Profile of work accidents caused by venomous animals in Brazil’s Federal District from 2009 to 2019

Perfil dos acidentes de trabalho por animais peçonhentos no Distrito Federal no período de 2009 a 2019

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ABSTRACT | Introduction: The high numbers of accidents involving venomous animals in tropical countries is a major public health problem and has prompted the World Health Organization to place them on its list of neglected tropical diseases. The Notifiable Diseases Information System shows that the number of notifications of accidents involving venomous animals increases every year. In Brazil, accidents involving venomous animals are the number one cause of human intoxications. The public health importance of accidents and their consequential importance for workers is clearly illustrated by the more than 100,000 accidents and almost 200 deaths that occur annually. Objectives: To observe and analyze the profile of accidents involving venomous animals in Brazil’s Federal District. Methods: A retrospective descriptive case series study of data from four databases containing information on accidents involving venomous animals. In addition to analyzing each one, they were also compared to each other. Results: A total of 11,376 accidents involving venomous animals from 2009 to 2019 were registered in the Federal District. There were 363 occupational accidents and zero deaths in the period. There were discrepancies between each of the databases analyzed. Conclusions: Subnotification and discrepancies should be better evaluated and subsequently resolved by the managers of each database. Actively seeking information and better organization of the organs responsible for database management are possible solutions to the current problems.

Keywords | Poisonous animals; health information systems; occupational accidents; social security; occupational accidents registry.

RESUMO | Introdução: O alto número de acidentes por animais peçonhentos em países tropicais, grande problema de saúde pública, fez com que a Organização Mundial da Saúde os enquadrasse na lista de doenças tropicais negligenciadas. O Sistema de Informação de Agravos de Notificação mostra que, a cada ano, os números de notificações de acidentes por animais peçonhentos têm aumentado. No Brasil, os acidentes por animais peçonhentos estão em primeiro lugar no número de intoxicações humanas. A importância dos acidentes para a saúde pública e para o trabalhador, por consequência, fica evidente a partir dos números: mais de 100 mil acidentes e próximo de 200 óbitos anualmente. Objetivos: Observar e analisar o perfil dos acidentes no Distrito Federal. Métodos: Estudo retrospectivo descritivo do tipo série de casos de quatro bases de dados sobre acidentes por animais peçonhentos. Além da análise de cada uma das bases, foi feita a comparação entre elas. Resultados: Foi encontrado um total de 11.376 acidentes por animais peçonhentos de 2009 a 2019, no Distrito Federal, sendo 363 acidentes de trabalho com zero óbitos no período. Houve discordâncias entre cada uma das bases pesquisadas. Conclusões: As subnotificações e discordâncias poderão ser mais bem avaliadas e posteriormente solucionadas pelos órgãos gestores de cada base. A busca ativa de informações e melhores organizações dos órgãos competentes são algumas soluções para os problemas enfrentados no momento.

Palavras-chave | Animais venenosos; sistemas de informação em saúde; acidentes de trabalho; previdência social; notificação de acidentes de trabalho.

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INTRODUCTION

Venomous animals have some type of apparatus for injecting venom that they produce or modify into prey or predators. In contrast, poisonous animals expose their predators to poison, without injecting it. The main venomous animals that cause accidents in Brazil include certain species of snakes, scorpions, spiders, lepidoptera (moths and their larvae), and others. The apparatus used to inoculate venom are fangs in snakes, the chelicera in spiders, and the telson in scorpions. A sufficient dose of venom causes harmful local and/or systemic effects to the prey or predator.

The high numbers of accidents involving venomous animals in tropical countries is a major public health problem, which prompted the World Health Organization (WHO), to place them on its list of neglected tropical diseases in 2009. This is a list of conditions that have been practically eradicated or eradicated in developed countries, but remain in developing countries.

Since the majority of the population affected by this problem have little political influence, neglected tropical diseases are accorded little importance in public health policy priorities. This results in scant investment in research and prevention and weakens epidemiological information flows, exacerbating poverty and poor health conditions.

Compounding the problems with access to healthcare and subnotification, the world’s 46 antivenin producers do not meet global demand.

It is pertinent to mention Brazilian contributions to research into antivenins. Pioneering research conducted by the scientist Vital Brazil led to production of specific antivenins for the venom of several venomous animals including snakes, scorpions, and spiders. His research broke paradigms and contributed to innovation in concepts and practices of medical and biological science. There is still no more effective method for neutralization of envenomation than the one he created in 1898.

The Notifiable Diseases Information System (SINAN - Sistema de Informação de Agravos de Notificação) shows that the number of registered accidents involving venomous animals increases every year. In 2010 there were around 124,000 accidents involving venomous animals. In 2014, the number had passed 170,000, with scorpions in first place (around 88,000 accidents), followed by snakes and spiders (around 27,000 accidents each). While the numbers of accidents in Brazil are high, the exact magnitude of these data is unknown, since there is considerable subnotification and missing data from investigation protocols.

A 2012 study revealed the lethality of accidents caused by the animals mentioned above in Brazil. The results were as follows: scorpions caused 63,619 accidents and 97 deaths; snakes caused 28,080 accidents and 127 deaths; and spiders caused 24,942 accidents and 16 deaths.

According to data from the most recent bulletin from the National Toxicological and Pharmacological Information System (SINITOX - Sistema Nacional de Informações Tóxico-Farmacológicas), released in 2017, in Brazil, accidents involving venomous animals are the number one type of human intoxication event, followed in second place by intoxication by medications.

The numbers of accidents involving venomous animals are increasing because of problems such as ecological imbalances and unplanned urban growth, which contribute to superimposition of spaces occupied by humans and by these animals, which seek food and shelter in urban areas. The profile of these accidents, once almost entirely rural, has been changed by this superimposition.

The public health importance of these accidents and their consequential importance for workers is clearly illustrated by the more than 100,000 accidents and almost 200 deaths that occur annually. Cases are concentrated among young adults performing labor activities, which are very often informal or unpaid.

Worldwide, venomous living beings are widely distributed throughout the animal kingdom, with more than 100,000 species in all major phyla. In Brazil, the snakes of medical interest are members of the genera Bothrops, Bothrocaupi, Crotalus, Lachesis, Micrurus, and Leptomicrurus. Scorpions are members of the Tityus genus. Venomous spiders are members of the genera Loxosceles, Phoneutria, and Latrodectus. The caterpillars of greatest concern are members of the Lonomia genus.

Given the importance of these events to workers’ health, especially in underdeveloped countries such as Brazil, the objective of this study was to observe and analyze the profile of accidents involving this specific population in Brazil’s Federal District.
METHODS

This is a retrospective descriptive case series study of data from four databases that provide information on accidents involving venomous animals. The study focuses on data for Brazil’s Federal District. The animals concerned are snakes, spiders, scorpions, and caterpillars. Once approval had been granted by the Ethics Committee at the Instituto de Gestão Estratégica de Saúde do Distrito Federal, under CAAE: 36272020.1.0000.8153, data were collected for later analysis using Microsoft Office Excel 365.

The first database analyzed contains data from 2009 to 2019 and is the SINAN, “Accidents involving venomous animals” database. Records were selected for the Federal District on work-related accidents for all occupations, analyzing the following variables: sex, educational level, site of sting/bite, zone of occurrence, number of accidents involving venomous animals per year in the series analyzed, and severity of accidents related to the time elapsed from the accident to the victim receiving care.

The second database analyzed, covering the same period and all occupations, was the SINAN “Occupational Accidents” database. Records were selected using International Classification of Diseases (ICD-10) codes that mention accidents involving the animals listed above, for which the location of the accident was the Federal District. The relevant ICD-10 codes are W59, X20, X21, X22, X25, X27, and X29.

The third database, also covering the same period, was the Toxicological Care and Information Center/Mobile Urgent Care Service (CIATox - Centro de Informação e Assistência Toxicológica/SAMU - Serviço de Atendimento Móvel de Urgência) database for the Federal District. Searches were run for occupational circumstances in accidents occurred in the Federal District. The toxic agents involved were venomous animals.

The last database accessed was the: “Historic Occupational Accidents Database” maintained by the Special Secretariat for Work and Pensions (Secretaria Especial de Previdência e Trabalho). Data for the Federal District from 2008 to 2018 were searched to determine the number of Occupational Accident Reports (OAR), the number of typical accidents, commuting accidents, and work-related diseases with the following ICD-10 codes: T63, W59, X20, X21, X22, X25, X27 and X29.

RESULTS

The “Accidents involving venomous animals” database reported a total of 11,376 accidents involving venomous animals (snake, spider, scorpion, and caterpillar), from 2009 to 2019 in the Federal District, 363 of which were occupational accidents, with zero deaths during the period.

Figure 1A illustrates the prevalence (in absolute numbers) of accidents by sex for each year in the series analyzed. From 2009 to 2019, the number of women involved increased seventeenfold and the number of men involved increased 3.15 times. Figure 1B shows a temporal projection calculated in Microsoft Excel from the historical data using version AAA of the exponential smoothing (ETS) algorithm. From 2009 to 2019 accidents were reported involving a total of 82 women and 281 men.

Data on the educational level of the accident victims shows that the greatest prevalence was among people who had remained at school up to the 5th to the 8th series of primary education.

Table 1 lists prevalence of the different body sites bitten or stung.

Figure 2A lists the distribution of accidents by zone of occurrence. 2B shows this distribution by year. From 2017 onwards there was a considerable increase in “urban” notifications and a corresponding fall in “rural” notifications.

In its 2020 Epidemiological Bulletin, the Federal District Department of Health (Secretaria de Saúde) revealed that 72.2% of accidents involving residents of the Federal District occurred in urban areas, 12.1% in rural areas, and 3.9% in periurban areas. In 9.8% the zone was unknown and in 2.1% of reports the relevant field was left blank.

In terms of the animals involved in the present study, accidents with scorpions accounted for 60.33% of the total (219 accidents); snakes for 34.99% of the total (127 accidents); and spiders for 3.31% (12 accidents), while caterpillars/lonomias were involved in 1.38% of the total (5 accidents). Figure 3 illustrates the distribution in
absolute numbers of accidents by type of animal for each year in the series analyzed.

A study that used data from the Unified Health System (SUS - Sistema Único de Saúde) IT Department (DATASUS) to analyze the SINAN reports for venomous animals in the Federal District, from 2010 to 2016 in the general population, covering the same animals as in the present study, found a total of 4,951 accidents, with the same sequence of magnitude: scorpions accounting for 71.01% of the accidents, snakes accounting for 15.99%, spiders accounting for 9.71%, and caterpillar accounting for 3.27%. However, in contrast with the current study, that study of the Federal District observed six deaths over the period.15

According to the Federal District Department of Health, 1,679 accidents in the general population involving scorpions, snakes, spiders, and caterpillars were notified in 2019 alone. The Department of Health’s data record 1,363 accidents with scorpions, 121 with snakes, 112 with caterpillars, and 83 with spiders,16 with a different sequence of magnitude to the present study.

The 2020 Epidemiological Bulletin on venomous animals showed that 2,402 accidents were registered in the Federal District. Accidents with scorpions were in first place with 1,878, followed by spiders with 131, snakes with 108, and caterpillars with 74.14 However, the sequence of magnitude differs from that recorded for 2019.

### Table 1. Distribution of accidents by site of bite/sting

| Bite/sting site | Total (n) | Percentage (%) |
|-----------------|-----------|----------------|
| Hand            | 92        | 25.34          |
| Foot            | 84        | 23.14          |
| Finger          | 57        | 15.70          |
| Leg             | 36        | 9.92           |
| Toe             | 28        | 7.71           |
| Arm             | 17        | 4.68           |
| Unknown         | 13        | 3.58           |
| Trunk           | 12        | 3.31           |
| Head            | 10        | 2.75           |
| Forearm         | 8         | 2.20           |
| Thigh           | 6         | 1.65           |
| Total accidents | 363       | 100.00         |

Source: “Accidents involving venomous animals” from the Notifiable Diseases Information System (SINAN - Sistema de Informação de Agravos de Notificação).

### Figure 1. A: Venomous animals - Occupational Accidents by Sex Over Time. B: Venomous animals - Trend in Occupational Accidents by Sex - Projection up to 2029.

Source: “Accidents involving venomous animals” from the Notifiable Diseases Information System (SINAN - Sistema de Informação de Agravos de Notificação).
on the SINAN, as illustrated in Figure 3. The bulletin also provides the sex distribution of Federal District resident victims for some animals, as follows: scorpions (47.9% men and 52.1% women) and spiders (50% men and 50% women), the proportions for snakes and caterpillars were not reported; but for all venomous animals, 50.2% of victims were men and 49.8% were women. Figure 4 illustrates the following proportions from the historical series for men and women respectively: scorpions accounted for 68.9% and 31.1% and spiders for 75.0% and 25.0%.

In the Ministry of Health Epidemiological Bulletin on occupational accidents with venomous animals involving field, forest, and water workers, from 2007 to 2017 95,205 occupational accidents with venomous animals were notified. Over the period there was a 38.25% increase in the number of records, from 7,830 in 2007 to 10,825 in 2017 (the year with the highest number of cases). The

![Figure 2. A: Venomous animals - occupational accidents - zone of occurrence, 2009 to 2019. B: Venomous animals - occupational accidents - zone of occurrence, by year.](image-url)

Source: “Accidents involving venomous animals” from the Notifiable Diseases Information System (SINAN - Sistema de Informação de Agravos de Notificação).
The greatest numbers of accidents involved snakes (45,763), scorpions (22,596), and spiders (16,474), in that order, and the number of accidents involving caterpillars was not mentioned.\(^\text{17}\)

With regard to the time elapsed between the accident and receiving care, the majority of victims presented within 3 hours, which coincides with the findings of the study of data for the general population.\(^\text{15}\)

**Figure 3.** Venomous animals – accidents per year.

Source: “Accidents involving venomous animals” from the Notifiable Diseases Information System (SINAN - Sistema de Informação de Agravos de Notificação).

**Figure 4.** Venomous animals – distribution by genera, 2009 to 2019.

Source: “Accidents involving venomous animals” from the Notifiable Diseases Information System (SINAN - Sistema de Informação de Agravos de Notificação).
The “Occupational accidents” database records a total of 5,968 occupational accidents in the Federal District from 2009 to 2019. A total of three accidents were identified for the following ICD-10 codes: W59, X20, X21, X22, X25, X27, and X29. One accident was coded W59 (bite or crushing provoked by other reptiles), there was one X22 accident (contact with scorpions) and one X29 accident (contact with unspecified venomous plants or animals).

The CIATox/SAMU-DF database records a total of 1,791 accidents in the Federal District from 2009 to 2019, involving the following animals: snakes, spiders, scorpions, lonomias, and others. However, when restricted to occupational accidents, a total of 12 accidents remained: two with scorpions, four with snakes, four with spiders, and two with members of the Hymenoptera order (ants, bees, and wasps).

The final database analyzed in the present study is the “Historic Occupational Accidents Database” maintained by the Special Secretariat for Work and Pensions (Secretaria Especial de Previdência e Trabalho). For the period from 2008 to 2018 (the years available for analysis),

Figure 5. A: Types of accidents per ICD-10 code for 2008 to 2018. B: Numbers of types of accidents for all ICD-10 codes per year.

Source: “Historic Occupational Accidents Database” maintained by the Special Secretariat for Work and Pensions (Secretaria Especial de Previdência e Trabalho).
we identified a total of 57 accidents, classified as: typical accidents with OAR, commuting accidents with OAR, work-related diseases with OAR, accidents without OAR, and unclassified accidents.

Figure 5A illustrates the distribution of types of accidents in the Special Secretariat for Work and Pensions database for each ICD-10 code of interest, from 2008 to 2018. Figure 5B illustrates the distribution of types of accidents for each year from 2008 to 2018 for all ICD-10 codes.

**DISCUSSION**

In the main database used for this study, “Accidents involving venomous animals”, we observed an increase from 14 to 58 occupational accidents involving venomous animals per year from 2009 to 2019, with a considerable increase among females, from one to 17 per year (1,600%), although accidents with males were the majority in all of the years in the historical series.

According to the calculations and projections performed in Excel, women would overtake men in absolute numbers of accidents in 2027. In the present study, the increase in the number of females involved in accidents can be observed from 2015 onwards. This can be explained by women’s inclusion in more economic activities because of, for example, the lower pay received by women in both the formal sector and the formal and informal sectors taken together.18

A study has shown that women and men do not differ in terms of the time needed to detect a venomous animal, but that men make fewer errors in detection of images showing venomous animals.19 Together with the increase in the number of women in the labor market, the findings of that study could help to explain the progressive increase in the number of women involved in accidents from 2015 to 2029.

Analysis of the educational level of those involved in accidents showed that the greater part of cases involved people who had attended school up to the 5th to 8th grades of primary education. This is an educational band that could be associated with a low level of instruction and information related to accidents involving venomous animals.

The hand was the body site most often affected in these accidents. This could be because of inadequate use of personal protective equipment (PPE), lack of PPE, or lack of attention when handling and picking up objects. Feet were in second place, which could also be because of inadequate use of PPE or failure to use PPE.

The increase in accidents in urban areas from 2016 to 2019 in relation to other zones may be because of the increased number of accidents with scorpions in this period. In parallel, the fall in the number of rural accidents from 2017 onwards could be because of the reduction in accidents with snakes.

Two positive points revealed by this database were that the majority of accident victims received care rapidly (in under 3 hours and, more specifically from 0 to 1 hour) and there were no deaths. It has been observed that the longer the time taken to receive care, the fewer mild accidents there are. The time taken to receive care is of fundamental importance to good patient prognosis, since the earlier the animal responsible is identified and treatment is initiated, the lower the likelihood of complications that could have irreversible sequelae, prolonged hospitalization (exposing the patient to the risk of developing comorbidities, such as nosocomial infections), and complications that could lead to death.20

It is important to point out that these accidents can cause considerable expenditure on treatment of serious sequelae, prolonged hospitalization, rehabilitation, and retirements for disability.20 Spending on workers and the population in general that is avoidable.

The profile of the distribution of accidents with spiders in the series analyzed precluded projections in Microsoft Excel like the one conducted for sex distribution. The application’s calculations distorted the results.

The huge variety of venomous animals (snakes, spiders, and scorpions) is already responsible for many accidents considered severe, leaving thousands of people with sequelae, many of them incapacitated, and can even cause death.6 This study did not identify any deaths in the two SINAN databases or the CIATox/SAMU-DF database, although there were records classified as “unknown” in the SINAN databases. This is a limitation of the data on accident outcomes.

In regard to the Special Secretariat for Work and Pensions database, we must consider self-employed and
informal workers and subnotification to explain the low number of accidents (57) over an 11-year period (2008 to 2018). It should be noted that information on accidents is not available for 2019.

Where the Special Secretariat for Work and Pensions database mentions the venomous animal involved, scorpions are in first place. This agrees with the “Accidents involving venomous animals” database.

Considerable discrepancies were observed between the data in the two SINAN databases. It would be expected that their figures would be similar since the “Occupational accidents” database supplements the information on occupational accidents contained in the “Accidents involving venomous animals” database. The Specialist Occupational Health Center in the Federal District, for example, actively seeks information on the records in the second of these databases to populate the first. This process may be compromised.

The CIATox/SAMU-DF database recorded an elevated number of accidents involving venomous animals, but few occupational circumstances, when compared with the SINAN “Accidents involving venomous animals” database. A lack of more detailed information about the care provided by CIATOX may be the reason for the discrepancies in these data.

None of the 12 accidents recorded in the CIATox/SAMU-DF database was registered in the “Occupational accidents” database and just one accident (involving a scorpion) was registered in the “Accidents involving venomous animals” database and classified as a work-related accident. Another two accidents in the CIATox database (one with a snake and the other with a spider) were registered in the “Accidents involving venomous animals” database, but the field related to work was filled with “ignored”. The remaining nine accidents were not registered.

A study of data from 2009 to 2013 had already revealed subnotification of exogenous intoxications in the CIATox database compared with the SINAN database, which can be extrapolated to the present study of data for 2009 to 2019 on venomous animals using the same databases.

Considering that the intoxication centers (CIATox/SAMU-DF) and SINAN have different data collection objectives and mechanisms, an intoxication event may not be reported on both systems, as was observed in the present study.

Accidents involving venomous animals, which are classified as neglected diseases, are compulsory notifiable diseases in Brazil. Public health policy focuses on provision of antivenins. This is why it is very important to complete all of the fields on the notification protocols and all of the government databases related to harm from venomous animals.

Epidemiological surveillance of accidents involving venomous animals requires a national information system universally distributed throughout the country’s territory and integrated with other systems. The intention behind surveillance of these accidents is to reduce their incidence. Correct notification of accidents is one means of revealing the distribution of these animals across the country. All of this enables correct diagnosis of accidents, and therapeutic and preventative measures.

Notifications of incidents involving venomous animals are important in the Federal District, since intoxications by venomous animals in the general population are second only to intoxication by medicines in this region.

One of the most important contributions of this study is to interrelate the different databases, which does not happen currently. The discrepancies between them create barriers to better evaluations and detailed analyses of occupational accidents.

These subnotifications and discrepancies should be analyzed better and subsequently resolved by the organs responsible for managing each database. Actively seeking missing information and better organization of the competent organs are some solutions for the problems faced at the moment. It is also important that physicians and other health professionals complete and encourage others to complete the notification protocols, including the greatest amount of information possible.

In principal, all cases of accidents recorded by CIATox/SAMU-DF should also be notified to SINAN. This lack of a unified and solid database limits assessments of the true extent of the problem of envenomation in Brazil.

Finally, the true magnitude of the epidemiological data is still inconsistent in Brazil, since there is subnotification and data re missing from many fields on the investigation protocols, as was found in this study.
Author contributions
CTT was responsible for the study conceptualization, formal analysis of the data and writing – original draft and review & editing of the text. AFAM was responsible for the study conceptualization. CTT and AFAM participated in the investigation, in obtaining resources, and in writing – review & editing of the text. All authors have read and approved the final version submitted and take public responsibility for all aspects of the work.

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