ORIGINAL ARTICLE

Epidemiological profile of accidents involving venomous animals in Maranhão from 2012 to 2021

Perfil epidemiológico de acidentes envolvendo animais peçonhentos no Maranhão no período de 2012 a 2021

Perfil epidemiológico de los accidentes con animales venenosos en Maranhão de 2012 a 2021

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ABSTRACT

Background and Objectives: the second greatest cause of human poisoning in Brazil is caused by venomous animals. Thus, this study aimed to analyze clinical and sociodemographic data, in order to outline the epidemiological profile of accidents involving venomous animals in Maranhão. **Methods:** this is an ecological study with a quantitative approach, carried out from data collection by the Notifiable Diseases Information System (SINAN) of notifications of accidents by venomous animals that occurred in the state of Maranhão from 2012 to 2021. **Results:** of the 34,808 cases reported, it was found that the highest incidence occurred in 2019 and, in general, January is the month in which most accidents are recorded. When analyzing the sociodemographic profile, it is noted that the majority of victims are represented by male individuals, between 20-39 years old, with an unidentified level of education. In the case of clinical and epidemiological criteria, it was evident that snakes of the genus *Bothrops* are responsible for the highest incidence, with most cases involving venomous animals occurring within 1-3 hours after the bite. Among the cases identified, 63% were described as mild and 82% progressed to cure. **Conclusion:** the epidemiological profile described in the study can be used by health agents to plan preventive measures in Primary Health Care, and knowing the profile of victims is essential to prevent and promote quality care.

Keywords: Scorpion. Snakes. Epidemiology.

RESUMO

Justificativa e Objetivos: a segunda maior causa de envenenamento humano no Brasil é ocasionada por animais peçonhentos. Dessa forma, este estudo visou analisar dados clínicos e sociodemográficos, a fim de traçar o perfil epidemiológico dos acidentes envolvendo animais peçonhentos no Maranhão. **Métodos:** trata-se de estudo

ecológico de abordagem quantitativa, realizado a partir da coleta de dados pelo Sistema de Informações de Agravos de Notificação (SINAN) de acidentes por animais peçonhentos ocorridos no estado do Maranhão no período de 2012 a 2021. **Resultados:** dos 34.808 casos notificados, constatou-se que a maior incidência ocorreu no ano de 2019 e, em geral, janeiro é o mês em que mais se registram acidentes. Ao analisar o perfil sociodemográfico, nota-se que a maior parte das vítimas é representada por indivíduos do sexo masculino, entre 20 e 39 anos, com grau de escolaridade não identificado. Tratando-se de critérios clínicos e epidemiológicos, evidenciou-se que as serpentes do gênero *Bothrops* são as responsáveis pela maior incidência, sendo que a maior parte dos atendimentos envolvendo animais peçonhentos ocorreu no intervalo de 1-3 horas após a picada. Entre os casos identificados, 63% foram descritos como leve e 82% evoluíram para a cura. **Conclusão:** o perfil epidemiológico descrito no estudo pode ser utilizado por agentes de saúde para o planejamento de medidas preventivas na Atenção Primária à Saúde, e conhecer o perfil das vítimas é essencial para prevenir e promover uma assistência de qualidade.

Descritores: Escorpião. Serpentes. Epidemiologia.

RESUMEN

Justificación y Objetivos: la segunda causa de envenenamiento humano en Brasil es causada por animales venenosos. Así, este estudio tuvo como objetivo analizar datos clínicos y sociodemográficos, con el fin de delinear el perfil epidemiológico de los accidentes con animales venenosos en Maranhão. **Métodos**: se trata de un estudio ecológico con abordaje cuantitativo, realizado a partir de la recolección de datos por el Sistema de Información de Enfermedades de Declaración Obligatoria (SINAN) de relatos de accidentes por animales ponzoñosos ocurridos en el estado de Maranhão entre 2012 y 2021. **Resultados**: de los 34.808 casos reportados, se encontró que la mayor incidencia ocurrió en 2019 y, en general, enero es el mes en el que se registran más accidentes. Al analizar el perfil sociodemográfico, se observa que la mayoría de las víctimas están representadas por personas del sexo masculino, entre 20-39 años, y con nivel de escolaridad no identificado. En el caso de los criterios clínicos y epidemiológicos, se evidenció que las serpientes del género *Bothrops* son las responsables de la mayor incidencia, y la mayoría de los casos que involucran animales venenosos ocurren entre 1 y 3 horas después de la mordedura. Entre los casos identificados, el 63% fueron descritos como leves y el 82% progresó hacia la curación. **Conclusión:** el perfil epidemiológico descrito en el estudio puede ser utilizado por los agentes de salud para planificar medidas preventivas en la atención básica de salud, y conocer el perfil de las víctimas es fundamental para prevenir y promover una atención de calidad.

Palabras Clave: Escorpión. Serpientes. Epidemiología.

INTRODUCTION

Venomous animals are recognized by those who produce venom and are able to inject it, such as snakes, scorpions, bees and beetles. Snake accidents are part of the list of neglected tropical diseases and represent a public health problem, recognized by the World Health Organization (WHO) as belonging to the list of neglected tropical diseases, a fact that even motivated the WHO to modify the strategic tools to eliminate neglected tropical diseases, with the aim of overcoming this situation by 2030.[1]

In Brazil, accidents involving venomous animals have become a problem for public health and are responsible for clinical emergencies, which require immediate assistance due to pathophysiological changes.[2] On average, 200 deaths are recorded annually for every 100,000 cases, making it the second largest cause of poisoning in humans.[1-3] For this reason, the diagnosis of accidents must be reported by clinical-epidemiological emissions by filling out the Venomous Animal Accident Investigation Form in the Notifiable Diseases Information System (SINAN - *Sistema de Informação de Agravos de Notificação*).[4]

This scenario has been justified by climate and environmental changes caused by disorderly urban growth, which has been causing an imbalance in these animals'

natural habitat. Thus, these factors are conditions for venomous animals to migrate from the wild to rural and urban areas in search of food and to attack as a form of defense. As a result, there is an increasing number of peri- and intra-domestic accidents, in addition to an increase in occupational risks of workers in the agricultural sector.[4,5]

The epidemiology of these accidents in northeastern Brazil, including the state of Maranhão, is still poorly understood,[6] especially in the context of these environmental changes in recent years. Furthermore, although there are studies that gather epidemiological data on these complications in Brazil, there are few studies in the literature that specifically deal with the state of Maranhão.

Thus, considering that accidents caused by venomous animals are considered neglected in the country, it is necessary to know the epidemiological profile to conduct prevention policies and guidelines for these risk groups that affect vulnerable, low-income individuals, workers, rural residents, peripheral communities in rural and urban areas, flows of places that bring human beings and the natural habitat together.[3,7] In this context, this study aimed to outline the epidemiological profile of accidents caused by venomous animals in the state of Maranhão from 2012 to 2021.

METHODS

This is an ecological epidemiological study. Data was collected on cases reported to victims of accidents caused by venomous animals in the state of Maranhão between January 2012 and December 2021. The state has a total territorial area of 329,651,496 km² and has an approximate population of 6,775,152 inhabitants (Figure 1).[8]
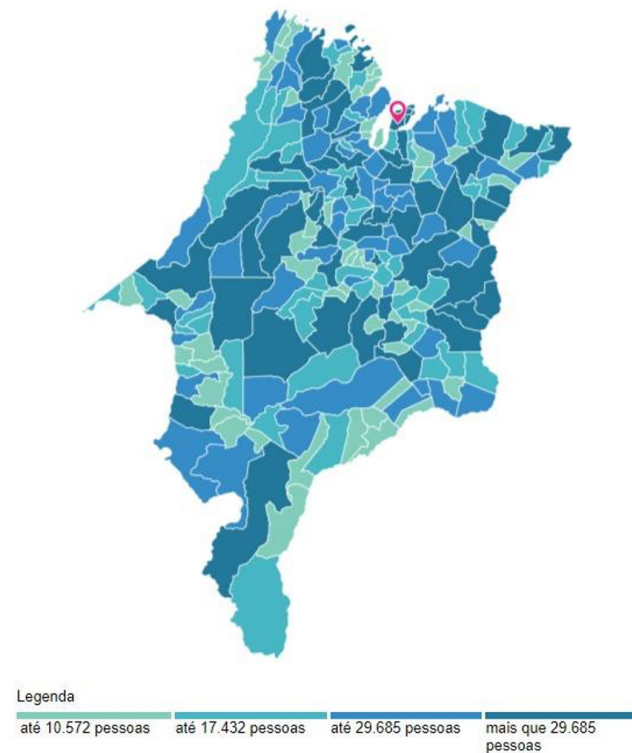

Figure 1. Population map of the state of Maranhão
Source: Brazilian Institute of Research and Statistics, 2022.

Information regarding patients' epidemiological profile was obtained through SINAN, made available by the Ministry of Health. Data was obtained from notification forms filled out by the local health service and stored in the TABNET program, public domain system provided by the Brazilian Health System Information Technology Department (DATASUS - *Departamento de Informática do Sistema Único de Saúde*), accessed on January 18, 2023.

After data collection, sociodemographic variables (sex, age group, education, race and period of gestation) and clinical-epidemiological variables (number of reported accidents caused by venomous animals, accident seasonality through monthly analysis, cause of accident, scorpion/snake/spider genus, final classification of the case, case evolution and time between bite and assistance).

To analyze the variables, stratified descriptive statistical analyzes with a quantitative approach were carried out in the form of proportions establishing the frequency of variables using Microsoft Excel Professional Plus 2021.

Incidence rates were calculated based on information accessed on the TABNET platform, to obtain the number of cases, and on the Brazilian Institute of Geography and Statistics (IBGE - *Instituto Brasileiro de Geografia e Estatística*) portal, to obtain the number of the resident population. The TABWIN program was used to perform this calculation.

As this work is carried out using information derived from secondary data sources in the public domain and without the possibility of identifying individuals, there is no need to submit a project to a Research Ethics Committee (REC), in accordance with Resolution 510/16 of the Brazilian National Health Council (2016).

RESULTS

In the state of Maranhão, a total of 34,808 accidents involving venomous animals were reported from 2012 to 2021. From data tabulation, the highest incidences were observed in 2019 (n=5,274; 74.45/100 thousand inhabitants), 2021 (n=5,188; 72.49/100 thousand inhabitants) and 2020 (n=4,815; 67.62/100 thousand inhabitants). The lowest incidence was recorded in 2012 (n=1,981; 29.42/100 thousand inhabitants) (Figure 2).
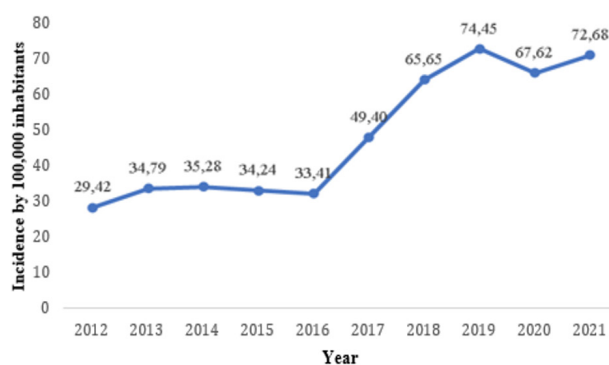
Figure 2. Incidence of accidents caused by venomous animals per 100 thousand inhabitants from 2012-2021, n= 34,808.
Source: adapted from SINAN.

It was observed that accidents occurred more frequently in January (n=3,563; 10.24%), February (n=3,396; 9.76%) and May (n=3,332; 9.57%), and less frequently in October (n=2,265; 6.51%) (Figure 3).
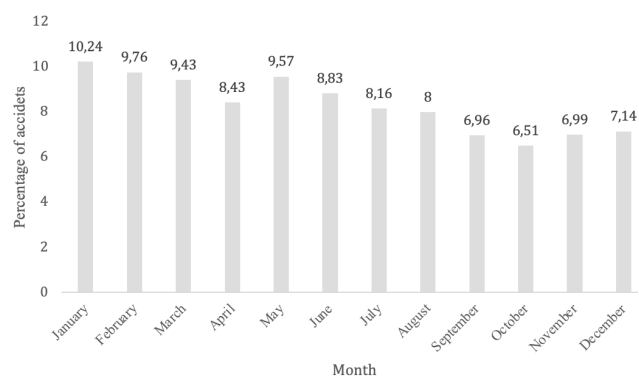

Figure 3. Seasonality of accidents caused by venomous animals registered in the state of Maranhão from 2012-2021, n=34,808.
Source: adapted from SINAN.

Regarding the sociodemographic profile, it was shown that 66.65% (n=23,199) of victims were male, while 33.34% (n=11,605) were female. Most cases occurred in the 20-39 age group (n=12,260; 35.22%), in brown people (n=26,553; 76.28%), whose education was up to elementary school (n =17,126; 49.20%). In relation to pregnancy, the majority of occurrences do not apply (n=26,737; 76.81%) due to predominance of males. However, among the accidents in which victims were pregnant (n=287), the 2nd trimester was the period with the highest number of cases (n=104; 36.23%) (Table 1).

The analysis of clinical and epidemiological characteristics revealed a higher incidence of accidents involving snakes (48.96%), while the highest fatality rate was for incidents involving spiders, compared to other reported etiological agents. As for the final classification, of the 34,808 cases, 22,270 were classified as mild. Regarding the outcome, 82.02% were cured. The most common time between the incident and the most common treatment was in the range of 1 to 3 hours (34.04%).[7]

Table 1. Sociodemographic profile of victims of accidents caused by venomous animals in the state of Maranhão, 2012-2021, n=34,808.

Variables	N = 34,808	%
Sex		
Male	23,199	66.65
Female	11,605	33.34
Ignored	4	0.01
Age group		
<1 year	560	1.61%
1 to 4	1,242	3.57%
5 to 9	2,036	5.85%
10 to 14	2,695	7.74%
15-19	3,293	9.46%
20-39	12,260	35.22%
40-59	8,804	25.29%
60-64	1,475	4.24%
65-69	1,016	2.92%
70-79	1,086	3.12%
80 and +	334	0.96%
Ignored/blank	7	0.02%
Education		
Not educated	2,579	7.41%
Elementary school	17,126	49.20%
High school	3,263	9.37%
University education	396	1.14%
Not applicable	2,513	7.22%
Ignored/blank	8,931	25.66%
Race		
White	2,732	7.85%
Black	2,691	7.73%
Yellow	448	1.29%
Brown	26,553	76.28%
Indigenous	1,372	3.94%
Ignored/blank	1,012	2.91%
Gestation		
1st trimester	56	0.16%
2nd trimester	104	0.30%
3rd trimester	64	0.18%
Gestational age ignored	63	0.18%
No	7,129	20.48%
Not applicable	26,737	76.81%
Ignored/blank	655	1.88%

Source: adapted from SINAN.

Table 2. Clinical and epidemiological characteristics of accidents caused by venomous animals in the state of Maranhão from 2012 to 2021.

Accident etiology	Notifications	%	Deaths	Lethality
Scorpion	12,686	36.44%	45	0.30%
Snake	17,044	48.96%	113	0.60%
Spider	1,623	4.66%	14	0.80%
Bee	1,345	3.86%	10	0.70%
Caterpillar	699	2%	3	0.42%
Others	1,130	3.24%	4	0.35%
Ignored/blank	311	0.89%	3	0.96%
Caused by snake	**Notifications**	**%**	**Deaths**	**Lethality**
Bothrops spp.	11,274	66.14%	51	0.45%
Crotalus spp.	3,900	22.88%	57	1.46%
Micrurus sp.	139	0.81%	-	-
Lachesis sp.	89	0.52%	-	-
Non-venomous	569	3.33%	1	0.17%
Ignored/blank	1,073	6.29%	4	0.44%
Spider genus	**Notifications**	**%**	**Deaths**	**Lethality**
Phoneutria	107	6.59%	-	-
Loxosceles	452	27.84%	6	1.32%
Latrodectus	20	1.23%	1	5%
Another species	447	27.54%	3	0.67%
Ignored/blank	597	36.78%	4	0.67%
Final classification	**Notifications**	**%**	**Deaths**	**Lethality**
Light	22,270	63.97%	78	0.35%
Moderate	8,549	24.56%	48	0.56%
Serious	1,114	3.20%	57	5.11%
Ignored/blank	2,875	8.20%	9	0.31%
Case evolution	**Notifications**	**%**	**Deaths**	**Lethality**
Cure	28,560	82.05%	-	-
Death	192	0.55%	192	100%
Death from other causes	5	0.01%	-	-
Ignored/blank	6,051	17.38%	-	-
Time between bite and assistance	**Notifications**	**%**	**Deaths**	**Lethality**
0-1 hour	10,581	30.39%	48	0.45%
1-3 hours	11,976	34.40%	59	0.49%
3-6 hours	5,099	14.64%	25	0.20%
6-12 hours	1,842	5.29%	17	0.92%
12-24 hours	1,408	4.04%	17	1.20%
More than 24 hours	1,511	4.34%	14	0.92%
Ignored/blank	2,391	6.86%	12	0.50%

Source: adapted from SINAN.

From an analysis focused on the clinical-epidemiological profile (Table 2), it was noted that the main causes of injuries are snakes (48.92%) and scorpions (36.4%). On the other hand, accidents caused by spiders (4.66%) and bees (3.86%), although they occurred in smaller numbers, were the most lethal.

Regarding snake genus, an important factor for choosing the specific antidote, it is noted that there is a preponderance of the genus *Bothrops* (*jararaca, jararacuçu*), with 66.14% of the total cases, followed by snakes of the genus *Crotalus* (rattlesnake), with 22.88%. In terms of lethality, accidents caused by rattlesnakes were the most fatal.

Of the injuries caused by spiders, there is a great deal of misinformation regarding genus, since 36.78% of incidents did not record this information. Despite this, from the analysis of available data, it appears that the genus *Loxosceles* had the highest number of cases (n=452) and the highest fatality rate (1.32%).

In the case of the final classification of cases, approximately 63% of accidents caused by venomous animals were considered mild, 24.56% moderate, 8.20% ignored/blank, and 3.20% severe. However, the lethality of severe cases was 5.11%, resulting in 57 deaths out of the 1,114 registered, while in cases identified as mild and moderate, fatality rates were, respectively, 0.35% and 0.56%. As for case evolution, the majority of accidents resulted in a cure, 82.05% (n=28,560), and only 0.55% of accidents resulted in death (n=192).

The lack of adequate understanding to classify accidents, combined with the discrepancy in case developments, reveals the gap in knowledge that exists in relation to incidents caused by venomous animals. Additionally, it denounces the deficiencies inherent to the Brazilian health system regarding the systematic and reliable data recording, since the progression of events from mild to moderate severity to fatal outcomes is not justified due to the lack of logical cohesion in this context. This problem corroborates other studies, which suggest difficulties in obtaining information about patients' clinical evolution.

When analyzing the time elapsed between bite and treatment, it is possible to see that, in cases treated within 12-24 hours after the bite, the fatality rate was 1.20%. On the other hand, cases in which care was provided within the first 6 hours after the bite achieved the highest cure rates.

DISCUSSION

Accidents caused by venomous animals, in general, are influenced by several variables, such as diversity and specificity of fauna, flora and regional ecosystem, local socioeconomic activities, degree of human contact with animals' natural habitat, the level of aversion to them and other factors that fluctuate over time, such as rainfall levels and temperature.[5,9,10]

It is possible to observe that, throughout the Brazilian territory, the number of accidents caused by venomous animals has been growing too much, including in large urban centers. This fact is due to imbalance of fauna as a result of the advance of deforestation and disorderly urban growth, generating an overlap between these animals' natural habitat and urban occupations, making peri- and intra-household accidents increasingly common. Here accidents with snakes stand out, and in Brazil the term "urbanization of snakebite" has already been adopted.".[11,12]

In relation to accident seasonality, it is possible to verify that January, February and May have the highest number of reported accidents from 2012 to 2021. This data highlights the relationship between accidents and rainfall rates and temperature variations during the year, relating to the season, with high rainfall and hot weather, characteristic of summer, which creates an environment conducive to these animals' reproduction. Thus, this seasonal pattern is also repeated in other studies.[5,10,13]

Thus, in the period under analysis, it was observed that there was a progressive increase over time, in line with studies previously carried out in other states.[11-14] This increase may be due to improvements in the notification system, in order to show increasingly reliable values, or be, in fact, a representation of the growing number of cases.[13]

Furthermore, it is possible to relate the drop in notifications in 2020 to the COVID-19 pandemic, since quarantine and the suspension of several activities occurred during this period, reducing the exposure of the population at occupational risk to this type of injury, or just by undernotification. However, it is worth noting that, despite the decrease in cases during the pandemic period, the numbers remained double when compared to some previous years, highlighting the epidemiological importance of these diseases.

The relationship between accidents and the development of work activities related to agriculture, construction and livestock farming justifies the majority of victims being male (n=23,199; 66.65%), at an economically active age of 20-39 years old and self-declared browns, whose level of education was ignored. This profile is characteristic and is repeated in the vast majority of studies,[5,11-18] as men tend to be more involved with activities in this sector of the economy, making them more vulnerable to accidents with venomous animals, with emphasis on snakebites and scorpionism, more common in the context of occupational risk, in addition to the risk arising from subsistence agriculture in rural areas.[10,12]

Due to possible complications caused by the venom, such as hemorrhage, uterine contraction, threat of abortion, decreased fetal movements and, in more serious cases, even fetal and maternal death,[19,20] the gestational period was used as an analysis criterion. In this study, most occurrences do not apply, as illnesses were more common. However, in cases where there was positivity for pregnancy, the 2nd trimester was the period with the highest number of cases.

Of the 34,808 cases, the most common symptoms were pain, edema and bruising, without complications such as shock, hemorrhage and anuria, since 63.97% of accidents were classified as mild. Bites usually occur on extremities of the body, such as hands, arms, legs and feet.[20]

Snake bites were included in the list of Neglected

Tropical Diseases (NTDs) in category A, in 2017, by the WHO, signaling their importance for public health.[21] In Maranhão, snakebites had the highest incidence among those caused by venomous animals, totaling 48.96% of cases. This finding reveals an increase in the number of snakebites when compared to research carried out in the same state in previous years.[5] Furthermore, studies[14,20] corroborate that snakebite accidents predominate in the Northeast, since 43% of species of medical importance in Brazil inhabit this region, and this is due to the better adaptation of these species in humid environments. Of the 25 species concentrated in the Northeast, 24 are found in Maranhão, and may be from the genera *Bothrops, Micrurus, Crotalus* or *Lachesis*.[7]

Among snakebites, bites by snakes of the genus *Bothrops*, belonging to the family *Viperidae*, have a higher incidence in Brazil, especially in rural areas, where human interaction with the environment is greater.[22,23] In Maranhão, similarities were observed, since the diseases caused by snakes *jararaca* and *jararacuçu*, of the genus *Bothrops*, had a higher incidence, followed by the coral snake, of the genus *Micrurus*, belonging to the family *Elapidae*, considered the most lethal.

In second place are accidents caused by scorpion stings, corresponding to 36.44% of cases. Scorpionism has a high incidence throughout Brazil, and is considered a public health problem, especially in the Northeast region[23]. However, in contrast to snakebites, scorpionism is prevalent in urban environments.[23,25]

There are more than 2,600 species of scorpions in the world, but in South America, mainly in Brazil, the genus *Tityus* stands out in the medical field.[25] Furthermore, in northern and northeastern Brazil, there is a favorable climate for the proliferation of this genus. Among the species, T. *serrulatus* stands out, known as the yellow scorpion, widely distributed throughout the Brazilian territory due to its easy adaptation in urban environments and parthenogenetic reproduction, characteristics that favor its rapid dissemination in different areas. There are also studies that associate a higher lethality rate with the species T. *obscuras*, common in hot and humid regions, such as the Amazon regions, the place with the highest occurrence of lethal accidents involving the species. Concern about the severity of accidents caused by this species of scorpion occurs due to the neurotoxic venom it inoculates, whose response to treatment is not as good.[11,26] Regarding symptoms, local pain is present in all cases, and other symptoms can vary according to severity, from hyperemia and sweating to systemic manifestations and multiple organ failure, with the pediatric age group being the most vulnerable.[24,26]

Accidents caused by spiders, although not the most common, were the most fatal, and this fact can be explained by the lack of adequate treatment due to the failure to identify the causative agent. Identification of a spider's gender is of great importance for case evolution and victim prognosis. Among the recorded genera, a greater number of accidents caused by the known "brown spiders", of the genus *Loxoceles*, were observed. It is important to highlight that, despite their non-aggressive tendency, when subjected to compression, they tend to adopt a defensive attitude. Furthermore, it is worth highlighting the color of these arachnids, which can make identification difficult, especially when they are found in clothing, waste and tree trunks in rural environments.[20]

Another genus of spiders reported is *Phoneutria*, popularly known as "armor spiders". These, as the name suggests, have more aggressive defense behavior and arm themselves when coming into contact with victims. They are nocturnal, which increases the risk of accidents in areas close to construction and debris at night when they go hunting.[20]

Furthermore, the time elapsed between the animal being bitten and the victim being treated is a very important point to be assessed, as it directly affects case evolution. In this context, it is considered early when done in an interval between bite and treatment <6 hours and late when >6 hours.[27] The present study found that the highest fatality rate occurred in treatments carried out within 12-24 hours, a finding consistent with the literature that predicts less success in treatment when it is carried out 6 hours after the accident,[20,27] highlighting the need for develop strategies for timely care.

In relation to case evolution, 82.05% progressed to cure, while only 0.55% of accidents resulted in death. This finding corroborates the results found in other studies.[18,20] These numbers may be related to time between bite and assistance in Maranhão, since in 79.43% (n=27,656) of cases treatment occurred between 0-6 hours after the accident, or due to the final classification of cases, in which 88.53% (n=30,819) were mild or moderate, while only 3.2% were serious.

The epidemiological profile of cases of accidents caused by venomous animals in the state of Maranhão from 2012 to 2021 showed a predominance of individuals whose education was unknown, aged between 20 and 39 years, male and brown. It was also possible to determine that accidents occurred more frequently in months with hotter and more humid climates, in addition to the increase in 2019, 2020 and 2021.

Human interaction in the environment is increasing the number of cases, whether due to the increase in global temperature or the invasion of preserved environments leading to greater contact between humans and venomous animals. Therefore, the growth analyzed in recent years leads to the need for measures to prevent and promote health, in addition to environmental preservation.

Therefore, it is important to highlight the relevance of this study for assessing the epidemiological profile that, through quantitative analysis, allowed monitoring the number of cases and variation due to socioeconomic characteristics, contributing to the development of public strategies to reduce morbidity and mortality from accidents caused by venomous animals.

It is worth highlighting that health depends on other factors and sectors, such as education and infrastructure. Therefore, the data presented here can be used by health agents to plan and organize prevention measures in Pri-

mary Health Care, with educating the population about risk factors. Alerting the population about the danger of accidents with venomous animals in land with a large accumulation of rubble and garbage, together with recommending the use of protective equipment, such as boots and gloves, by rural workers, are actions that can significantly contribute to the reduction of cases of injuries involving these animals.

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AUTHORS' CONTRIBUTIONS

Letícia Lima da Silva, Fernanda Carvalho Camargos Vieira and Rita de Cassia da Silva Oliveira contributed to article conception, design and manuscript writing. **Sávia Lorena Costa and Laís Gomes Ferreira Rosa** contributed to data analysis and interpretation and manuscript writing. **Guilherme de Andrade Ruela** contributed to the planning and design of the article, review and final approval of the article.

All authors approved the final version to be published and are responsible for all aspects of the work, including ensuring its accuracy and integrity.