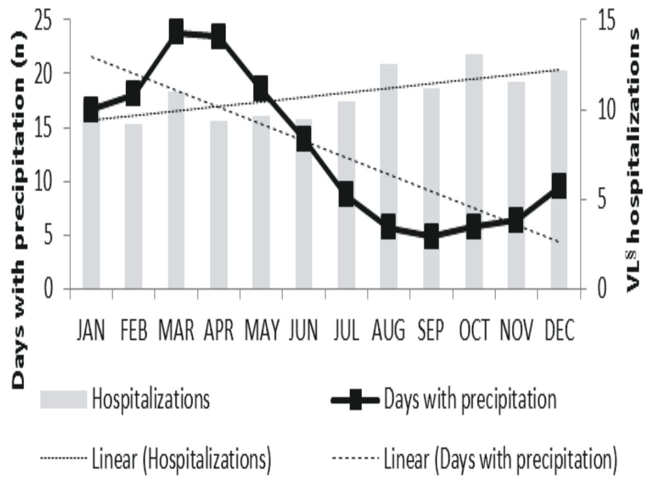
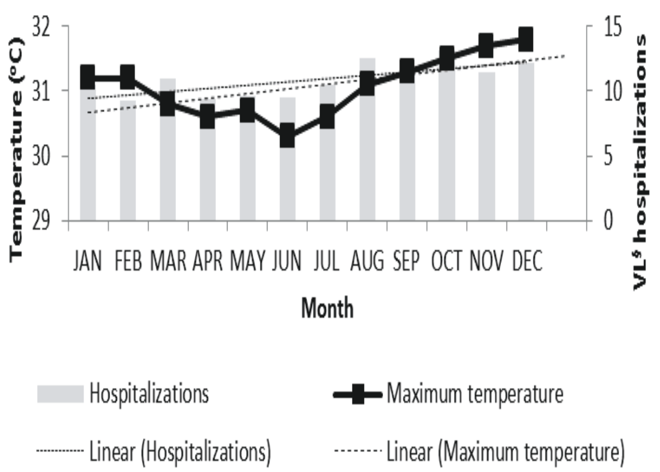
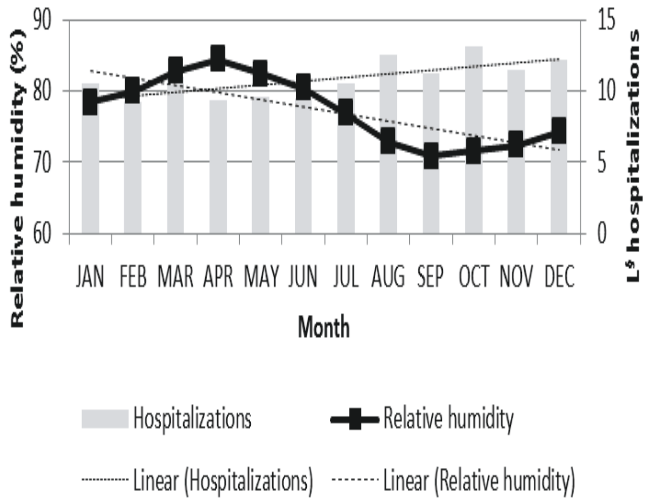


Figure 3. Mean monthly Viceral Leisshmaniasis hospitalizations and maximum temperature between 2003 and 2012, Fortaleza, CE, Brazil.



Inversely, there was a direct relationship with the maximum monthly mean temperature and the number of hospitalizations due to VL ($r = 0.643$; $p = .024$) (Figure 4). The number of monthly hospitalizations due to VL didn't correlate with the minimum monthly temperature variations ($r = -0.141$; $p = .661$).

Figure 4. Mean monthly Viceral Leisshmaniasis hospitalizations and average relative humidity between 2003 and 2012, Fortaleza, CE, Brazil.



DISCUSSION

There is a growing interest in understanding the interaction between climate and infectious diseases. Although the state of Ceará stands out in the number of VL cases in Brazil, little has been described so far about possible interactions between the disease and climate, which could be useful in planning health actions to control this endemic disease. Between the first and the second half of the 10 year period analyzed in our study, there was a significant increase (64.6%) in VL hospitalizations in Hospital São José, which accounts for about one quarter of reported cases of the disease in Ceará. It seems therefore reasonable to infer that our hospital could represent a mirror of seasonal variations in the distribution of VL cases in our region, although the fact that this hospital constitutes reference for more severe cases may represent a bias. Another possible weakness of our study is that we didn't investigate the incubation time, in view of difficulties such as the onset of symptoms of the patient's consciousness itself. In agreement with this inference, the official epidemiological data also showed an increase of VL cases in the same period (10). In turn, between 2003 and 2012, although with expected fluctuations, the regimen of precipitation, maximum and minimum temperatures and relative humidity demonstrated no significant trends of changes. In line with historical climate records in Ceará, the rainy season is concentrated in the first half of the year, when it is also observed a higher relative humidity. Higher temperatures are concentrated between November and February (FUNCEME Database).

Our study denotes that months with higher precipitations records and humidity levels were associated with a decrease in the number of VL cases. This may be due to a lower reproduction capacity of the vector under these conditions. In agreement with this, Andrade et al.,(2012) had studied phlebotomine fauna by capturing sandflies. They demonstrated a higher burden of *Lutzomyia longipalpis* infestation after the rainy season and recommended that control measures should be reinforced in such seasons[26]. However, these data are not in line with other series of reports also in the Brazilian Northeast; they can be assigned to other climate variables[27]. Although vector larvae need a humid environment to grow, first instar larvae are not resistant to water submersion, and thus rainy periods show a smaller chance of instar transition due to accumulated water. Alternatively, increased levels of infestation by the *Aedes aegypti* mosquito on this period of the year may, in theory, pose a competitive disadvantage for *Lutzomyia longipalpis* mosquitoes. Since this time period of the year also shows lower temperatures, which in turn were not associated with changes in number of hospitalizations for VL, this climatic variable does not seem to be critical for the reproduction of the kala-azar vector. On the other hand, there is evidence that most sandflies species' biting activity happens at twilight and may continue through the night, which are naturally cooler periods of the day. This shows that such vectors have a higher affinity for dark, cool environments[28].

One additional question is whether the well-known socioeconomic aggravations and consequent increase of malnutrition caused by periods of drought could be related or not to further predisposition infection fragility of the human host, especially in children, which could represent an issue for new studies to assess this plausible relationship.

According to our data, higher maximum temperatures were significantly correlated with an increase in the number of hospitalizations for VL. This is probably explained by the fact that environment warming favors vector reproduction. In addition to this, an accelerated process of urbanization is associated to poor socioeconomic conditions[29], in geographic spaces characterized by poverty, child malnourishment, garbage accumulation and abandoned animals. This results in a potential habitat for vectors, and thus contributes to disseminating Leishmaniasis. This evidence leads to a reflection on how the expanding endemics in Brazil and the increase in the number of VL cases that followed the rapid urbanization process in the country in the last two decades would be related to the elevation in mean temperature seen in the larger cities. While studying the interaction among Lutzomyia sandflies sp and specific chemical compound, Silva and colleagues found that carbonic acid was a chemical attractant for phlebotomine flies (30). Moreover, such evidence leads to questioning, on a future perspective, the impact that climate change related to global warming may have on VL incidence, as it predisposes the geographic expansion of VL and a rise in the number of VL cases in already endemic areas.

In conclusion, although VL is highly prevalent in the state of Ceará, Brazil, there are few studies concerning its association with climate and seasonality. In this study, we observed that precipitation and air humidity levels were inversely related to number of hospitalizations due to VL, and that mean maximum temperatures were directly related to hospitalization rates in the reference hospital for infectious diseases at Ceará, Brazil.
Climatic changes such as global warming may favor vector reproduction, thus leading to an increase in the incidence of VL worldwide. We encourage that similar studies should be carried out in other geographic areas to further assess the relationship between phlebotomine reproduction, VL incidence and climatic variables.

REFERENCES

1. Donovan C. A possible cause of kala-azar. Indian Med Gaz. 1903Dec; 38(12): 478.

2. World Health Organizaion. Control of the leishmaniases: report of a meeting of the WHO Expert Committee on the Control of Leishmaniases. Geneva 22-16 March 2010. Geneva: WHO; 2010. WHO Technical Report Series 949.

3. Sharma U, Singh S. Insect vectors of Leishmania: distribution, physiology and their control. J Vector Borne Dis. 2008; 45(4):255-72.PubMed PMID: 19248652.

4. Desjeux P. Leishmaniasis: current situation and new perspectives. Comp Immunol Microbiol Infect Dis. 2004 Sep; 27(5):305-18. doi: 10.1016/j.cimid.2004.03.004. PubMed PMID: 15225981.

5. Killick-Kendrick R. The biology and control of phlebotomine sand flies. Clin Dermatol. 1999 May-Jun;17(3):279-89. PubMed PMID: 10384867.

6. Gontijo CMF, Melo MN. Visceral Leishmaniasis in Brazil: current status, challenges and prospects. Rev Bras Epidemiol. 2004 Sept;7(3):338-49. doi: http://dx.doi.org/10.1590/S1415-790X2004000300011.

7. Monteiro EM, Silva JC, Costa RT, Costa DC, Barata RA, Paula EV, et al. Leishmaniose visceral: estudo de flebotomíneos e infecção canina em Montes Claros, Minas Gerais. Rev. Soc. Bras Med. Trop. 2005 Mar-Abr; 38(2):147-52. doi: http://dx.doi.org/10.1590/S0037-86822005000200004.

8. Oliveira CD, Assuncao RM, Reis IA, Proietti FA. Spatial distribution of human and canine visceral leishmaniasis in Belo Horizonte, Minas Gerais State, Brasil, 1994-1997. Cad Saude Publica. 2001Sep-Oct;17(5):1231-9. PubMed PMID: 11679897.

9. Maia-Elkhoury AN, Alves WA, Sousa-Gomes ML, Sena JM, Luna EA. Visceral leishmaniasis in Brazil: trends and challenges. Cad Saude Publica. 2008 Dec; 24(12):2941-7. doi: http://dx.doi.org/10.1590/S0102-311X2008001200024 .

10. Secretaria de Saúde (CE). Leishmaniose. Informe Epidemiológico. 2014 Ago. 1-12.

11. Freitas JCC, Sampaio AP Filho, Santos GJL, Lima AL, Nunes-Pinheiro DCS. Analysis of seasonality, tendencies and correlations in human and canine visceral leishmaniasis. Acta Scientiae Veterinariae. 2013; 41:1151.

12. Cortes S, Afonso MO, Alves-Pires C, Campino L. Stray dogs and leishmaniasis in urban areas, Portugal. Emerg Infect Dis. 2007 Sep;13(9):1431-2. doi: 10.3201/eid1309.070101.

13. Sutherst RW. Global change and human vulnerability to vector-borne diseases. Clin Microbiol Rev. 2004 Jan;17(1):136-73. doi: 10.1128/CMR.17.1.136-173.2004.

14. World Health Organization. Releve epidemiologique hebdomadaire / Section d'hygiene du Secretariat de la Societe des Nations. Wkly Epidemiol Rec. 2002;77(44):365-70.

15. Amin MR, Tareq SM, Rahman SH, Uddin MR. Effects of Temperature, Rainfall

and Relative Humidity on Visceral Leishmaniasis prevalence at two highly affected Upazilas in Bangladesh. Life Sci J. 2013 Jan;10(4):1440-6.

16. Kuhn KG. Global warming and leishmaniasis in Italy. TBull Trop Med Int Health. 199; (7):1-2.

17. Bounoua L, Kahime K, Houti L, Blakey T, Ebi KL, Zhang P, et al. Linking climate to incidence of zoonotic cutaneous leishmaniasis (L. major) in pre-Saharan North Africa. Int J Environ Res Public Health. 2013 Aug; 10(8):3172-91. doi: 10.3390/ijerph10083172.

18. Rajesh K, Sanjay K. Change in global Climate and Prevalence of Visceral Leishmaniasis. International Journal of Scientific and Research Publications. 2013 Jan; 3(1):1-2.

19. Bhunia GS, Kesari S, Chatterjee N, Kumar V, Das P. The Burden of Visceral Leishmaniasis in India: Challenges in Using Remote Sensing and GIS to Understand and Control. ISRN Infectious Diseases. 2013; 2013:14. doi: http://dx.doi.org/10.5402/2013/675846

20. Salahi-Moghaddam A, Mohebali M, Moshfae A, Habibi M, Zarei Z. Ecological study and risk mapping of visceral leishmaniasis in an endemic area of Iran based on a geographical information systems approach. Geospatial Health. 2010 Nov; 5(1): 71-7. doi: 10.4081/gh.2010.188.

21. Ben-Ahmed K, Aoun K, Jeddi F, Ghrab J, El-Aroui MA, Bouratbine A. Visceral leishmaniasis in Tunisia: spatial distribution and association with climatic factors. Am J Trop Med Hyg. 2009 Jul; 81(1):40-5.

22. Dahal S. Climatic determinants of malaria and kala-azar in Nepal. Regional Health Forum 2008;12(1):32-7.

23. Dias Fde O, Lorosa ES, Rebelo JM. Fonte alimentar sangüínea e a peridomiciliação de Lutzomyia longipalpis (Lutz & Neiva, 1912) (Psychodidae, Phlebotominae). Cad Saude Publica. 2003 Set-Out; 19(5):1373-80. doi: http://dx.doi.org/10.1590/S0102-311X2003000500015.

24. Patz JA, Githeko AK, McCarty JP, Hussein S, Confalonieri U. Climate change and infectious diseases In: World Health Organization., editor. Climate change and human health. Geneva: WHO; 2003. p. 103-32.

25. Instituto Brasileiro de Geografia e Estatistica. Perfil dos municípios brasileiros - 2012. Rio de Janeiro: IBGE; 2012.

26. Andrade ARO, Dorva MEMC, Andrade SMO, Marques A, Silva BAK, Andreotti R. Phlebotomine fauna in the Ponta Porã city: epidemiological importance in border line between Brazil and Paraguay. Asi Pac J Trop Dis. 2012 Oct; 2(5):362-6. doi: 10.1016/S2222-1808(12)60079-6.

27. Viana GM, Nascimento Mdo D, Rabelo EM, Diniz Neto JA, Binda Junior JR, Galvao Cde S, et al. Relationship between rainfall and temperature: observations on the cases of visceral leishmaniasis in Sao Luis Island, State of Maranhao, Brazil. Rev Soc Bras Med Trop. 2011 Nov-Dec; 44(6): 722-4. PMID: 22231245.

28. Galati EAB. Biologia, sistemática e noções práticas para o conhecimento de flebotomíneos: curso de controle integrado de vetores – USP. São Paulo: USP; 2000.

29. Dociu M. The Socio-Economic Impact of Urbanization. International Journal of Academic Research in Accounting, Finance and Management Sciences. 2012; 2(1): 47-52.

30. Silva DF, Vasconcelos SD, Eiras AE. Análise de atrativos químicos na coleta de flebotomineos em uma área de mata atlântica da cidade de Recife, Pernambuco, Brasil . Bol Mus Int Roraima. 2013; 7(1):24-7.

Como citar este artigo/How to cite this article:

Leite RD, Meneses RL, Magalhães TF, Ogawa MY, Falcão HO, Sousa AQ. Visceral Leishmaniasis hospitalizations and seasonality in Fortaleza, Ceará, Northeast Brazil between 2003 – 2012. J Health Biol Sci. 2018 Abr-Jun; 6(2):128-132.