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Epidemiologic profile of scorpion sting accidents in the duodecennial between 2011 and 2022 in the southeastern region of Brazil

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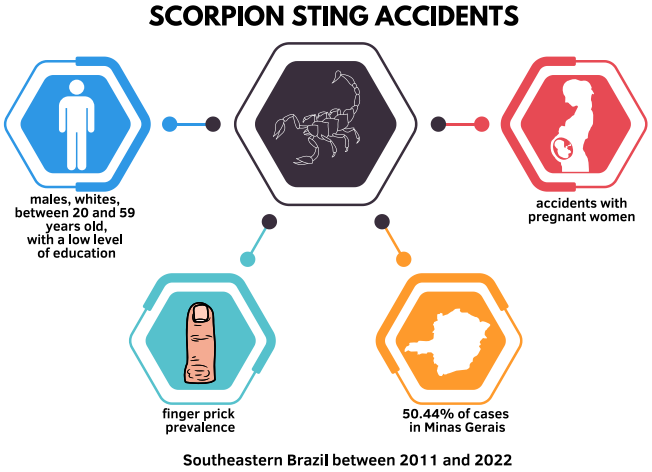
Abstract
Scorpion sting accidents have a significant impact in Brazil, leading to increased hospitalizations and healthcare costs, especially in regions with high scorpion populations. The present study aimed to perform an epidemiological analysis of these accidents in Southeastern Brazil. It is an epidemiological, ecological, and mixed-design study. The methodological strategy involved the analysis of epidemiological bulletins provided by the Sistema de Informação de Agravos de Notificação (Sinan) from 2011 to 2022. The data revealed that 613,385 cases of accidental scorpion bites were reported. Minas Gerais had the highest number of cases (50.44%). Males, Caucasians, between 20 and 59 years old, with a low level of education, are the most affected. Victims sought medical attention within 3 hours of the bite, and 27.34% were on the fingers. About 89.7% of the cases were classified as mild, 95.33% were cured, and 0.78% died from the reported disease. The results highlight the urgent need for targeted prevention strategies, improved medical management, and community awareness campaigns to reduce the impact of scorpion stings in the southeastern region of Brazil.

Keywords: Animals, poisonous, public health, scorpion sting.

Graphical Abstract



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1. Introduction

Brazil is known worldwide as a hotspot for animal and plant biodiversity. Many of these species have been domesticated, and some are extinct, but some can defend themselves when they feel threatened, such as venomous animals (Lima et al., 2021). The rapid and unregulated urbanization of the territory, coupled with human living conditions, facilitates the rapid proliferation of these animals, and predisposes humans to encounter them. A lethal consequence of this contact is poisoning accidents that can cause death (Silva et al., 2018).

Venomous animals are those that could produce venom, a toxic substance produced and actively used for hunting or defense, inoculated to the victim through specialized structures such as bristles, teeth, stingers, and spines, among others (Oliveira et al., 2018; Lima et al., 2021). It is possible to note that among the accidents with venomous animals, ophidism (poisoning by snake venom), scorpionism (poisoning by scorpion venom), and accidents with spiders are those with the greatest epidemiological interest for public health in Brazil (Oliveira et al., 2018).

Cases of scorpionism have significantly increased due to the high frequency of their occurrence and their severity, representing an emerging public health problem in Brazil, being more common in dry, humid, coastal, and urban areas (Cupo, 2015; Fontenele et al., 2015; Shibakura et al., 2020). In 2020, 238,433 accidents involving venomous animals were reported in Brazil. Of these, 39% occurred in the Southeastern region of the country, and 61% of the accidents were due to human contact with scorpions (Silva & Oliveira, 2021).

The main chelicerate arthropods of medical importance are *Tityus serrulatus*, responsible for more severe accidents, *T. bahiensis,* and *T. stigmurus* (Oliveira et al., 2018). The symptoms victims present after scorpion accidents are classified as mild, moderate, or severe. This classification comes from the arthropod species, the amount of venom inoculated, the victim's body mass, and the sensitivity to the injected toxic substance (Santos, Croesy, & Marinho, 2012).

Due to the high incidence associated with underreporting of these accidents, the World Health Organization added this type of event to the list of neglected tropical diseases in 2009 (Feitosa et al., 2015). Later, in 2010, they were included in the National List of Compulsory Notification of the Brazilian Ministry of Health, promulgated by Decree No. 2472 of August 31, 2010 (confirmed by Decree No. 104 of January 25, 2011). It also establishes that accidents should be reported to the Municipal Health Secretariat within 24 hours (Machado, 2016).

According to Sinan data (2007-2022), the Southeastern region presented 36.5% of the notifications of accidents caused by venomous animals (Brazil, 2023a). It is the most developed in the country, with two capital cities that outsource management and care in primary health care (Ramos & Seta, 2019). Given the exposed problem, the objective of this work was to describe the epidemiological characteristics of accidents with scorpions in the resident population of the Southeastern region of Brazil between 2011 and 2022.

2. Methodology

This article is the product of an epidemiological, ecological, mixed design (observational and cross-sectional) study, including the description of the temporal trend and spatial patterns of scorpionism in the Southeastern region of Brazil between 2011 and 2022.

The data analyzed and studied in this research were selected from the Sistema de Informação de Agravos de Notificação (Sinan) (Brazil, 2023b), a system used to register and monitor diseases and conditions of public health interest in Brazil. This type of methodology, which uses only publicly available data that does not identify participants, does not require approval for its conduct by the country's human research ethics committees.

The data were collected between December 2022 and February 2023. The elements studied were stratified according to the information available in the scorpionic accident reports. They were the number of reports per year, sociodemographic variables (sex, race, education, age group), reports on pregnant women, clinical information, and case evolution. The variables were transferred and analyzed using Microsoft Office Excel® and GraphPad Prism 6® and presented as figures and tables. The map of the spatial distribution of cases was generated using TabWin 4.15®.

To calculate the annual prevalence of scorpionism, the number of accidents in each year was used as the numerator, and the population living in the region by year, according to the projection of

the Brazilian Demographic Census (Brazil, 2023c), was used as the denominator. The results of the division were multiplied by ten thousand inhabitants, as adapted from Oliveira and collaborators (2022).

Statistical analysis was performed with GraphPad Prism 6®. The normality of the number of reports was assessed using the Kolmogorov-Smirnov test, which indicated a nonparametric data distribution. Kruskal-Wallis and Dunn's multiple comparison tests were used to compare the results between groups. P values <0.05 were considered significant.

3. Results

Between 2011 and 2022, 613,385 cases of scorpion bite accidents were reported in the Southeastern region of Brazil. A significant difference ($p<0.0001$) was found by Dunn's multiple comparison test between the years studied.

The number of reports per year and their annual prevalence are shown in **Fig. 1**. The bar graph represents the number of cases and should be analyzed with the y-axis on the left. The line graph with circular symbols refers to the annual prevalence in the period studied and should be analyzed with the y-axis on the right of the figure.

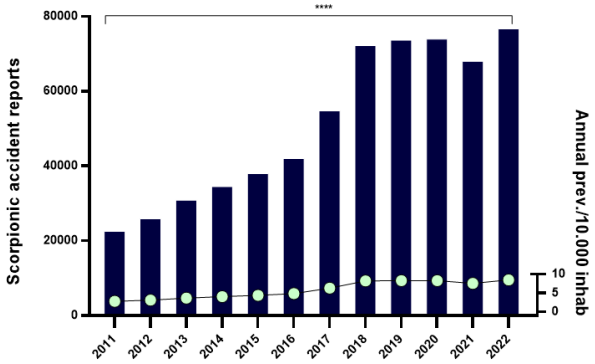

Fig. 1 Scorpion bite accidents and annual prevalence in Brazil (2011-2022). 'Prev.' refers to the prevalence and 'inhab' to the number of inhabitants. Source**:** Produced with data from Sinan (Brazil, 2023b).

The spatial distribution of cases according to the state where the accident occurred is shown in **Fig. 2**. The states of the Southeastern region of Brazil present a heterogeneous distribution of cases. Minas Gerais presented 50.44% of the cases, followed by São Paulo at 43.99%, Espírito Santo at 4.62%, and Rio de Janeiro at 0.95%.

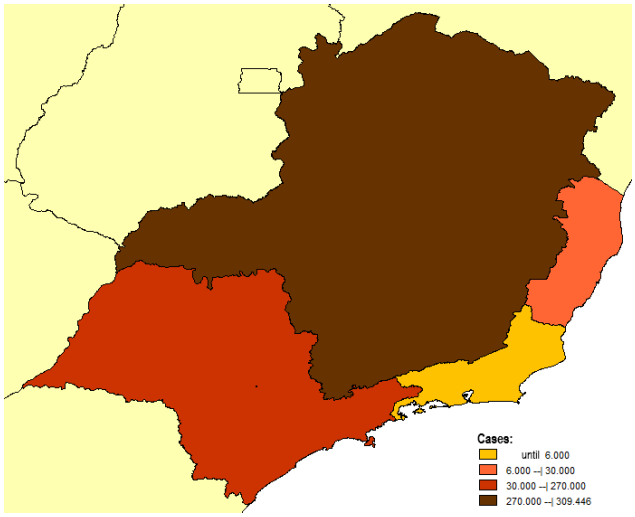

Fig. 2 Geographic distribution of scorpionic accidents in southern Brazil (2011-2022). States are highlighted in red (São Paulo), brown (Minas Gerais), yellow (Rio de Janeiro), and orange (Espírito Santo). Source: Produced with data from Sinan (Brazil, 2023b).

Table 1 shows the social and demographic variables of the victims. It was possible to determine that males, whites, between 20 and 59 years of age, with a low level of education, are the most affected.

Table 1 Social and demographic variables of accident victims in the Southeast region (2011-2022)

Sex	**n**	**%**
Male	331,697	54.08
Female	281,519	45.90
Ignored/white	169	27.55
Race	**n**	**%**
White	267,143	43.55
Black	44,624	7.28
Yellow	5,130	0.84
Brown	247,886	40.41
Indigenous	1,985	0.32
Ignored/white	46,637	7.6
Schooling	**n**	**%**
Illiterate	10,520	1.72
1st to 4th grade incomplete elementary school	64,456	10.51
4th grade complete of Elementary School	34,488	5.62
5th to 8th grade incomplete elementary school	69,979	11.41
Completed elementary school	36,144	5.89
Incomplete high school	44,423	7.24
Completed high school	91,983	15
Complete higher education	14,344	2.34
Incomplete higher education	6,376	1.04
Ignored/white	240,672	39.24
Age group	**n**	**%**
Less than 1 year	7,010	1.14
1-4 years	21,788	3.55
5-9 years	29,909	4.88
10-14 years	35,430	5.78
15-19 years	44,723	7.29
20-39 years	186,258	30.37
40-59 years	177,359	28.91
60-64 years	36,681	5.98
65-69 years	28,215	4.6
70-79 years	33,536	5.47
80 years or older	12,398	2.02

n is the raw number of notifications related to the described feature. Source: Produced with data from Sinan (Brazil, 2023b).

There were 5,624 cases reported in pregnant women. Of them, 1,464 were pregnant women in the 1st trimester, 1,952 in the 2nd trimester, and 1,454 in the 3rd trimester. In addition, there were 754 reports in which the gestational age was not reported.

In most reported accidents, the victims sought medical attention within 3 hours after the bite. Regarding the main sites of bites, 27.34% were on the fingers, 18.53% on the feet, and 17.98% on the hands. As for the outcome of the cases, 89.7% were classified as mild, 95.33% were cured, and 0.78% died of the reported disease.

4. Discussion

Despite the significant increase in the number of scorpion sting accidents in the Southeastern region between 2011 and 2018, in the last five years of the period analyzed, the accidents had a uniform distribution during the study period. This increase can be explained by the fact that the scorpions are arachnids that are active in the warm months, usually during rainy periods, but due to climate change, in some regions, these animals are active throughout the year (Amorim et al., 2003; Monaco, Meireles & Abdullatif, 2017; Lourenço, 2018).

Also, according to Oliveira et al. (2015) and Lopes et al. (2017), the increase in the number of notifications of these accidents may be related to improving health services in terms of epidemiologic surveillance, diagnosis, and notification of cases.

Furthermore, the methodological tool of epidemiology could contribute substantially to the adequate dimensioning of the prevalence of scorpion accidents in the Southeastern region of Brazil, characterizing the studied area as endemic for the type of accidents with venomous animals studied, presenting an average prevalence of 5.85%.

The data from this survey showed that males have a higher prevalence of vulnerability to scorpion accidents compared to female statistics, which is consistent with previous publications (Reckziegel & Pinto, 2014; Silva et al., 2017; Feitosa et al., 2020). Oliveira et al. (2010) highlight that civilian workers and manual laborers are constantly targeted by these accidents.

In this study, the data converge with that found in the scientific literature (de Paula Júnior, 2021; Albuquerque et al., 2023) as a higher prevalence of white (43.55%) and brown (40.41%) people affected were highlighted. According to Silva et al. (2017), the published scientific papers do not address an intrinsic relationship between accidents and the variable "race/color" to explain the statistical rates found.

This study also shows that the most reported accidents occurred in patients between 20 and 59 years of age, corresponding to the economically active population. From 30 years old, this population probably suffered accidents during work or domestic activities, exposing them to contact with the scorpion. These data are consistent with those described in the literature for other regions of the Brazil (Nodari et al., 2006; Maestri Neto et al., 2008; Mesquita et al., 2015); and worldwide (Santos et al., 2016).

In terms of education, the data obtained associate people with a medium level of education with more cases of accidents with scorpions. One of the factors that may contribute to the occurrence of accidents with venomous animals is the population's lack of knowledge about them (Ferreira & Rocha, 2019).

It was evident that pregnant women are vulnerable to the accidents studied. Unlike the cases of poisoning of pregnant women by snake bites, which are associated with high rates of complications and fetal and maternal mortality, depending on the degree of envenomation, accidents involving scorpions do not pose risks to the pregnant woman and the fetus (Albuquerque et al., 2023).

An important factor that exposes adults to scorpions is the working conditions, mainly related to the presence of debris. In construction sites, the presence of debris is constant, and workers are susceptible to the presence of scorpions that use this debris as shelter (Almeida et al., 2021).

Moreover, scorpions can also seek prey in accumulations of organic matter and debris, places like homes, where they can hide in dark places such as crevices, between clothes, and inside shoes (Chávez-Haro & Ortiz, 2015). For these reasons, the prevalence of bite sites found in this study is justified and is consistent with data from Santana et al. (2020), who state that up to 73% of scorpion stings occur on the extremities of the hands and feet.

The data showed that 89.7% were classified as mild and 95.33% were cured. It can be concluded that the severity of systemic effects caused by different scorpion species depends on the composition of the venom and the physical characteristics of the affected individuals. In general, children under the age of twelve and, less commonly,

the elderly with associated comorbidities present the worst symptoms, with most deaths occurring in these age groups (Reckziegel & Pinto, 2014; Cupo, 2015).

Regarding post-accident care in the sample studied, victims sought medical attention within 3 hours of the bite. Carmo et al. (2019) claim that patients seen within an interval of more than 3 hours have a 38% higher chance of worsening compared to those seen within 1 hour.

The results of this study suggest that the management of scorpion stings, which have increased in recent years, requires improvements in infrastructure/sanitation, education indicators, and the provision of jobs that indirectly facilitate access to good household biosanitation (Almeida et al., 2021).

5. Conclusion

This survey highlights the critical epidemiological importance of studying scorpion sting accidents in the Southeastern region of Brazil. The study analyzes the prevalence, geographic distribution, and associated social determinants of health of scorpion stings in this area to provide valuable insights for public health interventions. The findings highlight the urgent need for targeted prevention strategies, improved medical management, and community awareness campaigns to mitigate the impact of scorpion stings in the Southeastern region of Brazil. Understanding the epidemiology of these accidents is essential to guide evidence-based policies and interventions to protect human health in this vulnerable area.

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Authors' Contributions

M. V. G. S.: Data Curation, Writing - Review & Editing; P. L. F. N.: Data Curation, Writing - Review & Editing; G. S. P.: Data Curation, Writing - Review & Editing; P. L. F. N.: Data Curation, Writing - Review & Editing; G. H. O. D.: Data Curation, Writing - Review & Editing; E. L. P. R.: Data Curation, Writing - Review & Editing; J. P. M. C.: Writing - Review & Editing, Project administration; V. J. O.: Data Curation, Writing - Review & Editing, Supervision, Project administration. All authors read and approved the final manuscript.

Availability of data and materials

Not applicable.

Competing interests

The authors declare that they have no competing interests.

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