Cogitare Enfermagem

ORIGINAL ARTICLE

Spatial-temporal analysis of hospitalizations due to leptospirosis 2007-2022

HIGHLIGHTS

1. The Northwest, Center and South regions presented higher rates.
2. Clusters 1, 3 and 4 presented high relative risk.
3. Cluster 2 presented low relative risk.
4. Cluster 1 encompassed the largest set of municipalities in the state.

Mercedes de Oliveira Neto[1]
Mario Ribeiro Alves[1]
Aline Thomaz da Conceição Lucena[1]
Tatiana Rodrigues de Araujo Eleuterio[1]

ABSTRACT

Objective: To analyze the spatial-temporal distribution of the mean rates corresponding to hospitalizations due to leptospirosis during the 2007-2022 period, using the municipalities from the state of Rio de Janeiro as analysis units. **Method:** An ecological and analytical study conducted secondary data in the public domain. Annual hospitalization rates per 100,000 inhabitants and mean rates for each quadrennium of the period were calculated. A spatial autocorrelation analysis as per the Bivariate Local Moran Index was performed, as well as a spatial-temporal analysis. **Results:** The Northwest, Center and South regions of the state presented higher rates. In the spatial-temporal analysis, clusters 1, 3 and 4 presented high relative risk; in turn, Cluster 2 was categorized as low relative risk. In the spatial distribution, Cluster 1 encompassed the largest set of municipalities in the state. **Conclusion:** The disease is more frequent in territories characterized by social inequalities, where lack of public policies targeted at improving basic services and quality of life for the population stand out.

DESCRIPTORS: Ecological Studies; Epidemiology; Leptospirosis; Hospitalization; Spatio-Temporal Analysis.

HOW TO REFERENCE THIS ARTICLE:
Neto MO, Alves MR, Lucena ATC, Eleuterio TRA. Spatial-temporal analysis of hospitalizations due to leptospirosis 2007-2022. Cogitare Enferm [Internet]. 2026 [cited "insert year, month and day"];31:e103018en. Available from: https://doi.org/10.1590/ce.v31i0.103018en

[1]Universidade do Estado do Rio de Janeiro, Rio de Janeiro, RJ, Brasil.

INTRODUCTION

Leptospirosis is a febrile infectious disease of sudden onset with a clinical spectrum that can range from a subclinical process to severe forms. It is transmitted by direct exposure (through contact with an infected animal) or by indirect exposure (through soil or water contaminated with urine from rodents infected by the *Leptospira* bacterium, which penetrates injured skin or intact skin immersed in contaminated water for extended periods of time). Its incubation period varies from 1 to 30 days, with a mean of between 5 and 14[1].

It is considered a seasonal disease, with epidemics during rainy seasons or after natural disasters in tropical climate countries; in addition, high heat and humidity conditions collaborate for this bacterium to survive in the environment[2]. Its incidence is closely linked to environmental factors, with inundations and floodings as the most frequent ways of contracting the disease[3].

Extreme climactic events bring about significant repercussions in people's health, and environmental and socioeconomic factors are considered as elements that exert an influence on the emergence of leptospirosis cases. Both the precarious public services offered to population groups concentrated in disorganized settlements and overcrowding favor the proliferation of disease-causing vectors, increasing vulnerability among the population[4].

A number of studies[3-6] have evidenced that environmental and socioeconomic factors are associated with the emergence of leptospirosis cases in the state of Rio de Janeiro. The increasing and disorderly urbanization process as a generator of unhealthy physical and social environments, lack of basic sanitation (mainly in *favelas*) and frequent exposure to contamination during rainy and flood periods, as well as high demographic density with large population groups simultaneously subjected to environmental conditions that favor spread of this disease, are relevant factors for the incidence of leptospirosis in urban regions.

For being a disease related to environmental, socioeconomic and sanitation factors and considering its impact on the population health, facing it represents an important Public Health challenge. The objective of this study was to analyze the spatial-temporal distribution of the mean rates corresponding to hospitalizations due to leptospirosis during the 2077-2022 period, using the municipalities from the state of Rio de Janeiro as analysis units.

METHOD

An ecological and analytical study was conducted, resorting to secondary data and to the spatial-temporal analysis methodology.

The hospitalizations due to leptospirosis (icterohemorrhagic leptospirosis, other forms of leptospirosis and unspecified leptospirosis)[7] were obtained between September and November 2023 from the Mandatory Notification Diseases Information System (*Sistema de Informação de Agravos de Notificação*, SINAN) managed by the Ministry of Health[8], considering the municipalities of residence from the state of Rio de Janeiro as analysis units, by notification year during the 2007-2022 period. The source used for the estimated annual population by municipality was the Brazilian Institute of Geography and Statistics demographic census[9]. Annual rates corresponding to hospitalizations due to leptospirosis by 100,000 inhabitants were calculated, to subsequently calculate mean rates for each quadrennium of the study period (2007-2010, 2011-2014, 2015-2018, 2019-2022).

In addition to that, possible explanatory variables were collected for the spatial autocorrelation with the mean leptospirosis incidence rate for the entire period. The following variables were gathered from the Human Development Atlas in Brazil: percentage of people registered in the Unified Registry without proper garbage collection (2017); percentage of people living in extreme poverty in the Unified Registry post-*Bolsa Família* (2017); percentage of people in the Unified Registry post-*Bolsa Família* (2017); and percentage of vulnerable people in terms of poverty in the Unified Registry post-*Bolsa Família* (2017)[10].

The following variables were obtained from the Applied Economics Research Institute (*Instituto de Pesquisa Econômica Aplicada*, IPEA) based on the last data recorded in 2017: percentage of workers with formal employment contracts, percentage of autonomous workers and percentage of unpaid workers (all referring to individuals aged at least 18 years old), in addition to Social Vulnerability Index and Gini Index[11].

The Industry Federation from the State of Rio de Janeiro (*Federação das Indústrias do Estado do Rio de Janeiro*, FIRJAN) was the source consulted to obtain the 2025 FIRJAN Municipal Development Index (FMDI), a variable that is calculated based on health, education, employment and income indices[12]. The following variables referring to the 2007-2022 period were collected from the SUS Information and Informatics Department (DataSUS): percentage of the population earning monthly incomes of less than half a minimum wage, percentage of the population earning monthly incomes of less one-fourth of a minimum income; percentage of households connected to the general network (without pipeline information), percentage of households connected to the sewage or pluvial general network, and percentage of households with garbage collected by cleaning companies[13].

All of the aforementioned variables were organized by the respective municipalities in question, considering all those that presented statistically significant spatial correlations with the mean rate for the entire period, taking a 5% significance level into account.

The aforementioned spatial autocorrelation analysis was calculated by means of the Bivariate Local Moran Index, with autocorrelation values classified into the following strata: High-High, Low-High, High-Low and Low-Low. The analyses were performed in GeoDa (version 1.14.0.0).

In relation to the spatial-temporal analysis, a Kulldorff's cylindrical space-time scan statistic test with a 50-kilometer radius was performed, identifying leptospirosis clusters based on the population of each municipality. High and low risk clusters were identified by comparing the number of cases observed to the number of cases expected, only selecting the statistically significant clusters considering a 5% significance level[14]. That analysis was performed in SaTScan (version 9.6). The thematic maps were prepared in QGIS (version 2.18.20).

It is worth noting that, as described in National Health Council Resolution No. 466 dated December 12th, 2012, this study was not submitted to any Ethics Committee for using public domain data not including any personally identifiable information.

RESULTS

A total of 1,783 hospitalization records were identified throughout the study period, with 2009, 2010, 2018, 2019 and 2022 as the years presenting the highest absolute numbers (176, 223, 131, 144 and 139 hospitalizations, respectively). In relation to the rates calculated by quadrenniums, the municipalities from the Northwest, Center and South regions of the state presented higher rates. It is noted that, in general, there were

more municipalities with lower rates in the first period (2007-2010) and that higher rates were noticed in the third and fourth study periods (2015-2018, 2019-2022) (Figure 1).

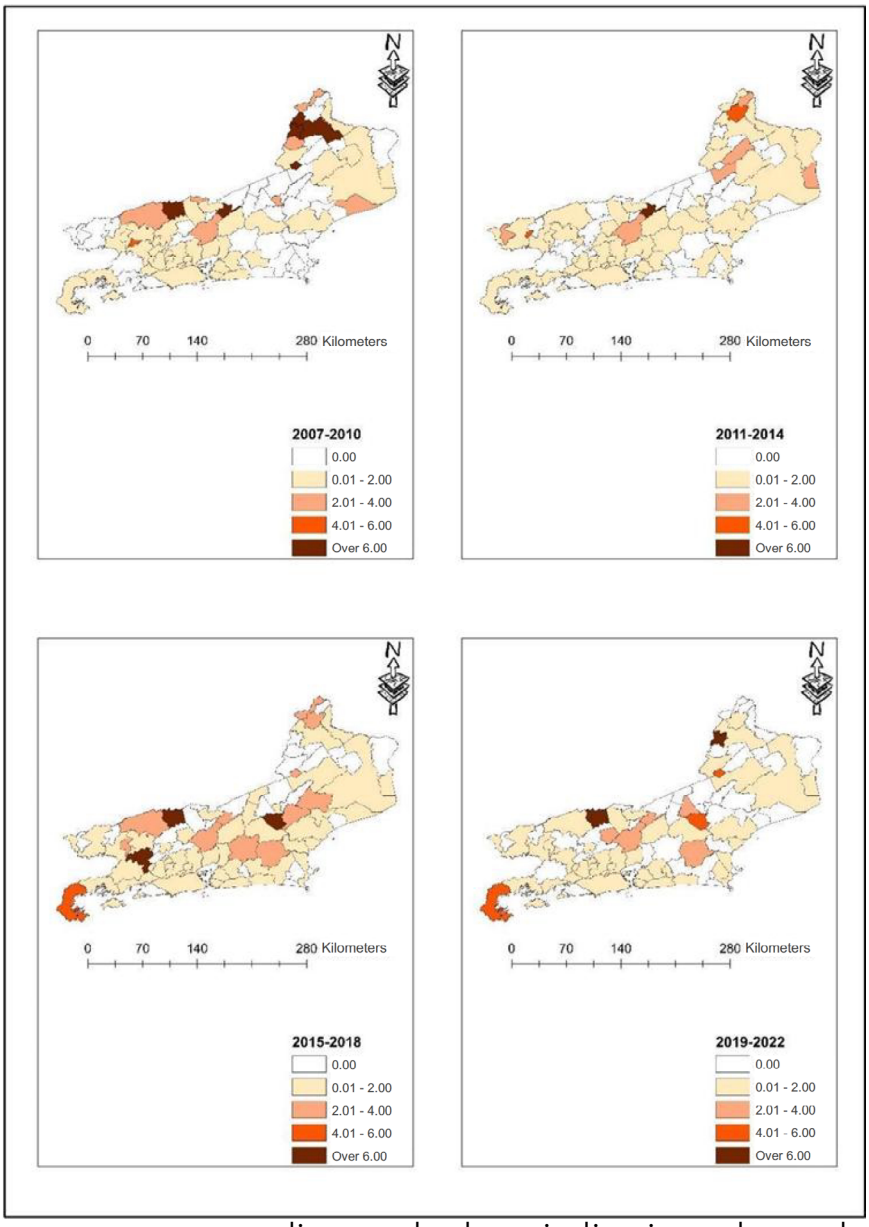

Figure 1. Mean rates corresponding to the hospitalizations due to leptospirosis, by study periods. Rio de Janeiro, RJ, Brazil, 2007-2022

Source: The authors, adapted from[8-9] (2023).

As for the spatial autocorrelations between the mean rate corresponding to the entire period (2007-2022) and the explanatory variables, the following ones were statistically significant (with their respective Bivariate Local Moran Index values): FIRJAN Index (FMDI) (0.087), percentage of people registered in the Unified Registry without proper garbage collection (0.087), percentage of the population earning monthly incomes of less than half a minimum wage (0.082) and percentage of households with garbage collected by cleaning companies (-0.056). The municipalities from the Center-South (High-High autocorrelations with the first two variables cited) and Center-East (Low-Low autocorrelations with all the variables in question) regions stood out (Figure 2).

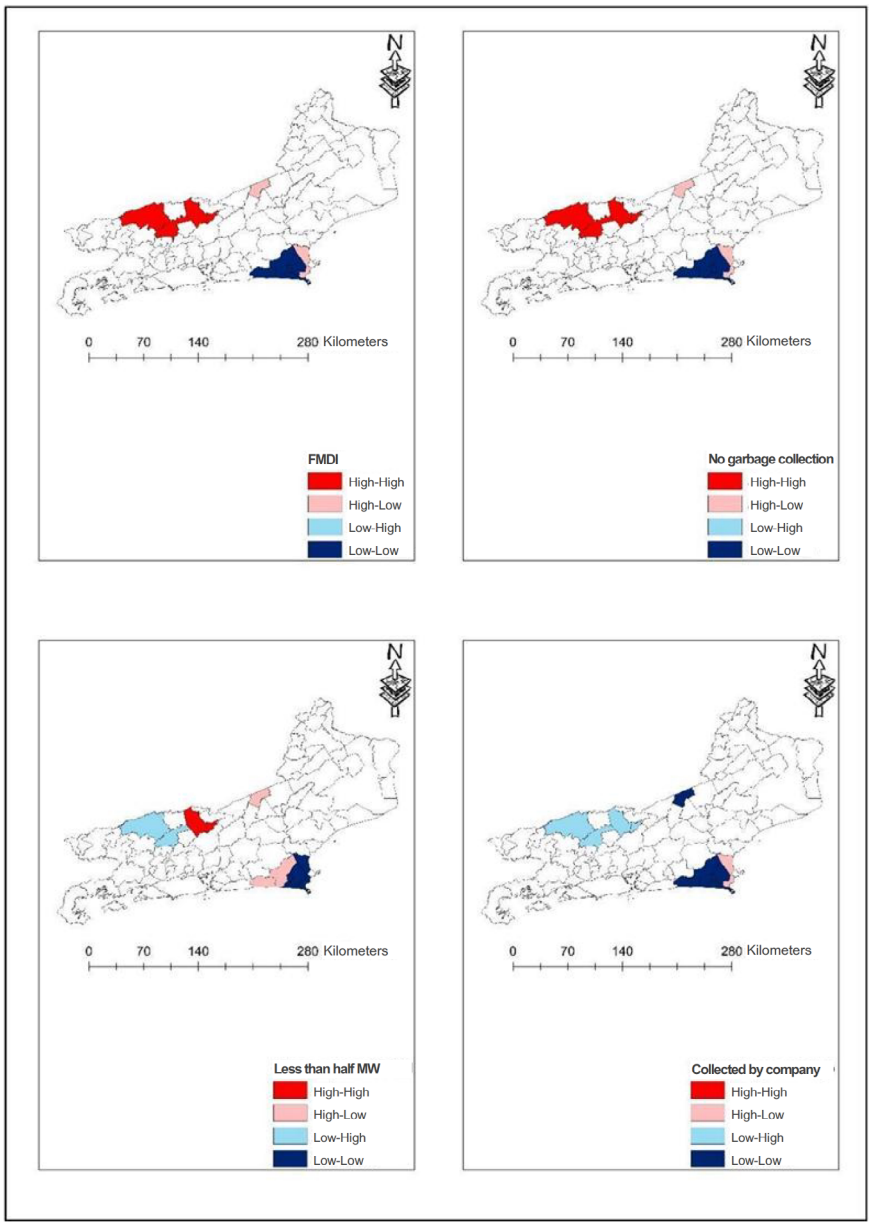

Figure 2. Spatial autocorrelations between explanatory variables and mean rates corresponding to hospitalizations due to leptospirosis. Rio de Janeiro, RJ, Brazil, 2007-2022

Source: The authors, adapted from[8-9] (2023).

As for the spatial-temporal analysis, four clusters were obtained, with 1, 3 and 4 characterized as of high risk (Relative Risk values of 3.19, 2.70 and 3.14, respectively). Cluster 2 was characterized as of low Relative Risk (0.53). Regarding the spatial distribution, Cluster 1 encompassed the highest number of municipalities in the state (including the Northwest, Northeast and Midwest regions) when compared to the other clusters, which corresponded to the municipalities in the Metropolitan Region (clusters 2 and 4) and in the South (Cluster 3) of the state (Figure 3).

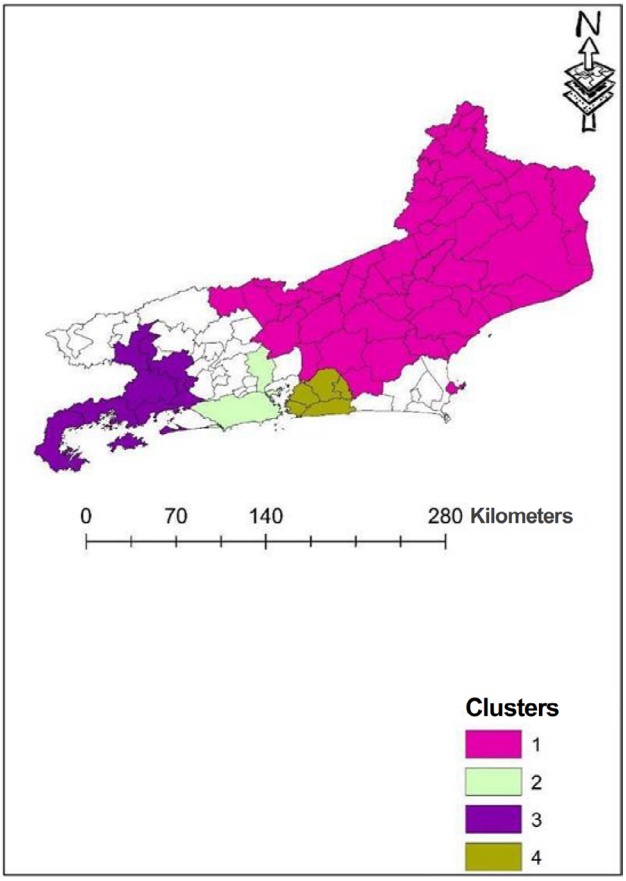

Figure 3. Spatial-temporal clusters corresponding to the hospitalizations due to leptospirosis, Rio de Janeiro, RJ, Brazil, 2007-2022

Source: The authors, adapted from[8-9] (2023).

DISCUSSION

Recent Brazilian studies reinforce the association between leptospirosis and socioeconomic vulnerability indicators that was identified in this study. A research study conducted in southern Brazil[15] evidenced that socioeconomic and geographical factors such as absence of garbage collection services, precarious sanitation and low incomes are directly related to incidence of this disease, corroborating the spatial autocorrelation pattern that was observed in this study between hospitalizations due to leptospirosis and these same variables.

Similarly, a retrospective spatial-temporal study conducted in the state of Sergipe[16] identified that risk clusters were formed in municipalities from the Metropolitan Area, associated with social inequalities; it also underscored persistent transmission of the disease in urban areas presenting deeper vulnerability, reinforcing the relevance of performing spatial analyses to devise health surveillance public policies.

As for the spatial-temporal distribution of leptospirosis in other Brazilian states, a study conducted between 2020 and 2024 in Espírito Santo[17] used the Kernel density estimation method and identified higher concentration of cases in the South and Metropolitan regions of the state, associated with socioenvironmental determinants and corroborating the spatial heterogeneity pattern detected in this study for Rio de Janeiro. In turn, an epidemiological survey implemented in Rio Grande do Sul after the 2024 floods[18] recorded an expressive increase in the number of confirmed leptospirosis cases, evidencing the role played by extreme climactic events as triggering factors

for outbreaks of the disease and reinforcing the need for intensified surveillance in environmental disaster scenarios, which have become more frequent in the country.

At the international level, a spatial-temporal study developed between 2004 and 2023 in the province of Anhui (China)[19] identified high risk clusters whose distribution varied over time, associated with climactic factors such as temperature, rainfall and vegetation cover, indicating that, as noticed in the current study, leptospirosis presents a dynamic spatial pattern sensitive to environmental determinants.

Complementarily, a geospatial analysis performed in two provinces from the Dominican Republic[20] identified seroprevalence clusters associated with specific environmental and sociodemographic factors, reinforcing that the distribution of leptospirosis is consistently related to social and environmental vulnerability conditions regardless of the geographical context, which situated the findings detected in this study in line with the international literature on the topic.

Some studies[3-5] have shown persistent leptospirosis transmission in the state of Rio de Janeiro, evidencing it as an important Public Health problem in one of the main Brazilian Federation units. Nevertheless and despite this scenario, for being a neglected disease, leptospirosis has not yet been considered as a topic requiring studies or scheduled intervention measures[6].

For being an endemic disease characterized by acute febrile symptoms, leptospirosis transmission is commonly associated with inadequate hygiene conditions, lack of basic sanitation and overcrowding, with higher risk of exposure to urine from contaminated rodents. Studies conducted in urban areas show incidence of this disease in places characterized by potential environmental and social vulnerability, mainly in areas that have recently witnessed population growth and are marked by accumulated recyclable waste that floods residential places, generating settings that are favorable for rodents' reproduction and exerting an influence on the increased risk for leptospirosis transmission[5,13,21-23].

Based on the results of the current study, significant autocorrelations were observed between the mean rate corresponding to hospitalizations due to leptospirosis during the study period and the variables related to population groups' exposure to socioeconomic vulnerability (no garbage collection, no garbage collection in charge of a specific service and incomes below half a minimum wage), corroborating the aforementioned considerations. The significant autocorrelation between high values in the rates corresponding to hospitalizations due to leptospirosis and high FMDIs also stands out, which can be explained by the fact that areas with higher development indices enjoy better structure and access in terms of health services, whereas areas with worse development indices tend to show worse access conditions regarding health services[24], leading to a scenario of a positive correlation between more hospitalizations and higher FMDI values (understood as a proxy for higher incomes).

In addition to that and as observed in the scientific literature, indicators reflecting low socioeconomic levels and inefficient sewage and garbage collection systems were associated with leptospirosis transmission in municipalities from the Rio de Janeiro Metropolitan Region, indicating that the epidemiology of this disease is a consequence of disorderly urban growth, aggravated by inefficient provision of environmental sanitation services[2].

Studies on the epidemiology of leptospirosis in urban areas show higher transmission rates in areas characterized by deeper socioenvironmental vulnerability, with agriculture-related traits and anthropic actions, characteristics inherent to places that have witnessed recent population growth. In addition, habits related to accumulating recyclable materials around houses end up generating settings that are favorable for the population of rodents to grow, increasing the transmission risk for the disease in

question[5,21-23]. This can be an indication of inadequate garbage collection, a finding that is consistent with the significant spatial autocorrelation observed in this study between hospitalization rates and percentage of households without proper garbage collection services.

Inadequate garbage transportation (observed in places that are expanding without popper sanitation structures) collaborates to the transmission of water-borne diseases as a consequence of water and soil contamination, which can be further aggravated by precarious personal hygiene habits. In a city from the Brazilian Northeast inland, deteriorated roads with accumulated waste were observed (also with garbage accumulated in vacant lots or being burned), with water pooling and woodlands, characteristic features of areas considered semi-urban and deepening favorable conditions for the proliferation of endemic diseases. Garbage accumulation involves cultural and political issues (given the burning practice, which ends up polluting the air) and is sustained by non-responsibility education, a consequence of the economic model characterized by excessive production of goods that generate waste and degrade the environment when consumed[25-26].

Corrective measures in relation to the environment and improvements in the sanitation system stand out among the main actions to be noted aiming to prevent leptospirosis. However, it is necessary to highlight the role played by citizens themselves as main and active environmental agents, with the need to stimulate healthy occupation of urban settings. In addition, it is important to note the stimulus to considering citizens both as belonging to nature and as elements of it, with duties and responsibilities. If any imbalance strikes this relationship, human beings will have to assume the consequences, inasmuch as we produce reality and are at once recipients of what we have devised[25-26].

As for preventive actions in the context of communicable diseases, the importance stands out of measures leading to sensitizing citizens based on incorporating a sense of belonging to the city, understood as a space for the coexistence of collective groups. At the same time, more involvement of public authorities is expected in terms of implementing periodic garbage collection services. In addition, for dealing with diseases transmitted via water bodies, precautions regarding drinking water and proper garbage disposal should be enhanced. It is also recommended to avoid direct contact with flooding waters, aiming to minimize exposure to rodents[13,27].

In relation to the limitations of this study, a possible underestimation regarding the actual epidemiological situation of this disease in the state of Rio de Janeiro stands out, considering that its benign or atypical forms can be manifested (hindering diagnosis and not representing a hospitalization criterion), as observed in children from Salvador. Furthermore, the large number of SINAN forms with empty/unknown fields may have resulted in omitting relevant information about the actual situation concerning the disease, hindering the adoption of health surveillance measures.

CONCLUSION

This study identified higher rates corresponding to hospitalizations due to leptospirosis in the Northwest, Center and South regions of the state of Rio de Janeiro, as well as a significant spatial autocorrelation between the disease and socioeconomic vulnerability and sanitation indicators, with inadequate garbage collection and family incomes below half a minimum wage standing out. For being a neglected disease that is more frequent in areas characterized by social inequalities, leptospirosis is one of the consequences of lack of basic sanitation, linked to accumulation of waste and of materials resulting from citizens' goods consumption, generating conditions that are favorable for the reproduction of host rodents. Deficiency or irregularity in terms of garbage collection services end up contributing to the aforementioned scenario

and should be highlighted as absence of public authorities as for the basic services provided, which should be urgently revisited aiming to reduce the transmission risk for this and other endemic diseases, in addition to improving the population quality of life.

The findings reinforce the relevance of prioritizing basic sanitation and periodic garbage collection public policies in the areas identified as of higher risk, supporting plans for targeted health surveillance actions and contributing to reducing the social inequalities associated with the incidence of leptospirosis.

The importance of digital mapping techniques is noted, as they represent a support tool for environmental and health planning actions, allowing constructing scenarios with potential risk regarding communicable diseases and illustrating priority areas for intervention measures. On the other hand, it is necessary to note the importance of sensitizing the population as for waste generation and disposal, aiming to avoid environmental conditions that favor increased risks for leptospirosis transmission.

REFERENCES

1. Ministério da Saúde (BR). Guia de vigilância em saúde: volume 3 [Internet], Brasília: Ministério da Saúde; 2024 [cited 2025 Jun 20]. 238 p. Available from: https://www.gov.br/saude/pt-br/centrais-de-conteudo/publicacoes/svsa/vigilancia/guia-de-vigilancia-em-saude-volume-3-6a-edicao/view

2. Barcellos C, Sabroza P. The place behind the case: leptospirosis risks and associated environmental conditions in a flood-related outbreak in Rio de Janeiro. Cad Saude Publica [Internet]. 2001 [cited 2026 Jun 5];17(Suppl):59-67. Available from: https://doi.org/10.1590/S0102-311X2001000700014

3. Guimarães RM, Cruz OG, Parreira VG, Mazoto ML, Vieira JD, Asmus CIRF. Análise temporal da relação entre leptospirose e ocorrência de inundações por chuvas no município do Rio de Janeiro, Brasil, 2007-2012. Cienc Saude Colet [Internet]. 2014 [cited 2026 Jun 5];19(9):3683-92. Available from: https://doi.org/10.1590/1413-81232014199.06432014

4. de Oliveira TVS, Marinho DP, Costa Neto C, Kligerman DC. Variáveis climáticas, condições de vida e saúde da população: a leptospirose no Município do Rio de Janeiro de 1996 a 2009. Cienc Saude Colet [Internet]. 2012 [cited 2025 Jun 20];17(6):1569-76. Available from: https://doi.org/10.1590/S1413-81232012000600020

5. Chaiblich JV, Lima MLS, de Oliveira RF, Monken M, Penna MLF. Estudo espacial de riscos à leptospirose no município do Rio de Janeiro (RJ). Saude Debate [Internet]. 2017 [cited 2025 Jun 5];41(Spe 2):225-40. Available from: https://doi.org/10.1590/0103-11042017S219

6. Tassinari WS, Pellegrini DCP, Sabroza PC, Carvalho MS. Distribuição espacial da leptospirose no município do Rio de Janeiro, Brasil, 1996-1999. Cad Saude Publica [Internet]. 2004 [cited 2025 Jun 15];20(6):1721-9. Available from: https://doi.org/10.1590/S0102-311X2004000600031

7. Organização Mundial da Saúde. Classificação estatística internacional de doenças e problemas relacionados à saúde (CID-11) [Internet]. Genebra: OMS; 2022 [cited 2026 Jun 5]. Available from: https://icd.who.int/pt

8. Brasil. Ministério da Saúde. DATASUS. Violência interpessoal/autoprovocada - Minas Gerais [Internet]. Brasília: Ministério da Saúde; 2023 [cited 2025 Jun 20]. Available from: http://tabnet.datasus.gov.br/cgi/deftohtm.exe?sinannet/cnv/violemg.def

9. Brasil. Ministério da Saúde. DATASUS. População residente - estimativas para o TCU - Mato Grosso [Internet]. Brasília: Ministério da Saúde; 2023 [cited 2025 May 10]. Available from: http://tabnet.datasus.gov.br/cgi/deftohtm.exe?ibge/cnv/poptmt.def

10. Atlas Brasil. Atlas do desenvolvimento humano no Brasil [Internet]. Brasília: PNUD, FJP, IPEA; 2010 [cited 2025 Jun 20]. Available from: http://www.atlasbrasil.org.br

11. Instituto de Pesquisa Econômica Aplicada (IPEA). Atlas da vulnerabilidade social [Internet]. Brasília:

IPEA; 2022 [cited 2025 Nov 15]. Available from: https://ivs.ipea.gov.br/#/

12. Federação das Indústrias do Estado do Rio de Janeiro (FIRJAN). Índice Firjan de Desenvolvimento Municipal (IFDM) [Internet]. Rio de Janeiro: FIRJAN; 2018 [cited 2025 May 22]. 27 p. Available from: https://www.firjan.com.br/ifdm/

13. Brasil. Ministério da Saúde. DATASUS. Saneamento - Censos 1991, 2000 e 2010 [Internet]. Brasília: Ministério da Saúde; 2023 [cited 2026 May 20]. Available from: https://datasus.saude.gov.br/saneamento-censos-1991-2000-e-2010

14. Kulldorff M. SaTScan user guide [Internet]. Boston: Kulldorff M; 2005 [cited 20 jul 2025]. Available from: https://www.satscan.org/cgi-bin/satscan/register.pl/SaTScan_Users_Guide.pdf?todo=process_userguide_download.pdf

15. Teles AJ, Bohm BC, Silva SCM, Bruhn FRP. Socio-geographical factors and vulnerability to leptospirosis in South Brazil. BMC Public Health [Internet]. 2023 [cited 2026 Aug 28];23:1311. Available from: https://doi.org/10.1186/s12889-023-16094-9

16. de Souza KOC, Góes JAP, Melo MS, Leite PMG, Andrade LA, Góes MAO, et al. Spatiotemporal clustering, social inequities and the risk of leptospirosis in an endemic area of Brazil: a retrospective spatial modelling. Trans R Soc Trop Med Hyg [Internet]. 2021 [cited 2026 Aug 28];115(8):854-62. Available from: https://doi.org/10.1093/trstmh/traa128

17. Gonçalves NB, Gonçalves GB, Vicente LP, Ferrari FM, Dalla Bernardina LSV, Roza BS, et al. Spatiotemporal distribution of leptospirosis in the Espirito Santo State, Brazil. Rev Inst Med Trop Sao Paulo [Internet]. 2025 [cited 2026 Aug 28];67:e58. Available from: https://doi.org/10.1590/S1678-9946202567058

18. Leal RK, Fernandes M, Vieira CP, Rocha ECC, Flores NF, Eufrazio WV, et al. Epidemiological aspects of leptospirosis in Rio Grande do Sul during the 2024 Flood. Rev Soc Bras Med Trop [Internet]. 2025 [cited 2026 Aug 28];58:e0426-2024. Available from: https://doi.org/10.1590/0037-8682-0426-2024

19. Lian Y, Qiu H, Zhou H, Li D, Li Q, Wu X, et al. The spatiotemporal epidemiology and influencing factor analysis of leptospirosis - Anhui Province, China, 2004-2023. China CDC Wkly [Internet]. 2025 [cited 2026 Aug 28];7(13):422-7. Available from: https://pubmed.ncbi.nlm.nih.gov/40226527/

20. Martin BM, Sartorius B, Mayfield HJ, Cadavid Restrepo AM, Kiani B, Then Paulino CJ, et al. Geospatial analysis of leptospirosis clusters and risk factors in two provinces of the Dominican Republic. PLoS Negl Trop Dis [Internet]. 2025 [cited 2026 Aug 28];19(6):e0013103. Available from: https://doi.org/10.1371/journal.pntd.0013103

21. Lara JM, Zuben AV, Costa JV, Donalisio MR, Francisco PMSB. Leptospirosis in Campinas, São Paulo, Brazil: 2007-2014. Rev Bras Epidemiol [Internet]. 2019 [cited 2025 Jul 20];22:e190016. Available from: https://doi.org/10.1590/1980-549720190016

22. Magalhães VS, Acosta LMW. Human leptospirosis in Porto Alegre, Rio Grande do Sul, Brazil, 2007-2013: characterization of confirmed cases and spatial distribution. Epidemiol Serv Saude [Internet]. 2019 [cited 2025 Jul 20];28(2):e2018192. Available from: https://doi.org/10.5123/S1679-49742019000200019

23. Mesquita MO, Trevilato GC, Saraiva LH, Schons MS, Garcia MIF. Material de educação ambiental como estratégia de prevenção da leptospirose para uma comunidade urbana reassentada. Cad Saude Colet [Internet]. 2016 [cited 2025 Jul 20];24(1):77-83. Available from: https://doi.org/10.1590/1414-462X2016000x0428

24. Boing AF, Matos IB, de Arruda MP, de Oliveira MC, Njaine K. Prevalence of medical visits and associated factors: a population-based study in Southern Brazil. Rev Assoc Med Bras [Internet]. 2010 [cited 2025 Jul 20];56(1):41-6. Available from: https://doi.org/10.1590/S0104-42302010000100014

25. Vaz BS, Costa AEB, Nascimento TRF, Goulart EV, Aguiar FP, Sousa YJS, et al. Fatores epidemiológicos que contribuem para a disseminação das doenças de veiculação hídrica. In: Vieira SL, organizadora. Educação, trabalho e gestão na saúde: reflexões, reflexos e ações [Internet]. São Paulo: Editora Científica Digital; 2021. p. 285-294.

26. Bessa MM, Carvalho MF, Silva SWS, de Souza JO, Vieira FG, de Freitas RJM. Implicações do lixo no processo saúde-doença: relato de experiência. Rev Saude Meio Ambiente [Internet]. 2020 [cited 2025 Nov 5];11(2):50-60. Available from: https://periodicos.ufms.br/index.php/sameamb/article/view/11151

27. Gomes AOS, Belém MO. O lixo como fator de risco à saúde pública na cidade de Fortaleza, Ceará. SANARE Rev Politicas Publicas [Internet]. 2022 [cited 2025 Jul 20];21(1):21-8. Available from: https://doi.org/10.36925/sanare.v21i1.1563

Received: 15/01/2026
Approved: 31/08/2026
Associate editor: Dr. Gilberto Tadeu Reis da Silva

Corresponding author:
Mercedes de Oliveira Neto
Universidade do Estado do Rio de Janeiro
Blvd. 28 de Setembro, 157 - Vila Isabel, Rio de Janeiro - RJ, 20551-030
E-mail: mercedesneto.uerj@gmail.com

Role of Authors:
Substantial contributions to the conception or design of the work; or the acquisition, analysis, or interpretation of data for the work - **Neto MO, Alves MR.** Drafting the work or revising it critically for important intellectual content - **Alves MR, Lucena ATC, Eleuterio TRA.** Agreement to be accountable for all aspects of the work in ensuring that questions related to the accuracy or integrity of any part of the work are appropriately investigated and resolved - **Neto MO.** All authors approved the final version of the text.

Conflicts of interest:
The authors have no conflicts of interest to declare.

Data availability:
The authors declare that all data are fully available within the article.

ISSN 2176-9133

This work is licensed under a *Creative Commons Attribution 4.0 International License*.