

# Pediatric epidemiological aspects of scorpionism and report on fatal cases from *Tityus stigmurus* stings (Scorpiones: Buthidae) in State of Pernambuco, Brazil

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## ABSTRACT

**Introduction:** Envenomation by scorpion stings is a major public health problem in numerous tropical countries because of its frequent incidence and potential severity. Approximately 1,900 species of scorpions are known in the world, and at least 130 of these have been described in Brazil. **Methods:** This work reports on 3 child deaths caused by *Tityus stigmurus* stings and characterizes epidemiological and clinical surveys on pediatric cases of scorpionism recorded in the *Centro de Assistência Toxicológica de Pernambuco* (Ceatox-PE). **Results:** Scorpion stings accounted for more than 60% of all cases recorded for venomous animals. The children were from 37 cities of the State of Pernambuco and accounted for 28.8% of the victims treated for scorpion stings, with the highest incidence in the metropolitan area of Recife. Stings occurred throughout the year and slightly increased during the rainy season. Independent of the elapsed time for a prognosis, most cases showed mild symptoms. Three moderate cases that resulted in death featured cardiogenic shock and/or pulmonary edema or severe neurological symptoms. For the first time, death attributed to *T. stigmurus* was confirmed by the presence of the scorpion. **Conclusions:** These results suggest that scorpionism in Pernambuco is a public health problem that needs to be monitored carefully throughout the year by the government.

**Keywords:** Scorpion venoms. Epidemiology. Public health. Pediatrics. Death.

## INTRODUCTION

Envenomation by scorpion stings is a major public health problem in numerous tropical countries because of its frequent incidence and potential severity. Of approximately 1,900 known scorpion species in the world<sup>1</sup>, approximately 30 are recognized as potentially dangerous to humans<sup>2</sup>. In South America, scorpions that are dangerous to humans belong to the Buthidae family, particularly those from the genus *Tityus* CL Koch, 1836<sup>2-7</sup>. Among more than 130 scorpion species described in Brazil<sup>8</sup>, at least 11 harm humans, specifically the species *Tityus serrulatus* Lutz & Mello, 1922), *T. bahiensis* (Perty, 1833), *T. stigmurus* (Thorell 1876) and *T. obscurus* (Lourenço, 2008), which are responsible for serious envenomation or death, particularly in children<sup>9</sup>. Other scorpion species in this country from the *Tityus* genera reported to cause mild reactions include *T. costatus* (Karsch 1879), *T. brazilae* (Lourenço & Eickstedt,

1984), *T. fasciolatus* (Pessoa, 1935), *T. metuendus* (Pocock, 1897), *T. neglectus* (Mello-Leitão, 1932), *T. mato grossoensis* (Borelli, 1901), *T. adrianoi* Lourenço 2003)<sup>10</sup> and *T. pussilus*<sup>11</sup>.

From 2007 to 2010, an alarming increase in the occurrence of scorpion poisoning has been noted in Brazil. The number of registered cases increased from 37,441 notifications in 2007 to 51,457 in 2010<sup>12</sup>. In 2012, the incidence was 26,3/100,000 inhabitants, with a mortality rate of approximately 0.2%<sup>13</sup>. Differences in the severity of scorpion poisoning have been associated worldwide with variations in the venom composition, the amount of venom inoculated, the individual body mass, the sensitivity of the injured patient to the poison and the time elapsed between the sting and administration of the antidote<sup>14,15</sup>.

In urban areas of northeastern Brazil, *T. stigmurus* is one of the most important health-threatening scorpion species. Originally described in Pernambuco (Brazil), this species is found in 8 of the 26 states in Brazil, including the island of Fernando de Noronha, State of Pernambuco, Brazil<sup>16</sup>. *Tityus stigmurus* formerly was found under roofs, among accumulated debris in the exterior areas of residences<sup>3,5</sup> and in cesspits<sup>17</sup>. Control measures rely on chemical insecticides that are not markedly successful<sup>18</sup>.

Scorpion envenomation from *T. stigmurus* constitutes a frequent medical emergency and causes major health problems in children less than 15 years of age<sup>3,6,19</sup>. Since the first report of death attributed to *T. stigmurus* in Recife, State of Pernambuco<sup>3</sup>,

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**Received** 1 May 2013

**Accepted** 9 July 2013

several notifications have been reported by the local health services organization, without precise information. The epidemiological data are deficient and typically controversial, possibly because of the reduced severity of scorpion poisoning in adults and the scarcity of information from the health services organization, as observed for other scorpion species<sup>2</sup>. Understanding the severity of envenomation, primarily in children, is crucial for establishing the prognosis and developing adequate treatments<sup>15,20</sup>. This study from 2006 to 2010 evaluated the epidemiology and clinical findings of scorpion envenomation in children caused by *T. stigmurus* stings in State of Pernambuco, Brazil and reports 3 confirmed fatal cases.

## METHODS

### Data collection

A retrospective study of scorpion stings in children was conducted through cases reported to the *Centro de Assistência Toxicológica de Pernambuco* (Ceatox-PE), which is located in Recife in northeast Brazil and works on a 24h schedule, accepting cases through a toll-free number or in-person assistance. Ceatox-PE provides treatment for and aids in the prevention of accidents related to venomous animals to the entire population in Pernambuco. Pernambuco is the seventh most populous state in Brazil, with 8,796,032 inhabitants, which corresponds to approximately 4.6% of the total Brazilian population<sup>21</sup>. Approximately 80.2% of the residents live in urban areas. The climate has a diverse pattern, featuring heavy rains in autumn and winter in *Zona da Mata/Litoral* and areas of wet and dry climates in *Agreste*. The *Sertão* has a semi-arid climate, with maximum rains in January through April (60-70% of the annual total), and March is the wettest month<sup>22</sup>.

The clinical and epidemiological data documented were: the clinical manifestations, treatment approaches, elapsed time between the sting and treatment, age, sex, anatomic site of the sting, and seasonality. Children under 12 years of age comprised the study population. Scorpion identification was performed by the health care staff.

The data analysis included the calculation of incidence rates per 100,000 people by municipality in metropolitan Recife/PE. The frequency distribution of cases was determined according to demographic details, clinical treatment, admission time (categorized) and the monthly geographical distribution of cases.

The severity of the envenomations (gradation) of the affected children was measured and classified into 3 clinical categories based on the Brazilian Health Service Manual for Accidents with Venomous Animals<sup>23</sup>. Class 1 indicated local manifestations (including localized pain and paresthesia). Class 2 indicated minor systemic manifestations (non-life-threatening, including discrete nausea, vomiting, sweating, salivation, agitation, tachypnea and tachycardia). Class 3 indicated major systemic manifestations (life-threatening symptoms such as profuse and uncontrollable vomiting, profuse sweating, intense salivation, prostration, convulsions, coma, bradycardia, heart failure, pulmonary edema and shock).

The chi-squared test for equal proportions was used to compare the relative frequencies of accidents between males and females and was performed using SAS software.

### Ethical considerations

This study was approved by the Ethics and Research Committee from *Hospital da Restauração*.

## RESULTS

During the studied period, 9,234 accidents caused by venomous animals (snakes, spiders, bees and scorpions) were registered in the Ceatox-PE. Scorpion accidents accounted for most of the cases (5,561), and poisoning in children accounted for 28.8% of the cases of scorpion stings. A gradual increase in the number of admitted patients at Ceatox-PE was registered during the studied period, from 239 scorpion stings in 2006 to 385 in 2010.

The affected children were from 37 of the 185 cities in Pernambuco, with the highest incidence in metropolitan Recife (**Table 1**). The largest proportion of accidents occurred in the *zona da mata/litoral*, particularly in the state capital, Recife (53.3%), a city of over 1,537,704 people that is spatially divided into 6 health districts (HD)<sup>24</sup>.

In Recife, the patients were from all 6 HDs, particularly from the neighborhoods of Varzea (35%), Agua Fria (27%) and Casa Amarela (19%). These are neighborhoods in HDs IV, II and III, which correspond to 17.8%, 14.5% and 20%,

TABLE 1 - Population and average incidence rate of scorpion envenomation in children below 12 years of age in the metropolitan area of Recife, between 2006 and 2010.

City	Population	Cases	Incidence*
Olinda	70,856	246	86.80
Recife	273,718	835	76.26
Camaraçibe	28,581	72	62.98
Igarassu	22,217	44	49.51
Paulista	57,521	86	37.38
Jaboatão dos Guararapes	131,659	189	35.89
Abreu e Lima	19,183	24	31.28
Itapissuma	5,529	6	27.13
São Lourenço da Mata	21,864	17	19.44
Cabo	39,705	25	15.74
Ipojuca	20,354	12	14.74
Moreno	11,963	7	14.63
Araçoiaba	4,520	2	11.06
Itamaracá	4,248	1	5.89
Total	711,918	1,566	54.99

\*Cases/100,000 habitants.

respectively, of the total HD populations. Clinical signs and/or symptoms were observed in 1,295 (80%) children, and 323 cases were asymptomatic (20%). According to the clinical signs, 66% of the affected children were classified into Class I (local manifestation), and 13.6% were in Class II (moderate). The severe cases (0.4%) comprised Class III. Children classified as Class I and Class III were treated with antivenom. All of the treatment decisions were made by the personal physicians. The age distribution of the affected children is displayed in **Table 2**. More scorpion stings and worse symptoms (Class III) were registered in children younger than 5 years of age (40%). The detailed clinical data are presented in **Table 3**.

A slight difference (chi-squared test for equal proportions,  $\chi^2=5.46$ , 1 df,  $p=0.02$ ) in the sex of the patients was observed (male 53%; female 47%). The most frequently affected areas of the body were the hands/arms (52%), followed by the legs (34.3%), thorax (4.8%) and head (0.9%) (**Table 2**). The

TABLE 2 - Epidemiological aspects of scorpion stings in children assisted at *Centro de Assistência Toxicológica de Pernambuco*, between 2006 and 2010.

Variable	Number	Percentage
<b>Age (years)</b>		
< 5	661	40.9
06 to 09	503	31.1
10 to 12	428	26.5
unknown	26	1.6
<b>Sex</b>		
male	856	53.0
female	762	47.0
<b>Sting location</b>		
lower extremity	842	52.0
upper extremity	554	34.3
thorax	78	4.8
head	15	0.9
unknown	129	8.0
<b>Time elapsed until admission (hours)</b>		
< 2	906	56.0
3 to 6	484	29.9
> 6	211	13.0
unknown	17	1.1
<b>Envenomation severity</b>		
asymptomatic	323	20.0
class I	1,069	66.1
class II	220	13.6
class III	6	0.4

accidents occurred year-round, although an average increase of 4% was registered during the rainy season from June through August (**Figure 1**).

#### Delay between the sting and hospital admission versus severity of envenomation

The interval between the sting and admission to the health center is presented in **Table 2**. Most (56%) of the patients reached a health service less than 2h after being stung. The severity of the clinical symptoms at hospital admission was influenced by the time elapsed after the sting. According to the notification records, most of the patients arrived at the hospital

TABLE 3 - Clinical aspects of scorpion envenomation in children below 12 years old in the metropolitan area of Recife, between 2006 and 2010.

Signs and Symptoms	Cases	Percentage
<b>Local</b>		
Pain	927	71.6
Paresthesia	221	17.2
Edema	31	2.3
Erythema	28	2.3
<b>Systemic</b>		
Vomit	236	18.2
Diaphoresis	62	4.8
Dyspnoea	50	3.9
Somnolence	45	3.5
Tachycardia	44	3.4
Nausea	38	2.9
Hyperthermia	25	1.9
Sialorrhoea	7	0.5
Cephalea	6	0.5
Pallor	5	0.4
Dizziness	3	0.2
Convulsion	3	0.2
Faint	2	0.2
Abdominal pain	2	0.2
Agitation	2	0.2
Tachypnea	2	0.2
Bradycardia	2	0.2
Chills	1	0.1
Hypotonia	1	0.1
Asthenia	1	0.1
Tremors	1	0.1
Redness	1	0.1
Edema	1	0.1

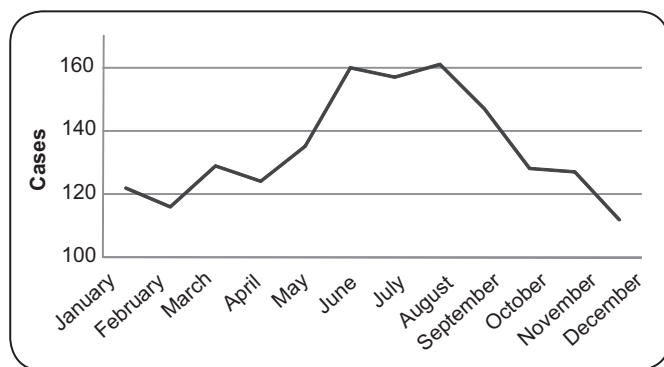


FIGURE 1 - Notification by month of children stung by *Tityus stigmurus* in Pernambuco and attended at *Centro de Assistência Toxicológica de Pernambuco*, Brazil, between 2006 - 2010.

between 1 and 2h after the sting (56% of patients). Of these patients, 78.3% were classified as Class I, and 9.1% and 0.1% were in Classes II and III, respectively (**Table 2**). Thirty percent of the patients arrived between 3 and 6h after a sting, including 2 cases that ended in death. Only 13% of the patients arrived after 6h following a sting, including 1 patient who died.

During the analysis period, 5 patients died. Of these patients, the scorpion involved was identified at the hospital as *T. stigmurus*, and this species was confirmed as the causative agent of poisoning. There was no confirmation of *T. stigmurus* in 2 deaths, which were not considered in this studied. The confirmed cases are described below.

### Case description

**Case 1.** A 3-year-old female from *Jaboatão dos Guararapes-PE* was the victim of a scorpion sting to the left hand and presented initially with vomiting and torpor at the health service. The patient was admitted to the Hospital of Restauração (HR) 4h after the accident and was in severe condition, presenting symptoms of pallor, sweating, dyspnea, tachycardia and a glucose level of 271mg/dl. Treatment included the administration of 6 ampoules of scorpion antivenom (SAEES). Death occurred within 4h of the sting.

**Case 2.** A 2-year-old male from *Pesqueira-PE* received a scorpion sting in the chest area. According to his mother's report, the family only noticed symptoms of vomiting, agitation and muscle hypertonia 9h after the accident. The child was admitted to the HR 20h after the sting with severe symptoms of somnolence, agitation and dyspnea and a glucose level of 112mg/dl. Six ampoules of SAEES were administered. The patient died 30h after the sting.

**Case 3.** A 3-year-old male from *Recife-PE* came to the HR health service complaining of a scorpion sting to the right hand within the previous 4h. The scorpion poisoning caused a severe condition with somnolence, agitation, tachycardia, tachypnea, cyanosis, pulmonary edema and a glucose level of 543mg/dl. Eight ampoules of SAEES were administered, but the child died of cardiac arrest within 8h of the accident.

## DISCUSSION

Based on the cases treated in Ceatox-PE, scorpion stings were shown to be the most frequent type of envenomation accident in Pernambuco between 2006 and 2010. Taking into account the clinical symptoms and scorpion description and identification, 100% of the scorpion poisoning cases were attributed to *T. stigmurus*, which confirms this species as the only one causing severe public health problems in this state. Most of the envenomation cases were successfully cured, but 3 children under 5 years of age died from scorpion stings during the analyzed period. The record is most likely underestimated because data from the *Ministério da Saúde* indicated 23 deaths between 2007 and 2010<sup>12</sup>. The record was supported by the data registered in the Ceatox-PE for these events. From a historical perspective, the first death associated with *T. stigmurus* in Pernambuco was suggested by Eickstedt in 1983, when a 4-year-old girl died after being stung by a scorpion. The specimen was not brought to the hospital, and Eickstedt inferred the results based on several clinical aspects identified in other studies with *T. stigmurus*. The present study describes the first confirmed cases, with verification of the specimen, of child death caused by *T. stigmurus* stings in Pernambuco, and it supports the suggestion of Eickstedt.

*Tityus stigmurus* is widespread in the northeastern region of Brazil<sup>8</sup>, but research based on epidemiological records, clinical aspects and case reports on this scorpion species is limited. Most information is from studies in Bahia, where *T. serrulatus* causes the most severe envenomation and death<sup>6</sup>. The high frequency of accidents and envenomation that can result in death in children and morbidity in adults justifies the classification of scorpionism from *T. stigmurus* stings as an important public health problem in Pernambuco. This designation is particularly important in high-density urban areas such as metropolitan Recife where there is a high risk of scorpion stings. Similar data were found in scorpionism studies in metropolitan São Paulo<sup>25</sup>, Belo Horizonte<sup>26</sup>, Salvador<sup>19</sup> and Ceará<sup>27</sup>. In Africa, Asia and other South American countries, an estimated 2.3 billion people live in areas at risk of scorpion poisoning, resulting in over 3,250 deaths per year<sup>2</sup>.

The deaths of children under 5 years of age suggest a higher susceptibility of this group to severe envenomation relative to older children. These findings are in agreement with the correlation between young age and the severity of clinical manifestations after scorpion envenomation found in other studies<sup>28-30</sup>. High morbidity and lethality rates in children have usually been associated with immune system vulnerability and the ratio of the dose of the venom to the body weight of the patient<sup>7,31</sup>. These factors contribute to a rapid progression from the mild to the severe phase in young children. In addition to patient age and susceptibility, other aspects reported to influence the signs and symptoms of scorpion envenomation include the species of scorpion, sex of the patient, site of the sting and period elapsed between the time of the sting and first medical aid<sup>14,15,29</sup>. In agreement with a previous study of *T. stigmurus* in Bahia<sup>6</sup>, pain at the sting site was the most common sign of envenomation



registered in our analyses and appears to be a common symptom for scorpion envenomation cases<sup>7,32,34</sup>. Other local manifestations such as paresthesia, edema and erythema were less frequent in the accidents caused by *T. stigmurus* in Pernambuco than in the accidents registered in Bahia. Paresthesia (17.2%) was the most frequently described symptom in patients registered at Ceatox-PE, followed by edema and erythema (both 2.3%). Envenomation caused by the same scorpion species in Bahia was associated with dormancy as the predominant symptom (30%), followed by edema, erythema (both 17.8%) and paresthesia (15.6%)<sup>6</sup>. Digestive disturbance (vomiting) was the most frequent systematic symptom in accidents caused by *T. stigmurus*, and its prevalence was higher in Pernambuco than in Bahia<sup>6</sup>. Other systematic disorders were rarely reported, except for symptoms that manifested psychologically from fear and agitation.

A similar incidence in the number of males and females being stung by scorpions was observed in this study, which agrees with other reports<sup>19,26,34,35</sup>. These findings are also in agreement with previous findings describing the lower extremities as the sites most frequently stung in children<sup>19,26,34,36</sup>. Many different reasons can account for why the children were stung, such as the highly activity level common in this age, activities close to or on the ground and walking barefoot<sup>35</sup>.

A strong positive correlation between scorpion stings and seasonality has been described in many regions of the world<sup>7,15,33</sup>, including southeast Brazil<sup>26</sup>. In these locales, accidents are more frequent during the hot season, when it is assumed that scorpions are more active, which increases the opportunity for stings. *T. stigmurus* stings occurred throughout the year, although a slight increase in frequency was registered during the rainy season. The increase in rainfall may result in scorpions leaving their habitats, which increases the possibility of contact with children. A similar pattern of scorpion stings was found in Bahia, a border state with an equivalent and stable climate, which suggests a possible contribution of environmental conditions to the uniform distribution of scorpionism<sup>34</sup>.

According to most studies of the time elapsed between the scorpion sting and antivenom therapy, faster treatment results in a better prognosis, as it is known that scorpion venom is rapidly distributed throughout the victim<sup>36</sup>. This relationship was also found in the present study, where the mean time between the scorpion sting and antivenom therapy (2h) was crucial for the progression of clinical symptoms. In experimental animals (rabbits, guinea pigs and rats), rapid distribution of the venom from the blood to the tissues has been shown through pharmacokinetic studies that estimated the half-life at 5.6 minutes, whereas the overall elimination half-life was 104 minutes<sup>36</sup>.

In general, the findings regarding scorpion accidents in Pernambuco caused by *T. stigmurus* are consistent with those reported in other states and identify critical aspects of scorpionism. Such findings should attract the attention of authorities in these locations, in which surveillance and health assistance must be handled with greater care and consistency.

This study shows that scorpion envenomation is the most common type of envenomation accident in Pernambuco and

occurs predominantly in urban areas. Early hospitalization and close monitoring of the victim in an intensive care unit will prevent the deaths of many children. The high number of stings occurring throughout the year has important consequences for the design of prevention strategies that target the reduction of the incidence of scorpionism. This work demonstrates the importance of *T. stigmurus* as a causative agent of lethal accidents in children and is the first report to confirm in loco the relevance of this agent in Pernambuco.

## CONFLICT OF INTEREST

The authors declare that there is no conflict of interest.

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