

AVALIAÇÃO DA VIGILÂNCIA DA LEPTOSPIROSE, PERNAMBUCO, BR, 2013–2022

*EVALUATION OF LEPTOSPIROSIS SURVEILLANCE, PERNAMBUCO, BR, 2013–
2022*

*EVALUACIÓN DE LA VIGILANCIA DE LA LEPTOSPIROSIS, PERNAMBUCO, BR,
2013–2022*

Davidianne de Andrade Moraes¹ Isabela de Lucena Heráclio² Francisco Duarte Farias Bezerra³
Raylene Medeiros Ferreira Costa⁴ Bruno Cesar Nunes⁵

RESUMO

Objetivo: Avaliar o Sistema de Vigilância da Leptospirose em Pernambuco (SVL-PE), Brasil, entre 2013 e 2022. **Métodos:** Estudo avaliativo que considerou os atributos de qualidade dos dados, representatividade, valor preditivo positivo (VPP) e oportunidade, abrangendo casos de leptospirose notificados por Pernambuco no Sistema de Informação de Agravos de Notificação, seguindo classificações previamente estabelecidas. Foi dispensada a submissão deste estudo a Comitê de Ética em Pesquisa. **Resultados:** Foi obtida classificação regular na qualidade dos dados (84,6%), na representatividade e no VPP (26,3%). A oportunidade do sistema foi classificada como ruim (62,8%), destacando atrasos em notificações após atendimento (54,7%) e encerramentos dos casos (34,2%). **Considerações finais:** Recomenda-se o treinamento de profissionais para o preenchimento adequado dos dados de notificação, bem como o cumprimento dos prazos do SVL-PE, realização de auditorias periódicas e integração intersetorial.

Descritores: Zoonoses; Bactérias; Infecção; Epidemiologia; Saúde Pública.

ABSTRACT

Objective: To evaluate the Leptospirosis Surveillance System in Pernambuco (SVL-PE), Brazil, between 2013 and 2022. **Methods:** An evaluative study that considered the attributes of data quality, representativeness, positive predictive value (PPV), and timeliness, covering leptospirosis cases reported by Pernambuco in the Notifiable Diseases Information System, following previously established classifications. This study did not require submission to a Research Ethics Committee. **Results:** The data quality (84.6%), representativeness, and PPV (26.3%) were classified as fair. The system's timeliness was classified as poor (62.8%), highlighting delays in notifications after care (54.7%) and case closures (34.2%). **Final considerations:** It is recommended that professionals be trained to properly fill out notification data, as well as to comply with SVL-PE deadlines, conduct periodic audits, and intersectoral integration.

Keywords: Zoonoses; Bacteria; Infection; Epidemiology; Public Health.

RESUMEN

Objetivo: Evaluar el Sistema de Vigilancia de la Leptospirosis en Pernambuco (SVL-PE), Brasil, entre 2013 y 2022. **Métodos:** Estudio evaluativo que consideró los atributos de calidad de los datos, representatividad, valor predictivo positivo (VPP) y puntualidad, abarcando los casos de leptospirosis notificados por Pernambuco en el Sistema de Información de Enfermedades de Notificación Obligatoria, siguiendo clasificaciones previamente establecidas. Se eximió la presentación de este estudio al Comité de Ética en Investigación. **Resultados:** Clasificación regular en calidad de datos (84,6%), representatividad y VPP (26,3%). La puntualidad del sistema fue clasificada como mala (62,8%), destacándose los retrasos en las notificaciones posteriores a la atención (54,7%) y en los cierres de casos (34,2%). **Consideraciones finales:** Se recomienda capacitar a los profesionales para el adecuado llenado de los datos de notificación, así como para cumplir con los plazos de la SVL-PE, realizar auditorías periódicas e integración intersectorial.

Palabras clave: Zoonosis; Bacterias; Infección; Epidemiología; Salud Pública.

1 Secretaria Estadual de Saúde. Recife/PE - Brasil. 

2 Ministério da Saúde. Brasília/DF - Brasil. 

3 Secretaria Estadual de Saúde. Recife/PE - Brasil. 

4 Secretaria Estadual de Saúde. Recife/PE - Brasil. 

5 Agência de Defesa e Fiscalização Agropecuária do Estado de Pernambuco. Recife/PE - Brasil. 

INTRODUÇÃO

Leptospirosis is an infectious zoonosis caused by bacteria of the genus *Leptospira*, with a significant impact on public health and the economy, affecting various mammals, including humans¹. Transmission occurs mainly through contact with urine or tissues from infected animals and contaminated environments, entering the body through mucous membranes or broken skin². The disease may present as a mild condition or progress to severe forms, leading to renal failure, hemorrhage, and death³.

In Brazil, leptospirosis is endemic and tends to intensify during rainy periods, particularly in urban areas with poor sanitation infrastructure³. In the Northeast, despite the semiarid climate, ecological diversity favors the circulation of *Leptospira spp*⁴. Although considered a neglected and underreported disease⁵, it is estimated to cause one million cases and 58,000 deaths annually worldwide⁶. In Pernambuco, between 2000 and 2023, 6,382 confirmed cases and 798 deaths were recorded, accounting for 42% and 40% of the regional total, respectively⁷.

Epidemiological surveillance is essential to reduce lethality and monitor the circulation of the disease. In Brazil, leptospirosis is a notifiable condition under the Notifiable Diseases Information System (Sinan)⁸. The system encompasses epidemiological and environmental investigations, including the identification of transmission sites and the implementation of control measures such as rodent management and health education³. The effectiveness of surveillance depends on the quality of reporting and the timeliness of response, making continuous evaluation of the system necessary to improve public health actions⁹.

Diagnosis combines clinical-epidemiological and laboratory criteria, with the microscopic agglutination test (MAT) considered the gold standard^{10,11}. Treatment includes antibiotic therapy and supportive measures to prevent complications³.

Given the epidemiological importance of leptospirosis in Pernambuco and the limited scientific literature on the evaluation of its surveillance system, this study aimed to assess the Leptospirosis Surveillance System in Pernambuco, Brazil, between 2013 and 2022.

MÉTODOS

This is an evaluative study based on the Centers for Disease Control and Prevention (CDC) guidelines for public health surveillance systems, which recommend the analysis of both qualitative attributes (data quality, based on completeness and consistency) and quantitative attributes (representativeness, positive predictive value, and timeliness).

The study population included suspected and confirmed leptospirosis cases reported in Pernambuco to Sinan between 2013 and 2022. Data were obtained from the public database of the Department of Informatics of the Unified Health System (Datusus) and analyzed using Microsoft Excel and Epi Info 7.2.6. Descriptive statistics were performed, calculating absolute and relative frequencies.

Data quality in the surveillance system was measured based on the attributes of completeness and consistency⁹. For completeness classification, the percentage of completion of mandatory variables (date of symptom onset; year of birth; sex; pregnancy status; date of investigation; date of attendance; final classification) and essential variables (race/ethnicity; education level; risk situation in the 30 days prior to symptom onset; signs and symptoms; hospitalization occurrence; confirmation/discard criteria; probable infection area; infection environment; work-related disease; case outcome; date of closure) was evaluated. Variables that were not filled in or recorded as “ignored” were classified as incomplete.

Consistency was measured by evaluating the coherence between related variables, assessing 16 pairs of records, including: date of symptom onset and date of investigation; date of symptom onset and date of notification; date of symptom onset and date of attendance; date of notification and date of investigation; sex (male) and pregnancy status (not applicable); date of hospitalization and date of attendance; discharge date and date of hospitalization; final classification and confirmation/discard criteria; confirmation/discard criteria and final classification; probable infection area and final classification; infection environment and final classification; infection environment (work-related) and work-related disease; date of notification and date of closure; final classification and date of closure; case outcome (death due to leptospirosis versus death from other causes) and date of death; date of investigation and date of closure.

Data completeness and consistency were considered excellent when $\geq 90\%$ of records were properly completed or consistent, respectively; fair when they ranged from 70% to 89.9%; and poor when below 70%^{12,13}. The overall data quality classification was determined by the average of these two attributes, using the same categorization parameters.

The representativeness of the leptospirosis surveillance system in Pernambuco was assessed by extracting confirmed cases from Sinan, covering three territorial levels: Pernambuco, the Brazilian Northeast, and Brazil, with variables organized into three blocks: Person (sex; race/ethnicity; education level; confirmation criteria; case outcome; work-related disease), Place (probable infection area; infection environment), and Time (year of notification; month of notification). The percentage of each category was calculated relative to the total confirmed cases at each territorial level, and categories were considered comparable when the difference between percentages was up to 10%.

The representativeness of each variable was classified as High (H), Moderate (M), or Low (L), according to the degree of comparability between the percentages obtained across different territorial levels. The evaluation of each block was classified as High (H), Moderate (M), or Low (L), considering the predominance of the individual variable classifications, with the highest classification adopted in case of a tie. The final attribute classification was defined as Excellent Representativeness when more than 50% of the blocks were classified as “H”; Fair Representativeness when more than 50% of the blocks were classified as “M”; and Poor Representativeness when more than 50% of the blocks were classified as “L.”

The positive predictive value (PPV) was calculated as the ratio between confirmed cases and the total number of notifications, and classified as excellent ($\geq 50\%$), fair (20–49.9%), or poor ($\leq 19.9\%$). To evaluate the timeliness of the system, four temporal indicators were considered: attendance within six days of symptom onset, notification within 24 hours, initiation of investigation within seven days, and case closure within 60 days. Each indicator was classified as excellent ($\geq 90\%$), fair (70–89.9%), or poor ($\leq 69.9\%$). The final assessment was based on the average of the four indicators, using the same categorization criteria.

As this study was based on secondary data from a public, non-identifiable database, submission to a Research Ethics Committee was not required, ensuring data confidentiality and privacy.

RESULTADOS

A total of 8,123 reported cases (suspected and confirmed) from the Pernambuco leptospirosis surveillance system were evaluated for the period from January 2013 to December 2022.

The assessment of completeness for the 18 variables across six blocks of the Leptospirosis Investigation Form revealed an overall average completion rate of 73.9% during the evaluated period, classified as fair. When analyzed separately, the mandatory variables showed an average completeness of 7,767 (95.6%), corresponding to an excellent level of completeness. In contrast, the essential variables had an average completeness of 4,596 (56.6%), corresponding to a poor classification (Table 1).

Table 1 - Completeness of essential variables evaluated in the leptospirosis surveillance system in Pernambuco from January 1, 2013, to December 31, 2022 (N = 8123).

Block	Variable	Complete	(%)	Completeness
Individual notification	Raça/Ethnicity	5.761	70,9	Fair
	Education level	3.073	37,8	Poor
Epidemiological history	Risk situation	5.750	70,8	Fair
Clinical data	Signs and symptoms	7.582	93,3	Excellent
Attendance	Hospitalization	6.891	84,8	Fair
	Confirmation/discard	7.052	86,8	Fair
Conclusion	Probable infection area	1.026	12,6	Poor
	Probable infection environment	778	9,6	Poor
	Work-related disease	1.367	16,8	Poor
	Case outcome	6.682	82,3	Fair
Average		4.596	56,6	Poor

Source: Sistema de Informação de Agravos de Notificação (Sinan).

Regarding the overall assessment of consistency, considering the 16 relationships established among the 16 variables listed, an average of 95.4% was found, which is classified as an excellent level. In the individual assessment of the relationships, a level of excellent consistency was obtained in 13 (81.0%) and fair consistency in three (19.0%), namely: probable area of infection and final classification; infection environment and final classification; and infection environment (work) and work-related disease (yes).

Considering the averages obtained for completeness (73.9%) and consistency (95.4%), the overall mean regarding data quality was 84.6%, classified as fair.

The assessment of representativeness allowed the characterization of the population profile affected by the disease in Pernambuco and its comparison with the profile of the Northeast region and Brazil (Table 2). The “Person” block showed high representativeness, while the “Place” and “Time” blocks showed moderate representativeness. Based on these findings, the representativeness of the leptospirosis surveillance system in Pernambuco was classified as fair.

Regarding the PPV, among the 8,123 suspected leptospirosis notifications in Pernambuco, 2,133 were classified as confirmed, corresponding to 26.3% and therefore classified as fair. However, when evaluated by year and month of notification, fluctuations in the PPV can be observed, reaching a maximum value of 50% in April 2022, meaning that half of the cases reported during this period were confirmed as leptospirosis, and a value of zero in January 2021 and October 2015, indicating that none of the cases reported during these periods were confirmed as leptospirosis (Figure 1).

The timeliness assessment revealed a fair classification for two indicators: care provided within six days from the onset of symptoms (72.5%) and investigation conducted within seven days after notification (89.9%). However, the remaining indicators were classified as poor: notification within 24 hours after care (54.7%) and case closure within 60 days after notification (34.2%). The overall mean of timely records was 62.8%, falling into the poor classification, highlighting the need for improvements in meeting established deadlines to enhance the effectiveness of the system.

Tabela 2 — Avaliação do atributo representatividade segundo Pessoa, Lugar e Tempo do sistema de vigilância da leptospirose de Pernambuco a partir dos casos confirmados de leptospirose no Sistema de Informação de Agravos de Notificação em Pernambuco, Nordeste e Brasil, 2013–2022.

Bloco	Variável	Categoria	Pernambuco (N = 2.133)		Nordeste (N = 4.972)		Brasil (N = 32.807)		RV	RB	RS
			n	%	n	%	N	%			
Pessoa	Sexo	Masculino	1.697	79,6	4.006	80,6	26.335	80,3	Elevado	A	Regular
	Raça/cor	Parda	1.304	61,1	3.339	67,2	13.639	41,6	Razoável		
	Escolaridade	EFI	386	18,1	1.249	25,1	9.161	27,9	Elevado		
	Confirmação	CL	1.318	61,8	3.449	69,4	27.808	84,8	Razoável		
	Evolução	Cura	1.669	78,2	3.759	75,6	27.015	82,3	Elevado		
	DRT	Não	949	44,5	2.545	51,2	19.900	60,7	Razoável		
Lugar	API	Urbana	782	36,7	2.442	49,1	17.714	54,0	Limitada	M	
	AI	Domiciliar	417	19,5	1.246	25,1	13.403	40,9	Razoável		
Tempo	AN	2022	536	25,1	968	19,5	3.123	9,5	Razoável	M	
	MN	Junho	537	25,2	904	18,2	2.857	8,7	Razoável		

Fonte: Sistema de Informação de Agravos de Notificação (Sinan). N = total de casos confirmados; n = total de casos confirmados por categoria; DRT = doença relacionada ao trabalho; API = área provável de infecção; AI = ambiente da infecção; AN = ano de notificação; MN = mês de notificação; EFI= Ensino Fundamental Incompleto; CL = clínico-laboratorial; RV = representatividade-variável; RB = representatividade-bloco; RS = representatividade do sistema; A = alta; M = moderada.

DISCUSSÃO

The assessment of data quality in the Leptospirosis Surveillance System in Pernambuco was classified as fair, reflecting excellent consistency but poor completeness in essential variables. Sociodemographic aspects, such as race/skin color (fair) and education (poor), were poorly recorded, compromising the characterization of the affected population. Similarly, the low completeness of environmental and occupational variables, such as area and environment of infection and work-related diseases, hinders epidemiological investigation, particularly in vulnerable areas¹⁴.

The incompleteness of crucial variables for preventing case worsening, such as hospitalization and case outcome, highlights the need to improve information recording. Previous studies indicate that healthcare professionals' workload and the complexity of notification forms affect data completeness^{15,16}. During epidemic periods, the prioritization of mandatory fields exacerbates this limitation, requiring strategies to optimize record completion^{16,17}. In this context, continuous monitoring of completeness is essential to ensure system quality¹⁸.

The assessment of data consistency was predominantly excellent, reflecting standardization in data collection and the commitment of healthcare professionals. However, overall consistency does not compensate for deficiencies in completeness, resulting in the loss of essential information for leptospirosis planning and control.

The representativeness of the Leptospirosis Surveillance System in Pernambuco was classified as fair, with significant variations among the analyzed blocks. In terms of sociodemographic aspects, the distribution of race/skin color showed a predominance of mixed-race individuals in Pernambuco and the Northeast region, whereas white individuals predominated in Brazil, reflecting regional sociodemographic differences¹⁹. The low education level observed among cases confirms the relationship between socioeconomic vulnerability and leptospirosis infection, as the disease is associated with poor living and working conditions²⁰.

Clinical-laboratory confirmation criteria were less frequent in Pernambuco compared to the national average, possibly due to structural and logistical limitations in laboratory diagnosis, reflecting disparities in healthcare infrastructure between regions. In the "Place" block, moderate representativeness indicated a predominance of infection in urban and household areas, supporting findings that associate leptospirosis with deficiencies in sanitation infrastructure, flooding, and rodent exposure^{20,21}.

In the "Time" block, temporal discrepancies between Pernambuco and Brazil may be attributed to climatic and geographic diversity, considering the influence of climate on leptospirosis epidemiology. The similarity between Pernambuco and the Northeast region suggests regional consistency, while national differences highlight the country's environmental heterogeneity²².

The overall representativeness of the system was fair, but it would have been classified as excellent if only the comparison between Pernambuco and the Northeast region were considered, indicating greater regional homogeneity.

The system's overall positive predictive value (PPV) was classified as fair, reflecting challenges in differential diagnosis and laboratory consolidation.

Furthermore, at two points during the analyzed period, no leptospirosis cases were confirmed in Pernambuco, which may be attributed to atypical epidemiological conditions or variations in surveillance. The PPV seasonality underscores the importance of intensifying surveillance and prevention measures during rainy periods, minimizing underreporting and diagnostic inaccuracies.

The timeliness of the system was considered poor, with failures in meeting established deadlines for case notification and closure, which compromises the effectiveness of the response to leptospirosis. The overload of healthcare teams and structural limitations may have influenced this performance, highlighting the need for investments in infrastructure, integration across surveillance levels, and professional training.

Finally, the study limitations include the use of secondary data, which are subject to inaccuracies, and the possible influence of the COVID-19 pandemic on reduced notifications. Despite these constraints, the findings reinforce the need to improve the surveillance system, ensuring higher data quality and a more efficient response to leptospirosis in Pernambuco.

FINAL CONSIDERATIONS

The leptospirosis surveillance system in Pernambuco was evaluated as having fair data quality, with excellent consistency contrasting with fair completeness, fair representativeness, fair PPV, and poor timeliness.

To strengthen the leptospirosis surveillance system in Pernambuco, it is recommended that Municipal Health Departments conduct periodic training to improve the completion of investigation forms and reinforce active surveillance, integrating actions with the environmental sector. The State Health Department should monitor and supervise the notification process through periodic audits and incentives for good practices, such as certifications or bonuses. The Ministry of Health should review the investigation form to make it more objective and enhance the SINAN system, including automatic validations to reduce errors. Finally, managers across the three levels of government should promote the integration of surveillance systems, continuously evaluate weaknesses, and intensify educational campaigns targeting vulnerable populations, thereby strengthening disease prevention and control.

AGRADECIMENTOS

We thank the Applied Epidemiology Training Program for Health Services (EPISUS/Brazil/FETP), Ministry of Health; the Ceará School of Public Health (ESP/CE); the State Health Department of Pernambuco (SES/PE); and all those who contributed directly or indirectly to the completion of this work.

REFERÊNCIAS

1. Santos JO, Santos JC, Santos JO, Santos MIG. Reservatórios animais da leptospirose e legislação vigente: uma revisão bibliográfica. Research, Society and Development [online]. 2023; 12(1): 1-11. DOI: 10.33448/rsd-v12i8.42902

2. Fagre AC, Mayo CE, Pablonia KL, Landolt GA. Seroprevalence of *Leptospira* spp. in Colorado equids and association with clinical disease. *Journal of Veterinary Diagnostic Investigation* [online]. 2020; 32(1): 718–721. DOI: 10.1177/1040638720943155
3. Ministério da Saúde (BR). Secretaria de Vigilância em Saúde e Ambiente. Departamento de Ações Estratégicas de Epidemiologia e Vigilância em Saúde e Ambiente. Guia de vigilância em saúde: volume 3, edição 6. Ministério da Saúde [online]. Brasília: 2024. Disponível em: https://bvsms.saude.gov.br/bvs/publicacoes/guia_vigilancia_saude_6ed_v3.pdf
4. Viana MP, Silva JD, Lima AMC, Alves FSF, Pinheiro RR, Costa DF, Silva GCP, Calado LGLP, Azevedo SS, Alves CJ. Epidemiological and geospatial characterization of goat leptospirosis in Northeast region of Brazil. *Small Ruminant Research* [online]. 2022; 206(1): 106589. DOI: 10.1016/j.smallrumres.2021.106589
5. Cilia G, Bertelloni F, Fratini F. *Leptospira* infections in domestic and wild animals. *Pathogens* [online]. 2020; 9(1): 573. DOI: 10.3390/pathogens9070573
6. Costa F, Hagan JE, Calcagno J, Kane M, Torgerson P, Martinez-Silveira MS et al. Global morbidity and mortality of leptospirosis: a systematic review. *PLoS Neglected Tropical Diseases* [online]. 2015; 9(9): e0003898. DOI: [10.1371/journal.pntd.0003898](https://doi.org/10.1371/journal.pntd.0003898)
7. Ministério da Saúde (BR). Casos e óbitos de leptospirose, 2000 a 2024. Ministério da Saúde [online]. Brasília: 2024. Disponível em: <https://www.gov.br/saude/pt-br/assuntos/saude-de-a-a-z/l/leptospirose/publicacoes/casos-e-obitos-2000-a-2024.pdf>
8. Ministério da Saúde (BR). Portaria nº 204, de 17 de fevereiro de 2016. Ministério da Saúde [online]. Brasília: 2016. Disponível em: https://bvsms.saude.gov.br/bvs/saudelegis/gm/2016/prt0204_17_02_2016.html
9. German RR, Lee LM, Horan JM, Milstein RL, Pertowski CA, Waller MN. Updated guidelines for evaluating public health surveillance systems: recommendations from the guidelines working group. *MMWR* [online]. 2001; 50(13): 1-35. Disponível em: <https://www.cdc.gov/mmwr/preview/mmwrhtml/rr5013a1.htm>.
10. Ramos TMV, Balassiano IT, Silva TSM, Nogueira JMR. Leptospirose: características da enfermidade em humanos e principais técnicas de diagnóstico laboratorial. *Revista Brasileira de Análises Clínicas* [online]. 2021; 53(3): 211-218. Disponível em: <https://www.rbac.org.br/artigos/leptospirose-caracteristicas-da-enfermidade-em-humanos-e-principais-tecnicas-de-diagnostico-laboratorial/>
11. Organização Mundial de Saúde (OMS). International Leptospirosis Society (ILS). Human leptospirosis: guidance for diagnosis, surveillance and control. Organização Mundial de Saúde [online]. Geneva: 2003. Disponível em: https://iris.who.int/bitstream/handle/10665/42667/WHO_CDS_CSR_EPH_2002.23.pdf
12. Abath MB, Lima MLLT, Lima OS, Silva MCM, Lima MLC. Avaliação da completude, da consistência e da duplicidade de registros de violências do Sinan em Recife, Pernambuco, 2009-2012. *Epidemiologia e Serviços de Saúde* [online]. 2014; 23(1): 131-142. DOI: <https://doi.org/10.5123/S1679-49742014000100013>
13. Souza VMM, Brant JL, Arsky MLS, Araújo WN. Avaliação do Sistema Nacional de Vigilância da Leptospirose – Brasil, 2007. *Cadernos de Saúde Coletiva*. 2010; 18(1): 95-105.
14. Lara JM, Donalisio MR, Zuben AV, Rodrigo-Angerami R, Francisco PMSB. Avaliação do sistema de vigilância epidemiológica da leptospirose em Campinas, São Paulo, 2007 a 2014. *Cadernos Saúde Coletiva* [online]. 2021; 29(2): 201-208. DOI: 10.1590/1414-462X202129020474
15. Muguande OF, Ferraz ML, França E, Gontijo ED. Evaluation of the quality system of epidemiological surveillance of acute Chagas disease in Minas Gerais, 2005-2008. *Epidemiologia e Serviços de Saúde* [online]. 2011; 20(3): 317-25. DOI: 10.5123/S1679-49742011000300006
16. Barbosa JK, Barrado JCS, Zara ALSA, Siqueira-Júnior JB. Avaliação da qualidade dos dados, valor preditivo positivo, oportunidade e representatividade do sistema de vigilância epidemiológica da dengue no Brasil, 2005 a 2009. *Epidemiologia e Serviços de Saúde* [online]. 2015; 24(1): 49-58. DOI: 10.5123/S1679-49742015000100006

17. Santos KC, Siqueira-Júnior JB, Zara ALSA, Barbosa JR, Oliveira ESF. Avaliação dos atributos de aceitabilidade e estabilidade do sistema de vigilância da dengue no estado de Goiás, 2011. *Epidemiologia e Serviços de Saúde* [online]. 2014; 23(2): 249-58. DOI: [0.5123/S1679-49742014000200006](https://doi.org/10.5123/S1679-49742014000200006)
18. Aguiar LR, Ralph RMC, Sá RGC, Silva VMF. Avaliação da completude dos dados registrados na ficha de notificação de tétano acidental. *Cadernos ESP*, Ceará [online]. 2014; 8(2): 38-49. Disponível em: <https://cadernos.esp.ce.gov.br/index.php/cadernos/article/view/130>
19. Instituto Brasileiro de Geografia e Estatística (BR). Censo Brasileiro de 2022. Instituto Brasileiro de Geografia e Estatística [online]. Rio de Janeiro: 2022. Disponível em: <https://www.ibge.gov.br/estatisticas/sociais/trabalho/22827-censo-demografico-2022.html?edicao=42309>
20. Magalhães VS, Acosta LMW. Leptospirose humana em Porto Alegre, Rio Grande do Sul, de 2007 a 2013: caracterização dos casos confirmados e distribuição espacial. *Epidemiologia e Serviços de Saúde* [online]. 2019; 28(2): e2018192. DOI: [10.5123/S1679-49742019000200019](https://doi.org/10.5123/S1679-49742019000200019)
21. Flores DM, Flores LM, Romanielo AFR, Dutra GS, Souza AV, Finta ALN et al.. Epidemiologia da Leptospirose no Brasil 2007 a 2016. *Brazilian Journal of Health Review* [online]. 2020; 3(2): 2675-2680. DOI: [10.34119/bjhrv3n2-114](https://doi.org/10.34119/bjhrv3n2-114).
22. Agência Nacional de Águas e Saneamento Básico (BR). Banco de dados das estações pluviométricas em operação. Dados diários e mensais 2013 a 2022. Agência Nacional de Águas e Saneamento Básico [online]. Brasília: 2024. Disponível em: <https://dadosabertos.ana.gov.br/search?groupIds=51e4bfdcbaaf4b01b9c0806be3e26fa8> Acesso em: 22 de dezembro de 2024