

ORIGINAL ARTICLE

EPIDEMIOLOGY OF SCORPION ENVENOMATION IN THE STATE OF *CEARÁ*,
NORTHEASTERN BRAZIL

Sanny da Silva FURTADO, José Franscidavid Barbosa BELMINO, Ana Gilza Quaresma DINIZ & Renner de Souza LEITE

SUMMARY

This report is a retrospective study of the epidemiology of scorpion sting cases recorded from 2007 to 2013 in the State of *Ceará*, Northeastern Brazil. Data were collected from the Injury Notification Information System database of the Health Department of *Ceará*. A total of 11,134 cases were studied and distributed across all the months of the studied period and they occurred mainly in urban areas. Victims were predominantly 20-29 years-old women. Most victims were bitten on the hand; and received medical assistance within 1-3 hours after being bitten. Cases were mostly classified as mild and progressed to cure. Scorpion envenomation in *Ceará* is an environmental public health problem that needs to be monitored and controlled throughout the year.

KEYWORDS: Arachnids; Envenomation; Public Health.

INTRODUCTION

Scorpion envenomation is a worldwide public health problem, particularly in tropical and subtropical countries, due to its high incidence and the capacity of some species to induce severe clinical manifestations, being at times fatal^{1,2}. The Brazilian scorpion fauna is a large group, consisting of about 131 species, 23 genera and 4 families³. In Brazil, four species of scorpions of the genus *Tityus* have been responsible for envenomation of medical importance: *Tityus stigmurus*, *T. bahiensis*, *T. paraensis* and *T. serrulatus*, the last one being mainly responsible for the most severe cases, indicating a high rate of lethality, especially in children^{4,5}. The toxicity of scorpion venom varies between different species and between the same species from different regions^{3,6,7}. Scorpion venoms contain proteins and peptides that block and/or modulate different types of ionic channels (e.g. sodium, potassium, chlorine, and calcium), mainly in the autonomous nervous system. At the nerve terminals of such a system, scorpion venom induces the release of acetylcholine and/or catecholamines (adrenaline and/or noradrenaline), leading to clinical manifestations^{5,8}. Scorpion envenomation may induce immediate local pain only, but it may also be accompanied by other local manifestations, such as swelling, hyperemia, paresthesia, and piloerection. The development of systemic symptoms (gastrointestinal, respiratory, cardiovascular, and/or neurological disorders) indicate an increase in the severity of the envenomation^{2,5}. The severity depends on the scorpion and/or the victim. Factors related to the scorpions include the species and size of the animal, the content of the venom glands, the status of the venom ducts of the telson, the number of stings, and the amount of venom inoculated.

The factors associated with the victim are age, part of the body stung, body mass, health status, sensitivity to venom, time elapsed between sting and treatment, and the maintenance of vital functions⁸. In Brazil, the number of cases of scorpion sting increased from 12,552 in 2000 to 69,033 in 2013⁹. The Brazilian Northeast has had the highest incidence of cases, followed by the Southeast, Midwest, North, and South⁹. The first region has also had the highest number of deaths caused by scorpion stings¹⁰. Despite its medical importance, the epidemiological profile of scorpion envenomation cases in Northeastern Brazil has not been conclusively determined. Moreover, social and environmental changes occurring in this region during recent decades, demanding a new research on this topic. To address this shortcoming, the current study retrospectively analyzed epidemiological data regarding scorpion sting cases recorded between 2007 and 2013 in the State of *Ceará*, Northeastern Brazil.

METHODS

Study area

The State of *Ceará*, whose capital is *Fortaleza*, is a federal unit that integrates the Brazilian Northeast. It is composed of 184 municipalities, with a population of 8,452,381 inhabitants and a population density of 56.76 inhabitant/ km². Approximately 75% of its residents live in urban areas¹¹. The State covers an area of 148,825.6 km², occupying 9.5% of the northeastern territory, and 1.7% of the Brazilian area¹¹ (Fig. 1). The majority of its territory (97%) is located within the "Drought Polygon", an area that is affected annually by prolonged periods of drought¹². Almost



Fig. 1 - Distribution by municipality of scorpion sting cases in the State of Ceará, from 2007 to 2013.

the entire region has a low rainfall rate, high average temperatures, acute water shortage, generally thin and often salty soils, and *caatinga* vegetation¹².

Data collection

An epidemiological retrospective study of scorpion sting cases was performed. Data were collected from the Injury Notification Information System (SINAN) database of the Health Department of Ceará. Demographic and population data from the Brazilian Institute of Geography and Statistics were used to calculate the incidence rates for scorpion stings. Statistical analyses were performed using Chi-square (Likelihood Ratio Chi-Square), Mann-Whitney, Kruskal-Wallis, and Odds Ratio tests. The tests were carried out using the software SPSS®

version 13.0 (Statistical Package for Social Sciences) for Windows. The level of significance was $p < 0.05$. Even though only secondary data provided by SINAN were analyzed, without identifying any of the victims, the present study was submitted and approved by the Ethics Research Committee of the Federal University of *Campina Grande* (protocol number 835.900/2014).

RESULTS

A total of 11,134 scorpion sting cases were recorded by the Health Department of Ceará from January/2007 to December/2013. There was a gradual increase in the number of cases during the investigated period: from 681 cases in 2007 to 3,401 cases in 2013. The average incidence rates per 100,000 inhabitants were 8.05; 5.50; 8.54; 13.03; 28.20; 28.16; and 40.24 cases from 2007 to 2013, respectively. Five deaths were recorded, and the average lethality rate was of 0.07%. Figure 2 shows that scorpion sting cases occurred across all of the months of the years studied, with the higher frequencies occurring in May ($n = 1,055$; 9.48%) and October ($n = 1,021$; 9.17%). No significant differences were observed between months. Table 1 shows that the frequency of cases involving women ($n = 7,058$; 63.39%) was higher than those involving men ($n = 4,076$; 36.61%) ($p < 0.01$). The highest frequency of stings was found in individuals between 20 and 29 years old ($n = 2,208$; 19.93%), followed by the age range between 30 and 39 years ($n = 1,799$; 16.16%). No statistical differences were observed between age ranges. The frequency of cases was higher in urban ($n = 9,625$; 86.45%) than in rural areas ($n = 1,327$; 11.92%) ($p < 0.01$). The majority of victims were not at work at the time of the sting ($n = 10,076$; 90.50%). Table 2 shows that the majority of cases were classified as mild ($n = 10,440$; 93.77%), while few cases were classified as moderate ($n = 365$; 3.28%) or severe ($n = 17$; 0.15%). There was predominance of cases that were eventually cured ($n = 10,673$; 95.86%). Antivenom therapy was administered to 835 patients (7.50%), and 9,961 patients (89.46%) received no serotherapy. Of the 835 victims treated with antivenom, 71% received it up to three hours following the sting (Table 2). Figure 3 shows that the frequency of stings on the hand ($n = 4,165$; 37.41%) and foot ($n = 3,932$; 35.32%) was significantly different ($p < 0.01$) when compared to the head ($n = 183$; 1.64%), arm ($n = 639$; 5.74%), forearm ($n = 146$; 1.31%), trunk ($n = 465$; 4.18%) and leg ($n = 1,143$; 10.27%). Figure 4 shows that the most frequent time intervals that elapsed between sting and medical assistance was

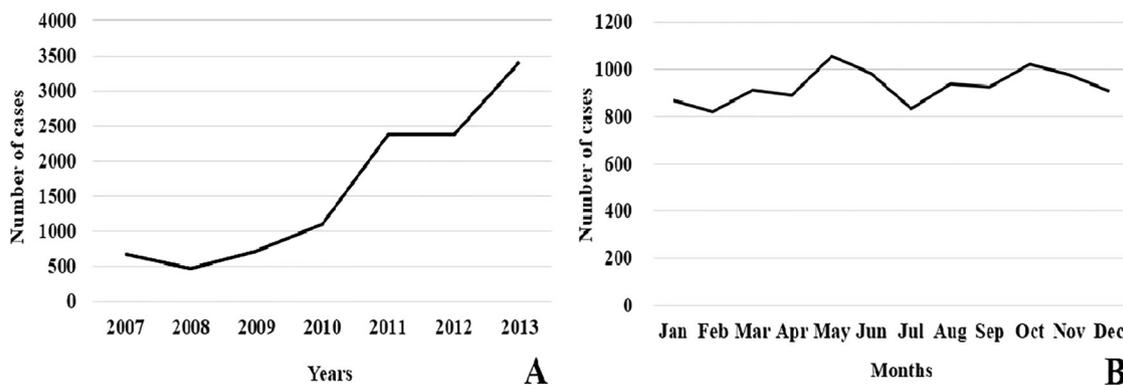


Fig. 2 - Distribution by year and month of scorpion sting cases in the State of Ceará, from 2007 to 2013.

Table 1

Epidemiological characteristics of scorpion sting cases in the State of Ceará, from 2007 to 2013

Variables	Number of cases	%
Gender		
Male	4,076	36.61
Female	7,058	63.39
Victim's age (years)		
0 — 9	1,301	11.68
10 — 19	1,600	14.37
20 — 29	2,208	19.93
30 — 39	1,799	16.16
40 — 49	1,614	14.50
50 — 59	1,235	11.09
60 — 69	803	7.21
≥70	574	5.16
Geographical location of the case		
Urban	9,625	86.45
Rural	1,327	11.92
Periurban	37	0.33
Unknown	145	1.30
Work-related accident		
Yes	410	3.68
No	10,076	90.50
Unknown	648	5.82
Total of cases	11,134	100%

Table 2

Distribution of scorpion sting cases in the State of Ceará, from 2007 to 2013, according to severity, progression, and antivenom therapy

Variables	Number of cases	%
Severity		
Mild	10,440	93.77
Moderate	365	3.28
Severe	17	0.15
Unknown	312	2.80
Progression		
Cure	10,673	95.86
Death	5	0.04
Unknown	456	4.10
Antivenom		
Yes	835	7.50
Not	9,961	89.46
Unknown	338	3.04
Total of cases	11,134	100%

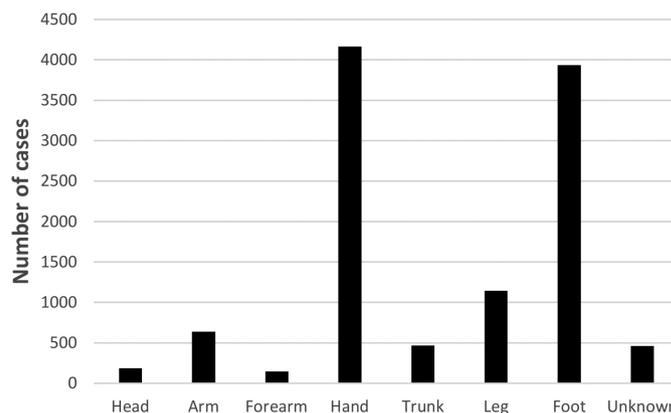


Fig. 3 - Distribution of scorpion sting cases in the State of Ceará, from 2007 to 2013, according to the body part affected by the sting.

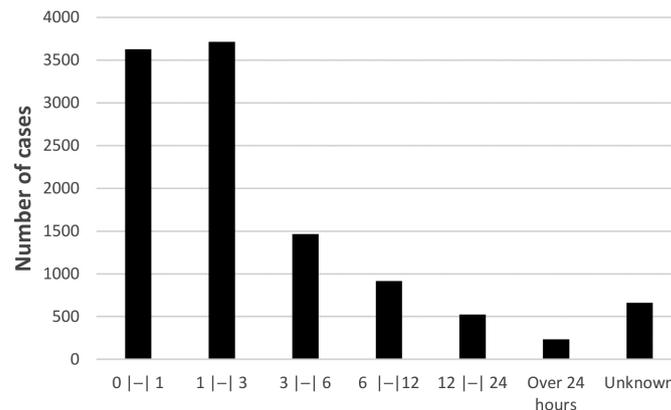


Fig. 4 - Distribution of scorpion sting cases in the State of Ceará, from 2007 to 2013, according to the time elapsed from sting until medical care.

1 to 3 hours (n = 3,712; 33.34%), followed by 0 to 1 hour (n = 3,627; 32.58%). There was significant difference between time intervals, as well as between other intervals ($p < 0.01$).

DISCUSSION

There was a significant increase of scorpion sting cases in Ceará from 2007 to 2013. The annual average incidence was of 18.57 cases/100,000 inhabitants, which is in agreement with that reported by the Brazilian Health Ministry⁹. Scorpion sting cases were distributed over 168 out of the 184 municipalities of Ceará, indicating the presence of scorpions in most regions of the State. The highest numbers of cases were observed in Fortaleza (n = 6,473; 71.19%), Sobral (n = 284; 2.55%), Limoeiro do Norte (n = 236; 2.12%), Juazeiro do Norte (n = 182; 1.63%), and Russas (n = 182; 1.63%) (Fig. 1). The other municipalities recorded <1.0% of all scorpion stings reported during the study period. The high incidence of stings in Fortaleza may be a result of its large resident population (2,452.185 habitants) and high population density (7,786.52 inhabitant/km²). In addition, its climatic and urban conditions are appropriate for the shelter and proliferation of scorpions. ALVES *et al.* (2007) similarly reported that domestic accidents caused by scorpions in Fortaleza have gradually increased due to the ideal conditions for their proliferation, such

as the presence of debris, trash, high population density, and inadequate sanitation¹³. Moreover, the easy adaptation of the scorpions to urban home life contributes to the increase of such domestic accidents¹³. Taken together, these findings suggest that *Fortaleza* may be a high-risk area for scorpion stings. It is interesting to note that cases were distributed throughout the years, with no significant variation between months, similar to what was reported in other northeastern States of Brazil^{6,13,14}. On the other hand, in the South and Southeast regions, scorpion stings follow a noteworthy seasonality, being more frequent from October to December^{2,15}. The little variation between months may be attributed to the climatic conditions of the region studied, which is characterized by an average annual temperature of 28 °C. Furthermore, the temperature in this region varies little between summer and winter, especially when compared to the South and Southeast regions. This stable climatic condition favors the reproduction of scorpions, thus leading to the occurrence of cases all across the year. Accordingly, preventive actions against scorpion stings should be carried out during all the months of the year. Such actions would include effective educational programs on the prevention and treatment of scorpion envenomation, to be offered to both community and health care workers. The highest number of cases involving women indicates a differential risk between genders in this region. The risk of stings in women was 1.62 times higher than in men. Moreover, the risk of stings involving women in urban areas was 0.48 times higher than in rural areas. This could be explained by the generally longer permanence of the women inside home, which consequently increases the risk of scorpion stings. Other studies in Northeastern Brazil also reported that scorpion sting cases were more frequent among women^{13,14}. In the North⁷ and Southeast¹⁶ regions, on the other hand, scorpion envenomation has shown to be more frequent in men. This difference may be attributed to both, the behavioral and occupational characteristics between these regions. The greatest number of cases in the age range of 20-49 years indicates that the economically active population is more likely to be bitten by a scorpion. This result is in accordance with studies carried out in *Paraíba*¹⁷, *Minas Gerais*¹⁶, and *Bahia*⁶. The risk of stings in individuals aged between 10 and 19 years was 2.34 times higher than in other age ranges. Our results also showed that children and adolescents (0 to 19 years old) were involved in 26.05% of the cases. The risk of scorpion envenomation is inherent to routine household activities, with a significant impact on children, who are at greater risk of death than adults. The highest number of cases in urban areas (87.25%) is in accordance with ALVES *et al.*, (2007), who reported a high incidence of cases in *Fortaleza*, mainly in the urban area¹³. The presence of scorpions in large urban areas has also been reported by other authors for different regions of the country^{6,14,18}. Scorpions have become adapted to urban home life, possibly due to the presence of human beings in regions originally occupied by those animals. They have had to adapt to the conditions offered by human housing, seeking shelter in places containing garbage, piles of bricks and roof tiles, and generally feeding on insects¹⁸. Furthermore, the lack of predators and natural competitors in urban areas, such as monkeys, toads, and frogs, can contribute to a rapid proliferation of scorpions¹⁶. In this sense, control and prevention are essential to reduce the incidence of cases, and their effectiveness depends on multidisciplinary actions that involve health public agencies, environmental management, and the community with the aim of avoiding favorable settling conditions for the proliferation of scorpions. According to studies on the time elapsed between the scorpion sting and antivenom therapy, faster treatment results in better prognoses^{4,5}. In the current study, most victims received medical assistance up to 3 hours following sting (67%), similar to what was observed in the States of *Paraíba*¹⁷ and *Minas Gerais*¹⁶. Of the 835 victims treated with antivenom, 71% received it up

to 3 hours after being stung, showing that the population is well informed about the importance of urgent medical care in the case of scorpion envenomation. This result may also indicate that the health service in the region studied provides relatively good medical care for victims of scorpion envenomation. The parts of the body most frequently bitten were the lower and upper limbs, mainly the hand (37.41%) and foot (35.32%). Scorpion stings often occur when victims put on their clothes or shoes. This may explain the highest proportion of stings in the extremities of the body. Some other epidemiological studies corroborate this result^{6,14}. In the present study, the identification of the species of scorpion involved in the envenomation cases was not possible. ALVES *et al.* (2007), investigating scorpion sting cases in *Ceará*, reported that most cases were caused by the species *T. stigmurus* and *T. serrulatus*¹³. Accordingly, it is probable that these species are also responsible for the cases reported in this study. The identification of the species of scorpions involved in the envenomation and their distribution in many Brazilian municipalities, particularly in the State of *Ceará*, are still precarious, representing a gap of important data for the proper assessment of envenoming.

Envenomation by a scorpion of the genus *Tityus* induces mainly local manifestations and less often systemic, cardiovascular, neurological, respiratory, and digestive disorders^{4,6,15,16}. Clinical symptoms were recorded in 99.18% of the cases, and local manifestations (97.36%) were more frequent than systemic ones (1.21%). Pain around the area of the sting was the most common local sign of envenomation (69.12%), which is similar to results described in the literature^{6,14}. Other common local symptoms, such as edema (16.81%), dry mouth (7.54%), hyperemia (2.86%), ecchymosis (1.38%), paresthesia (1.30%), and burning (0.15%) were less frequent. Neurological manifestations, such as dizziness (7.93%), somnolence (2.07%), tremors (1.72%), fever (4.83%), and headache (0.20%) were also reported. Gastrointestinal manifestations were present in 33 cases (11.37%), including nausea (9.65%) and vomiting (1.72%). The predominant signs involving the cardiorespiratory system were tachycardia (2.41%), hypertension (1.38%), dyspnea (1.38%), and hypotension (0.34%). These symptoms suggest an adrenergic autonomic disorder, involving mainly the sympathetic system. Nonetheless, sweating (3.45%), fainting (1.34%), and sialorrhea (1.03%) were also reported, indicating cholinergic stimulation or the involvement of the parasympathetic system. Our data supports previous reports on *Tityus* envenomation^{4,6,7,15}, indicating that symptoms of scorpion envenomation are varied. The clinical manifestations of the cases analyzed, in relation to both local and systemic symptoms, are similar to other national studies^{4,18}. The majority of cases were classified as mild (93.77%), while few cases were classified as moderate (3.28%) or severe (0.15%). This finding is similar to data reported for other Brazilian regions^{2,16}. The predominance of cases progressing to cure (95.86%) is also in accordance to epidemiological studies performed in other Brazilian regions^{2,5}. Taken together, these findings show that most cases of scorpion envenomation in Brazil may be classified as mild. Importantly, 35.29% of the severe cases involved children aged between 1 and 9 years. A significant association was found between the age of the victims and the classification of severity ($p < 0.05$). The cases involving individuals over 50 years old were predominantly moderate, while cases in children in the age range of 1 to 9 years old tended to be severe. These data is in agreement with the correlation between young age and the severity of clinical manifestations reported in other studies^{2,13}. Five deaths occurred in *Ceará* between 2007 and 2013, indicating that the lethality rate is low. However, the cause of the deaths was not recorded,

showing a failure in recording epidemiological information. Other failures were also identified in the patients' medical records. These included a high number of records lacking information on the victim's clinical progression, the time of the day when the sting occurred, the part of the body stung, and the time elapsed between sting and treatment. Since epidemiological data is fundamental to improve knowledge on scorpion envenomation cases at regional levels, the enhancement of data collection procedures seems to be urgent. Accordingly, a better understanding of cases in the studied region seems to require further training of health workers and more precise protocols to register the victim's information. Without basic infrastructure and training, it will be difficult to gather precise evidence about health problems related to scorpion stings in the Brazilian Northeast. It is important to highlight that the current study was based on a secondary epidemiological data source supplied by different professionals, allowing different interpretations of the medical records. Although this underreporting is a reality for the scorpion sting cases, there is no other way to measure their magnitude due to the lack of national comparison systems. Nonetheless, the information regarding the incidence of scorpion envenomation per region and the epidemiological features of the cases are essential for evaluating the problem and developing public policies aimed at both reducing the number of scorpion stings and improving the medical assistance. In this sense, the current study may contribute to a better understanding of scorpion sting cases in the State of Ceará, thus representing a useful instrument for identifying the factors that may raise the risk of scorpion stings in the Northeastern Brazil. This knowledge may in turn provide a basis for educational campaigns designed to prevent scorpion envenomation.

In conclusion, our findings on scorpion sting cases in Ceará are consistent with those reported to other Northeastern States in Brazil. There was a significant increase of the scorpion envenomation cases in Ceará between 2007 and 2013. Most cases occurred in urban areas throughout the year, with little variation between months. Victims were predominantly young women, and were mostly stung on the limbs (hand and foot). Antivenom therapy was generally used within the proper time. Most cases were classified as mild and progressed to cure. The majority of victims had local pain and edema at the site of the sting, with no systemic manifestations. Scorpion envenomation in Ceará is an environmental public health problem that needs to be monitored and controlled throughout the year. Further training for health professionals seems to be necessary to improve their skills in recording epidemiological information. Future studies on the species and community structure of those scorpions existing in the Northeast region are necessary to increase our understanding on the species involved in the cases of scorpion envenomation.

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