

Epidemiology of the injury with venomous animals in the state of Rio Grande do Norte, Northeast of Brazil

Epidemiologia dos acidentes com animais peçonhentos
no estado do Rio Grande do Norte, Nordeste do Brasil

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Abstract *This report is an investigation of the epidemiological features of injuries with venomous animals in the Rio Grande do Norte state, Northeastern Brazil, from 2007 to 2014. A total of 30,429 cases were analyzed. Cases were distributed over all months of the period studied and occurred mainly in urban areas. Scorpion stings showed the highest percentage of cases, but the chance of death among snakebites was higher. Envenomation predominated in females with age between 20 and 49 years old. Children and elderly showed a higher chance of death. Most victims were bitten on the extremities of the limbs and received medical care within 0-1 hour after being bitten. The main local and systemic symptoms reported were pain and headache, respectively. Cases were mostly classified as mild and progressed to cure. Few victims show local and systemic complications. The high number of accidents with venomous animals shows that Rio Grande do Norte may be an important risk area for such injuries. Furthermore, this study provides data for the development of health actions to promote control and prevention of these injuries in this region.*

Key words *Venomous animals, Envenomation, Public health*

Resumo *Este estudo é uma investigação das características epidemiológicas dos acidentes com animais peçonhentos no estado do Rio Grande do Norte, Nordeste do Brasil, de 2007 a 2014. Um total de 30.429 casos foram analisados. Os casos foram distribuídos em todos os meses do período estudado e ocorreram principalmente em áreas urbanas. Os acidentes escorpiônicos representaram maior percentual de casos, entretanto, a chance de morte entre acidentes ofídicos foi maior. Os envenenamentos predominaram em mulheres com idade entre 20 e 49 anos. Crianças e idosos exibiram maiores chances de morte. A maioria das vítimas foi picada nas extremidades dos membros e recebeu assistência médica entre 0-1 hora após o incidente. Os principais sintomas locais e sistêmicos reportados foram dor e cefaléia, respectivamente. Os casos foram principalmente classificados como leves e progrediram para cura. Poucas vítimas manifestaram complicações locais e sistêmicas. O elevado número de acidentes com animais peçonhentos indica que o estado do Rio Grande do Norte pode ser uma importante área de risco para tais acidentes. Além disso, este estudo fornece dados que poderão ser utilizados para a elaboração de ações em saúde, a fim de promover o controle e a prevenção desses acidentes nesta região.*

Palavras-chave *Animais peçonhentos, Envenenamento, Saúde pública*

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Introduction

Accidents with venomous animals are a public health problem in Brazil due to high frequency in all regions of the country and potential severity^{1,2}. In some cases, especially those caused by snakes, victims may develop sequelae that cause temporary or permanent incapacity to perform work and/or delays, or lead to death³. According to the Brazilian Health Ministry, cases of accidents with venomous animals have increased in recent years, from 31,746 in 2000 to 171,705 in 2016, with a total of 1,924,406 cases in this period⁴. There has also been an increase in the number of deaths, which increased from 83 in 2000 to 326 in 2016, totaling 3,645 deaths⁵. The Northeast region has the highest incidence of cases (94/100,000 inhabitants), followed by the South (93.8/100,000 inhabitants), North (85.3/100,000 inhabitants), Southeast (76.6/100,000 inhabitants) and Midwest (59.3/100,000 inhabitants)⁶.

Among the venomous animals responsible for most envenomation of medical importance there are snakes, scorpions, spiders, bees and caterpillars¹. Scorpions are responsible for the largest number of accidents in Brazil³. They occur predominantly in urban areas⁷, with a higher risk of death in children⁸. The species of scorpions recognized for their medical importance in Brazil belong to the genus *Tityus*, namely *T. serrulatus*, *T. bahiensis*, *T. obscurus*, *T. silvestris*, *T. metuendus*, *T. stigmurus* and *T. pusillus*⁷. Snakebites mainly affects men living and working in rural areas⁹. Most cases are caused by snakes of the genera *Bothrops*, *Crotalus*, *Lachesis* and *Micrurus*. *Bothrops* accidents are the most frequent in all regions of Brazil, but *Crotalus* cases show the highest lethality rate¹⁰. There are three genus of spiders of medical importance in Brazil: *Phoneutria*, *Loxosceles* and *Latrodectus*¹¹. Envenomation by spiders of the genus *Loxosceles* is characterized as the most severe and frequent, especially in the southern and southeastern regions of the country^{1,3}.

African bees (*Apis mellifera scutellata*), characterized by their aggressive nature and high honey production, were introduced in Brazil in 1956. In the following year, there was an accidental release of some queens of this species, resulting in the hybridization or africanization of European bees (*Apis mellifera mellifera* and *Apis mellifera ligustica*) and uncontrolled mixed breeding of the Africanized species in the Brazilian environment. The frequency of serious and/or fatal envenomation caused by Africanized honey bee stings have increased since 1960^{12,13}. Erucism is

the name given to injuries caused by caterpillars of Lepidoptera in humans. The families mainly associated with injuries in Brazil are *Megalopygidae*, *Saturniidae*, *Limacodidae* and *Arctiidae*¹⁴. Caterpillars of genus *Lonomia* (*Saturnidae* family) have a greater relevance for public health, because they may provoke severe accidents or even deaths due hemorrhagic syndrome¹⁵. Chippaux³ shows that caterpillars, mainly those belonging to the genus *Lonomia*, were responsible for 4% of envenomation and 1% of deaths provoked by venomous terrestrial animals. Envenomation predominated in males with no variation in incidence as a function of age, and cases were mostly classified as mild³.

The State of the *Rio Grande do Norte*, whose capital is Natal, is a federal unit that integrates the Northeast region of Brazil. It is composed of 167 municipalities, covering an area of 52,811,126 km². These municipalities are distributed in four regions: *Oeste Potiguar*, *Central Potiguar*, *Agreste Potiguar* and *Leste Potiguar*. According to *Instituto Brasileiro de Geografia e Estatística* (IBGE), the total resident population of state is of 3,168,027 inhabitants, with 2,464,991 living in urban areas and 703,036 in rural areas. The population density is of 60 inhabitants/km². Regarding gender, its population consists of about 1,548,887 men and 1,619,140 women¹⁶. In *Rio Grande do Norte* there are two climatic types: tropical and semiarid. The first takes place on the east coast, with more abundant rainfall, while the latter dominates almost all areas of the state, including the north coast. In the region of semiarid climate, rainfall is scarce and irregular. The majority of the territory of the *Rio Grande do Norte* (98%) is located within the "Drought Polygon", an area that is affected annually by prolonged periods of drought. Almost the entire region has a low rainfall rate, high average temperatures, acute water deficits, generally thin and often salty soils, and *caatinga* vegetation. The average annual temperature in the state is 26°C, with a maximum of 31°C and minimum of 21°C. The rainy season occurs between the months of April to July and rainfall is below 600 mm annually¹⁷.

Although there is information provided by Brazilian Health Ministry on the annual incidence of the accidents with venomous animals in the State of *Rio Grande do Norte*, there is a lack of updated local and/or regional epidemiological information consistent with the medical importance of such envenomation. Moreover, there are few epidemiological studies on these injuries in the Northeastern Brazil, some cases are underre-

ported and the epidemiological data collection is deficient. Finally, many social and environmental changes occurring in this region during recent decades have indicated that new research is needed to update the knowledge on this topic. To address this shortcoming, the current study analyzed epidemiological data regarding accidents with venomous animals recorded between 2007 and 2014 in the State of *Rio Grande do Norte*, northeastern Brazil.

Methods

Study area

The State of Rio Grande do Norte.

Data collection

Injury with venomous animals are mandatorily recorded by the National System of Notifiable Diseases [*Sistema Nacional de Agravos de Notificação (SINAN)*]¹⁸ based on medical records used in the investigation and follow-up of cases of injury with venomous animals. The SINAN is a national electronic surveillance system which contains a variety of diseases in an integrated database that also includes venomous animals¹⁹. All cases of accidents with venomous animals in the State of *Rio Grande do Norte* recorded to SINAN from 2007 to 2014 were included in the current study. Epidemiological data was analyzed according to gender and age of the victim, year and month of the incident, area of occurrence (urban or rural) of the case, part of the body stung, time elapsed until medical care, severity and progression of the case, local and systemic manifestations and local and systemic complications. Demographic and population data from the *Instituto Brasileiro de Geografia e Estatística* were used to calculate the incidence rates for accidents with venomous animals.

Spatial distribution

The map was prepared with the software QGIS 2.8, using estimates of the average incidence by municipality. The incidence rate was calculated as the ratio of cases by the population of each municipality, estimated for every 100,000 inhabitants. Spatial interpolation of the incidence of cases was mapped using data from 167 municipalities and it was performed by the Inverse Distance Weight method²⁰.

Statistical analysis

Statistical analyses were performed using the Chi-square (Likelihood Ratio Chi-Square) test and Correspondence Analysis (ANACOR), Mann-Whiney and Kruskal-Wallis and Odds Ratio tests. The level of significance was $p < 0.05$. All statistical analyses were performed using the software SPSS® version 22.0 (Statistical Package for Social Sciences) for Windows.

Ethical clearance

This study was carried out on the basis of secondary database. The authors did not have access to the nominal data of the accident victims or any other data that would allow identification and they were in compliance with ethics legislation/recommendations of research in the country.

Results

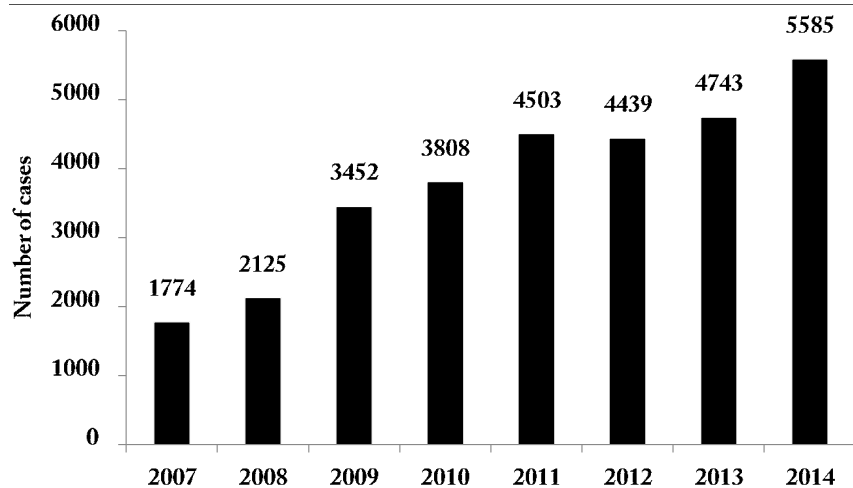
There have been reported 30,429 cases of accidents with venomous animals in the State of *Rio Grande do Norte*, from January 2007 to December 2014. Scorpion stings showed the highest percentage of cases ($n = 20,554$; 67.5%), followed by snakebites ($n = 3,019$; 9.9%), honey bees ($n = 2,168$; 7.1%) and spiders ($n = 1,073$; 3.5%) (Table 1). Graph 1 shows that the cases of accidents increased between the period of 2007 to 2011. Among 2011 and 2012 the cases decreased and from 2013 occurred an increase in the number of cases. Graph 2 shows that the cases occurred in all months of the investigated years, with the highest frequency in August ($n = 2,733$; 9%) and September ($n = 2,735$; 9%).

Regarding the spatial distribution of cases, the average incidence rates were irregularly distributed in the state, with values between 0 and 947,255 cases/100,000 inhabitants (Figure 1). The most significant incidence rates were reported in the *Leste* and *Agreste Potiguar* region, namely, *São Gonçalo do Amarante*, *Natal*, *Extremoz*, *Barcelona*, *Ruy Barbosa*, *São José do Campestre* and *Monte das Gameleiras*.

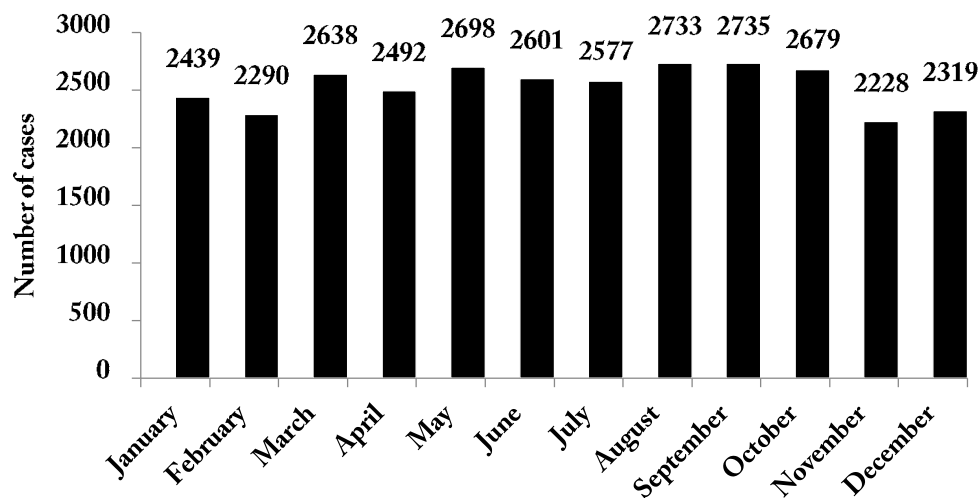
Table 1 shows that the majority of cases involved female subjects ($n = 16,521$; 54.3%) when compared with males ($n = 13,908$; 45.7%). Women were most affected in cases of scorpion stings and the envenomation caused by snakes, honey bees, spiders, caterpillars and other animals affected mainly men, who presented a higher chance of death (OR = 2.49; 95% CI: 1.21 - 5.10).

Table 1. Distribution of the accidents with venomous animals in the State of Rio Grande do Norte, from 2007 to 2014, according to the type of aggressor animal, area of occurrence, aged, time elapsed until medical care and part of body affected by injury.

Variables	Female		Male		Total		Odds ratio
	n	%	n	%	n	%	OR (CI: Upper limit - Lower limit)
Aggressor animal							
Snake	715	4.3	2,304	16.6	3,019	9.9	OR = 5.64 (IC 95%: 2.82 - 11.28)
Spider	516	3.1	557	4.0	1,073	3.5	OR = 0.83 (IC 95%: 0.11 - 6.07)
Scorpion	12,67	76.6	7,885	56.7	20,55	67.5	OR = 0.43 (IC 95%: 0.22 - 0.84)
Caterpillar	134	0.8	142	1.0	276	0.9	-
Bee	779	4.7	1,389	10.0	2,168	7.1	OR = 1.26 (IC 95%: 0.39 - 4.13)
Other	783	4.7	848	6.1	1,631	5.4	-
Unknown	925	5.6	783	5.6	1,708	5.6	OR = 0.30 (IC 95%: 0.00 - 0.22)
Victim's age (years)							
0 — 9	1,535	9.3	1,865	13.4	3,4	11.2	OR = 3.81 (IC 95%: 1.86 - 7.83)
10 — 19	2,222	13.4	2,152	15.5	4,374	14.4	OR = 1.03 (IC 95%: 0.40 - 2.66)
20 — 29	3,154	19.1	2,977	21.4	6,131	20.1	OR = 0.25 (IC 95%: 0.06 - 1.03)
30 — 39	2,665	16.1	2,369	17.0	5,034	16.5	OR = 0.32 (IC 95%: 0.08 - 1.32)
40 — 49	2,729	16.5	1,857	13.4	4,586	15.1	OR = 0.55 (IC 95%: 0.17 - 1.78)
50 — 59	1,995	12.1	1,315	9.5	3,31	10.9	OR = 0.79 (IC 95%: 0.24 - 2.59)
60 — 69	1,277	7.7	820	5.9	2,097	6.9	OR = 1.31 (IC 95%: 0.40 - 4.28)
70 — 79	668	4.0	416	3.0	1,084	3.6	OR = 2.62 (IC 95%: 0.80 - 8.60)
≥ 80	276	1.7	137	1.0	413	1.4	OR = 4.56 (IC 95%: 1.09 - 19.09)
Geographical location of the case							
Urban	14,29	86.5	10,21	73.4	24,51	80.5	OR = 0.17 (IC 95%: 0.09 - 0.33)
Rural	1,417	8.6	2,73	19.6	4,147	13.6	OR = 8.06 (IC 95%: 4.09 - 15.87)
Periurban	112	0.7	119	0.9	231	0.8	-
Unknown	698	4.2	845	6.1	1,543	5.1	OR = 0.57 (IC 95%: 0.08 - 4.15)
Time from bite until assistance (h)							
0-1h	5,659	34.3	4,487	32.3	10,15	33.3	OR = 0.52 (IC 95%: 0.23 - 1.19)
1-3h	4,2	25.4	3,499	25.2	7,699	25.3	OR = 0.51 (IC 95%: 0.20 - 1.32)
3-6h	1,705	10.3	1,532	11.0	3,237	10.6	OR = 2.18 (IC 95%: 0.95 - 5.01)
6-12h	957	5.8	722	5.2	1,679	5.5	OR = 1.66 (IC 95%: 0.51 - 5.43)
12-24h	873	5.3	633	4.6	1,506	4.9	OR = 1.86 (IC 95%: 0.57 - 6.09)
> 24	895	5.4	745	5.4	1,64	5.4	OR = 1.10 (IC 95%: 0.26 - 4.58)
Unknown	2,232	13.5	2,29	16.5	4,522	14.9	OR = 1.49 (IC 95%: 0.65 - 3.41)
Affected part of the body							
Head	496	3.0	932	6.7	1,428	4.7	OR = 0.62 (IC 95%: 0.08 - 4.50)
Arm	577	3.5	524	3.8	1,101	3.6	OR = 1.67 (IC 95%: 0.40 - 6.96)
Forearm	386	2.3	356	2.6	742	2.4	-
Hand	1,861	11.3	1,705	12.3	3,566	11.7	OR = 0.73 (IC 95%: 0.22 - 2.39)
Finger	3,486	21.1	2,476	17.8	5,962	19.6	OR = 0.26 (IC 95%: 0.06 - 1.07)
Trunk	636	3.8	662	4.8	1,298	4.3	OR = 2.18 (IC 95%: 0.66 - 7.12)
Thigh	647	3.9	418	3.0	1,065	3.5	-
Leg	618	3.7	654	4.7	1,272	4.2	OR = 0.69 (IC 95%: 0.10 - 5.08)
Foot	4,333	26.2	3,363	24.2	7,696	25.3	OR = 3.49 (IC 95%: 1.57 - 7.80)
Toe	2,042	12.4	1,353	9.7	3,395	11.2	OR = 1.37 (IC 95%: 0.53 - 3.55)
Unknown	1,439	8.7	1,465	10.5	2,904	9.5	OR = 1.26 (IC 95%: 0.44 - 3.59)
Total	16,521	100%	13,908	100%	30,429	100%	-



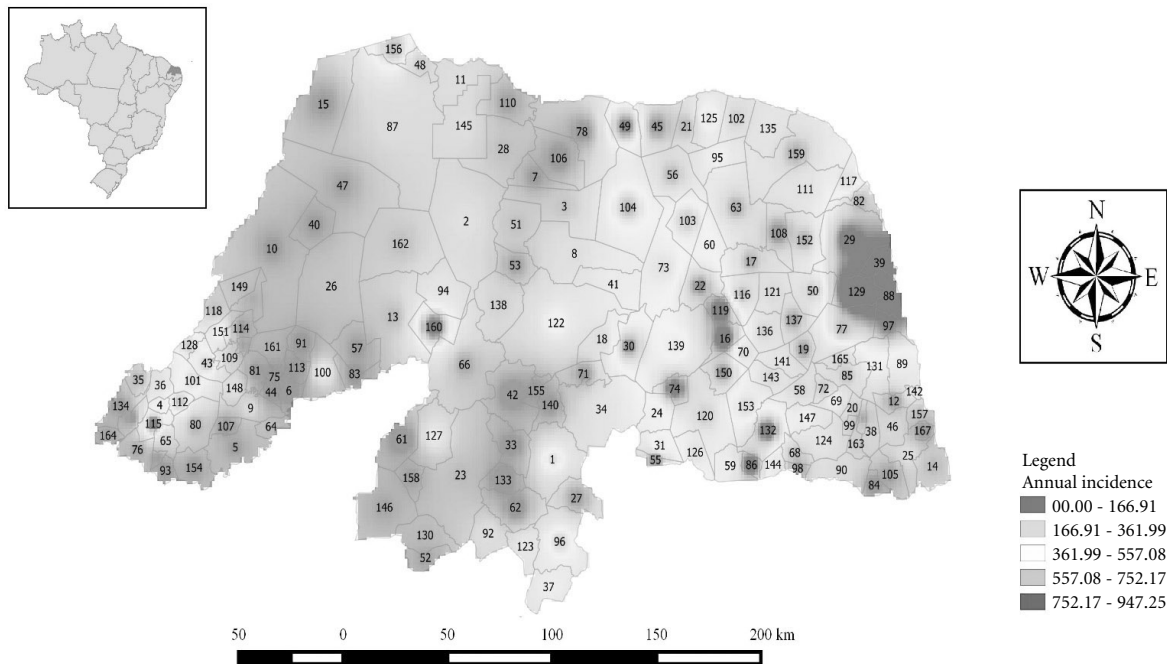
Graphic 1. Distribution by year of the accidents with venomous animals in the State of Rio Grande do Norte, from 2007 to 2014.



Graphic 2. Distribution by month of the accidents with venomous animals in the State of Rio Grande do Norte, from 2007 to 2014.

There was a predominance of cases involving individuals between 20 and 29 years of age ($n = 6,131$; 20.1%), followed by the age range between 30 and 39 years ($n = 5,034$; 16.5%) and 40 to 49 years ($n = 4,586$; 15.1%). Individuals aged up to 9 years old (OR = 3.81; 95% CI: 1.86 - 7.83) and between 80 years or more (OR = 4.56; 95% CI: 1.09 - 19.09) have a higher chance of death. Accidents occurred predominantly in the urban areas ($n = 24,508$; 80.5%) and less frequently in rural

areas ($n = 4,147$; 13.6%). Accidents in rural areas have a higher chance of death (OR = 8.06; 95% CI: 4.09 - 15.87) when compared to those in urban areas. Most of the victims received medical care between 0 and 1 hour after the accident ($n = 10,146$; 33.3%) and between 1 and 3 hours after the accident ($n = 7,699$; 25.3%). The stings affected mainly the extremities of the body, such as the foot ($n = 7,696$; 25.3%), followed by the finger ($n = 5,962$; 19.6%), hand ($n = 3,566$; 11.7%)



Acari	1	Canguaretama	25	Guamaré	49	Lajes	73	Parnamirim	97	Santa Maria	121	Serra do Mel	145
Açu	2	Caraubas	26	Ielmo Marinho	50	Lajes Pintadas	74	Passa-e-Fica	98	Santana do Matos	122	Serra Negra do Norte	146
Afonso Bezerra	3	Carnaúba dos Dantas	27	Ipanguaçu	51	Lucrécia	75	Passagem	99	Santana do Seridó	123	Serrinha	147
Água Nova	4	Carnaubais	28	Ipueira	52	Luis Gomes	76	Patu	100	Santo Antônio	124	Serrinha dos Pintos	148
Alexandria	5	Ceará-Mirim	29	Itajá	53	Macaíba	77	Pau dos Ferros	101	São Bento do Norte	125	Severiano Melo	149
Almino Afonso	6	Cerro Corá	30	Itaú	54	Macau	78	Pedra Grande	102	São Bento do Trairi	126	Sítio Novo	150
Alto do Rodrigues	7	Coronel Ezequiel	31	Jaçanã	55	Major Sales	79	Pedra Preta	103	São Fernando	127	Taboleiro Grande	151
Angicos	8	Coronel João Pessoa	32	Jandaíra	56	Marcelino Vieira	80	Pedro Avelino	104	São Francisco do Oeste	128	Taipu	152
Antônio Martins	9	Cruzeta	33	Janduíis	57	Martins	81	Pedro Velho	105	São Gonçalo do Amarante	129	Tangará	153
Apodi	10	Currais Novos	34	Januário Cicco	58	Maxaranguape	82	Pendências	106	São João do Sabugi	130	Tenente Ananias	154
Areia Branca	11	Doutor Severiano	35	Japi	59	Messias Targino	83	Pilões	107	São José de Mipibu	131	Tenente Laurentino Cruz	155
Arês	12	Encanto	36	Jardim de Angicos	60	Montanhas	84	Poço Branco	108	São José do Campestre	132	Tibau	156
Augusto Severo	13	Equador	37	Jardim de Piranhas	61	Monte Alegre	85	Portalegre	109	São José do Seridó	133	Tibau do Sul	157
Baía Formosa	14	Espírito Santo	38	Jardim do Seridó	62	Monte das Gameleiras	86	Porto do Mangue	110	São Miguel	134	Timbaúba dos Batistas	158
Baraúna	15	Extremoz	39	João Câmara	63	Mossoró	87	Pureza	111	São Miguel do Gostoso	135	Touros	159
Barcelona	16	Felipe Guerra	40	João Dias	64	Natal	88	Rafael Fernandes	112	São Paulo do Potengi	136	Triunfo Potiguar	160
Bento Fernandes	17	Fernando Pedroza	41	José da Penha	65	Nisia Floresta	89	Rafael Godeiro	113	São Pedro	137	Umarizal	161
Bodó	18	Florânia	42	Jucurutu	66	Nova Cruz	90	Riacho da Cruz	114	São Rafael	138	Upanema	162
Bom Jesus	19	Francisco Dantas	43	Jundiá	67	Olho-d'Água do Borges	91	Riacho de Santana	115	São Tomé	139	Várzea	163
Brejinho	20	Frutoso Gomes	44	Lagoa d'Anta	68	Ouro Branco	92	Riachuelo	116	São Vicente	140	Venha-Ver	164
Caiçara do Norte	21	Galinhas	45	Lagoa de Pedras	69	Paraná	93	Rio do Fogo	117	Senador Elói de Souza	141	Vera Cruz	165
Caiçara do Rio do Vento	22	Goianinha	46	Lagoa de Velhos	70	Paraú	94	Rodolfo Fernandes	118	Senador Georgino Avelino	142	Viçosa	166
Caicó	23	Governador Dix-Sept Rosado	47	Lagoa Nova	71	Parazinho	95	Ruy Barbosa	119	Serra Caiada	143	Vila Flor	167
Campo Redondo	24	Grossos	48	Lagoa Salgada	72	Parelhas	96	Santa Cruz	120	Serra de São Bento	144		

Figure 1. Spatial distribution of the accidents with venomous animals in the State of Rio Grande do Norte, from 2007 to 2014.

Table 2. Distribution of the accidents with venomous animals in the State of Rio Grande do Norte, from 2007 to 2014, according to the severity, progression, clinical manifestations and clinical complications.

	Female		Male		Total	
	n	%	n	%	n	%
Severity						
Mild	15,588	94.4	12,274	88.3	27,862	91.6
Moderate	353	2.1	736	5.3	1,089	3.6
Severe	38	0.2	92	0.7	130	0.4
Unknown	542	3.3	806	5.8	1,348	4.4
Progression						
Cure	15,456	93.6	12,481	89.7	27,937	91.8
Death by venomous animals	11	0.1	23	0.2	34	0.1
Death by other causes	1	0.0	0	0.0	1	0.0
Unknown	1,053	6.4	1,404	10.1	2,457	8.1
Local manifestations						
Pain	14,472	93.5	11,316	90.6	25,788	92.2
Paresthesia	7,468	48.3	4,636	37.1	12,104	43.3
Swelling	5,698	36.8	5,393	43.2	11,091	39.7
Hyperemia	3,032	19.6	1,78	14.3	4,812	17.2
Injury	412	2.7	340	2.7	752	2.7
Erythema	360	2.3	332	2.7	692	2.5
Ecchymosis	242	1.6	426	3.4	668	2.4
Cramp	212	1.4	114	0.9	326	1.2
Hypoaesthesia	187	1.2	123	1.0	310	1.1
Redness	108	0.7	90	0.7	198	0.7
Necrosis	19	0.1	40	0.3	59	0.2
Systemic manifestations						
Headache	377	28.9	285	23.5	662	26.3
Vagal	154	11.8	200	16.5	354	14.1
Fever	160	12.3	119	9.8	279	11.1
Sweating	170	13.0	95	7.8	265	10.5
Neuroparalytic	69	5.3	166	13.7	235	9.3
Nausea	175	13.4	56	4.6	231	9.2
Dizziness	102	7.8	106	8.8	208	8.3
Miolytic/hemolytic	38	2.9	114	9.4	152	6.0
Chill	77	5.9	50	4.1	127	5.1
Tremors	71	5.4	38	3.1	109	4.3
Renal	20	1.5	62	5.1	82	3.3
Vomit	42	3.2	18	1.5	60	2.4
Dyspnea	26	2.0	30	2.5	56	2.2
Agitation	29	2.2	11	0.9	40	1.6
Local complications						
Secondary infection	38	76.0	50	72.5	88	73.9
Functional deficit	9	18.0	11	15.9	20	16.8
Necrosis	5	10.0	4	5.8	9	7.6
Amputation	1	2.0	1	1.4	2	1.7
Compartment syndrome	1	2.0	0	0.0	1	0.8
Systemic complications						
Respiratory failure/acute pulmonary edema	11	42.3	19	50.0	30	46.9
Renal	10	38.5	18	47.4	28	43.8
Shock	6	23.1	8	21.1	14	21.9
Septicaemia	0	0.0	2	5.3	2	3.1

and toe (n = 3,395; 11.2%). The cases where the stings occurred in the foot (OR = 3.49; 95% CI: 1.57 - 7.80) has a greater chance of death.

Table 2 shows that most cases exhibit mild severity (n = 27,862; 91.6%), some cases moderate severity (n = 1,089; 3.6%) and few severe cases (n = 130; 0.4%). The moderate (OR = 3.60; 95% CI: 1.27 - 10.24) and severe (OR = 160.20; 95% CI: 78.36 - 327.52) cases showed a higher chance of death in relation to mild cases. There was also a significant association between the severity of the case and the type of aggressor animal ($\chi^2 = 4,501.44$; $p < 0.05$). Correspondence analysis shows that snakebites are more associated with moderate and severe cases. Our results also show a significant association between the severity of the case and the type of aggressor animal ($\chi^2 = 4,310.55$; $p < 0.05$) and the time elapsed between the sting and the medical care ($\chi^2 = 1,674.19$; $p < 0.05$). Regarding the progression of the case, the majority progressed to cure (n = 27,937; 91.8%) and 34 cases of deaths were recorded, resulting in lethality rate of 0.1%. A significant association between the progression of the case, area of occurrence ($\chi^2 = 1550.39$; $p < 0.05$) and time elapsed between the sting and medical care ($\chi^2 = 800.33$; $p < 0.05$). It was also observed a significant association between the type of aggressor animal and the progression of the case ($\chi^2 = 702.06$; $p < 0.05$). Snakebites were more likely to progress to death (OR = 5.64, 95% CI: 2.82 - 11.28).

Table 2 also shows that 27,963 cases (91.9%) exhibited local symptoms, while 2,514 (8.3%) manifested systemic symptoms. The main local manifestation was pain (n = 25,788; 92.2%), followed by paresthesia (n = 12,104; 43.3%), edema (n = 11,091; 39.7%) and hyperemia (n = 4,812; 17.2%). Regarding systemic manifestations, headache predominated (n = 662; 26.3%), followed by vagal manifestations (n = 354; 14.1%), fever (n = 279; 11.1%) and sweating (n = 265; 10.5%). The most frequent local complications were: secondary infection (n = 88; 73.9%), functional deficit (n = 20; 16.8%) and necrosis (n = 9; 7.6%). In relation to systemic complications, there were mainly edema (n = 30; 46.9%), renal complications (n = 28; 43.8%) and shock (n = 14; 21%).

Discussion

The current study shows that there was an increase of venomous animal injury cases in *Rio*

Grande do Norte from 2007 to 2016. In this period, a total of 30,429 cases were recorded by the Health Department of *Rio Grande do Norte*, with an average of 3,804 cases per year. The annual average incidence rate was of 117,36 cases/100,000 inhabitants, which is in agreement with that reported by the Brazilian Health Ministry⁶. Most of the envenomation were caused by scorpions (67.5%), followed by snakes (9.9%) and honey bees (7.1%). Similar results were described by Barbosa²¹ in a study also carried out in *Rio Grande do Norte*, pointing out scorpions, snakes and honey bees as the main aggressor animals. Taken together, these results suggest that *Rio Grande do Norte* may be considered as a risk area to such envenomation in the northeast of the Brazil.

The occurrence of cases in all municipalities of the state indicates a wide spatial distribution of venomous animals in this region. Highest incidences were reported in the municipalities located in the regions of the *Leste* and *Agreste Potiguar*, mainly in the regions of *Natal*, *Macaíba* and *Borborema Potiguar*. The *Leste Potiguar* region is the most populous of the state and in it is the capital, *Natal*, as well as the Metropolitan region of *Natal*¹⁶. The regions of *Natal* and *Macaíba* have a population of 1,030,764 and 288,836 inhabitants, respectively¹⁶. In these regions there were predominance of accidents with scorpions that may be due to high population density. Lima et al.²² reported that scorpion sting is common in urban areas due to population density, inefficient basic sanitation, garbage accumulation, and lack of a natural predator. The increase of the scorpion envenomation in large urban areas has also been described in studies carried out in the Northeast of Brazil, such as: Lira-da-Silva et al.²³ in the State of the *Bahia* and Barros et al.²⁴ in the State of the *Paraíba*. The region of *Agreste Potiguar* is the third most populous of the state¹⁶. In the region of *Borborema Potiguar* there were predominance of ophidian cases. According to *Instituto Brasileiro de Geografia e Estatística*, this region has a population of 134,027 inhabitants and stands out as being a region of high agricultural and pastoral activities^{16,25,26}. The prevalence of ophidian accidents in this region may be a result of the high number of individuals working with agro-pastoral activities. These activities favor the encounter of the individual with the snakes, which may increase the possibility of occurrence of the incidents²⁷.

Although an increase in the number of cases was observed, the annual variation was not statis-

tically significant between the period studied ($p = 0.43$), which is in agreement with data provided by the Brazilian Health Ministry⁴. The incidence of injury with venomous animals is related to seasonal factors, which may change according to the region^{28,29}. Chippaux³ reported that the incidence of cases is stable throughout the year in all the regions of Brazil, except in the South, where the incidence decreases during the winter months. Our results show a slight increase in cases reported between August and September, but without significant monthly variation ($p = 0.99$). The uniform distribution of cases in all months of the studied years may be attributed to the stable climatic conditions of the region, which is characterized by low seasonal amplitudes, low precipitation, high luminosity and high average temperature³⁰.

Most of the cases involved women (54.3%), agreeing with the study performed by Barbosa²¹ in the State of *Rio Grande do Norte*, as well with the SINITOX³¹. However, higher chance of death was between men, probably due to the larger exposure of these individuals to accidents with snakes, honey bees and spiders, which are more lethal. Our results about the aggressor animal seem to reinforce that the men are the most affected by accidents with snakes, honey bees and spiders. Moreover, the men have a greater chance of progression to death, since the accidents with these animals also resulted in the highest rates of lethality, being 0.43 (snakes); 0.14 (honey bees) and 0.9 (spiders). The majority of the cases affected individuals aged between 20 and 49 years old (51.7%), indicating that the economically active population of the region investigated is the most affected by the accidents. These results are in agreement with the study carried out in State of *Mato Grosso* by Santana and Suchara³² and by data provided by the Brazilian Health Ministry³³. Individuals aged up to 9 years old and between 80 years or more represent a smaller number of total medical records but have a higher chance of death.

The prevalence of cases in urban areas (80.5%) is in agreement with the study of Barbosa²¹ and with the findings reported by the *Instituto Butantan*²⁹. The increase of such accidents is due to the easy adaptation of scorpions to life in an urban environment³⁴. This characteristic has been described in several epidemiological investigations in the Northeast region of Brazil^{24,35}. Although accidents occurring in rural areas represent a lower percentage of cases (13.6%), they have a higher chance of death (OR = 8.06; 95% CI: 4.09 - 15.87) when compared to those in urban areas. The increased chance of death may be

due to the difficulty of accessing the victims to the health center. Tavares et al.²⁷ in an investigation conducted in *Rio Grande do Norte*, also indicated a higher chance of death among the cases occurred in rural areas. Cases received medical care predominantly between 0 and 1 hour (33.3%) after the accident ($p < 0.05$), which is in agreement with the epidemiological studies carried out in the North region³⁶, Midwest region³² and Southeastern Brazil³⁷.

The extremities of the body (foot and hand) were the anatomical regions most affected by the stings or bites, totaling 68% of the cases. Injury often occurs when individuals perform activities such as putting on shoes, wearing clothes, manipulating building materials, performing farming or cleaning activities, without using personal protective equipment. This may explain the increased frequency of pricking at the extremities of the limbs. The cases where the stings occurred in the foot showed a greater chance of death. In our results, the greater chance of death among bites that affected the foot may be due to the high number of accidents caused by snakes, which are more lethal.

Regarding the severity of the cases, the majority were classified as mild (91.6%), followed by moderate (3.6%) and severe (0.4%) cases ($p < 0.05$). The moderate and severe cases showed a higher chance of death in relation to mild cases. Similar results were reported in studies carried out in the State of *Mato Grosso* by Silva et al.³⁸ and in the State of *Minas Gerais* by Ladeira and Machado³⁹. There was also a significant association between the severity of the case and the type of aggressor animal ($\chi^2 = 4,501.44$; $p < 0,05$). Correspondence analysis shows that snakebites are more associated with moderate and severe cases. This may be explained due to the greater toxicity of snake venom⁴⁰. Accidents with scorpions, honey bees and spiders were more associated to mild cases. Our results also show a significant association between the area of occurrence and the severity of the case ($\chi^2 = 4,310.55$; $p < 0.05$). Envenomation in urban areas were more associated to mild cases, while accidents occurring in rural areas were more associated with moderate and severe cases. In rural areas, victims take more time to move to the nearest health facility. The graphical distances obtained on the perceptual map show that the time elapsed between the sting and the medical care may influence the severity of the cases ($\chi^2 = 1,674.19$; $p < 0.05$). Mild cases are more associated with shorter time gaps, from 0 to 1 hour and from 1 to 3 hours. On the

other hand, moderate and severe cases are more associated with longer time gaps. These results indicate that delays in medical care may influence the severity of the cases.

Most of the cases progressed to cure (91.8%) and 34 to death, of which 16 were caused by scorpions, 13 by snakes, 3 by honey bees, 1 by spiders and in 1 case the animal causing the accident was unknown. A strong association also was found between the type of aggressor animal and the progression of the case ($\chi^2 = 702.06$; $p < 0.05$). In current study, snakebite cases were more likely to progress to death, followed by honey bee sting cases. Importantly, the largest number of severe envenomation with systemic complications and manifestations was among ophidian accidents. In fact, snake venom is probably the most complex and deadly of all poisons of venomous animals of medical importance⁴⁰. On the other hand, Lopes *et al.*³⁶ showed that in the North of Brazil the highest lethality rates were of the cases with honey bees (0.59%) and snakes (0.47%). Moreover, Forrester *et al.*⁴¹, showed that honey bee envenomation progress to death more frequently than those caused by snakes, scorpions and spiders. This may be due to hypersensitivity reactions induced by honey bee stings and/or even by the absence of a specific treatment with antivenom. Hypersensitivity reactions may be caused by a single sting and lead to death due to glottal edema or anaphylactic shock^{12,13}. It was also observed significant association between the progression of the case, area of occurrence ($\chi^2 = 1,550.39$; $p < 0.05$) and time elapsed between the sting and the medical care ($\chi^2 = 800.33$; $p < 0.05$). Accidents occurring in rural areas and those with delays in medical care are more associated with death. This data indicates that the chance of a case progressing to death is associated with late medical care, favored by the distance between the rural area and the nearest health facility.

Most deaths occurred in rural areas (55.9%) and involved predominantly men (67.6%) between 0 and 9 years old (32.4%) and over than 50 years old (32.4%). Bites reached mainly the foot (38.2%). Deaths were predominant among accidents with bees (41.1%) and snakes (38.2%). The majority of victims sought medical care tardly, between 3 and more than 24 hours after being bitten (44.1%). Regarding the clinical manifestations 88.2% of cases show local manifestations, while 38.2% show systemic manifestations. In relation to severity, there was a predominance of mild (38.2%) and severe (38.2%) cases. Only 8.8% of individuals who evolved to death exhib-

ited local complications and 35.3% exhibited systemic complications.

The main local manifestations were pain (92.2%), paresthesia (43.3%) and swelling (39.7%). The most frequent systemic manifestations were headache (26.3%), vagal manifestations (14.1%), fever (11.1%) and sweating (10.5%). These results are in agreement with the local and systemic manifestations reported in the Brazilian literature^{11,27,42}. The highest proportion of victims did not show local and/or systemic complications. The prevalence of complications was among cases of snakebites. The main local complications were infection (73.9%), functional deficit (16.8%) and necrosis (7.6%). Secondary infection has been reported mainly in ophidian⁴³ and spider accidents⁴⁴. The functional deficit occurs mainly in ophidian accidents^{40,45}. Necrosis is also described in accidents with snakes⁴⁶, spiders⁴⁶, caterpillars⁴⁷, ants⁴⁸, and some species of venomous fish^{49,50}. The main systemic complications were: edema (46.9%), renal failure (43.8%) and shock (21.9%). Renal insufficiency and shock are the most common complications in accidents with snakes⁴⁶ and honey bees¹³. Glottis edema is a frequent complication reported in cases of bee stings, which can lead victims to death¹³. Acute pulmonary edema and shock have also been described in cases of scorpion stings⁵¹ and renal failure among spider accidents⁴⁶.

In conclusion, accidents with venomous animals may be considered an environmental public health problem in the state of *Rio Grande do Norte* which needs to be monitored and controlled throughout the year. The occurrence of cases in all municipalities indicates the wide dispersion of venomous animals in the state. Therefore, the findings of the current study increase the understanding of epidemiology of injury by venomous animals in the state and will be useful in identifying the conditions that increase the risk of envenomation in northeastern Brazil.

Collaborations

AV Tavares worked in the analysis, interpretation data, and wrote the first version of the article. KAM Araújo and MRV Marques worked in the survey of the literature, in the research and methodology. R Leite worked on the conception and design the study, final approval of the version of the article to be published.

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