



HEALTH SCIENCES

Epidemiology of arthropods envenomation in Brazil: a public health issue

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Abstract: Brazil is located between the Equator and Tropic of Capricorn, which allows diverse climates, reliefs, and habitats for arthropods, which sting represents a risk to human health and a public health issue. This manuscript updates the epidemiological data of cases of human envenoming by spiders, scorpions, and insects with medical relevance in Brazil from 2010 to 2021. Epidemiological data were taken using the Brazilian Notifiable Diseases Information System. Statistics of non-parametric data used the Kruskal-Wallis followed by the Nemenyi test. On average, more than 145,000 envenomation and 145 deaths are recorded annually, and more than 60% of deaths are caused by scorpion bites. When the number of deaths was pondered by the number of cases with each arthropod, bees kill the most. Most stings cause mild symptoms and affect men of working age. The incidence decreases during the colder months, which is better noticeable in regions with well-defined seasons. The distribution is distinct among the regions: Southeast, Northeast, and South have the highest rate of bites. The growing number of cases of envenomation reported annually is a serious public health concern, especially involving scorpions, and highlights the importance of studying arthropod venom and improving the therapies.

Key words: Brazil, arthropoda, epidemiology, bites, stings.

INTRODUCTION

Arthropoda is the largest phylum in the Animalia kingdom, consisting of 116 orders and almost 270 thousand known species (Roskov et al. 2019). A limited number are venomous, such as spiders, scorpions, caterpillars, bees, and wasps. Upon the bite, the venom penetrates the body and causes a series of physiological changes, which are influenced by the victim's health status, age, body mass, bite site, inoculation dose, among other minor factors. Most of the cases of envenomation involving arachnids in Brazil are caused by both scorpions (genus *Tityus*) and spiders (frequently *Phoneutria* and *Loxosceles* genera and unusually by the *Latrodectus* genus),

but it is also recorded envenomation with insects, as bees and caterpillar (Ministério da Saúde do Brasil 2022).

Spiders of the genus *Phoneutria* are distributed from Central America to southern South America. It is the biggest, the most aggressive, and dreaded spider involved in envenomation in Brazil when it assumes the typical attack position. Studies revealed that its venom presents a high neurotoxic activity, causing a complex scenario of excitatory symptoms (Peigneur et al. 2018). *Phoneutria* sting is quite common, and the symptoms include intense and radiating pain, restlessness, sweating, vomiting, arrhythmia, salivation, muscle hypertonia, priapism, shock, and/or

pulmonary edema (De Lima et al. 2016, Raposo et al. 2016). Although species from different geographic regions have been identified in Brazil, most stings are attributed to *P. nigriverter*, probably because of its wider geographic distribution. *Loxosceles* genus is also known as the brown spider. The sting is painless and usually caused by the female. In Brazil, the bites by *Loxosceles* spider occur mainly in the South, the coolest region. The envenomation often causes slow and progressive cutaneous alteration characterized by edematous erythema accompanied by burning pain, which develops within 2-6 h (Malaque et al. 2016). Subsequently, a hemorrhagic vesicle appears often surrounded by an edge of venom-induced vasoconstriction and can result in a dermonecrotic wound within several days (Chaves-Moreira et al. 2017). Systemic alterations include fever, fatigue, headache, vomiting, pruritus and rash. Although unusual, complications consist of hemoglobinuria, intravascular hemolysis, disseminated intravascular coagulation, and acute renal failure mainly in children (Robinson et al. 2017). The main species found in Brazil are *L. intermedia*, *L. gaucho*, and *L. laeta*. Spiders of the genus *Latrodectus* are distributed worldwide and envenomation symptoms come in waves during 48 to 72 hours, and is rarely fatal (Monte 2012). Also known as the black widow spider, the most common local symptoms are skin irritation, erythema, burning pain, edema, muscle spasm, and diaphoresis starting at the inoculation site and migrating proximally (Caruso et al. 2021). Erythema and excessive drooling can be present in children. Systemic effects include nausea, tachycardia, hypertension, restlessness, and, rarely, severe abdominal rigidity or chest pain, which can be mistaken for peritonitis or myocardial infarction (Herness et al. 2022). *L. curacaviensis* is the species that causes the majority of the bites of this genus in Brazil. *L.*

geometricus has few cases reported (Almeida et al. 2009). There are several reports with *L. mactans* in North America, but in Brazil although present, there are no official reports to date.

More than 2000 species of scorpions are described worldwide, being scorpions of medical importance belonging to the Buthidae family (Laustsen et al. 2016). *Tityus* scorpions are the most conspicuous genus of this family, with nearly 220 species (Lourenço 2015). In Brazil, about 160 scorpion species were described, however, only *T. serrulatus*, *T. bahiensis*, *T. stigmurus*, and *T. obscurus* are considered medically relevant to date. The yellow scorpion *T. serrulatus* is the most relevant species in Brazil, due to its capacity for parthenogenesis reproduction and adaptability in urban environments, it can be found in most states of Brazil. The manifestations of *T. serrulatus* poisoning include intense pain at the site of the sting, salivation, nausea, vomiting, sweating, psychomotor agitation, hyperemia, and cardiorespiratory symptoms, including cardiac arrhythmias, hypertension, pulmonary edema, and circulatory failure, especially among children (Campos et al. 1980, Freire-Maia & Campos 1989, Parrela et al. 2022).

Estimates suggest that about 5.5 million species of insects exist on Earth, making them a large and very diverse group of animals. However, only two orders have medical interest in Brazil and have their venom studied: Hymenoptera and Lepidoptera.

Social Hymenoptera is an order of insects that includes bees, wasps, and ants. Bioactive compounds in bee and wasp venom can produce toxic effects on prey and predators. Due to their allergenic fraction, bee and wasp stings can lead to local and systemic allergic reactions and are one of the most common causes of anaphylaxis in humans by animals (Sahiner & Durham 2019). The severity of the stings depends on the personal sensitivity and

number of stings. In mild cases, bee and wasp sting is followed by skin symptoms such as urticarial or angioedema. Moderate cases can induce dyspnea, gastrointestinal symptoms, or dizziness; and severe symptoms are characterized by unconsciousness, anaphylactic shock, respiratory or cardiac arrest (Sturm et al. 2018).

Caterpillars represent the larval stage of insects of the order Lepidoptera. The pruritus happens with contact with the larva or pupa. Although many species can cause envenomation, mostly results from skin contact with urticate caterpillar bristles and, in general, acute and benign evolution, without medical relevance. In Brazil, an exception is the caterpillar from the genus *Lonomia*, which the species *L. obliqua* (South) and *L. achelous* (North) are associated with human occurrences. A poison gland is connected to spines present in hollow hairs that cover their bodies, and inoculate the venom when pressed. The common local symptoms are pain, edema, urticarial dermatitis, and hyperemia (Seldeslachts et al. 2020). Homeostatic alterations can be intense and start up to 6 hours after the bite (Berger et al. 2015). Systemic reactions consist of allergy, headache, nausea, vomiting, arthralgia, dizziness, and abdominal pain. More severe cases include hemorrhagic syndrome, associated with coagulopathy, intravascular hemolysis, and acute renal failure (Caovilla & Barros 2004, Maggi & Faulhaber 2015). Although the clinical symptoms of both *Lonomia* species are similar, the mechanism appears to be different. Studies have shown that the *L. obliqua* venom has procoagulant activity, which leads to a consumption coagulopathy associated with intravascular thrombin generation and secondary fibrinolysis. On the other hand, *L. achelous* venom has both procoagulant and anticoagulant activities, being the envenomation characterized by an initial

mild disseminated intravascular coagulation, which is masked by overwhelming fibrinolytic activity due to their fibrinolytic enzymes (Villas-Boas et al. 2018). Contact with the bristles of the caterpillar *Premolis semirufa*, found in the Amazon rainforest region, cause an intense itching sensation, followed by symptoms of an acute inflammation, which lasts for three to seven days and culminate with chronic symptoms similar to rheumatoid arthritis (Villas-Boas et al. 2015, Seldeslachts et al. 2020).

In this study, we update the epidemiology of human envenomation with arthropods in Brazil from 2010 to 2021, which is important for public health decision making. These comprise spiders from the genus *Phoneutria*, *Loxocles*, and *Latrodectus*, scorpion from genus *Tityus* and insects from the order Hymenoptera, such as bees and wasps, and order Lepidoptera, such as caterpillars.

MATERIALS AND METHODS

Study area

Brazil is an extended country (8.5 million Km²), comprising five regions, mostly located between the Equator and the Tropic of Capricorn, in which climate includes equatorial (47%), tropical (47%), and subtropical (6%). For this reason, several habitats are available, allowing quite diverse *fauna* and *flora* that include many different poisonous animals, such as snakes, spiders, scorpions, centipede, fish, and insects.

The North (N) region (3.9 million Km²) has the largest area and the largest preserved forest on the planet, the Amazon rainforest. With an equatorial climate, the temperature in summer reaches 35°C with high precipitation; during winter temperatures drop around 20°C at night and rains are lower. It comprises seven different states: Amazonas, Pará, Acre, Rondônia, Tocantins, Amapá, and Roraima.

In the Northeast (NE) (1.6 million Km²), three different climates are identified: tropical (with well-defined dry and wet season), semi-arid (prolonged drought), and humid equatorial (abundant rain). This region is located in the intertropical zone of the Earth that receives high amounts of solar irradiation and brings the temperatures high throughout the year (average 20-28°C). It has nine states: Maranhão, Piauí, Ceará, Rio Grande do Norte, Paraíba, Pernambuco, Alagoas, Sergipe, and Bahia.

The Southeast (SE) (0.9 million Km²) prevails in the tropical and subtropical climate, with two well-defined seasons: wet summer and dry winter. It possesses four states: Minas Gerais, São Paulo, Rio de Janeiro, and Espírito Santo. A large range of vegetation, temperatures, and subclimates are found, depending on the altitude, such as high altitude tropical in the mountains, semi-arid and humid coast. Bordering the ocean there is the Atlantic rainforest. Due to the impermeable soils, savanna (*cerrado*) developed inward, consisting of small trees, twisted twigs, and undergrowth. *Caatinga* (a Brazilian semi-arid scrub forest) is found in northern Minas Gerais (which does not exceed 800 mm of annual rainfall). *Araucaria* forest is present in southern São Paulo state.

The Middle West (MW) (1.6 million Km²) of Brazil is an ecologically diverse and rich region, with a stretch of *cerrado* and rainforest (Amazon). In this region is also found the *Pantanal* Biome, which occupies the lowland, and covers part of the states of Mato Grosso and Mato Grosso do Sul (together with Goiás and Federal District form this region) and extends over the territories of Paraguay and Bolivia. It is a large swamp that floods during periods of rain; generally in the summer when the temperatures are high (it can reach 40°C). Winters are dry and temperatures drop to up to 15°C in the coldest months.

The South (S) (0.6 million Km²) is the smallest and coldest region and comprises three states: Paraná, Santa Catarina, and the Rio Grande do Sul. With subtropical climate, it has well-defined seasons in most of the territory. The rains are distributed throughout the year. Temperatures can be extremes as 40°C and 0°C, with an average between 24 to 32°C during the summer and 10 to 15°C during the winter (depending on the altitude).

Data source

Epidemiological data presented here was acquired in January 2022, in the Brazilian Notifiable Diseases Information System (SINAM) from the Brazilian government data system (DATASUS 2019) and refers to the period from 2010 to 2021. Data and estimation about the population were taken from the official Brazilian Institute of Geography and Statistics website (IBGE 2021).

Envenomation with venomous animals, including some species of arthropods, occur in all regions. Until 2006, they were not notified in Brazil and the data were restricted to the hospitals and poisoning centers. Since 2007, with the establishment of SINAN, these notifications are mandatory. As showed in the Chippaux (2015) article, the initial data were severely underreported and became more consistent every year. The period 2010-2021 was chosen in this manuscript because it presents more solid data. However, in 2020 the state of Espírito Santos, in the SE region, decided to notify in their system and brought fragility to the SINAM data. Once the cases of envenomation in Espírito Santo state represent $2.21 \pm 0.34\%$ of the Brazilian incidents and $6.90 \pm 0.32\%$ of the SE region, the lack of these data had a larger impact on the region data, as expected. Thus, this study includes compiled data from 2010-2021 for the Brazilian database, and 2010-2019 when regions

were analyzed separately. It is also important to stress that the data for 2021 is still under revision and can present some divergence.

Data analysis

Data were collected by year and the mean ± standard error of the mean (SEM) was calculated, which is presented in graphs and tables, except when annual data are presented. Statistics for nonparametric data were performed using Kruskal-Wallis (Kruskal & Wallis 1952) followed by the Nemenyi test (Nemenyi 1963) for paired comparisons between the number of incidents between Brazilian regions (N, NE, S, SE, MW), considering all groups of venomous arthropods, as well as the number of envenomations of each group of venomous arthropods within each region. For these analyses, we used the PMCMR package (Pohlert 2014). The effect of the seasons using the peak of each season (summer – January; autumn – April; winter – July; and spring – October) was tested by performing Generalized Linear Models. For

this, the quasipoisson family was used for the distribution of errors (Hastie & Pregibon 1992). The level of statistical significance used in the study was 95%. All statistical analyzes were performed in the R software (R Core Team 2021).

RESULTS

Annually there are over 140,000 envenomation involving arthropods in Brazil, causing on average 145.3±13.1 deaths, which means that about one person dies for every 1,000 stings. There was an increase in the arthropod stings (Figure 1a) and deaths (Figure 1b) over the last 12 years. Scorpion envenomation represent the majority of them (67.0± 1.51%), followed by spider (20.6± 1.36%), bee (9.4± 0.20%), and caterpillar (2.9± 0.18%) (Table I). Figure 1c shows that the proportion of the annual number of envenomation with spiders have decreased (from 28.4% in 2010 to 14.0% in 2021), while scorpion bites have increased at an average rate of 2% per year. The proportion of bee stings varied between 8.4% (2010) to 10.7%

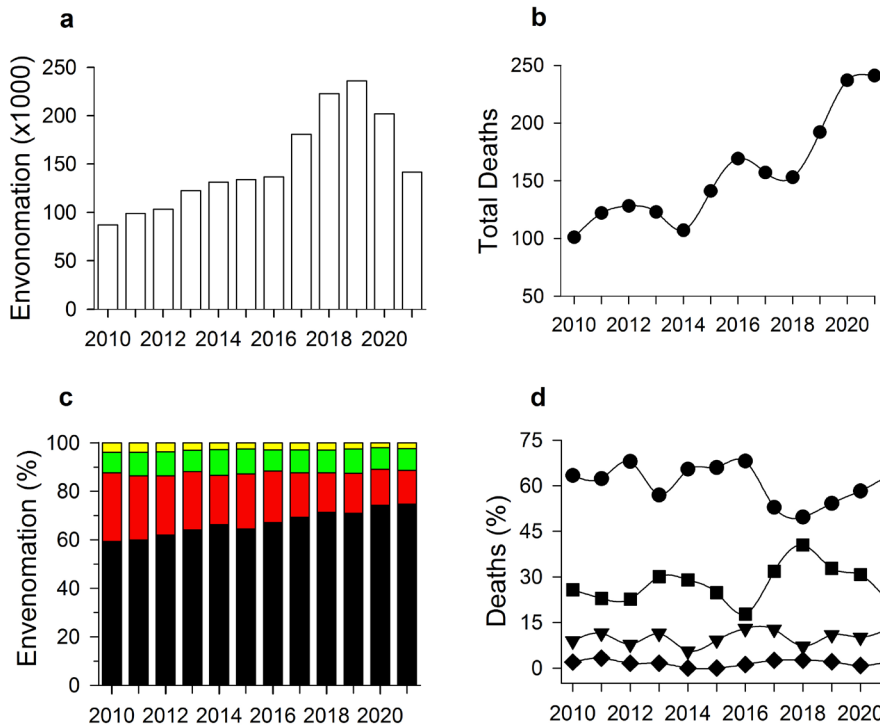


Figure 1. Panorama of arthropods envenomation in Brazil from 2010 to 2021*. (a) Number of the cases of total arthropods envenomation per year. (b) Total number of deaths by arthropods envenomation per year. (c) Percentage of each arthropod sting in Brazil per year (from bottom to top: black, scorpion; red, spider; green, bee; yellow, caterpillar). (d) The proportion number of deaths per year by scorpion (circle), bee (square), spider (inverted triangle) and caterpillar (diamond). *Data of 2021 is still under review.

(2014) annually and caterpillar envenomation remained between 2.5 to 3.0% since it decreased in 2013.

The amount of deaths fluctuates a lot among the years (Figure 1d). Following the number of cases, scorpion lead the deaths (49.7 to 68.0%). Bee stings represent the second in the total number of deaths, with proportional deaths ranging from 17.8% (2016) to 40.5% (2018) and overcoming spider deaths, which comes in third in this ranking. Deaths by caterpillars represent only 1.65% on average. Analysis of the relationship between deaths and the total number of envenomation changed the whole scenario. It showed in the Table I that the bee is indeed the arthropod that kills the most (0.31±0.018%), followed by scorpions (0.10±0.009%), caterpillar (0.06±0.010%), and spiders (0.05±0.001). Considering that deaths result from serious cases, bees continue to have the highest proportion of deaths, 34.4±1.29% of the serious cases evolved to death, followed by the caterpillar (16.3±3.96%), spider (10.2±1.95%), and scorpion (9.8±0.77%).

The graphs in Figure 2 show the dependence of the season for the arthropod stings. As expected, there were a statistically reduced number of total stings in the coldest month (July) (Figure 2a). It was found a strong relationship between the number of stings and the season in the regions S and SE, associated with cooler climates (Figure 2b-d). During the winter (June to August), there is a remarkable reduction in the

number of envenomation for all arthropods in the S (Figure 2b-e), and caterpillars and bees in the SE (Figure 2d-e). The scorpion sting increases during spring (September to December) in the SE, S, and MW (Figure 2c). The other regions are warmer throughout the year, and these differences are not marked. In the NE, MW, and N caterpillar poisoning are slightly increased during the rainy season (Figure 2d).

There are relevant differences in arthropods stings among the regions. As shown in the Table II SE head the amount of arthropods sting followed by NE, S, MW, and N. However, these regions have very different population densities, being the SE the most populated of them. When the number of bites is pondered by the population NE became the first, followed by S, SE, MW, and N.

Comparing the proportion of envenomation by each arthropod per region (Figure 3a), it is noteworthy that scorpion causes the majority of them in all regions of Brazil, ranging between 68.2±0.61% (N) to 87.8±0.50% (NE), except in the S, where the spiders are the main responsible (72.5±1.4%). In the N spider causes 16.1±0.35% of the stings, followed by bee (11.4±0.74%), and caterpillar (4.4±0.29%), mainly the species *L. achelous* and *P. semirufa*. As mentioned, the region NE has the largest amount of scorpion incidents (87.8±0.50%). Bee comes in second with 8.2±0.50%, followed by spider (3.2±0.09%), and caterpillar has the smallest proportion (0.85±0.05%). Moving to the southern, the SE

Table I. Average of envenomation and deaths by each arthropod in Brazil recorded in SINAM between 2010 and 2021.

	Spider	Scorpion	Caterpillar	Bee
Envenomation (%)	20.6±1.4	67.0±1.5	2.9±0.2	9.4±0.2
Deaths (%)	10.1±0.7	60.7±1.8	1.7±0.3	27.6±1.8
Deaths/Envenomation	0.05±0.001	0.10±0.009	0.06±0.010	0.31±0.018
Deaths/Serious Cases	10.2±1.95	9.8±0.77	16.3±3.96	34.4±1.29

Annual average ± SEM (n=12).

region has $71.4 \pm 1.25\%$ of scorpion sting, followed by $15.7 \pm 0.77\%$ of spider, $9.7 \pm 0.38\%$ of bee, and $3.2 \pm 0.24\%$ of the caterpillar. MW has $75.3 \pm 0.95\%$ of scorpions, and $2.8 \pm 0.22\%$ of erucism. Spiders and bee sting do not differ statistically in this region with $11.9 \pm 0.57\%$ and $10.0 \pm 0.45\%$ ($p > 0.05$), respectively. The S region has a very different pattern: spider bites are more abundant ($72.5 \pm 1.35\%$), followed by bee ($11.6 \pm 0.60\%$) that does not differ statistically from scorpion ($9.0 \pm 0.99\%$), and caterpillar (6.9 ± 0.36) caused predominantly by *L. obliqua*.

Even though Figure 3a showed most of the stings in the N and MW are with scorpions, when compared with all scorpion incidents in Brazil, it represents only $4.1 \pm 0.21\%$ and $5.0 \pm 0.21\%$, respectively (Figure 3b), which is due to the relatively low abundance of cases of envenomation by arthropods in these

regions (Figure 3a). NE contributes $46.5 \pm 0.90\%$ of the scorpion stings, SE with $42.1 \pm 0.90\%$, and S appears with only $2.4 \pm 0.09\%$ of them. As expected, $61.4 \pm 1.67\%$ of all spider bites are in the S region, SE comes next with $28.1 \pm 1.10\%$, followed by NE ($5.2 \pm 0.40\%$), N ($2.9 \pm 0.11\%$) and MW ($2.3 \pm 0.16\%$). Most of the sting by bees are split among SE ($39.2 \pm 0.91\%$), NE ($29.6 \pm 0.60\%$) and S ($22.0 \pm 1.24\%$); less than 10% are in N ($4.6 \pm 0.12\%$) and MW ($4.5 \pm 0.21\%$). Erucism form a wave coming from the S ($41.5 \pm 2.59\%$), passing through SE ($39.1 \pm 1.81\%$), NE ($9.8 \pm 0.95\%$), N ($5.6 \pm 0.39\%$), and in the MW has the lowest rate ($3.9 \pm 0.42\%$).

Considering the evolution of the envenoming (Table III), most of the cases are mild. Spiders have the highest percentage of moderate cases ($19.0 \pm 0.97\%$). Serious cases evolve 1% or less of the sting people. Analyzing the profile of the people stung (Table III), those of working age

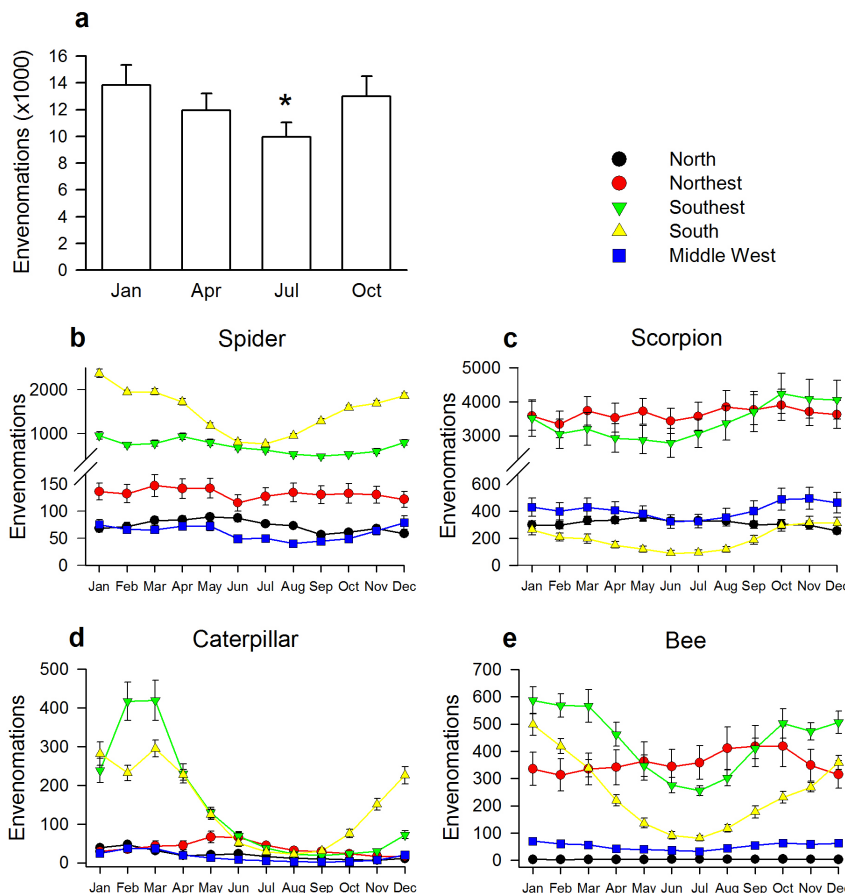


Figure 2. Relationship of the season for arthropod envenomation in each region from 2010 to 2019. (a) The national average (\pm SEM, $n=10$) in the peak of each season (summer - January, autumn - April, winter - July, and spring - October) shows the incidents throughout the seasons (* $p < 0.05$ compared with January). Envenomation by (b) spiders, (c) scorpions, (d) caterpillars and (e) bees by Brazilian regions pondered by the population.

(20-59 years old) are more involved in incidents (spider 62.5%, scorpion 58.8%, caterpillar 52.0%, and bee 59.3%). Men are statistically more stung by bees and caterpillars, probably because they are the major workforce in the rural area where they are more exposed (Ministério da Saúde do Brasil 2019). Scorpion envenomation is more frequent in women, perhaps due to the adaptation of the scorpion to urban areas, causing the majority of incidents in or near homes.

DISCUSSION

The epidemiological data reported in this article show that the number of the sting by arthropods is concentrated in the most populous region, the SE, and has increased nationwide since 2010. It can be due to an increase in the notification, a real increase in this envenomation, or both. Likely, these data are somehow under-reported, once the country is enormous and it is not uncommon for the patients not be able to reach the medical center on time or even try to treat

Table II. Cases of arthropods envenomation by region, and pondered by population.

Region	Arthropods Envenomation		Population		Envenomation/1,000,000
		%	x 1,000,000	%	
North (N)	5561±509 ^a	3.9±0.12	17.2±0.3	8.5±0.05	319.9±24.6 ^a
Middle West (MW)	6475±997 ^a	4.3±0.21	15.2±0.3	7.5±0.04	417.7±58.0 ^a
South (S)	25234±1071 ^{a,b}	18.6±1.24	28.9±0.3	14.3±0.01	872.5±29.7 ^b
Northeast (NE)	50504±6113 ^b	34.6±0.61	55.7±0.5	27.6±0.08	900.5±103.3 ^b
Southeast (SE)	56624±7127 ^b	38.6±0.91	84.8±0.9	42.0±0.03	661.4±77.1 ^{a,b}

Annual average ± SEM of envenomation cases/population in each Brazilian region between 2010 and 2019. Statistical analysis (a and b): equal letter p>0.05; different letter p<0.05 (n=10).

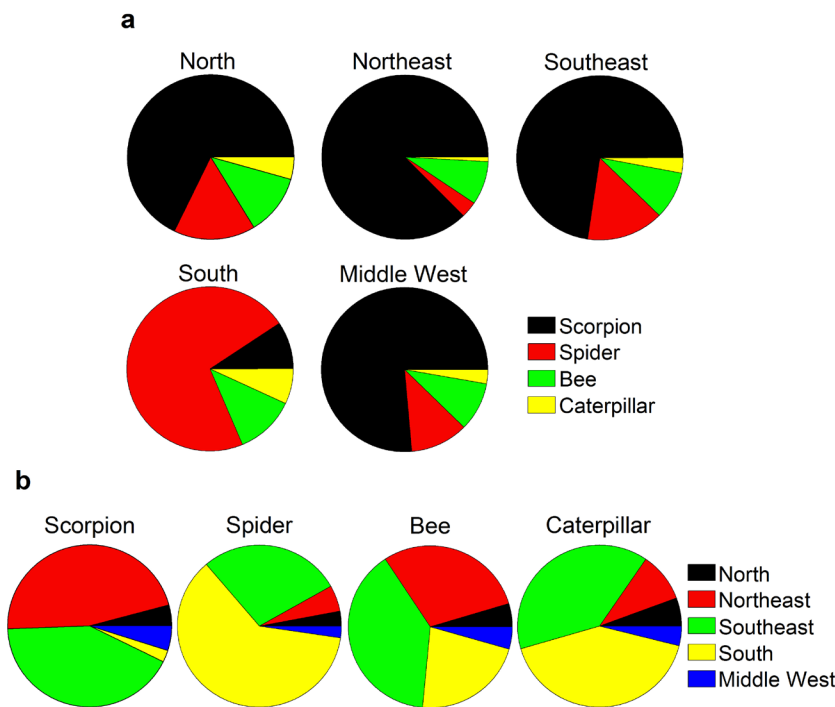


Figure 3. Relationship between arthropods envenomation and Brazilian regions from 2010 to 2019. (a) The proportion of each arthropod incident by Brazilian regions. (b) Contribution of each region on total poisoning for each arthropod.

the poisoning themselves. On top of that, around 10% of the records did not have “type of incidents” filled, which means the animal could not be identified. It was unexpected that bees are the arthropods that kill the most in Brazil when we compare the number of incidents. Studies estimate that the lethal dose of the bee venom in animals averages 3.5 mg/kg (Schumacher et al. 1994); however, the lethal dose to humans remains unknown. As for all cases involving venom injection, age, body weight, number of stings, and individual characteristics of the victim (immune status, comorbidities, and previous sensitization) determine the severity of the condition. The high proportions of deaths with bee stings are likely due to the anaphylactic shock rather than the venom effects. The main allergens in bee venom are phospholipase A, hyaluronidase, acid phosphatase, and melittin (Burzyńska & Piasecka-Kwiatkowska 2021).

In general, there is a reduction in arthropod sting during the winter (June-August), which is more evident in the regions with well-defined seasons, such as S and SE, especially related to bee stings. Perhaps the lesser exposure to the outdoors may exacerbate this decrease. This relationship is more difficult to determine in other regions, maybe due to slight differences among the seasons. As expected, caterpillar poisoning increase during the rainy season and have the lowest rate in the NE, where solar radiation is more intense, disfavoring their proliferation and/or displacement. The parthenogenetic scorpions, such as *T. serrulatus*, reproduce in the spring and coincides with the period warmer and rainier, which increases their activity and the number of stings (Furtado et al. 2020).

One would think that most arthropods poisoning happen in the Amazon rainforest (N) or the *Pantanal* biome (MW), but these regions

Table III. Evolution of envenoming and the profile of people stung.

	Spider	Scorpion	Caterpillar	Bee
Gravity of the incident (%)				
Mild	78.4±1.00	86.9±0.66	89.2±0.45	84.2±0.25
Moderate	19.0±0.97	7.97±0.43	6.78±0.31	9.95±0.19
Serious	0.97±0.04	1.0±0.06	0.45±0.05	0.88±0.02
Age of the people stung (%)				
>1	1.3±0.02	1.1±0.1	1.1±0.10	1.1±0.15
1 – 9	8.9±0.13	10.7±0.08	18.5±0.23	15.8±0.45
10 – 19	11.6±0.37	14.8±0.33	14.1±0.60	15.6±0.52
20 – 39	33.0±0.17	32.1±0.32	26.2±0.21	38.8±0.35
40 – 59	29.5±0.13	26.7±0.28	25.8±0.34	20.5±0.48
60 – 69	9.7±0.27	8.6±0.28	8.9±0.34	4.8 ±0.16
<70	6.0±0.20	6.1±0.2	5.4±0.31	3.4±0.10
Gender of the people stung (%)				
Female (%)	47.5±0.3	50.7±0.13	44.8±0.45*	36.2±0.26*
Male (%)	52.5±0.32	49.3±0.13	55.1±0.44*	63.8±0.27*

Annual average ± SEM (n=12) of the envenomation cases in Brazil between 2010 and 2021. *Statistically different between the gender (p<0.05).

have the fewest arthropod bites recorded in the country. This raises two hypotheses: it can be under-reported due to the difficulty of reaching the medical center and/or the conserved natural habitat keeps arthropods away from towns and cities, which have also low demographic density.

Almost 40% of the total the cases of envenomation by arthropods are in the SE of Brazil, mainly due to the scorpion sting. *Tityus* scorpions are very well adapted to live in sewers and garbage in urbanized areas, where there is high availability of food, such as cockroaches, larvae, and small spiders (Furtado et al. 2020), this can be the reason that women are slightly more stung than men, different than the others arthropods analysed in this study. However, when the population is considered NE and S overcome SE, having together more than 55% of the cases. Altogether, these 3 most populated regions of the country sum up more than 75% of scorpion stings.

The identification of the spider genus is worrying, as it is difficult to capture the animal or keep it entire, as it is a natural reflex to flee or crush it. In more than 90% of the reports, this information was absent in all regions, except in the S, where *Loxosceles* is endemic and was identified in 23.1% of the cases, followed by *Phoneutria* (8.9%). *Latrodectus* was identified in less than 0.01% of the bites, in all regions of the country (DATASUS 2019). Other spiders can cause local allergic reactions and bring people to healthcare facilities, without complications.

Erucism is not very frequent; it affected an average of $4,306 \pm 370$ people annually in Brazil, which represents 3.0% of all arthropod envenomation reported. This total also includes those caterpillars that are not venomous to humans and cause local allergic reactions. Although the hemorrhagic syndrome observed in poisoning with *Lonomia* caterpillar is quite potent, since the Butantan Institute in Brazil

developed the antivenom in 1994, deaths do not exceed 4 per year; which represents less than 0.1%. Two different species of *Lonomia* are present in Brazil, *L. obliqua* (South), and *L. achelous* (North), which explains why these two extreme regions of the country share this common characteristic.

Poisoning by arthropod sting is recognized by the World Health Organization as a neglected public health problem (World Health Organization 2007) in many parts of the world, especially in developing countries. The warm climate in Brazil throughout most of the year favors the proliferation of arthropods that cause stings. Fortunately, Brazil has antivenom for poisoning by spiders, scorpions, and caterpillars of the genus *Lonomia*, the only antivenom for caterpillars available in the world. The growing number of envenomation cases reported annually highlights the importance of studying arthropod venom and improving therapies. Furthermore, epidemiological studies should continue to be carried out in the future, to drive decision-making on public policies for the prevention and treatment of incidents in the regions that most need it.

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