



Epidemiological profile of accidents caused by venomous animals in Amazonas state

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ABSTRACT

Introduction: The Amazonas is the largest state of Brazil, being located in the northwestern of the country. Nevertheless, the Amazonas is not so populous; its population corresponds only to 1.9% (4,063,614 habitants) from the population of Brazil. On the other hand, the state is famous for its rich flora and fauna including venomous animals such as snakes, spiders and scorpions. Therefore, epidemiological studies of venomous animal accidents in the region becomes essential for the development of better therapeutical strategies and preventing actions to reduce the occurrence of these accidents. **Objective:** The present study aimed to perform an epidemiological analysis of accidents caused by venomous animals in the Amazonas state from 2012 to 2015. **Methods:** The data were obtained by consulting the Sistema de Informação de Agravos de Notificação (SINAN, Information System for Notifiable Diseases) and Sistema Nacional de Informações Tóxico-Farmacológicas (SINITOX, National System of Toxic-Pharmacological Information) databases. Data of accidents caused by venomous animals between 2012 and 2015 were collected from the Amazonas 60 municipalities. The variables analyzed were: year of highest incidence, municipality with the highest incidence, age of the victims, sex of the victim, animal responsible for the accident, time interval between the accident and therapeutics and deaths. **Results:** During the years 2012 to 2015, a total of 9,349 cases of accidents involving venomous animals were reported in Amazonas state, with most victims registered in Manaus (1,331 cases). Most of the victims present 20 to 39 years-old and were male. The snakes were responsible for the most accidents, followed by scorpions. Most of the victims reach the hospital and start the therapy between 1 to 3 hours after the accident. The deaths in the state present less than 20 cases per year. **Conclusion:** This study expands the knowledge about the epidemiological profile of venomous animal accidents in Amazonas state, which is crucial for quantifying the disease burden, contributing to evidence-based healthcare planning, and evaluating effectiveness and relative contribution of primary, secondary and tertiary preventative measures for reducing these accidents and their complications in the region.

Keywords: Amazonas, epidemiology, venomous animals, envenoming.

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Received: 09/08/2017 / Accepted: 30/10/2017

1. INTRODUCTION

Venomous animals are characterized to produce and store toxins in specialized glands together to their injecting ability through structures such as teeth and stingers, which have the main function of venom inoculation in prey or predators. On the other hand, poisonous animals do not present structures to inoculate their toxins, that is, their toxins exist as a constituent form in the animal tissue (Nelsen *et al.*, 2014).

Several species are included in the worldwide list of venomous animals. In Brazil, the most important venomous animals regarding incidence and a severity of the accidents are: (1) snakes of the genus *Bothrops*, *Crotalus*, *Lachesis* and *Micrurus*; (2) scorpions of the *Tityus* genus; and spiders of the genus *Phoneutria*, *Loxosceles* and *Latrodectus* (Bochner

et al., 2014; Cardoso and Cristiano, 2009; Cordeiro *et al.*, 2015). Occasionally, bees and wasps massive stings also occur, which can lead to a local inflammation until a severe envenomation (Fitzgerald and Flood, 2006; Franca *et al.*, 1994). Moreover, caterpillars are also responsible for important envenomings in the south of the country (Gamborgi *et al.*, 2006).

Depending on the species venom toxicity, different clinical manifestations are observed during envenoming. Therefore, the knowledge about the venom components and their biological effects in living organisms offers the possibility to perform strategies aiming to reduce or eliminate the severity of clinical evolution (e.g. amputations) as well as deaths (Bochner, 2013; Jorge *et al.*, 1999; Malasit *et al.*, 1986).

Therefore, envenoming epidemiological studies present evident importance to facilitate the prevention and management of these accidents. For example, these studies can drive physician clinical decisions, such as choosing the best therapy (antivenom) for venomous animals of a determined region (Chippaux, 1998, 2015).

In Brazil, the Ministry of Health (MH) has been responsible for managing the development of antivenoms in the country since 1986. Today, the antivenom producer institutions are: Instituto Butantan (São Paulo, SP), Instituto Vital Brazil (Rio de Janeiro, RJ), Fundação Ezequiel Dias (FUNED, Belo Horizonte, MG) and Centro de Produção e Pesquisa de Imunobiológicos (Piraquara, PR). In this context, the MH is the responsible for the delivery (free of charge) of all antivenoms produced by the listed institutions to each state/city of the country. Nevertheless, for purposes, the MH takes into account the analysis of the epidemiological information registered by the Sistema de Informação de Agravos de Notificação (SINAN, Information System for Notifiable Diseases) (Portal-da-Saúde, 2014).

Currently, accidents involving venomous animals belong to the list of neglected tropical diseases, since it is controlled or practically with nonoccurrence in developed countries, which differs from the reality of developing countries. In addition, with the annual increases of accidents number, the government costs are extremely high, being envenomings also considered a public health problem. Thus, prevention approaches need to be disseminated and implemented in the population (Cupo, 2015; Portal-da-Saúde, 2014).

The Amazonas is the largest state of Brazil, being located in the northwestern of the country. However, the Amazonas is not so populous; its population corresponds only to 1.9% (4,063,614 habitants) from the population of Brazil. Moreover, many of them are forest-dwelling population, including indigenous people, rubber tappers (seringueiros) and inhabitants of riverine communities (Hui Wen *et al.*, 2015). On the other hand, concerning venomous animal accidents, the state presents high incident and severity of them. In this sense, the present study aims to perform an epidemiological analysis of accidents caused by venomous animals in the Amazonas state from 2012 to 2015.

2. MATERIAL AND METHODS

The data were obtained by consulting the Sistema de Informação de Agravos de Notificação (SINAN, Information System for Notifiable Diseases) and Sistema Nacional

de Informações Tóxico-Farmacológicas (SINITOX, National System of Toxic-Pharmacological Information) databases. Data of accidents caused by venomous animals between 2012 and 2015 were collected from the Amazonas municipalities.

Amazonas' 60 municipalities were selected: Alvarães, Amaturá, Anamá, Anori, Apuí, Atalaia do Norte, Autazes, Barcelos, Barreirinha, Benjamin Constant, Beruri, Boa Vista do Ramos, Boca do Acre, Borba, Caapiranga, Canutama, Carauari, Careiro, Coari, Codajás, Eirunepé, Envira, Fonte Boa, Guajará, Humaitá, Ipixuna, Iranduba, Itacoatiara, Itamarati, Itapiranga, Japurá, Juruá, Jutai, Lábrea, Manacapuru, Manaquiri, Manaus, Manicoré, Maraã, Maués, Nhamundá, Nova Olinda do Norte, Novo Airão, Novo Aripuanã, Parintins, Pauini, Presidente Figueiredo, Rio Preto da Eva, Santa Isabel do Rio Negro, Santo Antônio do Içá, São Gabriel da Cachoeira, São Paulo de Olivença, São Sebastião do Uatumã, Tabatinga, Tapauá, Tefé, Tonantins, Uarini, Urucará and Urucurituba.

Data processing was performed using the Tabwin32 from the Departamento de Informática do Sistema Único de Saúde (DATASUS, Department of Information Technology of the Unified Health System). The analysis of the variables were performed using Excel Software (Microsoft Office 2013) and GraphPad Prism (version 5). The variables analyzed were: year of highest incidence, municipality with the highest incidence, age of the victims, sex of the victims, animal responsible for the accident, time interval between the accident and therapeutics, and deaths.

3. RESULTS

During the years 2012 to 2015, a total of 9,349 cases of accidents involving venomous animals were reported in Amazonas state. The 2013-year shown the highest number of these accidents (2,658) following by 2014 and 2012 (2,596 and 2,489, respectively). Interestingly, there was a relevant decrease of the accidents in 2015, registering 1,606 cases (Fig. 1).

Analyzing the municipalities of Amazonas state, the most victims were registered in Manaus (state capital), which presented 1,331 of the reported cases during all the 4 years, representing 14% of the total number of accidents in the 60 municipalities analyzed. Furthermore, Manaus was responsible for the highest incidence among municipalities in all analyzed years (2012 – 368; 2013 – 411; 2014 – 426; and 2015 – 126 cases) (Table 1 and Fig. 2).

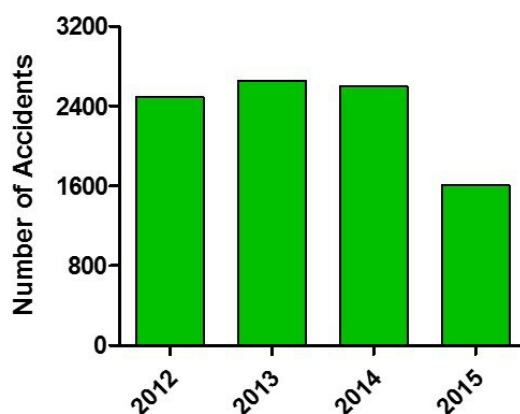


Figure 1. Incidence of accidents caused by venomous animals in Amazonas state per year, during 2012-2015.

Table 1. Amazonas municipalities' incidence of accidents caused by venomous animals, during 2012-2015.

Municipality	2012	2013	2014	2015
Alvarães	64	53	48	64
Amaturá	10	18	11	16
Anamã	14	14	11	6
Anori	14	10	6	5
Apuí	90	85	85	74
Atalaia do Norte	36	42	35	18
Autazes	42	46	39	12
Barcelos	24	45	18	9
Barreirinha	69	62	65	68
Benjamin Constant	51	42	44	21
Beruri	24	28	11	2
Boa Vista do Ramos	12	21	27	13
Boca do Acre	34	24	11	15
Borba	64	59	76	77
Caapiranga	18	23	26	14
Canutama	17	14	9	10
Carauari	31	23	15	10
Careiro	18	24	30	15
Coari	54	72	56	46
Codajás	20	15	26	17
Eirunepé	19	20	18	15
Envira	14	22	21	7
Fonte Boa	25	20	15	5
Guajará	10	11	12	2
Humaitá	46	50	44	25
Ipixuna	11	9	9	9
Iranduba	74	77	59	25
Itacoatiara	76	114	95	80
Itamarati	10	7	10	3
Itapiranga	6	11	13	4
Japurá	9	11	15	4
Juruá	5	10	8	4

Municipality	2012	2013	2014	2015
Jutaí	22	20	20	31
Lábrea	52	53	59	44
Manacapuru	104	128	101	54
Manaquiri	16	11	8	7
Manaus	368	411	426	126
Manicoré	28	45	63	52
Maraã	12	24	12	17
Maués	94	91	103	33
Nhamundá	16	11	7	6
Nova Olinda do Norte	34	45	42	26
Novo Airão	23	25	30	19
Novo Aripuanã	3	25	18	15
Parintins	54	69	114	80
Pauini	9	26	15	11
Presidente Figueiredo	26	34	50	25
Rio Preto da Eva	139	135	136	80
Santa Isabel do Rio Negro	48	28	15	17
Santo Antônio do Içá	16	25	26	12
São Gabriel da Cachoeira	76	61	58	20
São Paulo de Olivença	45	38	37	32
São Sebastião do Uatumã	5	6	4	5
Silves	10	17	8	0
Tabatinga	29	40	63	46
Tapauá	30	25	27	7
Tefé	132	68	67	59
Tonantins	11	5	7	6
Uarini	35	59	54	53
Urucará	20	12	19	7
Urucurituba	7	15	20	16

Other municipalities also stand out for their incidence during the four analyzed year, but with numbers much more modest than the state capital. Rio Preto da Eva, for example, is the second city responsible for venomous animals victims during the analyzed period, with a total of 490 cases, corresponding to 5% of the total number of accidents in the 60 municipalities analyzed (less than half of the number presented by Manaus).

There are municipalities that also presented important relevance such as Manacapuru (387 cases), Itacoatiara (365 cases), Apuí (334 cases), Tefé (326 cases), Maués (321 cases), and Parintins (317 cases). On the other hand, São Sebastião do Uatumã was the municipality with the lowest incidence, with only 20 cases throughout the analysed years.

Regarding the age of the victims, the range of 20→39 years presented the highest incidence among accidents

(2012 – 868; 2013 – 929; 2014 – 915; and 2015 - 580 cases), followed by the ranges of 40→59 (2012 - 550; 2013 - 596; 2014 - 608; and 2015 - 359 cases) and 15→19 years (2012 – 288; 2013 – 314; 2014 – 285; and 2015 - 185 cases). The age group corresponding to children with less than 1 year-old (2012 - 19; 2013 - 36; 2014 - 33; and 2015 - 10 cases) and elderly with 80 years or over (2012 - 17; 2013 - 15; 2014 - 10; and 2015 - 11 cases) represented the age ranges with less accidents (Fig. 3A).

In respect to victim sex, it is possible to note the predominance of males in all the analyzed years, being the difference quite expressive. Thus, the number of male victims presented about 100% higher than the number of female victims: 2012 - male 1,814 cases vs female 674 cases; 2013 - male 1,931 cases vs female 727 cases; 2014 - male 1,859 cases vs female 737 cases; and 2015 - male 1,193 cases vs female 413 cases (Fig. 3B).

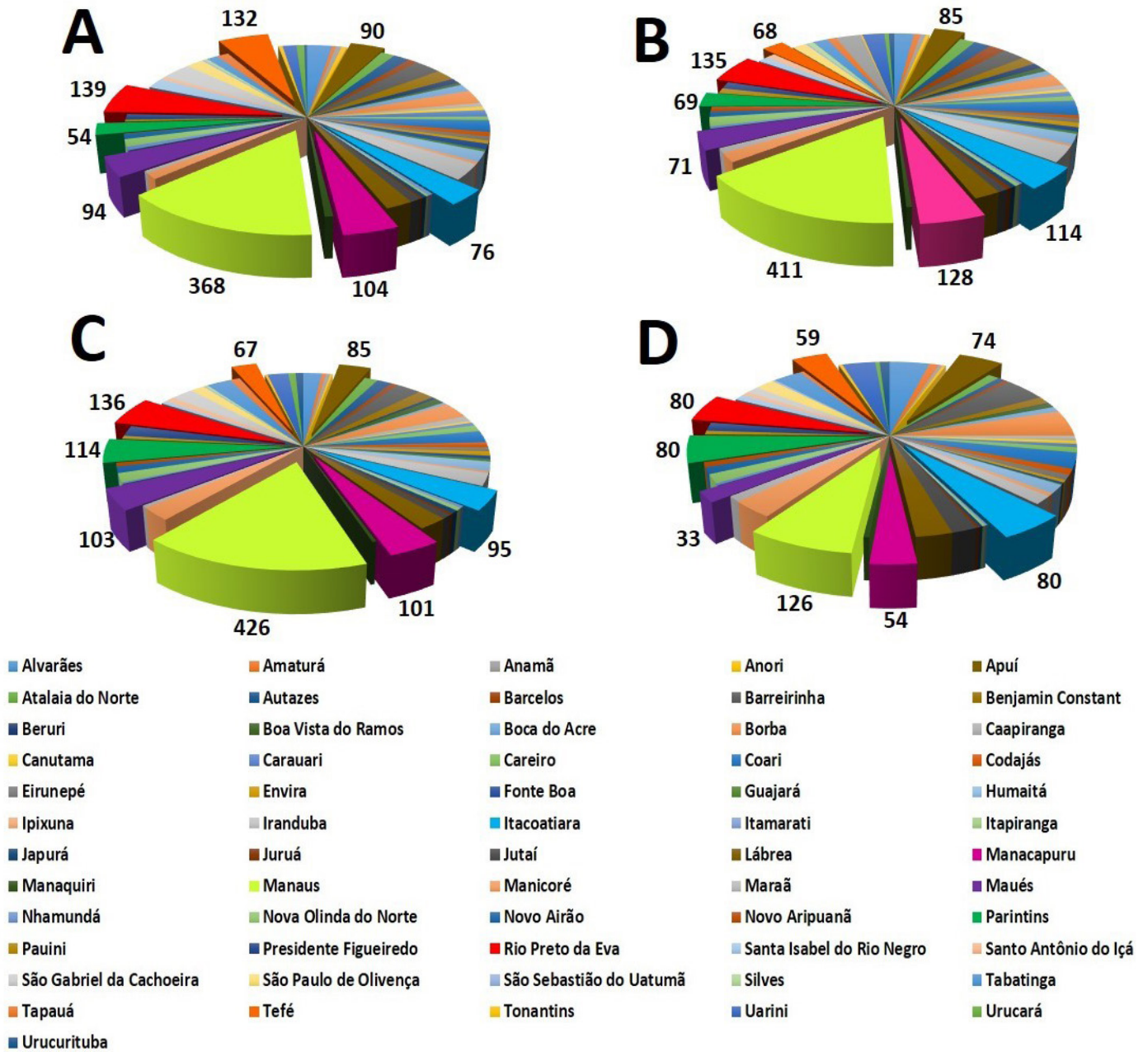


Figure 2. Amazonas municipalities' incidence of accidents caused by venomous animals, during 2012-2015. (A) 2012; (B) 2013; (C) 2014; and (D) 2015. The municipalities with most venomous animal accident numbers are highlighted through moved slices and respective number cases.

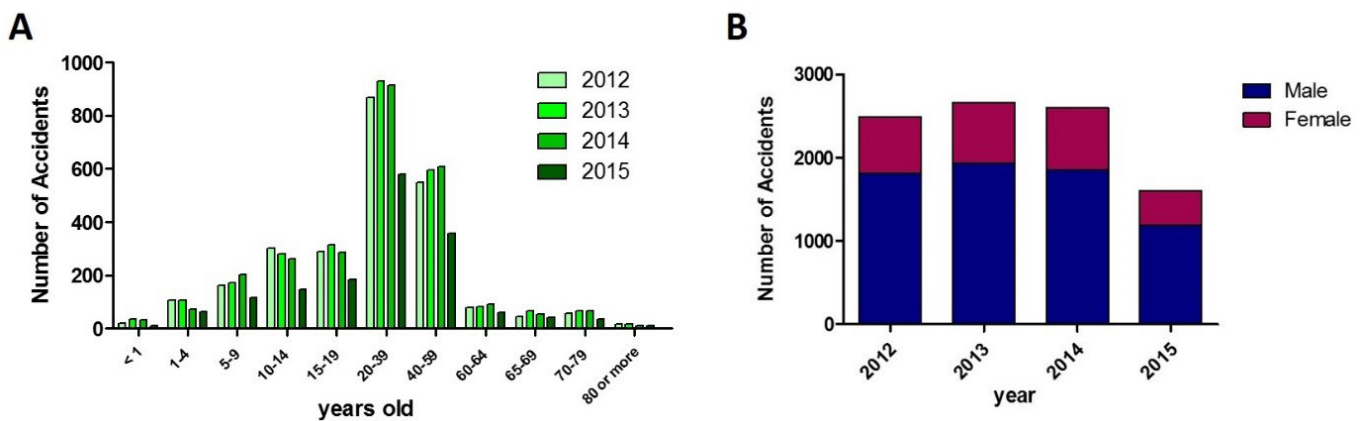


Figure 3. Age- and sex-related number accidents caused by venomous animals in Amazonas state, during 2012-2015. (A) Age-related. (B) Sex-related.

The analysis of the animal species that were responsible for these accidents demonstrated the predominance of snake accidents (2012 - 1,611 cases; 2013 - 1,806 cases; 2014 - 1,745 cases; and 2015 - 1,058 cases) (Fig. 4). Among these, accidents caused by *Bothrops* genus was responsible for most of the numbers (2012 - 1,089 cases; 2013 - 1,232 cases; 2014 - 1,180 cases; and 2015 - 693 cases), followed by *Lachesis* (2012 - 321 cases; 2013 - 380 cases; 2014 - 347 cases; and 2015 - 248 cases), *Crotalus* (2012 - 13; 2013 - 7; 2014 - 4; and 2015 - 5 cases) and *Micrurus* (2012 - 4; 2013 - 10; 2014 - 10; and 2015 - 9).

On the other hand, scorpion accidents appear as the second most recurrent with numbers much more modest than snakes (2012 - 347; 2013 - 390; 2014 - 389; and 2015 - 236 cases), followed by spiders (2012 - 206; 2013 - 227; 2014 - 229; and 2015 - 151 cases), caterpillars (2012 - 60; 2013 - 63; 2014 - 73; and 2015 - 11 cases) and bees (2012 - 42; 2013 - 63; 2014 - 20; and 2015 - 22 cases).

Concerning the time between the accident and the

therapeutics (the antivenom administration), the majority of the accidents registered were treated between 1 to 3 hours after the accident (2012 - 705; 2013 - 800; and 2014 - 757), with exception of 2015, in which the interval with most accidents was between 0 to 1 hour (2015 - 457 cases). It is very worrying the delay to antivenom administration especially after 24 hours of the accident. Unhappily, these cases were also registered (2012 - 178; 2013 - 170; 2014 - 186; and 2015 - 90 cases) (Fig. 5).

Although the number of accidents in Amazonas state demonstrated to be very serious, the number of deaths are not an alarming problem (2012 - 11; 2013 - 13; 2014 - 21; and 2015 - 15 cases) (Fig. 6A). Indeed, most of the accidents evolved to cure. Nevertheless, many cases evolutions (cure or death) were not documented (unknown information). Furthermore, it is important to emphasize that most of deaths were caused by snake envenoming, in special by *Bothrops* genus followed by *Lachesis* (Fig. 6B).

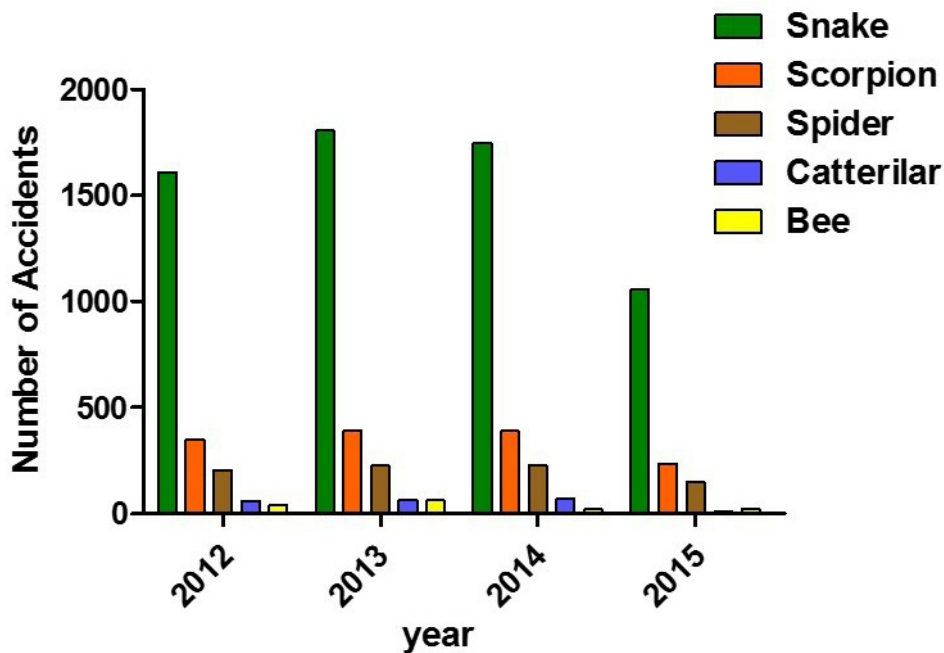


Figure 4. Number of accidents caused by venomous animals in Amazonas state regarding animal species, during 2012-2015.

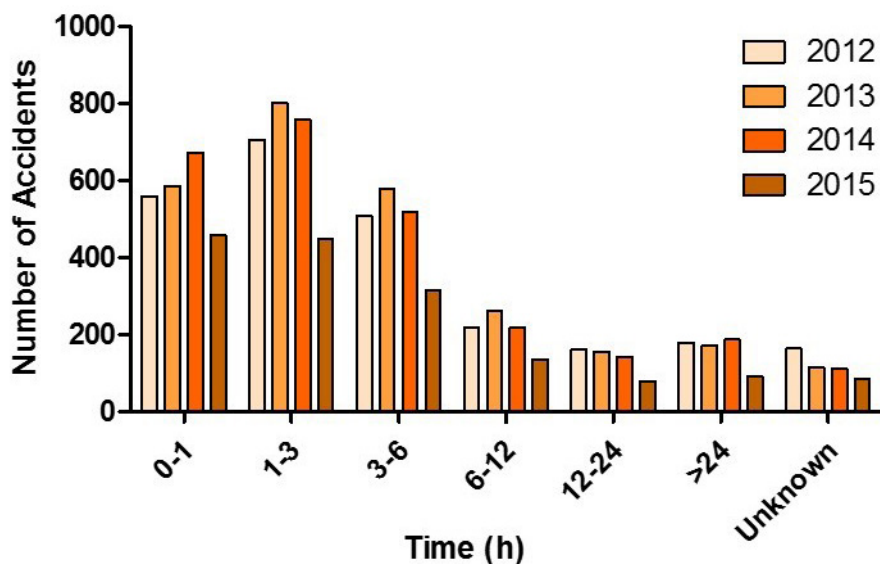


Figure 5. Number of accidents registered concerning therapeutical intervention time, during 2012-2015.

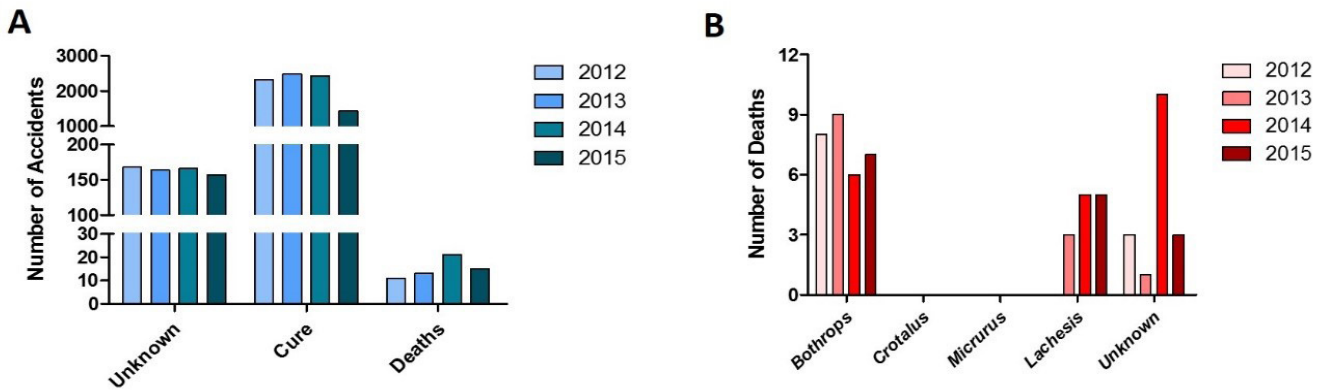


Figure 6. (A) Envenoming evolution (cure vs deaths), during 2012-2015. (B) Deaths caused by snakes' genera, during 2012-2015.

4. DISCUSSION

Epidemiological surveillance studies of venomous bites and stings are crucial to reflect the real magnitude of venomous animal accidents in a specific country. In Brazil, SINAM and SINATOX are considered important systems, presenting detailed information about envenomation cases caused in the country. However, the numbers expressed in these databases (as long data sheets) are most of time difficult to interpret. In this way, studies that compile, analyses, interpret, and shown the information visually (colorful figures) are considered very important in the academic community, although infrequent.

The present study analyzed the epidemiological information concerning venomous animal envenomations in the Amazonas, the biggest Brazilian state (1.571 million km²), with most of its area composed by an exuberant tropical jungle. Thus, with many forest extensions, the state also presents a very rich fauna, including many species of venomous animals.

The number of accidents caused by venomous animals in Amazonas during 2012-2015 are low (less than 2%) in comparison of the numbers registered in Brazil (2012 - 142,697; 2013 - 161,727; 2014 - 170,139; and 2015 - 105,862) (SINAN, 2016). Nevertheless, in respect to 2015, the state of Amazonas as well as all the Brazil, the number of these accidents declined considerably. This could be a reflection of the population's awareness of preventing accidents by these animals, exemplified as follows: (1) during rainy periods snakes usually leave their dens and invade urban environments close to forests and, nowadays, the population known about that, avoiding certain environments after rainfalls due to a possible attack (Henderson and Hoevers, 1997; Punde, 2005); (2) regarding scorpion accidents, cleaner environments that diminish the existence of cockroaches, scorpions preferred food, may lead to a reduction in the numbers of these animals close to homes (Pucca et al., 2015a); (3) concerning bees, caterpillars and other venomous animals, the respect for their natural habitats guarantees harmonious living avoiding the occurrence of victims.

Regarding the accidents distribution among the municipalities the largest registry of notifications was in the capital, Manaus, probably because its high population (more than 2 millions) as well as the presence of hospitals and trained professionals able to notify effectively the accidents comparing to other small and precarious cities.

Even though, other municipalities such as Rio Preto da Eva, Manacapuru, Itacoatiara, Apuí, Maués, Tefê and Parintins, also present relevant numbers of accidents by venomous animals. These cities are located in border zones of forests and dense wood, which could explain the high incidence of venomous animal accidents (Martins and Oliveira, 1998).

Concerning the victims predominant age group (20–39 years), immediately it is correlated to the age range of economically active life, probably because of the working conditions that expose them to the risk (e.g. workers involved in farming, hunting, and forestry activities) (Pierini et al., 1996; Waldez and Vogt, 2009). The male sex was also responsible for most of the accidents, suggesting an occupational risk. The patriarchal system, which most families live in, makes the male responsible for the home, corroborating with a greater occurrence of male victims that are related to accidents caused by venomous animals (Hui Wen et al., 2015; Spyles et al., 2016).

In respect to the animal genera responsible for the accidents in Amazonas, the snakes demonstrated to be the champions in incidence highlighting accidents caused by “jararacas” (*Bothrops*) and “surucucus” (*Lachesis*), which was also demonstrated previously (Borges et al., 1999). Scorpions was the second with high incidence in Amazonas state. These numbers confront the epidemiological data from other states (such as São Paulo and Minas Gerais) as well as the Brazilian numbers, which scorpionism represent the most registered accidents (Pucca et al., 2015b). *Tityus serrulatus* is the scorpion responsible for the most of these accidents and the most severe. The parthenogenesis reproduction and the easy adaptability of this species to urban areas are responsible for the highest number of scorpion accidents in Brazil (Pucca et al., 2015a).

The antivenom administration is recognized as the only specific therapy for accidents caused by venomous animals. These antivenoms are composed of immunoglobulins prepared by immunizing horses with the target venom and subsequently extracting and purifying the horse serum (Hui Wen et al., 2015; Roncolato et al., 2015). The analysis of the time between the accident and the hospital treatment, which includes antivenom therapy, shown that most of people reach the emergency between 1 and 3 hours. However, there are still cases documented after 24 hours. It is well-known that the intervening time from the accident to the treatment is of great importance to the success of patient recovery. Other studies demonstrated that victims which were treated

after 24 hours developed severe problems and even death (Adam *et al.*, 2006; Albuquerque *et al.*, 2013).

Although the considerable number of accidents in the Amazonas state, the deaths are rare, with less than 20 fatalities per year. This can be attributed to federal actions. Since 1986, the Brazilian Ministry of Health implemented the National Program for Snakebites Control, extended to other poisonous animals in 1988. After that, antivenom production from national laboratories (Instituto Butantan, Fundação Ezequiel Dias, Instituto Vital Brazil and the Centro de Produção e Pesquisa de Imunobiológicos) was acquired by the Ministry of Health for distribution free of charge to patients. Nevertheless, most of the time, the antivenoms are only available in the big and centralized hospitals. Therefore, the decentralization of health centers possessing antivenoms is of great relevance for the reduction of deaths and sequelae of the victims.

5. CONCLUSION

This study demonstrated the epidemiological profile of accidents caused by venomous animals in Amazonas state. The state showed an impressive number of accidents even though most of its territory is covered by closed forest and it is sparsely populated. Moreover, most of the registered accidents were occasioned by snakes, differing from the Brazil's numbers, which presents scorpionism as the highest incidence. Although the number of deaths are not considered alarming, they still present concern. In this way, it is necessary to create and improve public policies that enable the dissemination of information regarding prevention of accidents caused by venomous animals. Therefore, this study expands the knowledge about epidemiological profile of venomous animal accidents in Amazonas state, which is crucial for quantifying the disease burden, contributing to evidence-based healthcare planning, and evaluating effectiveness and relative contribution of primary, secondary and tertiary preventative measures for reducing these accidents and their complications in the region.

CONFLICT OF INTEREST

The authors declares that there is no conflict of interest regarding the publication of this paper.

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