


Scorpionism in the Far South of Bahia, Brazil, 2010-2017: case profile and factors associated with severity*

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Nereide Santos Lisboa¹ –  orcid.org/0000-0003-3397-6256

Vanner Boere¹ –  orcid.org/0000-0002-2239-5782

Frederico Monteiro Neves² –  orcid.org/0000-0002-8836-1307

¹Universidade Federal do Sul da Bahia, Programa de Pós-Graduação em Ciências e Tecnologias Ambientais, Porto Seguro, Bahia, BA, Brazil

²Universidade Federal do Sul da Bahia, Instituto de Humanidades, Artes e Ciências Paulo Freire, Teixeira de Freitas, Bahia, BA, Brazil

Abstract

Objective: to describe the epidemiological profile of scorpionism and to investigate factors associated with case severity in the Far South of Bahia, Brazil. **Methods:** this was a descriptive study using data on scorpion accidents reported on the Notifiable Health Conditions Information System (SINAN) from 2010 to 2017; odds ratios (OR) were calculated to investigate factors associated with severe cases. **Results:** 3,055 cases were reported, of which 411 (13.5%) were severe and included 10 deaths; highest incidence occurred in 2017 (1.3 per 1,000 inhabitants); cases predominated in rural areas (62.5%), among males (70.1%), those aged 20-49 years (51%), and Black people (84%); 22.7% of those stung received serotherapy; severe cases were more frequent among children under 15 years old (OR=3.26; 95%CI 2.55;4.74), and people stung in rural areas (OR=1.40; 95%CI 1.10;1.78). **Conclusion:** scorpionism incidence increased; case severity was associated with younger people and occurrence in rural areas.

Keywords: Epidemiology, Descriptive; Neglected Diseases; Scorpion Stings.

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Correspondence:

Nereide Santos Lisboa – Rua Visconde de Abaeté, No 363, Bela Vista, Teixeira de Freitas, BA, Brazil. CEP: 45990247
E-mail: nereideslisboa@outlook.com

Introduction

In several tropical countries the occurrence of scorpion envenomation accidents has taken on such serious proportions that the World Health Organization (WHO) has included them on the list of neglected tropical diseases (NTDs).¹ Disorderly growth of urban areas, with precarious basic sanitation and lack of adequate housing can result in the creation of environments propitious to the proliferation of scorpions and people coming into contact with them.² Scorpion accidents can give rise to local and systemic manifestations, causing harm to individual health and, consequently, causing an impact on Public Health.³

Owing to the increase in the number of cases of accidents involving venomous animals, in 1987 the Ministry of Health introduced the National Venomous Animal Accident Control Program with the aim of ensuring quality treatment of victims and mapping areas with greater risk of occurrence.⁴

Scorpionism is a Public Health problem in Brazil, due to its high incidence, widespread geographic distribution and high lethality

In Brazil, surveillance of scorpion accidents is passive, based on records held on the Health Ministry's Notifiable Health Conditions Information System (SINAN).⁵ Created in 1993, SINAN made notification of all cases of accidents caused by venomous animals mandatory, thus enabling access to information to guide public health authorities on serum distribution and care of victims.⁶ Despite all these efforts, Ministry data show that between 2010 and 2017 there was a sharp increase in accidents involving scorpions (from 52,509 to 124,077), totaling 644,175 cases and 740 related deaths.⁷

Scorpionism is a Public Health problem in Brazil, due to its high incidence, widespread geographic distribution and high lethality.^{8,9} Three species of the *Tityus* genus are responsible for most of the accidents involving humans in Bahia and in other Brazilian states: *Tityus serrulatus* (yellow scorpion, responsible for the majority of severe accidents), *Tityus babiensis* (brown scorpion) and *Tityus stigmurus*.⁸

The objective of this study was to describe the epidemiological profile of scorpionism and to investigate factors associated with the severity of cases reported in the Far South of Bahia state.

Methods

This is a descriptive study of accidents and deaths caused by scorpions in the Far South of Bahia between 2010 and 2017.

The Far South of Bahia is a region located in Northeast Brazil, between latitude 16°40' and 18°20' south, and longitude 39°8' and 40°37' west. In 2010, the region had population of 463,163 inhabitants and geographic density of 24.9 inhab./km².¹⁰ The territory of the Far South of Bahia¹¹ is comprised of 13 municipalities occupying an area of almost 18,536 km², corresponding to approximately 3.9% of the total territory of the state of Bahia. The region has two types of climate: humid in the eastern part and subhumid-dry in the western part. The regional economy, based on trade, farming, eucalyptus forestry, sugarcane and coffee plantations, has low socio-economic indices, reflected by most of the population being in the extreme poverty and medium income brackets, housing conditions and a Gini index lower than those for Bahia state as a whole, in addition to having high endemic disease rates.¹²

The following variables were investigated:

- a) sociodemographic variables age range (in years: <1; 1-4; 5-9; 10-14; 15-19; 20-34; 35-49; 50-64; ≥65);
 - schooling (unknown/not informed; illiterate; incomplete elementary education grades 1-4; complete elementary education grade 4; incomplete elementary education grades 5-8; complete elementary education; incomplete high school education; complete high school education; incomplete higher education; complete higher education; not applicable);
 - race/skin color (unknown/not informed; white; black; yellow; indigenous ['brown' and 'black' were grouped together as 'black']); and¹³
 - sex (male; female).
- b) Clinical and epidemiological variables
 - scorpion sting site (unknown/not informed; head; arm; hand; torso; leg; foot);
 - zone of occurrence (unknown/not informed; urban; rural; peri-urban);
 - case classification (unknown/not informed; mild; severe);
 - case progression (cure; death from scorpion accident; death from other causes);
 - local symptoms (unknown/not informed; yes; no);
 - systemic symptoms (unknown/not informed; yes; no);

- serotherapy (unknown/not informed; yes; no);
- time until care (in hours: unknown/not informed; 0-1; 1-3; ≥ 3);
- work-related accident (unknown/not informed; yes; no); and
- months and seasons in which accidents occurred.

We opted to dichotomize the 'severity' variable: (i) severe case, which included moderate and severe cases; or (ii) non-severe case, comprising mild cases only. Grouping moderate cases together with severe cases is justified by the greater proximity of their clinical characteristics, as well as by the greater possibility of comparing the results of this study with the literature.¹⁴

Scorpion accident incident rates (per 1000 inhabitants) were calculated for each of the 13 municipalities in the Far South of Bahia for the period 2010-2017. The resident population estimates for these municipalities were used as denominators, as provided by the Brazilian Institute of Geography and Statistics (IBGE), and available on the website of the Health Surveillance and Protection Superintendent's Office / State of Bahia Health Department (<http://www.saude.ba.gov.br/suvisa/>).

In order to calculate lethality, the total number of deaths was divided by the total of scorpion accident cases that occurred between 2010 and 2017.

Pearson's chi-square test was used to compare proportions. Odds ratios (OR) and respective 95% confidence intervals (95%CI) were calculated in order to compare characteristics of severe and non-severe cases, and thus investigate factors associated with accident severity.

We used TabWin32 3.6b and Microsoft Excel 2010.

We used individualized data from the Ministry of Health SINAN system, in accordance with the Access to Information Act. No data was accessed containing patients' names or any other data enabling them to be identified, in accordance with Legislation and research ethics norms recommended in Brazil. As such the study project was not required to be submitted to a Research Ethics Committee, as determined by National Health Council (CNS) Resolution No. 466, dated December 12th 2012.

Results

Between 2010 and 2017, 3,055 scorpion accident cases were reported in the 13 municipalities comprising the Far South of Bahia. The lowest number of cases (197) was reported in 2010 and the highest (606) in

2017. Ten deaths were reported, two every year between 2010 and 2013, one in 2014 and one in 2017. Nova Viçosa was the municipality with the highest number of deaths (5) and greatest lethality was found in Caravelas (1%) (Table 1).

Teixeira de Freitas was the only municipality in the Far South of Bahia where accident frequency in the city's urban area (64.2%) was greater than in its rural area (23.2%) (Table 1).

Incidence rates and lethality can be seen in graph format in Figure 1. Greatest incidence was found in 2017 (1.3 per 1000 inhab.) while highest lethality was found in 2010 (1%).

Scorpion accidents in the Far South of Bahia region were distributed throughout the year, with a slight gradual increase between April and December followed by a decrease until March.

Over half the accidents (51%) were concentrated in the 20-49 years age range. The majority of deaths arising from accidents occurred among children up to nine years old (7/10). With regard to schooling, information was missing for 38.1% of cases. The majority of victims (84%) self-reported being of Black race/skin color, and all deaths occurred in this population. Males accounted for the majority of cases (70.1%) and for the majority of deaths (6/10) (Table 2).

The anatomical regions most affected by scorpion stings were the hands (61.9%) and the feet (21%). The majority of deaths (7/10) occurred in cases that were stung in the hand. With regard to the zone of occurrence, both accidents (62.5%) and deaths (6/10) were more frequent in the rural areas of the municipalities (Table 3).

The majority of cases were mild (82.8%); although there were 411 severe cases (13.5%), which accounted for the majority of deaths (7/10). Regarding symptoms, 92.0% had local clinical manifestations and 8% had systemic manifestations. The majority of victims did not have serotherapy (74.9%); among those who died, 60% received this form of treatment. The majority of victims (55.8%) and the majority of those who died (9/10) received care more than an hour after the accident. The majority of cases (57.8%) were not related to the victim's job (Table 3).

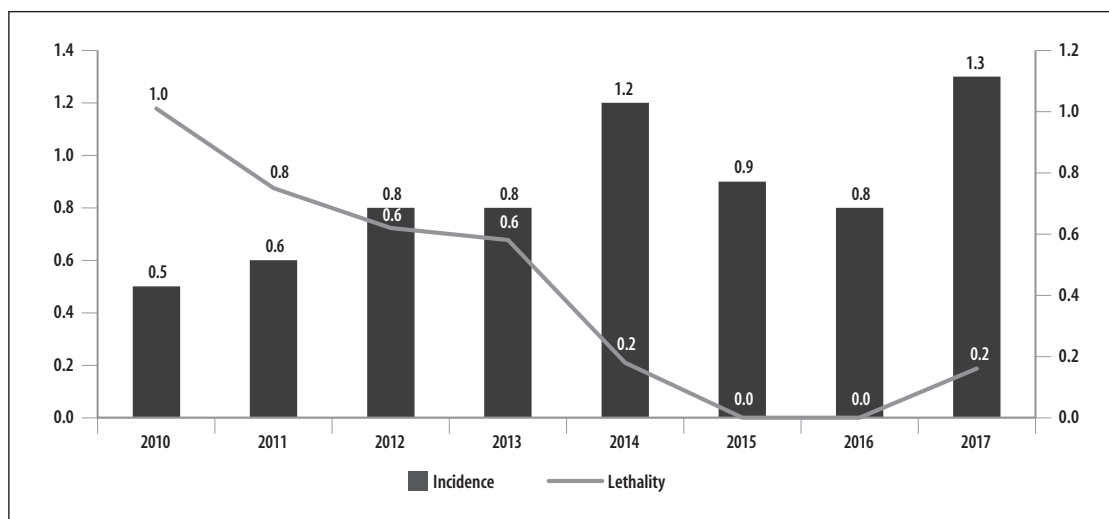
Standing out among factors associated with case severity (Table 4) were zone of occurrence and age range. Accidents occurring in the rural areas of the

Table 1 – Number, number of deaths, lethality and zone of occurrence of scorpion accident cases, by municipality of occurrence, Far South of Bahia, 2010-2017

Municipality	Year								Total N	Incidence rate	Deaths N	Lethality%	Zone		
	2010	2011	2012	2013	2014	2015	2016	2017					Urban N (%)	Rural N (%)	Peri-urban/unknown N (%)
Alcobaça	6	9	2	3	6	3	5	13	47	2.1	–	–	4 (8.5)	39 (83.0)	4 (8.5)
Caravelas	36	48	39	22	56	30	21	44	296	13.4	3	1.0	55 (18.6)	208 (70.3)	33 (11.1)
Ibirapuã	6	4	11	20	30	53	38	10	172	20.3	1	0.6	39 (22.7)	133 (77.3)	–
Itamaraju	7	2	5	2	11	15	9	29	80	1.2	–	–	25 (31.3)	47 (58.8)	8 (10.0)
Itanhém	18	9	13	21	29	16	8	20	134	6.6	–	–	18 (13.4)	101 (75.4)	15 (11.2)
Jucuruçu	2	3	2	–	5	3	4	2	21	2.1	–	–	3 (14.3)	18 (85.7)	–
Lajedão	11	17	19	25	39	12	12	20	155	39.5	–	–	50 (32.3)	104 (67.1)	1 (0.6)
Medeiros Neto	32	29	74	75	122	71	70	120	593	26.0	–	–	165 (27.8)	425 (71.7)	3 (0.5)
Mucuri	37	44	28	38	45	35	58	95	380	9.6	1	0.3	129 (34.0)	242 (63.7)	9 (2.4)
Nova Viçosa	23	60	76	84	107	59	38	144	591	14.2	5	0.8	135 (22.8)	453 (73.6)	21 (3.6)
Prado	1	3	2	3	8	7	1	6	31	1.1	–	–	6 (19.4)	22 (71.0)	3 (9.7)
Teixeira de Freitas	18	37	48	44	68	114	113	102	544	3.6	–	–	349 (64.2)	126 (23.2)	69 (12.7)
Vereda	–	1	–	2	1	2	4	1	11	1.6	–	–	–	10 (90.9)	1 (9.1)
Total	197	266	319	339	527	420	381	606	3,055	6.8	10	3.3	978 (32)	1,910 (62.5)	167 (5.5)

Source: Notifiable Health Conditions Information System (SINAN).

Note: incidence per 1000 inhabitants.



Sources: Notifiable Health Conditions Information System (SINAN); Brazilian Institute of Geography and Statistics (IBGE).

Note: incidence per 1000 inhabitants.

Figure 1 – Scorpion accident incidence rates and lethality, by year of occurrence, Far South of Bahia, 2010-2017

municipalities had 40% more likelihood of being characterized as severe, compared to those occurring in their urban areas (OR=1.40; 95%CI 1.10;1.78). Victims under 15 years old were three times more likely to be severe cases, compared to all other victims of scorpion accidents (OR=3.26; 95%CI 2.55;4.74). There were no significant differences between the other variables with regard to case severity.

Discussion

Between 2010 and 2017 an increase was found in the incident rate of scorpion accidents reported in the Far South of Bahia (from 0.5/1000 inhab. to 1.3/1000 inhab.). The majority of victims receiving care from the health system were of productive age, male, lived in the rural areas of the municipalities, had low schooling

Table 2 – Sociodemographic characteristics of scorpion accident cases and deaths, Far South of Bahia, 2010-2017

Sociodemographic data	Cases		Deaths N=10	Lethality %
	N=3,055	%		
Age range (in years)				
<1	54	1.8	–	–
1-4	78	2.6	3	3.8
5-9	119	3.9	4	3.4
10-14	176	5.8	–	–
15-19	235	7.7	–	–
20-34	809	26.5	2	0.2
35-49	750	24.5	1	0.1
50-64	565	18.5	–	–
≥65	269	8.8	–	–
Schooling				
Unknown/not informed	1.165	38.1	2	0.2
Illiterate	146	4.8	–	–
Incomplete elementary education grades 1-4	400	13.1	1	0.3
Complete elementary education grade 4	157	5.1	–	–
Incomplete elementary education grades 5-8	638	20.9	1	0.2
Complete elementary education	99	3.2	–	–
Incomplete high school education	123	4.0	–	–
Complete high school education	139	4.5	–	–
Incomplete higher education	9	0.3	–	–
Complete higher education	12	0.4	–	–
Not applicable	167	5.5	6	3.6
Race/skin color				
Unknown/not informed	281	9.2	–	–
White	169	5.5	–	–
Black (black + brown)	2.567	84.0	10	0.4
Yellow	25	0.8	–	–
Indigenous	13	0.4	–	–
Sex				
Male	2.142	70.1	6	0.3
Female	913	29.9	4	0.4

and were Black. Children with severe symptoms were at greater risk of dying.

Growth in case incidence in the municipalities of the Far South of Bahia follows the same trend as many other Brazilian municipalities, where scorpionism has increased and is reaching epidemic proportions.¹⁵

Contrary to this trend, lethality was found to have reduced (from 1.0/1000 to 0.2/1000) in the Far South of Bahia, differently to the state's other municipalities, where there was an almost 50% increase in the number of deaths, from 27 cases in 2010 to 40 in 2017.¹⁶ Reduction in scorpion accident lethality in the 13 municipalities of the Far South of Bahia also contrasted with the increasing trend seen in Brazil as a whole.¹⁷

The increase in the number of reported cases may reflect not only growth in accidents, but also improved case reporting by health services. With effect from 2009,

the Ministry of Health has been holding training courses on scorpion identification, management and control in the Brazilian states, in cooperation with the State Health Departments, intensifying programs to raise the population's awareness about the risk represented by scorpion stings. These programs have resulted in health establishments being sought more in cases of scorpion accidents.¹⁸

Of the 13 municipalities analyzed, only Teixeira de Freitas had a higher proportion of accidents in its rural area, possibly related to the high urbanization rate – 93.4% in 2010 – and to economic activity, in particular the construction industry which accounted for 61.3% of economic activity in the municipalities comprising the territory studied, especially in Teixeira de Freitas.¹² Moreover, some studies have suggested that occurrence of scorpion accidents may be associated with low socio-economic indices and lack of urban infrastructure.^{2,4}

Table 3 – Epidemiological and clinical characteristics of scorpion accident cases, Far South of Bahia, 2010-2017

Epidemiological/clinical data	Cases		Deaths	Lethality
	N=3,055	%	N=10	%
Scorpion sting site				
Unknown/not informed	116	3.8	–	–
Head	42	1.4	–	–
Arm	182	6.3	–	–
Hand	1,789	61.9	7	0.4
Torso	84	2.9	1	1.2
Leg	186	6.4	1	0.5
Foot	606	21.0	1	0.2
Zone of occurrence				
Unknown/not informed	101	3.3	–	–
Urban	978	32.0	4	0.4
Rural	1,910	62.5	6	0.3
Peri-urban	66	2.2	–	–
Case classification				
Unknown/not informed	114	3.7	–	–
Mild	2,530	82.8	3	0.1
Severe ^a	411	13.5	7	1.7
Local symptoms				
Unknown/not informed	50	1.6	–	–
Yes	2,814	92.0	9	0.3
No	191	6.3	1	0.5
Systemic symptoms				
Unknown/not informed	127	4.2	1	0.8
Yes	244	8.0	6	2.5
No	2,684	87.9	3	0.1
Serotherapy				
Unknown/not informed	73	2.4	–	–
Yes	695	22.7	6	0.9
No	2,287	74.9	4	0.2
Time until care (in hours)				
Unknown/not informed	399	13.1	–	–
0-1	953	31.2	1	0.1
1-3	1,200	39.3	7	0.6
≥3	503	16.5	2	0.4
Work-related accident				
Unknown/not informed	599	19.6	–	–
Yes	690	22.6	1	0.1
No	1,766	57.8	9	0.5

a) Severe plus moderate-severe.

Source: Notifiable Health Conditions Information System (SINAN).

According to the Ministry of Health, in some regions scorpions have become active all year round due to global climate changes. According to a study conducted by the Ministry,⁹ scorpion accidents were not found to occur seasonally and showed a certain uniformity over the months and seasons, corroborating the results found by Barros et al.¹⁹ This finding may be explained by the fact of climate conditions being relatively stable and favorable to the survival and proliferation of scorpions all year round. The

region's rainfall pattern is characterized as being well distributed along with low temperature variation (between 20 and 25°C) during the year.¹²

Accidents occurred predominantly in the 20-49 years age range, i.e. the economically active population. The region's main economic activities – agriculture, cattle-rearing and the construction industry – provide conditions of high risk of scorpion stings. However, only a small part of cases was work-related, in contrast to the study conducted by Reckziegel & Pinto:²⁰

Table 4 – Epidemiological, clinical and sociodemographic characteristics of scorpion accidents by case severity (N=3,055), Far South of Bahia, 2010-20170

Variables	Severity		p-value ^a	OR ^b	95%CI ^c
	No (%)	Yes (%)			
Zone of occurrence					
Urban	838 (88.8)	106 (11.2)	–	1.00	–
Rural	1,582 (85.0)	280 (15.0)	0.006	1.40	1.10;1.78
Station of the year (occurrence)					
Spring/summer	1,257 (85.4)	215 (14.6)	–	1.00	–
Autumn/winter	1,273 (86.7)	196 (13.3)	0.323	0.09	0.73;1.11
Time until care (in hours)					
0-1	797 (85.8)	132 (14.2)	–	1.00	–
≥1	1,411 (85.2)	246 (14.8)	0.660	1.05	0.84;1.32
Scorpion sting site					
Legs, arms and torso	380 (13.8)	61 (13.8)	–	1.00	–
Head, hands and feet	2,013 (85.6)	338 (14.4)	0.764	1.05	0.78;1.40
Age range (in years)					
≥15	2,243 (88.6)	290 (11.4)	–	1.00	–
<15	287 (70.3)	121 (29.7)	<0.001	3.26	2.55;4.74
Sex					
Male	1,784 (86.6)	277 (13.4)	–	1.00	–
Female	746 (84.8)	134 (15.2)	1,196	1.16	0.93;1.45
Race/skin color					
White	144 (88.3)	19 (11.7)	–	1.00	–
Black (black + brown)	2,120 (85.4)	361 (14.6)	0.308	1.29	0.79;2.11
Schooling					
Complete high school education or higher	139 (88.0)	19 (12.0)	–	1.00	–
Incomplete/complete elementary education	1,171 (86.0)	190 (14.0)	0.504	1.19	0.72;1.96
Illiterate	124 (85.5)	21 (14.5)	0.528	1.24	0.64;2.41
Serotherapy/time until care					
Serotherapy in 0-1 hour	93 (44.5)	116 (55.5)	–	1.00	–
Serotherapy in ≥1 hour	188 (47.5)	208 (52.5)	0.485	0.89	0.63;1.24

a) Pearson's chi-square test.

b) OR: odds ratio.

c) 95%CI: 95% confidence interval.

according to these authors, over half of scorpion accidents (62.5%) occurred during activities in the rural area. Due to the vulnerability of rural activities, in which employment and health rights receive little consideration,²¹ work-related accidents may have been underreported in our study. Moreover, the relevant percentage (19.6%) of notification forms with no information on work circumstances involved or not involved raises the hypothesis of the number of work-related cases being higher.

Scorpion accidents involve multiple severity and death risk factors. The most relevant is age, with risk of death and severe symptoms in children up to 9 years old, in whom venom concentration tends to be high in view of their body volume.¹⁴ In this study, 70% of deaths occurred among children aged between 1 and 9 years old; and those under 15 years

old were three times more likely to be severe cases in comparison to other people who had been stung by scorpions.

The increase in scorpion accidents is directly related to the disorderly growth of urban centers, inadequate household structure and environmental imbalance.^{22,23} In view of this situation, socio-economically vulnerable individuals, self-reported as being Black (84.0%), living in the rural areas of the municipalities and with low schooling (illiterate and with up to 7 years of schooling) were those who most suffered scorpion accidents. Production activities in rural areas are mainly performed by men, thus increasing their risk of exposure to scorpions, as reported in a recent study by Silva et al.²⁴

In our study, as in the study conducted by Bucarechi et al.,²⁵ the hands were the anatomic region

most affected by scorpion accidents. This finding is justified both by domestic activities²⁶ and also by failure to use personal protective equipment (PPE) by workers in their activities.²⁴ Scorpion accidents are characterized above all by activities involving handling objects and places where scorpions gather. PPEs could be an important instrument for avoiding scorpion accidents at work.

Corroborating other studies,^{14,20} the majority of accidents in this study were clinically classified as being mild. Occurrence of severe cases and deaths may be related to the time until care is received by the victims: the majority of deaths were caused by accidents in rural areas, with precarious logistical conditions for immediate and efficient health care. In 70% of deaths, time until receiving care ranged between 1 and 3 hours. Deaths were practically restricted to cases classified as being severe, mostly caused by *T. serrulatus*, a commonly found species in Bahia.⁹ In order to avoid negative outcomes, related to sequelae and death, it is essential for the interval of time between accident and care to be smaller.^{20,27,28} It is therefore fundamental for the population to be informed about health centers where serotherapy is provided, so that victims can be taken to them immediately.

Intense pain is the most common local symptom, as described in the majority of cases.^{15,19} However, in more severe accidents, pain may be camouflaged by systemic symptoms which progress as time goes by until care is provided.⁸ System symptoms were reported in 8% of accidents analyzed in this study. They are important for triggering the decision as to treatment most indicated for the patient. Vagal systemic symptoms (arterial hypotension, dizziness, blurred vision, bradycardia, abdominal colic and diarrhea) were present in 60% of patients who died. For this reason, the patient's clinical symptoms at the time care is provided need to be assessed with due attention, as they determine case classification and whether serotherapy is to be used or not.¹⁵

The Health Surveillance Guide (2017) recommends serotherapy only for cases classified as moderate and severe, which may progress to death¹⁵ and which, in the case of this study, accounted for 13.5% of patients. Notwithstanding, 22.7% of patients received serotherapy, suggesting an error in case classification or treatment with serotherapy. Another mistake in the records are deaths classified as mild (30%), having only pain and edema as local symptoms, and no systemic symptoms

or serotherapy, with time until care between 1 and 3 hours (two cases) and 3 to 6 hours (one case). These facts suggest either an interpretation error or a SINAN investigation form typing error on the part of health professionals responsible for this.²⁰ Over half the cases that died received serotherapy, which is a treatment with resolutive capacity when the correct dose is given. It is possible that further factors may have contributed to deaths occurring and as such future and more in-depth investigation of these determinants is recommended.

High occurrence of scorpionism in the Far South of Bahia region between 2010 and 2017, associated with socio-economic factors, forms an epidemiological scenario with increased cases, despite the reduction in deaths, suggesting improvement in the service provided by the health care network. Nevertheless, the increase in accidents needs to be better understood in order for prevention and health care actions to be adopted, especially in the case of the male rural population and children.

The main economic activities of the Far South of Bahia region include sugarcane and coffee production, eucalyptus forestry and cattle-rearing.¹⁰ These activities lead to land clearing and occupation by humans, altering the natural habitat of scorpions and favoring human contact with scorpions and potential accidents. Studies of scorpion ecology are needed in order to better understand the impact of agriculture and forestry on the incidence of scorpion accidents in the region.^{29,30}

This study has limitations related to using a secondary data source. Errors occur with SINAN investigation form filling in and typing and this can compromise the results of local level analysis results. Even though such shortcomings exist, they do not invalidate the results obtained, given the size of the sample used in the study period. Moreover, in the 13 municipalities studied, information duplication does not occur frequently, given that serotherapy is restricted to the few health centers where care – and notification – take place.

The results presented allow the conclusion to be reached that scorpion accident incidence in the Far South of Bahia is high and, apparently, is increasing, differently to most of Brazil. The increase in scorpionism frequency in recent years calls for intensification of health surveillance actions in the region, above all with regard to continuing training of health professionals, aimed at adequate diagnosis, treatment and filling in of investigation forms.

Authors' contributions

Lisboa NS contributed to the conception and design of the study, data analysis and interpretation, reviewing the literature and writing the article. Souza VB and Neves FM contributed to the study design, theoretical guidance, analysis and critical interpretation of the data and final reviewing of the article. All the authors have approved the final version of the article and are responsible for all aspects of the work, including guaranteeing its accuracy and integrity.


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Associate Editor: Bruno Pereira Nunes –  orcid.org/0000-0002-4496-4122