

Original Article

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Epidemiological survey of accidents with venomous animals treated at the Regional Hospital of Bom Jesus, Piauí, Northeast Brazil

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How to cite this article: dos Santos Silva GD, Pereira da Silva JV, Abel I, Silva Guimarães RC, Padda H, de Arruda Xavier D, Pereira da Costa RT, Silva Catenacci L. Epidemiological survey of accidents with venomous animals treated at the Regional Hospital of Bom Jesus, Piauí, Northeast Brazil. *One Health Implement Res* 2024;4:4-14. <https://dx.doi.org/10.20517/ohir.2023.49>

Received: 23 Oct 2023 **First Decision:** 2 Apr 2024 **Revised:** 23 Apr 2024 **Accepted:** 20 May 2024 **Published:** 29 May 2024

Academic Editor: Jose M. Martin-Moreno **Copy Editor:** Pei-Yun Wang **Production Editor:** Pei-Yun Wang

Abstract

Aim: Venomous animals are responsible for 26.8% of all poisonings occurring in people registered in Brazil, reflecting serious economic, medical, and social public health issues in tropical countries. The objective of this work was to characterize the cases notified of accidents involving venomous animals in humans in a Public Regional Hospital located in Piauí state, Northeast Brazil.

Methods: We analyzed the notification forms registered at the National Notifiable Diseases Information System (SINAN), provided by the Hospital Regional Manoel de Souza from July 2009 to December 2017. The data were organized in spreadsheets and were exported to SPSS v. 24 for statistical analysis. A linear regression analysis was performed, and variables were considered significant when the estimated regression model presented $P \leq 0.05$.



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Results: From 2009 to 2017, 833 cases of accidents caused by venomous animals treated were reported on SINAN. Accidents caused by scorpions were the most frequent, accounting for 69.7% ($n = 269$) of cases, followed by snakes at 17.6% ($n = 68$) and insects at 12.7% ($n = 49$). The people most affected by venomous animals were men (53.9%; $n = 208$) between the ages of 20 and 39 (42.5%; $n = 164$). The most frequent bite site was on the extremities, with the feet being the most affected region at 39.3% ($n = 235$), followed by the hands at 25.8% ($n = 154$) and the legs at 8% ($n = 48$). The study showed that despite the Regional Hospital covering 18 cities, the municipality of Bom Jesus had the highest incidence of accidents caused by venomous animals, mainly scorpions. Therefore, this investigation is a starting point for understanding the spatial distribution of these accidents. The data show that there are still flaws in the SINAN information flow. In the serotherapy variable, for example, 51.1% of cases were not completed.

Conclusion: It is necessary to provide guidance and carry out educational work in order to improve official data records, so that they can be incorporated into the care routine.

Keywords: Epidemiology, venomous snakes, ophidism, scorpion

INTRODUCTION

Venomous animals are all those that possess structures such as glands or pouches that produce venom (poison)^[1,2], which is delivered through modified teeth, stingers, or chelicerae^[3]. The main venomous animals responsible for causing accidents in humans and, therefore, of medical interest in Brazil are species of snakes, scorpions, spiders, moths, bees, wasps, some species of fish, caterpillars, and ants^[4].

These animals are considered the second cause of human poisoning after drug use and are responsible for 26.8% of all human intoxications recorded in Brazil^[5,6]. Cases involving snakes, scorpions, and spiders are the most prevalent, followed by intoxications caused by other species^[7,8]. Due to the high number of recorded occurrences and the severity of the cases^[7,9-12], accidents with venomous animals reflect serious economic, medical and social public health problems in tropical countries. The significant lethality and ability to cause temporary or permanent disability, or even death, along with the difficulty in accessing health units and the scarcity of antivenom for treatment^[13,14], further underscore the critical importance of this condition in the country. According to data provided by the National Notifiable Diseases Information System (SINAN) from the Brazilian Ministry of Health, there were 1,180,844 accidents by snakes, the same number for spiders, 521,977 for scorpions, and 79,580 for bees from 1975 to 2015. These data confirm the importance of epidemiological surveillance of accidents involving venomous animals for public health in Brazil^[15].

The Hospital Regional Manoel de Souza is located in Piauí State, northeast of Brazil, between savanna and Caatinga biomes (latitude 09°04' south and longitude 44°21' west). Piauí is characterized as an agrarian pole, and currently, approximately 430 thousand hectares are cultivated with grains such as soybean, rice, and corn^[16]. Considered the last agricultural frontier of Brazil, the pressure exerted on the environment has caused numerous changes in the landscape, thus exposing the human population to the risk of harm, such as accidents by venomous animals. Moreover, the accidents have been intensified by the absence of adequate urban planning and overlapping use of space for animals and humans^[17]. This descriptive study aims to describe the venomous animal-related accidents in humans treated at the Regional Public Hospital of Piauí and to analyze the temporal and spatial distribution of these incidents from 2009 to 2017.

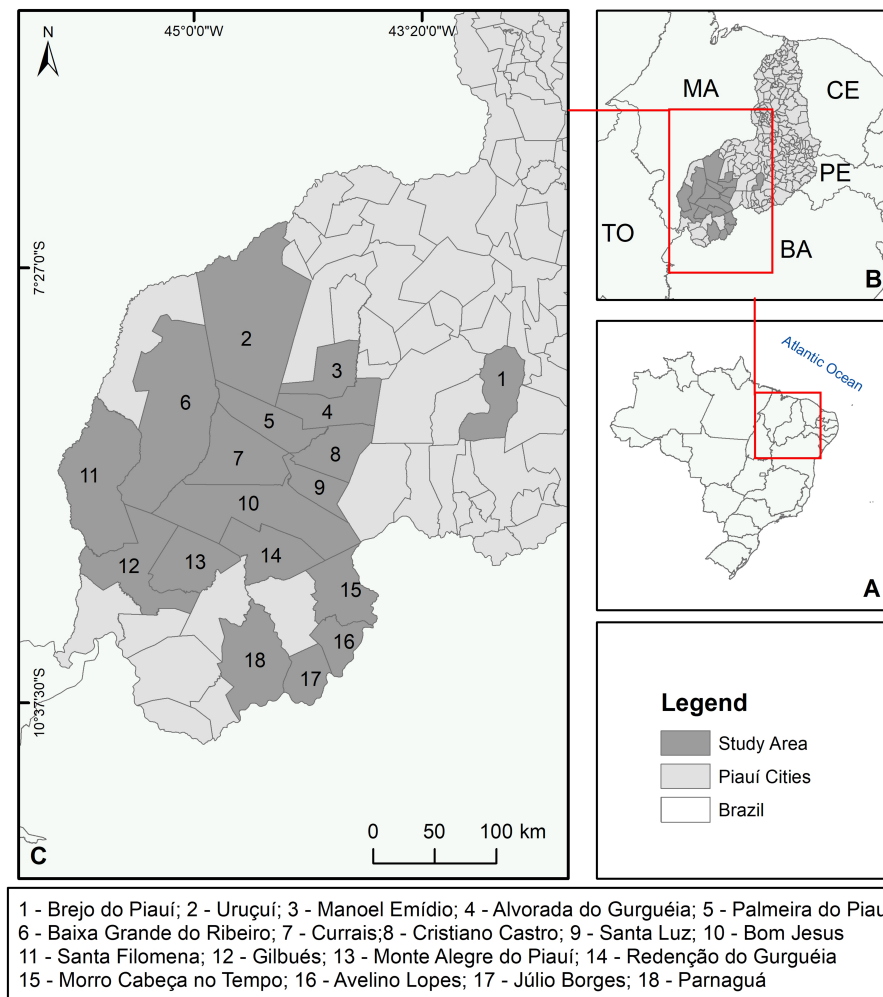


Figure 1. Location of the study area.

METHODS

Study area and data collection

The notification forms registered in SINAN were provided by the Epidemiology sector of the Hospital Regional Manoel de Souza in Bom Jesus, PI, from July 2009 to December 2017. The Hospital is responsible for treating cases of accidents by venomous animals from 18 municipalities in the south of the state: Alvorada do Gurguéia, Avelino Lopes, Baixa Grande do Ribeiro, Bom Jesus, Brejo do Piauí, Cristino Castro, Currais, Gilbués, Júlio Borges, Manoel Emídio, Monte Alegre do Piauí, Morro Cabeça no Tempo, Palmeira do Piauí, Parnaguá, Redenção do Gurguéia, Santa Filomena, Santa Luz, and Uruçuí [Figure 1].

All these cities, according to Brazilian Institute of Geography and Statistics (IBGE) data, have the predominance of the population in the rural area and the main economic activity is family agriculture in the Caatinga area and soy, bean, and corn plantations in the Brazilian savanna [Figure 2]. The weather is characterized by distinct seasons, with dry winters and rainy summers. The average maximum temperature reaches 38 °C, while the minimum averages 24 °C. The dry period typically lasts up to six months, from May to September^[18]. According to the Köppen climate classification^[19,20] the climate of the study area falls into the Aw type.

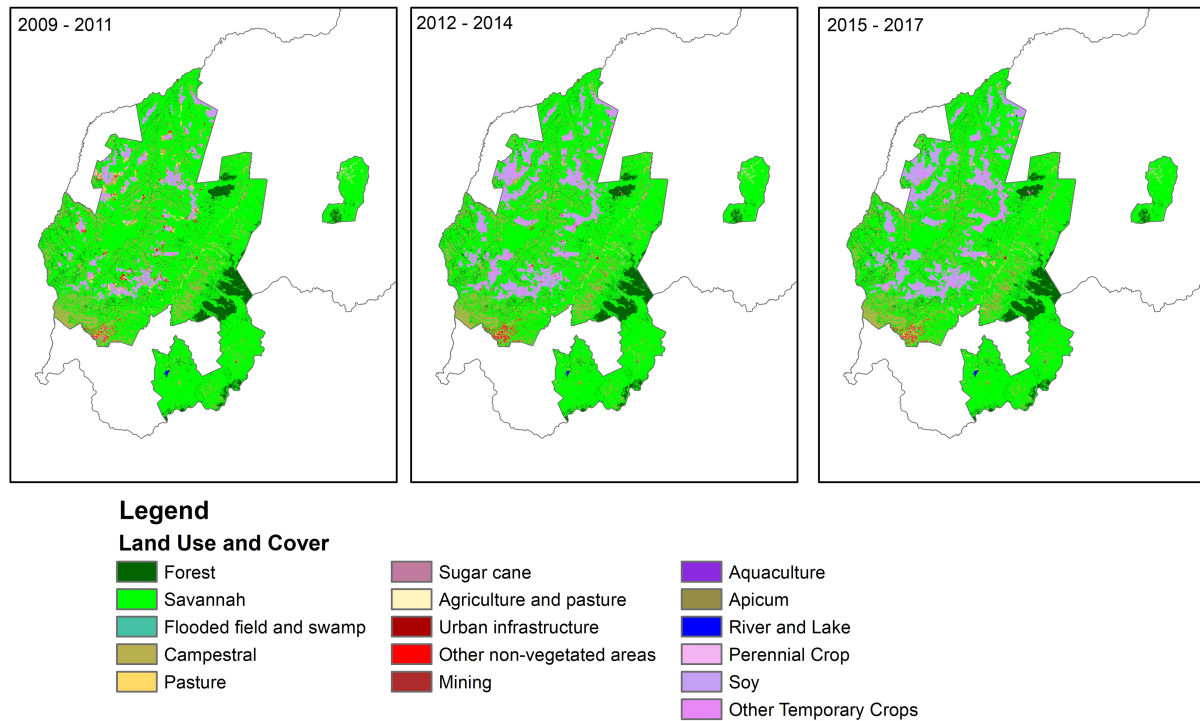


Figure 2. Land use and occupation in the municipality of Bom Jesus - PI, from 2009 to 2017. The data for building this map were taken from the MapBiomas platform (<https://brasil.mapbiomas.org/>).

Data analysis

This is a descriptive study analyzing notifications registered in the National Notifiable Diseases Information System (SINAN), provided by the Hospital Regional Manoel de Souza from July 2009 to December 2017. The study compiled information reported by the public health service, thus relying on secondary public data without access to the identities of the participants.

The data were organized in spreadsheets and were exported to SPSS v. 24 for statistical analysis. The distribution of accidents was analyzed according to the following epidemiological variables: age, sex, city of occurrence, zone, place of the bite, type of accident, whether work-related or not, and time elapsed until service. In order to observe the annual seasonality of accidents, the occurrence was considered as the day of notification of the accidents. A linear regression analysis was performed, and variables were considered significant when the estimated regression model presented $P \leq 0.05$.

For reference population of the municipalities, data from the demographic census of the IBGE were used. Demographic data obtained by the IBGE were also considered to estimate the probability of annual accidents with different species of venomous animals.

The frequencies were classified into three categories: snakes, scorpions, and insects. The “insects” category includes bees, wasps, ants, and other unidentified insects.

RESULTS

In the period between 2009 and 2017, 833 cases of accidents caused by venomous animals treated at the Hospital Regional Estadual Manoel de Sousa Santos were reported to SINAN. In 2010, there was a lower

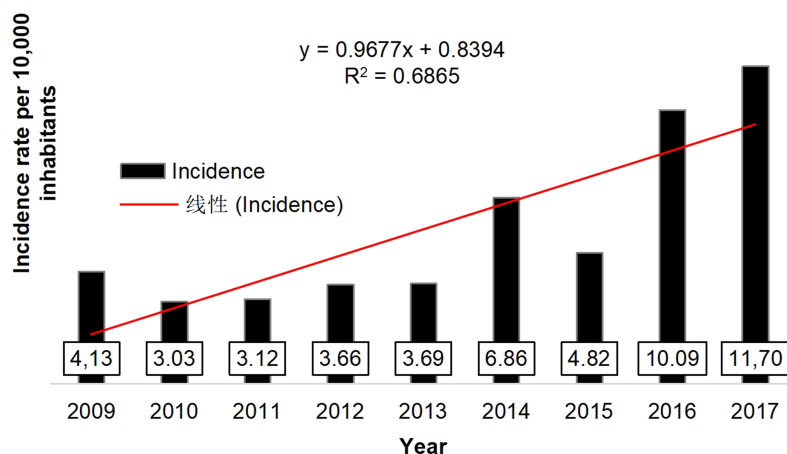


Figure 3. Incidence of accidents with venomous animals reported at Hospital Regional Manoel de Sousa Santos, Bom Jesus - PI, from 2009 to 2017.

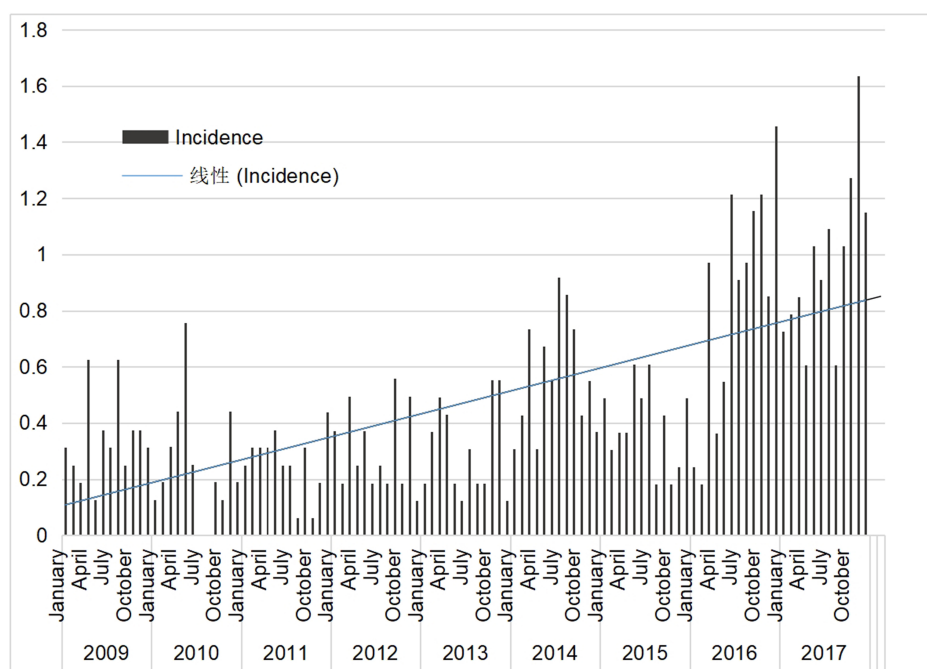


Figure 4. Monthly incidence/10,000 inhabitants of accidents by venomous animals reported at Hospital Regional Manoel de Souza, Bom Jesus - PI, from 2009 to 2017.

incidence, with 3.1 cases per 10,000 inhabitants. However, there was a notable trend of 68% growth in cases over the study period [Figure 3].

During the course of the year, accidents were concentrated in the rainy season, with a tendency of increasing incidence over the years of rainy seasons [Figure 4].

Accidents by scorpions were the most frequent, accounting for 69.7% ($n = 269$) of the cases, followed by snakes (17.6%; $n = 68$) and insects (12.7%; $n = 49$). Although the Regional Hospital is rightfully responsible for providing assistance to only seven municipalities, it extends its coverage to 12 municipalities nearby.

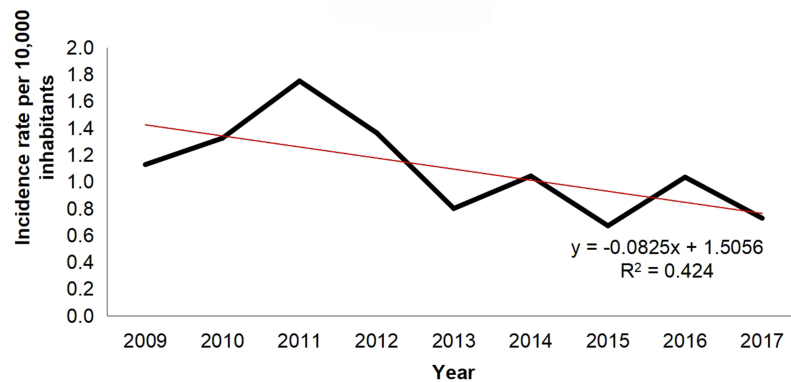


Figure 5. Annual distribution of accidents by venomous snakes reported at the Manoel de Souza Regional Hospital, Bom Jesus - PI, from 2009 to 2017, and annual incidence/10,000 inhabitants.

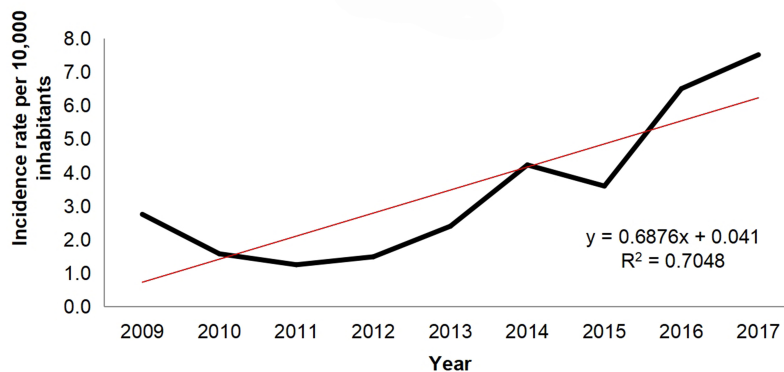


Figure 6. Annual distribution of accidents caused by scorpions reported at the Manoel de Souza Regional Hospital, Bom Jesus - PI, from 2009 to 2017, and annual incidence/10,000 inhabitants.

Bom Jesus City reported the highest occurrence (57%; $n = 459$).

While there was a 42% decrease in accidents caused by snakes over the years during the study [Figure 5], there was a distinct trend of scorpion-related accidents increasing by 70% [Figure 6].

The people most affected by venomous animals were men (53.9%; $n = 208$) among the age groups from 20 to 39 years (42.5%; $n = 164$) [Table 1]. Professionals who practiced activities in closed environments were the most attacked (57%; $n = 220$) [Table 1]. However, specifically for snakes, professionals with activities in closed places were the least exposed to accidents ($B = -1,302$, $OR = 0,568$, 95%CI = 0,272, 0,130) and those between adolescents 10 and 19 were more likely to be injured by a snakebite ($B = 1,526$, $OR = 4,598$, 95%CI = 1,460, 14,474). Hospital care for victims occurred predominantly until the first 3 h of the accident (68.6%, $n = 464$). The patients demonstrated local pain with or without paresthesia, with most cases classified as mild.

About 50.3% ($n = 194$) of the victims showed systemic manifestations, including neuromuscular symptoms (11.2%, $n = 50$) and vasovagal syncope (8%; $n = 36$). Regarding treatment, 87.2% of those affected required specific serum therapy, with 97.2% of cases of accidents involving scorpions ($n = 317$) recovered [Table 1].

Table 1. Characterization of accidents by venomous animals, reported at the Manoel de Souza Regional Hospital, Bom Jesus - PI, from 2009 to 2017

Feature	Number of cases	Percentage (%)
Gender		
Male	208	53.9
Female	178	46.1
Age group		
10-19 years old	61	15.8
20-39 years old	164	42.5
40-59 years old	71	18.4
60-69 years old	51	13.2
Local of work/occupation		
Intradomiciliary	220	57
Extradomiciliary	166	43.0
Time elapsed until service		
0 a 1 h	215	28.1
1-3 h	249	32.6
3-6 h	98	12.8
6-12 h	45	5.9
12-24 h	29	3.8
Most of 24 h	41	5.4
Ignored	87	11.4
Case classification		
Light	402	70.0
Moderate	155	27.0
Serious	16	2.8
Ignored	1	0.2
Work-related accident		
Yes	101	19.8
No	395	77.3
Ignored	15	2.9
Performing serum therapy		
Yes	356	87.3
No	51	12.5
Ignored	1	0.2
Case evolution		
Cure	317	94.6
Death by venomous animal	6	1.8
Death from another cause	2	0.6
Transfer	1	0.3
Ignored	9	2.7

The most frequent bite site was on the extremities, with the feet being the most affected region, accounting for 39.3% ($n = 235$), followed by the hands at 25.8% ($n = 154$) and the legs at 8% ($n = 48$) [Figure 7]. A total of 96.4% ($n = 372$) presented local manifestation, with the most reported symptoms by victims being pain (50.5%, $n = 522$) and edema (43.4%, $n = 448$). Despite the detailed nature of the SINAN forms, it was possible to identify errors or omissions in the completion of the forms. For example, 51.1% of cases were omitted in the variable serum therapy.

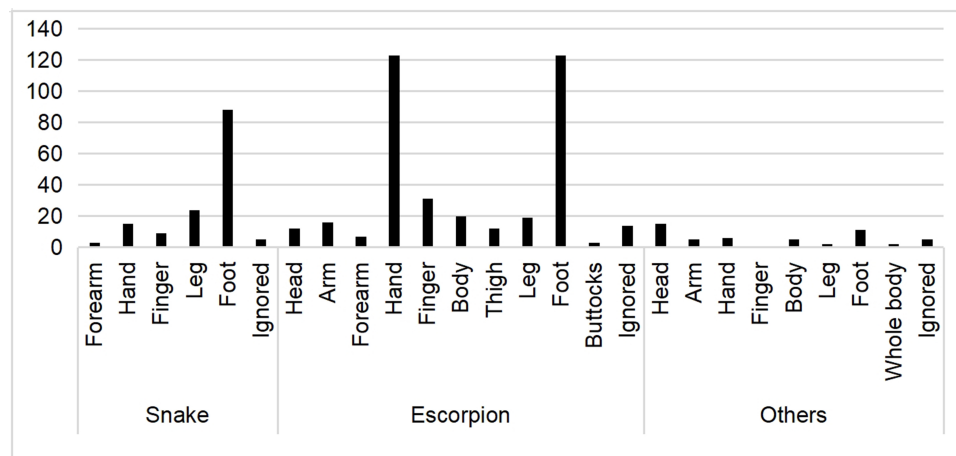


Figure 7. Frequency of accidents by venomous animals according to the site of the bite on the body and animal species reported at the Regional Hospital Manoel de Souza, Bom Jesus - PI, from 2009 to 2017.

DISCUSSION AND CONCLUSION

In the present work, the greatest difficulties lay in the organization of the monthly and annual service records, as well as in understanding them due to poor handwriting and incomplete information. In this study, it was observed that most accidents were caused by scorpions, followed by snakes. Likewise, two different studies conducted by Cantinho Júnior *et al.* from 2007 to 2014 and by Benício *et al.* from 1999 to 2010 on accidents across different regions of the State of Piauí, revealed a remarkable incidence of scorpion-related accidents, followed by snakes^[21,22]. In a study in the city of Palmas, Brazil, it was also observed a higher frequency of reported accidents caused by scorpions and snakes^[23]. We believe that different types of habitats support a diversity of venomous animal species, many of which hold significant medical importance.

Data from the Ministry of Health indicate the occurrence of approximately 8,000 accidents by scorpions per year, with an incidence coefficient of approximately three cases/100,000 inhabitants. Consistent with the findings in the present study, other reports also show a high number of scorpion accidents recorded in Brazil^[24-26]. These incidents are frequent as scorpions have adapted quite well to urban environments and the conditions provided by housing. The urbanization process has created environments conducive to their survival, including shelter possibilities such as garbage and rubble, consequently leading to a plentiful diet due to the presence of cockroaches and other insects^[11,27,28]. Ecological imbalances and human activities, such as disorderly urban growth, poor sanitary conditions and replacement of vegetation for the implantation of new subdivisions or plantations, as evidenced in the use of land occupation in Piauí, may be one of the possible explanations for the trend of increasing cases in the study period.

Differently from what was found in the present study, Parise found that in more than 50% of the cases, the time elapsed between the accident and the care was less than 1 h, and in 25.82%, between 1 and 3 h^[23]. The urgency of care is extremely important, as it is directly related to a lower severity of the case or a good prognosis^[29]. The longer arrival time at the hospital mentioned in the present study can be attributed to the fact that this regional hospital is the sole provider of such specialized care. Therefore, we suggest that population awareness measures be taken to reduce this arrival time.

Regarding seasonality, there was a predominant increase in accidents by venomous animals in the rainy season. Some studies commented that the highest occurrence of accidents is related to higher temperatures and not greater rainfall^[29].

In agreement with several other studies, the predominance of male accidents was observed. One such study analyzed the epidemiology of venomous animal accidents that occurred in the last 100 years in Brazil^[8], revealing that the most affected population comprises male rural workers. Similar findings have been reported elsewhere in Brazil, with over 60% of the accidents occurring in males^[11,23,30-33], which may be directly linked to work activities. The early engagement of these individuals in agricultural labor, most likely aimed at augmenting family income, is evident, as corroborated by the present work^[34-36].

As observed in previous studies, the present study also revealed a high rate of bites on the lower limbs, especially on the feet, as the most commonly affected areas by these animals^[23,24,37]. The anatomical site of a scorpion sting significantly impacts the severity of the accident, as proximity to vital organs correlates with increased complications and sequelae of the accident^[38]. The species of scorpions and the amount of venom are also risk factors for the classification of cases. However, it was observed that there is no reference to the species of aggressor scorpion in the SINAN form. We therefore recommend amending the form and including this information, along with providing training to the agents responsible for completing it, enabling them to identify the venomous animals prevalent in the region.

Local clinical manifestations such as pain and edema were very common and verified by several studies^[39]. The most effective treatment for scorpion accidents is the administration of anti-scorpion serum. Upon analyzing the results of serum therapy, it was noted that the administration of serum occurred in 87.2% of the cases. The use of serum for scorpion stings should only be administered to patients classified as moderate and severe, who present systemic manifestations or other symptoms beyond pain, swelling, and local paresthesia such as numbness or tingling. The amount to be applied directly depends on the medical diagnosis that must be made for each type of accident, evaluating the clinical manifestations presented by the individual and laboratory tests. This is in line with what was observed in this study, in which most patients required specific serum therapy, depending on the aggressor animal.

The study showed that Piauí is an area with a high incidence of accidents by venomous animals, mainly scorpions. Therefore, this investigation is a starting point for understanding the spatial distribution of these accidents. The data show that there are still gaps in the flow of information from SINAN and that the number of accidents is increasing. Therefore, it is imperative to facilitate and conduct educational initiatives aimed at enhancing the accuracy of official data records, so that they can be incorporated into the care routine. Given the frequency and severity of these accidents, as well as the necessity for comprehensive data collection (including precise location and demographic information of affected populations), this effort is crucial for improving patient prognoses.

DECLARATIONS

Acknowledgments

We would like to thank the Management of the Regional Hospital and the Municipal Health Department for the availability of data and provision of information that enriched this work.

Authors' contributions

Made substantial contributions to the conception and design of the study and performed data analysis and interpretation: dos Santos Silva GD, Pereira da Silva JV, Abel I, Padda H, Pereira da Costa RT, Silva Catenacci L

Performed graphic assistance and interpretation: de Arruda Xavier D

Provided technical support: Silva Guimarães RC

Availability of data and materials

Not applicable.

Financial support and sponsorship

None.

Conflicts of interest

All authors declared that there are no conflicts of interest.

Ethical approval and consent to participate

Not applicable.

Consent for publication

Not applicable.

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REFERENCES

1. Arruda Carneiro D, Bastos EMAF, Resende FC, et al. Pocket guide: venomous animals. Ezequiel Dias Foundation, Belo Horizonte. 2015. (in Portuguese) Available from: <http://vigilancia.saude.mg.gov.br/index.php/download/guia-de-bolso-animais-peconhentos-funed/?wpdmdl=3991>. [Last accessed on 27 May 2024].
2. Utkin YN. Animal venom studies: current benefits and future developments. *World J Biol Chem* 2015;6:28-33. DOI PubMed
3. Kularatne SAM, Senanayake N. Venomous snake bites, scorpions, and spiders. *Handb Clin Neurol* 2014;120:987-1001. DOI PubMed
4. Brazil Ministry of Health. Sus from A to Z: guaranteeing health in municipalities. (in Portuguese) Available from: https://bvsmis.saude.gov.br/bvsmis/publicacoes/sus_az_garantindo_saude_municipios_3ed_p1.pdf. [Last accessed on 27 May 2024].
5. Brazil Ministry of Health. Health Surveillance Secretariat. Epidemiological Surveillance Department. Infectious and parasitic diseases: pocket guide/ministry of health, health surveillance secretariat, epidemiological surveillance department. 2010. (in Portuguese) Available from: https://bvsmis.saude.gov.br/bvsmis/publicacoes/doencas_infecciosas_parasitaria_guia_bolso.pdf. [Last accessed on 27 May 2024].
6. Meschial WC, Martins BF, Reis LM, Ballani TSL, Barboza CL, Oliveira MLF. Hospital admissions of victims of accidents caused by venomous animals. *Rev René* 2013;14:311-9. (in Portuguese). Available from: <http://www.repositorio.ufc.br/handle/riufc/11724>. [Last accessed on 27 May 2024]
7. Alves F, Machado C, de Lemos ERS. Ants and wasps as a public health problem. *J Health Npeps* 2017;2:122-9. (in Portuguese). Available from: <https://periodicos.unemat.br/index.php/jhnpeps/article/view/1793>. [Last accessed on 27 May 2024]
8. Bochner R. Accidents due to venomous animals: historical, epidemiological, environmental and socioeconomic aspects. 2003. (in Portuguese) Available from: <https://www.arca.fiocruz.br/handle/icict/1341>. [Last accessed on 27 May 2024].
9. Brazil Ministry of Health. Department of Health Care. Department of Primary Care. Health surveillance: Zoonoses. 2009. (in Portuguese) Available from: https://bvsmis.saude.gov.br/bvsmis/publicacoes/vigilancia_saude_zoonoses_p1.pdf. [Last accessed on 27 May 2024].
10. Busato MA, Silva Corralo V, Bordin SMS, Guarda C, Zulian V, Lutinski JA. Accidents due to venomous animals in the West of the State of Santa Catarina, Brazil. *Brazilian J Med Health Geography* 2014;10:129-39. (in Portuguese). DOI
11. Leobas GF, Feitosa SB, Seibert CS. Accidents due to venomous animals in the State of Tocantins: clinical-epidemiological aspects. *Challenges Interdiscip J Fed Univ Tocantins* 2016;2:269-82. (in Portuguese). Available from: https://www.researchgate.net/publication/305452336_Acidentes_por_animais_peconhentos_no_Estado_do_Tocantins_aspectos_clinico-epidemiologicos. [Last accessed on 27 May 2024]
12. Soares FGS, Sachett JAG. Characterization of accidents with venomous animals: the particularities of the interior of Amazonas. *Scientia Amazonia* 2019;8:29-38. (in Portuguese). Available from: <https://scientia-amazonia.org/wp-content/uploads/2019/08/v.-8-n.-3-CS29-CS38-2019.pdf>. [Last accessed on 27 May 2024]
13. Gutiérrez JM, Theakston RDG, Warrell DA. Confronting the neglected problem of snake bite envenoming: the need for a global partnership. *PloS Med* 2006;3:e150. DOI
14. Chippaux JP. Epidemiology of envenomations by terrestrial venomous animals in Brazil based on case reporting: from obvious facts to

- contingencies. *J Venom Anim Toxins Incl Trop Dis* 2015;21:13. PubMed PMC
15. Oliveira ATAL, Sousa AFPB, Castro Leite Alcantra I, Miranda ITN, Marques RB. Accidents with venomous animals in Brazil: literature review. *Revinter* 2018;11:119-36. (in Portuguese). DOI
 16. Rufo TF, Sobrinho FA. Agricultural modernization in the Cerrados of Piauí: new socio-spatial dynamics and urban transformations in Bom Jesus and Urucui. *Ecuador Mag* 2018;7:42-61. (in Portuguese). DOI
 17. Gonçalves ES, Salomão MG, Santos SMA. The use of spatio-temporal monitoring of urban expansion in the diagnosis of areas possible of venomous epidemiological risk in Guarulhos-State of São Paulo, Brazil. In: Proceedings XIII Brazilian Symposium on Remote Sensing, Florianópolis, Brazil. 2007. pp. 3171-8. (in Portuguese) Available from: <http://marte.sid.inpe.br/col/dpi.inpe.br/sbsr@80/2006/11.09.10.50/doc/3171-3178.pdf>. [Last accessed on 27 May 2024].
 18. Medeiros RM. Agrometeorological study for the state of Piauí. 2016. (in Portuguese) Available from: http://sites.dca.ufcg.edu.br/dca_old/posgrad_met/teses/RaimundoMainardeMedeiros_2016.pdf. [Last accessed on 27 May 2024].
 19. de Holanda RM, de Medeiros RM. Climate classification using the Köppen and Thornthwaite methods in Bom Jesus Do Piauí, Brazil. *Pantaneira Mag* 2019;16:57-69. (in Portuguese). Available from: <https://periodicos.ufms.br/index.php/revpan/article/view/9075>. [Last accessed on 27 May 2024]
 20. Alvares CA, Stape JL, Sentelhas PC, de Moraes Gonçalves JL, Sparovek G. Köppen's climate classification map for Brazil. *Meteorologische Zeitschrift* 2013;22:711-28. DOI
 21. Cantinho Júnior JJ. Accidents caused by venomous animals in the state of Piauí between 2007 and 2014: a series of cases. 2016. (in Portuguese) Available from: <https://www.arca.fiocruz.br/handle/icict/28359>. [Last accessed on 27 May 2024].
 22. Benício RA, Carvalho LS, Fonseca MG. Venomous animals of Piauí: epidemiology of accidentes and list of medical important species. *Rev Brasil Zootecnia* 2019;20. (in Portuguese). DOI
 23. Paris EV. Surveillance and monitoring of accidents due to venomous animals in the municipality of Palmas, Tocantins, Brazil. *Brazilian J Med Geography Health* 2016;12:72-87. (in Portuguese). DOI
 24. Barbosa IR. Clinical and epidemiological aspects of accidents caused by venomous animals in the State of Rio Grande Do Norte. *Plural Sci Mag* 2015;1:2-13. (in Portuguese). Available from: <https://periodicos.ufrn.br/rep/article/view/8578>. [Last accessed on 27 May 2024]
 25. Biondi-De-Queiros I, Santana VG, Rodrigues D. Retrospective study in the metropolitan region of Salvador (Rms), Bahia, Brazil. *Sitientibus* 1996;15:273-85. (in Portuguese). Available from: https://repositorio.ufba.br/bitstream/ri/22778/1/16_v.9_3.pdf. [Last accessed on 27 May 2024]
 26. Nunes CS, Bevilacqua PD, Jardim CCG. Demographic and spatial aspects of scorpion accidents in the Northeast Health District, Municipality of Belo Horizonte, Minas Gerais, 1993 to 1996. *Public Health Notebook* 2000;16:213-23. (in Portuguese). DOI
 27. Ministry of Health. Manual for diagnosis and treatment of accidents due to venomous animals. 2001. (in Portuguese) Available from: <https://www.icict.fiocruz.br/sites/www.icict.fiocruz.br/files/Manual-de-Diagnostico-e-Tratamento-de-Acidentes-por-Animais-Pe-onhentos.pdf>. [Last accessed on 27 May 2024].
 28. Soares MRM, Azevedo CS, De Maria M. Scorpionism in Belo Horizonte, Minas Gerais: a retrospective study. *J Braz Soc Trop Med* 2002;35:359-63. (in Portuguese). DOI
 29. Barbosa MGR, Bavia ME, Silva CEP, Barbosa FR. Epidemiological aspects of scorpion accidents in Salvador, Bahia, Brazil. *Braz Anim Sci* 2003;4:155-62. (in Portuguese). Available from: <https://repositorio.ufba.br/bitstream/ri/2324/1/303-1421-1-PB.pdf>. [Last accessed on 27 May 2024]
 30. Almeida ICF, Azevedo BM. Analysis of snake accidents reported between 2007 and 2010 in Floriano-PI. VII CONNEPI 2012. (in Portuguese) Available from: <https://propi.ifo.edu.br/ocs/index.php/connepi/vii/paper/view/3171/1555>. [Last accessed on 27 May 2024]
 31. da Cunha VP, dos Santos RVSG, Ribeiro EEA, Filho ALMN, Marques RB. Epidemiological profile of accidents involving venomous animals in Piauí. *Revinter* 2019;12:76. DOI
 32. de Oliveira SF, Tajra NA, Santos BS, Dias GRL, Viana MRP. Epidemiology of accidents caused by venomous animals in the state of Piauí - Brazil. (in Portuguese) Available from: <https://downloads.editoracientifica.org/articles/200700627.pdf>. [Last accessed on 27 May 2024].
 33. Albuquerque ICS, Albuquerque HN, Albuquerque EF, Nogueira AS, Cavalcanti MLF. Scorpionism in Campina Grande - PB. *J Biol Earth Sci* 2004;4:1-9. (in Portuguese) Available from: <https://www.redalyc.org/articulo.oa?id=50040114>. [Last accessed on 27 May 2024].
 34. Feitosa RFG, Melo IMLA, Monteiro HSA. Epidemiology of accidents due to venomous snakes in the State of Ceará - Brazil. *Revsocbras Med Trop* 1997;30:295-301. (in Portuguese). DOI
 35. Borges CC, Sadahiro M, dos Santos MC. Epidemiological and clinical aspects of snake accidentes in the municipalities of the State of Amazonas, Brazil. *Revsocbras Med Trop* 1999;32:37-46. (in Portuguese). DOI
 36. Rojas CA, Gonçalves MR, Almeida-Santos SM. Epidemiology of snakebites in the northwest region of the State of São Paulo, Brazil. *Revbras Saúde Prodan* 2007;8:193-204. (in Portuguese) Available from: https://www.researchgate.net/publication/236035426_Epidemiologia_dos_acidentes_ofidicos_na_regiao_noroeste_do_estado_de_Sao_Paulo_Brasil. [Last accessed on 27 May 2024].
 37. Saraiva MG, Oliveira DS, Filho GMCF, Coutinho LASA, Guerreiro JV. Epidemiological profile of snakebites in the State of Paraíba, Brazil, 2005 to 2010. *Epidemiol Health Serv* 2012;21:449-56. (in Portuguese). Available from: http://scielo.iec.gov.br/scielo.php?script=sci_arttext&pid=S1679-49742012000300010&lng=en&nrm=iso&tlng=pt. [Last accessed on 27 May 2024].
 38. Sorensen B. Venomous animals. Rio De Janeiro: Atheneu, 1990. (in Portuguese)
 39. Santana VTP, Suchara EA. Epidemiology of accidents with venomous animals recorded in Nova Xavantina - MT. *J Epidemiol Infect Cont* 2015;5:141-6. (in Portuguese) DOI