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Original Article

Temporal trend and epidemiological profile of accidents caused by venomous animals in the state of Pará, 2018-2022

Tendência temporal e perfil epidemiológico dos acidentes causados por animais peçonhentos no Estado do Pará, 2018-2022

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Abstract

Accidents involving venomous animals are a significant public health issue in Brazil, with about 140,000 cases reported annually. Pará, with its vast forests and biodiversity, experiences high incidences exacerbated by human-environment interactions. This study analyzes the temporal trend and epidemiological profile of such accidents in Pará from 2018 to 2022. A cross-sectional study using SINAN data, employing Prais-Winsten linear regression to evaluate temporal trends. Incidences were stratified by sex, age group, and accident location (rural, agricultural, work, residential, leisure). From 2018 to 2022, accidents in rural areas, particularly agricultural, increased notably, with a 40% rise overall. Males aged 20-39 years were most affected. March consistently recorded the highest cases, indicating a seasonal peak. Accidents involving venomous animals in Pará are increasing, particularly in areas of agricultural expansion. This trend highlights the need for intensified prevention efforts, public education, and effective treatment strategies, integrating public health measures and environmental management.

Keywords: venomous animals, epidemiology, public health, Pará, temporal analysis.

Resumo

Acidentes envolvendo animais peçonhentos representam uma questão significativa de saúde pública no Brasil, com cerca de 140.000 casos relatados anualmente. O Pará, com suas vastas florestas e biodiversidade, apresenta altas incidências exacerbadas pelas interações humano-ambiente. Este estudo analisa a tendência temporal e o perfil epidemiológico de tais acidentes no Pará de 2018 a 2022. Foi realizado um estudo transversal utilizando dados do SINAN, empregando a regressão linear de Prais-Winsten para avaliar tendências temporais. As incidências foram estratificadas por sexo, faixa etária e local do acidente (rural, agrícola, trabalho, residencial, lazer). De 2018 a 2022, os acidentes em áreas rurais, particularmente agrícolas, aumentaram notavelmente, com um aumento de 40% no total. Homens de 20 a 39 anos foram os mais afetados. Março registrou consistentemente o maior número de casos, indicando um pico sazonal. Os acidentes envolvendo animais peçonhentos no Pará estão em crescimento, especialmente em áreas de expansão agrícola. Essa tendência destaca a necessidade de intensificar esforços de prevenção, educação pública e estratégias de tratamento eficazes, integrando medidas de saúde pública e gestão ambiental.

Palavras-chave: animais peçonhentos, epidemiologia, saúde pública, Pará, análise temporal.

1. Introduction

Accidents involving venomous animals are compulsory notifiable events in Brazil due to their significant morbidity and mortality and their potential to cause temporary or permanent sequelae. Annually, around 140,000 accidents are reported, representing a serious public health problem that primarily affects the most vulnerable populations, including the state of Pará (Chippaux, 2021).

The state of Pará, with its vast forested area and abundant biodiversity, presents a high incidence of accidents with venomous animals, exacerbated by the complex interactions between humans and the environment (Williams et al., 2019). The diversity of biomes in Pará, which includes part of the Amazon, makes this state one of the richest in fauna and flora in Brazil, but also one of the most challenging in terms of public health related to accidents with venomous animals (Brasil, 2022). Factors such as agricultural expansion, deforestation, and unplanned urban growth contribute to increased risks associated with

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these accidents, influencing the distribution and behavior of venomous animals in the region (Ferreira et al., 2020; Antunes et al., 2016).

Previous studies indicate that the incidence of accidents involving venomous animals varies significantly depending on changes in land use and predominant economic activities, which alter the habitat of these animals and patterns of human exposure (Almeida et al., 2016a; Brasil, 2021). Therefore, it is crucial to understand these dynamics to develop effective prevention and management strategies.

This study aims to analyze the temporal trend of accidents involving venomous animals in Pará, identify the main risk factors, and suggest interventions that can mitigate the impacts of these incidents on the local population. By establishing the relationship between human activities and the incidence of accidents with venomous animals, we can guide more targeted and efficient public policies, ensuring the safety of the population and the conservation of local biodiversity. Understanding the epidemiological profile and temporal trends of these accidents is fundamental to guiding these policies and improving public health in the specific context of Pará and similar regions.

2. Methods

2.1. Data collection

Data were obtained electronically through the Health Information platform (TABNET), provided by the Department of Informatics of the Unified Health System (DATASUS). Filters were applied to select specific data related to the type of venomous animal involved in the accidents, including snakes, scorpions, spiders, caterpillars, bees, and others, as well as the year of notification, the municipality of occurrence, and demographic variables such as sex and age group of the affected individuals. The type of accident location was also categorized and analyzed, including Rural or Agricultural Areas, Work Areas, Residential Areas, and Leisure Areas, to assess potential differences in accident occurrences based on these locations. Data quality was assessed by considering the completeness of records and the frequency of inconsistencies, with discrepancies verified directly with local health departments (Gutiérrez et al., 2021).

2.2. Population stratification

The studied population was stratified by sex, age group, and location type of the accident. The age groups were divided into: 0-4 years, 5-9 years, 10-14 years, 15-19 years, 20-39 years, 40-59 years, 60-79 years, and 80 years or older. This stratification aims to identify groups with higher vulnerability to accidents based on demographic, occupational, and locational exposure patterns.

2.3. Statistical analysis

For data analysis, Prais-Winsten linear regression was used, a technique that adjusts for autocorrelation, to evaluate the temporal trend of venomous animal accidents over the five years, stratified by type and location of the accident. The incidence of accidents was calculated per 100,000 inhabitants for each category of analysis. Relative risks were calculated to compare the incidence of accidents between sexes, age groups, and accident locations. Autocorrelation diagnostics were performed using the Durbin-Watson test.

2.4. Data quality assurance

To ensure data accuracy, periodic reviews of the consistency of the information recorded in the Notifiable Diseases Information System (SINAN) were conducted. Discrepancies found were verified with local health departments. Statistical validations included the internal consistency analysis of the data and the detection of outliers using exploratory data analysis techniques.

2.5. Ethical considerations

This study, by using secondary and publicly available data that do not involve direct identification of individuals, was exempt from ethical evaluation according to current regulations. However, all analyses were conducted respecting ethical principles for research with human data, ensuring confidentiality and anonymity of the information.

3. Results

During the study period from 2018 to 2022, a total of 44,343 cases of accidents caused by venomous animals were recorded in the State of Pará. The temporal analysis indicated an increasing trend in cases, with a particularly notable rise in 2021 and 2022, coinciding with the expansion of agricultural activities and urbanization in previously predominantly forested areas.

The annual distribution of cases showed a steady increase, rising from 7,469 cases in 2018 to 10,458 cases in 2022, representing an approximate 40% increase over five years. Prais-Winsten linear regression indicated a statistically significant increasing trend ($p < 0.05$), with 95% confidence intervals for the annual estimates (Table 1).

Monthly analysis of the cases shows that March consistently records the highest number of cases, followed by May and April, indicating a peak during the period of intense rains. This seasonal variation can be attributed to the active behavior of many venomous animals during the rainy season, when they are more likely to come into contact with humans.

The highest incidences were observed in the age group of 20-39 years, representing 37% of cases, followed by the age group of 40-59 years, with 26%. Men were more affected than women, with 65% of cases recorded among males. These data indicate that the economically active population is the most affected, likely due to greater exposure to occupational and environmental risks (Table 2).

The mapping of cases revealed a significant concentration in regions such as Altamira and Marabá, which also correspond to areas of intense deforestation and agricultural expansion. In 2022, Altamira recorded

Table 1. Annual and monthly distribution of cases of accidents caused by venomous animals in Pará, 2018 to 2022.

Month	Years				
	2018	2019	2020	2021	2022
January	628	850	993	821	905
February	688	819	918	822	984
March	717	879	916	831	1,094
April	680	743	770	784	1,009
May	638	714	633	782	1,019
June	611	719	612	774	906
July	677	754	639	724	900
August	561	603	587	661	823
September	562	601	580	735	756
October	572	678	537	745	776
November	569	681	607	761	718
December	566	677	659	807	568
Total	**7,469**	**8,718**	**8,451**	**9,247**	**10,458**

Table 2. Age group and sex of the most affected cases in Pará, 2018 to 2022.

Characteristics		n	%
Sex	Female	11,392	26%
	Male	32,949	74%
	Ignored	2	0%
Age Group	<1	645	1%
	1-4	1,244	3%
	5-9	2,233	5%
	10-14	3,494	8%
	15-19	4,467	10%
	20-39	16,422	37%
	40-59	11,645	26%
	60-64	1,655	4%
	65-69	1,168	3%
	70-79	1,091	2%
	80 or +	278	1%
	Ignored	6	0%

the highest number of cases, with 1,050 occurrences, representing a 30% increase compared to 2018 (Figure 1).

Scorpionism displayed the highest frequency, with a cumulative total of 26,606 cases, demonstrating an annual increase from 4,486 in 2018 to 6,275 in 2022. Accidents involving snake venom were also significant, totaling 13,302 cases over the period, with an increase from 2,241 cases in 2018 to 3,137 in 2022. Araneism accounted for 2,217 cases, maintaining a stable presence over the years. Less frequent were bee-related accidents and caterpillar envenomations, with 1,331 and 444 cases recorded, respectively. Other categories of venomous animal envenomations contributed 444 cases over the five years studied (Table 3).

In Table 4, we present the main locations of occurrence, where rural or agricultural areas were the most affected, with a total of 21,286 cases, starting with 3,585 in 2018 and increasing to 5,020 in 2022. Following this, work areas recorded 13,747 cases, with an observed increase from 2,315 in 2018 to 3,242 in 2022. Residential environments

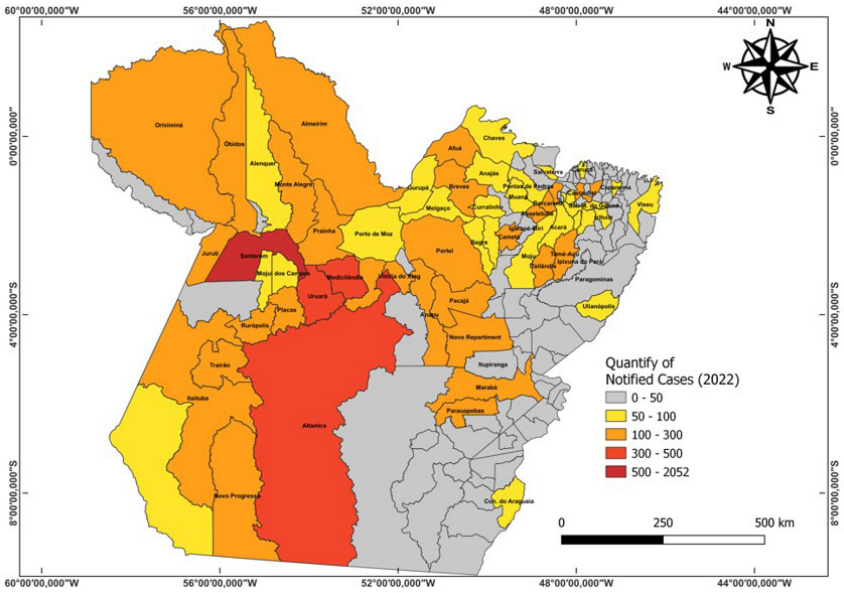

Figure 1. Map of the state of pará with the geographic distribution of cases, 2022.

Table 3. Types of venomous animal accidents during the period from 2018 to 2022.

Type of Accident	2018	2019	2020	2021	2022	Total
Scorpionism	4,486	5,238	5,071	5,548	6,275	**26,606**
Ophidism	2,241	2,615	2,535	2,784	3,137	**13,302**
Araneism	373	436	423	462	527	**2,217**
Apilic Accidents	225	262	254	277	314	**1,331**
Erucism	70	87	85	82	105	**444**
Others	74	80	85	92	101	**444**
Total	**7,469**	**8,718**	**8,451**	**9,247**	**10,458**	**44,343**

accounted for 5,763 accidents over the five years, with a gradual increase from 971 in 2018 to 1,358 in 2022. Leisure areas had the lowest number of cases, totaling 3,547, with 598 cases in 2018 rising to 838 in 2022 (Table 4).

4. Discussion

The results obtained in this study reflect a concerning upward trend in the number of accidents involving venomous animals in the state of Pará, with a significant increase over the five-year period analyzed. This growth is particularly notable in areas of agricultural expansion and urbanization, where human interference in natural habitats is more intense (Almeida et al., 2016a; Brasil, 2021). Understanding the dynamics that influence these trends is crucial for formulating effective public policies and targeted health interventions (Brasil, 2021; Pimenta et al., 2019). The data reveal that the incidence of accidents is higher in the age group of 20 to 39 years and among men, with significant seasonal variations, especially from March to May. These findings indicate that the economically active population, particularly rural workers, is more vulnerable (Silva et al., 2015; Taniele-Silva et al., 2020). Compared to the existing literature, it is observed that the incidence of accidents involving venomous animals is strongly associated with the destruction of natural habitats, a phenomenon that increases the likelihood of encounters between humans and venomous animals (Taniele-Silva et al., 2020; Moreno et al., 2005; Silva et al., 2019).

The significant increase in cases of scorpionism in the state of Pará, from 4,486 in 2018 to 6,275 in 2022, reflects an alarming growth trend, with a cumulative total of 26,606 occurrences. This rise can be attributed to both urban expansion and changes in agricultural practices, which can displace scorpions from their natural habitats into inhabited areas, increasing the incidence of encounters with humans (Matos et al., 2020). Similarly, ophidism also showed a considerable increase, from 2,241 to 3,137 cases over the same

Table 4. Main locations of venomous animal acidentes during the period from 2018 to 2022.

Location of Occurrence	2018	2019	2020	2021	2022	Total
Rural or Agricultural Areas	3,585	4,185	4,057	4,439	5,020	21,286
Work Areas	2,315	2,703	2,620	2,867	3,242	13,747
Residential Environments	971	1,133	1,099	1,202	1,358	5,763
Leisure Areas	598	697	675	739	838	3,547
Total	**7,469**	**8,718**	**8,451**	**9,247**	**10,458**	**44,343**

period, totaling 13,302 records. These data suggest that dangerous interactions between snakes and the population are intensifying, likely due to human encroachment into previously wild areas and improper waste management that attracts snake predators to residential zones (Seldeslachts et al., 2020; Almeida et al., 2021). Furthermore, detailed analysis of the locations of occurrence reveals that rural or agricultural areas are the most affected, with an increase from 3,585 in 2018 to 5,020 in 2022, totaling 21,286 cases. This scenario underscores the vulnerability of rural workers and agricultural communities, who frequently face working conditions that favor contact with venomous animals (Barbosa et al., 2016; Carmo et al., 2016). Work areas, including both industrial and agricultural zones, accounted for 13,747 cases, highlighting the need for more effective and specific occupational health policies for these environments. Although residential environments and leisure areas report lower numbers, with 5,763 and 3,547 cases respectively, they still represent significant risk locations, necessitating education and prevention strategies tailored to the characteristics and needs of each environment (Cozzer et al., 2019; Martins et al., 2018).

These findings call for an integrated approach that combines public health, environmental management, and community education to reduce the incidence of accidents involving venomous animals (Cozzer et al., 2019; Martins et al., 2018). Investments in basic infrastructure, such as sanitation and waste management, along with educational programs focusing on accident prevention and proper treatment, are essential to mitigate the impacts of these encounters (Martins et al., 2018). Collaboration among government agencies, research institutions, and local communities will be fundamental in developing sustainable and long-term solutions that can effectively reduce the risks associated with venomous fauna in the region (Carmo et al., 2016; Martins et al., 2018; Souza et al., 2022). The data from this study underscore the urgent need for prevention strategies that include educating the population about the risks associated with venomous animals and the importance of using personal protective equipment (Almeida et al., 2016b; Antunes et al., 2016). Additionally, it is essential for public policies to integrate public health measures with environmental conservation, seeking to mitigate the impacts of human development on local biodiversity. Examples of successful policies in other regions, such as antivenom distribution programs and public awareness campaigns, can serve as models for Pará (Seldeslachts et al., 2020; Almeida et al., 2022, 2022).

This study has some limitations that should be considered. The reliance on SINAN data may introduce biases due to underreporting or inconsistencies in records. Additionally, the lack of qualitative data limits the understanding of the specific circumstances of each accident. Future studies should aim to integrate qualitative and quantitative data for a more comprehensive analysis. Future research should focus on longitudinal studies to track changes in the incidence of accidents over time and evaluate the effectiveness of implemented interventions. Moreover, qualitative research is needed to better understand the risk factors and circumstances of the accidents, which can inform more effective prevention strategies.

5. Conclusion

The analysis of the data illustrates an alarming reality regarding the increase in accidents involving venomous animals, a direct consequence of the growing interactions between humans and these animals in the context of accelerated urbanization and agricultural expansion. The notable increase in cases, especially in areas of greater economic activity and population movement, underscores the urgent need for a review of public health and environmental management policies. Current strategies must be expanded and strengthened to encompass not only immediate medical prevention and response but also continuous education of the population about the dangers associated with these encounters. The implementation of policies that promote environmental conservation, combined with effective waste management and land use programs, could significantly reduce the incidence of these accidents.

Therefore, it is essential that future efforts focus on integrating public health measures with environmental conservation practices and sustainable development. Intersectoral collaboration between governments, academic institutions, and local communities must be intensified to create and maintain interventions that are both effective and culturally relevant. Additionally, future studies should aim to better understand the seasonal and demographic patterns of accidents to more precisely direct prevention and education actions. This study sheds light on a growing crisis and serves as a call to action to protect both public health and biodiversity in one of the richest and most vulnerable regions of Brazil.

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