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ARTICLE

Snakebites in the Pampa biome, southwest of Rio Grande do Sul state, Brazil

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ABSTRACT: (Snakebites in the Pampa biome, southwest of Rio Grande do Sul state, Brazil). Records regarding accidents with venomous animals are the main sources of information to establish prevention strategies for snakebites in Brazil. We conducted an epidemiological study of snakebites in the Pampa region named "Campanha Gaúcha", located in southwest Rio Grande do Sul state, southern Brazil. We used seven years of snakebite data. In total, 241 records of accidents caused by snakes were analyzed and used to discuss variables related to the causative agent of the accident, the site of the accident, the characteristics of the victims and the treatment applied. The majority of reported cases corresponded to accidents with snakes of the genus *Bothrops* (80%). The location with the highest incidence was São Gabriel municipality (23%). Most of the snakebites occurred in rural areas (75%), with rural male workers (32%) aged between 15 and 45 years (50%). The lower limbs were the most affected (59%). The highest occurrence of cases was observed in January and March. The anti-venom used (7.13 ampoules/patient) was not compatible with the fact that most cases are considered mild accidents (47%). All accidents were cured without major complications. The records require greater precision, especially regarding the species that caused the accidents and the place of incident. The lack of such information may compromise understanding of the epidemiology of these events, hindering possible preventive actions.
Keywords: *Bothrops*, poison, snake, snakebite, ophidism.

RESUMO: (Acidentes ofídicos no bioma Pampa, sudoeste do estado Rio Grande do Sul, Brasil). O registro de informações sobre acidentes com animais peçonhentos é a principal fonte de informação para estabelecer estratégias de prevenção de acidentes ofídicos. Foi realizado um estudo epidemiológico de acidentes ofídicos na região de Pampa denominada "Campanha Gaúcha", no sudoeste do Rio Grande do Sul. Foram utilizados sete anos de dados sobre os acidentes ofídicos. No total, 241 registros de acidentes causados por serpentes foram analisados e utilizados para discutir as variáveis relacionadas com o agente causador do acidente, o local do acidente, as características das vítimas e do tratamento aplicado. A maioria dos casos relatados corresponderam a acidentes com serpentes do gênero *Bothrops* (80%). O local com maior incidência de acidentes foi o município de São Gabriel (23%). A maioria dos acidentes ocorreu na área rural (75%), com trabalhadores rurais do sexo masculino (32%), com idade entre 15 e 45 anos (20%). Os membros inferiores foram os mais afetados (59%). A quantidade de ampolas do antiveneno utilizadas (média de 7,13 ampolas/paciente) não foi compatível com o índice de gravidade dos acidentes. Todos os acidentes evoluíram para cura. Os registros carecem de maior precisão, especialmente referente a identificação das espécies e local de ocorrência do acidente. A falta de informações pode comprometer o entendimento das características dos eventos, dificultando o estabelecimento de ações preventivas efetivas.
Palavras-chave: *Bothrops*, envenenamento, ofidismo, serpente, ofidismo.

INTRODUCTION

The record of accidents with venomous animals and their classification into discrete categories allows us to identify patterns of, for example, where and when they occur, which of the groups are affected in that activity, and which are potentially dangerous species, among other information. The historical accumulation of this information is the first step towards the establishment of measures designed to reduce and prevent injuries by venomous animals. In Brazil, the perception of the epidemiological significance of accidents with venomous animals, specifically with snakes, materialized in 1901 when Vital Brazil first began coordinating the production of anti-venom (Bochner & Struchiner 2002). Over the years, systems were created to sort and group the records regarding ophidian accidents. These records are the main sources of information used to establish prevention strategies for ophidian accidents in Brazil (Bochner & Struchiner 2003).

There are about 25,000 accidents per year in Brazil involving snakes (Bernarde 2014, BRASIL 2015). The occurrence of snakebites is related, in general, to climatic factors such as high temperatures and precipitation, as well as increased human activity in rural areas (Pinho & Pereira 2001). The genera responsible for the most serious accidents are *Bothrops*, *Crotalus*, *Lachesis* (Viperidae family) and *Micrurus* (Elapidae family; Nicolella *et al*. 1997, Bernarde 2014). Snakes of the genera *Bothrops* and *Micrurus* can be found throughout the country, the genus *Crotalus* occurs mainly in the Southeast and South and the genus *Lachesis* is predominant in the Amazon region (Bernarde 2014). Most records of accidents with

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snakes involve lanceheads (*Bothrops*, 90%). Accidents with rattlesnakes (*Crotalus*), corals (*Micrurus*) and bushmaster (*Lachesis*) snakes are less frequent, although they can cause more serious accidents (Azevedo-Marques *et al*. 2003, Bernarde 2014). However, in many cases of snakebites, the species is not identified or accidents are not reported (Nicolella *et al*. 1997, Bernarde 2014).

Most snakes in the study area belong to the Dipsadidae family (Bencke 2009, Bernils & Costa 2012) and are not considered venomous. However, many of these species have opisthoglyphous dentition and can cause accidents with medical importance. Among these, the snake *Philodryas olfersii* stands out (Nicolella*et al*. 1997, Santos-Costa *et al*. 2001, Rocha & Furtado 2007). In the state of Rio Grande do Sul, research on snakebites is scarce (Tauffer & Zanella 1996). Regarding the Campanha region, in the southwest Rio Grande do Sul state, there is no research related to the epidemiology of snakebites. However, in this region species exist that can potentially cause accidents, such as *Bothrops alternatus* (Duméril, Bibron & Duméril 1854), *Bothrops pubescens* (Cope 1870), and *Crotalus durissus* (Linnaeus 1758) (Lema 1994). Thus, the aim of this study was to gather and discuss the epidemiological characteristics of accidents with snakes in the southwest region of Rio Grande do Sul.

METHODS

Data were obtained from the municipalities of the southwest region of Rio Grande do Sulhaving more than 40,000 inhabitants (IBGE 2010). We used data from seven years (2003–2010) of snakebites in seven municipalities: Alegrete, Bagé, Rosário do Sul, Santana do Livramento, São Borja, São Gabriel and Uruguaiana (Fig. 1). The region of study is called Campanha Gaúcha, which is situated within the fields of the Pampa biome. This area is characterized by grassland vegetation that predominates in plain reliefs and a dense vegetation that is shrubby and arboreal on the slopes and along water courses (Leite & Klein 1990). The landscape lies between 500 m and 800 m altitude and has a subtropical climate with mild temperatures, constant rainfall and fertile soil. This characteristic has contributed to the development of agricultural activity. Currently, the economy in the region revolves around sheep and cattle, in addition to grain production, mainly rice, corn, wheat and soybeans (Bencke 2009).

The data related to snakebites were collected from the Epidemiological Surveillance of each municipality, according to the records of Envenomation Investigation of the National Information System of Notification Diseases (Sistema de Informação de Agravos de Notificação, SINAN). Data were also obtained from the 10ª Regional Health Coordination, located in the Alegrete municipality. With the information from the records, variables related to the causative agent of the accident, the place of the accident, the characteristics of the victims and the treatment applied were analyzed. Regarding the causative agent, the record presenting identification of the genus or species level was considered. In relation to the accident site, whether the accident occurred in an urban area or rural area was investigated. Regarding the injured individuals, sex, main economic activity, age and anatomical region were considered. For treatment, we analyzed the number of ampoules used and the evolution of the pa-

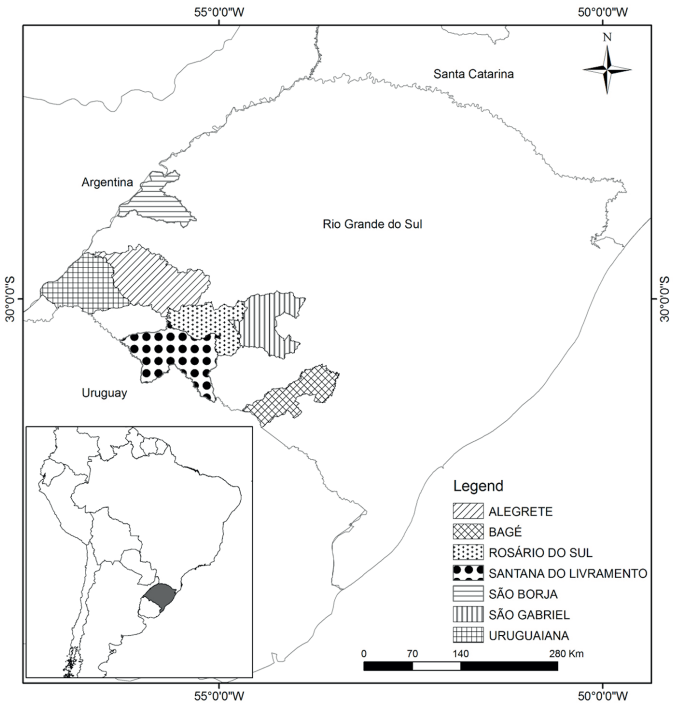

Figure 1. Municipalities in the southwest region of Rio Grande do Sul state, Brazil, with more than 40,000 inhabitants.

tients. The nomenclature used in this study follows the Brazilian Reptiles List of Species (Costa & Bérnils 2014). The statistical tests used were a correlation analysis for the distribution of accidents in different municipalities and a chi-square test to analyze the characteristics of victims and causing agents. Statistical tests were performed using the program BioEstat 5.

RESULTS

Overall, 241 snakebites were recorded during the period analyzed in the seven municipalities of southwest Rio Grande do Sul. The São Gabriel municipality registered the largest absolute number of cases (N=56; 23.3%; Table 1). The estimated number of accidents per 100,000 inhabitants in each municipality shows a higher incidence of snakebites in São Gabriel and a lower incidence in Uruguaiana (Table 1). There was no correlation between the number of accidents and the population size of each municipality ($r=-0.23$, $R^2=0.05$, $p<0.05$).

In relation to the time of year, March had the highest incidence of snakebites (N=42; 17.5%), followed by January (N=49; 16.25%), April (N=33; 13.75%) and December (N=32; 13.33%; Fig. 2).The frequency of snakebites was significantly higher in rural compared to urban areas ($\chi^2=72.22$, $p<0.0001$; Table 2). The accidents occurred mainly with rural workers (N=77, 32.08%). However, in relation to this information, many records were incomplete (N=98, 40.84%). Men had significantly more accidents than did women (78.42% of the accidents were with men; $\chi^2=77.07$, $p<0.0001$). In relation to age, the distribution of the number of accidents among the age classes was uniform, with two groups standing out: 15 to 30 years (N=58, 24.17%) and 31 to 45 years (N=63, 26.25%). The foot was the most frequently affected anatomical region in most cases (N=95, 39.75%), followed by the hand and the leg (both with N=48, 20.08%; Table 2).

Table 1. Distribution of snakebites by municipalities in southwest Rio Grande do Sul state, Brazil.

City	Number of records (%)	Accidents/ 100,000 inhabitants	Population
Alegrete	38 (15.8)	48.6	78,188
Bagé	41 (17.0)	36.4	112,550
Rosário do Sul	14 (6.2)	37.0	40,509
Santana do Livramento	42 (17.4)	50.3	83,479
São Borja	40 (16.6)	64.7	61,834
São Gabriel	56 (23.2)	96.9	57,798
Uruguaiana	9 (3.7)	7.3	123,743
Total	241 (100)	-	558,101

Bothrops snakes were responsible for most accidents (N=193, 80.41%; Table 2), with the other two genera being reported less often: *Crotalus* (N=3, 1.25%) and *Philodryas* (N=1, 0.42%). In 42 records (17.5%), the snake genus involved in the snakebite was not identified. Most accidents caused by snakes of the *Bothrops* genus were classified as mild (N=104, 47.30%) and the average number of ampoules/patient was 7.13 (SD=4.74). In two cases, polyvalent serum (antibothropic-crotalic) was used and in three records, the information regarding the number of ampoules used was not available. For

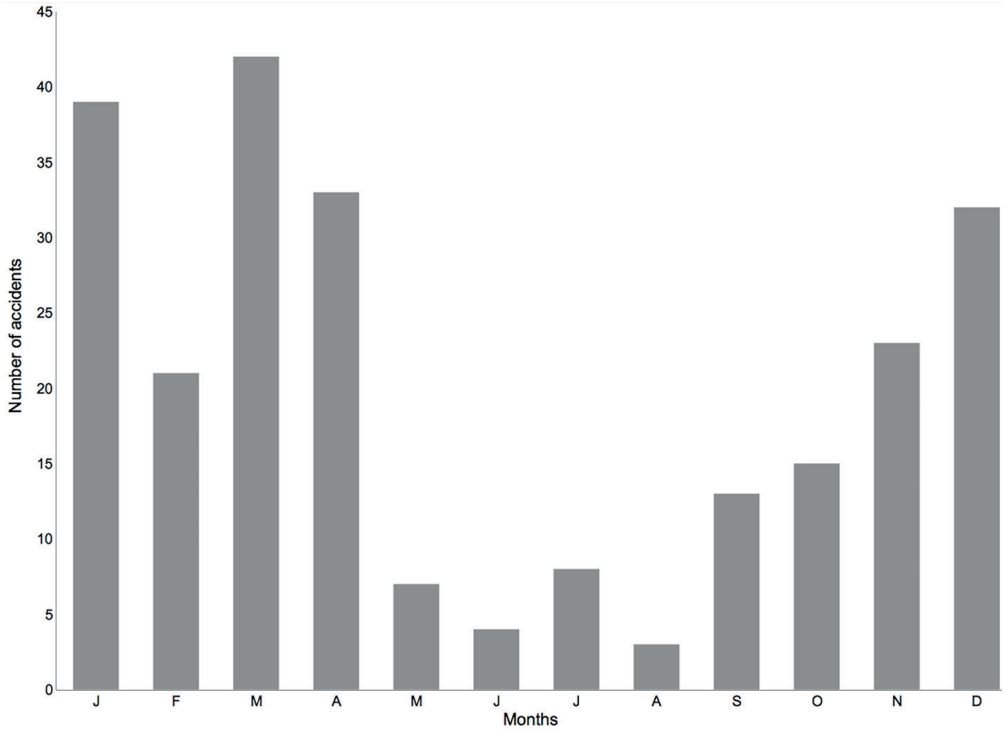

Figure 2. Monthly distribution of snakebites in southwest Rio Grande do Sul state, Brazil.

Table 2. Distribution of snakebites in different categories related to characteristics of the injured and the causative agent, according to the municipalities in southwest Rio Grande do Sul state, Brazil.

Variable	Rural area		Urban area		Area not informed	Total	
	N	%	N	%	N	N	%
Gender							
Male	36	19.78	15	28.85	1	52	21.58
Female	146	80.22	37	71.15	6	189	78.42
Profession							
Rural worker	67	36.81	6	11.54	4	77	32.08
Student	20	10.99	9	17.31	0	29	12.08
Housewife Housework	8	4.40	3	5.77	0	11	4.58
Retiree	11	6.04	3	5.77	0	14	5.84
Others	5	2.75	6	11.54	0	11	4.58
Uninformed	71	39.01	25	48.08	2	98	40.84
Age (years)							
<15	29	15.93	12	23.08	0	41	17.08
15–30	44	24.18	11	21.15	3	58	24.17
31–45	47	25.82	14	26.92	2	63	26.25
46–55	30	16.48	11	21.15	1	42	17.50
>56	32	17.58	4	7.69	0	36	15.00
Anatomical region							
Foot	73	40.11	21	40.38	1	95	39.75
Leg	35	19.23	13	25.00	0	48	20.08
Hand	39	21.43	8	15.38	1	48	20.08
Arm	7	3.85	0	0.00	0	7	2.93
Abdomen and Thorax	2	1.10	1	1.92	0	3	1.26
Head	2	1.10	1	1.92	0	3	1.26
Uninformed	23	12.64	8	15.38	4	35	14.64
Snake (gender)							
Bothrops	150	82.42	38	73.08	5	193	80.41
Crotalus	3	1.65	0	0.00	0	3	1.25
Philodryas	0	0.00	1	1.92	0	1	0.42
Non venomous	1	0.55	0	0.00	0	1	0.42
Uninformed	28	15.38	13	25.00	1	42	17.50

accidents considered moderate (N=86; 35.98%), the average number of used ampoules was 9.11 (SD=3.24). In accidents considered severe (N=16; 6.64%), the average number of ampoules used was 11.33 (SD=1.55). Among the three patients with a crotalic accident, two cases were classified as moderate and received eight ampoules. One accident was considered severe and 24 ampoules of antibothropic were used, plus a second dose of 20 ampoules of anticrotalic and a third dose of three ampoules of polyvalent serum (antibothropic-crotalic). All cases of ophidian accidents were healed. In the case of the *Philodryas* snake accident, this was considered mild, so no serum was applied and the patient was cured.

DISCUSSION

Campanha Gaúcha, in southwest Rio Grande do Sul, is a relatively homogeneous region in relation to landscape, use and occupation of land (Bencke 2009). As a result, we expected a positive correlation between the number of snake bites with population size. We think that the lack of correlation could be associated with one of the follow conditions: differences in the proportion of the population subject to snakebites, for example in agricultural activities; local differences in the diversity and abundance of snakes; or differences in registering the event in the information system. The largest number of records was in the São Gabriel municipality,even though this municipality not have the largest population.

It could be related to the fact that a larger percentage of the population is associated with agropastoral activities. However, São Gabriel has a rural population that is not proportionally higher compared to other municipalities (IBGE 2010). We also did not identify any differences in the characteristics of the snake fauna between the municipalities studied, although the region is lacking in studies on the ecology of communities and populations of snakes (Bencke 2009).

The system of registration of accidents is standardized and, apparently, all municipalities use it effectively. However, we realize that differences in the efficiency and quality of the record may occur. We understand that the greatest number of recorded snakebites in São Gabriel may be associated with efficiency in the registering of information, due to behavioral factors associated with the population. In other words, the highest number of notifications in this municipality may be associated with the behavior of the population that seeks medical help, even if the accident is of minor medical importance, enabling registration of the accident.

The high occurrence of snakebites in the countryside and with rural workers did not differ from official Brazil data (BRASIL 2001a). Most accidents occur in the 15–45 year-old age group in both sexes, which does not differ from other studies done in the Passo Fundo and Porto Alegre municipalities of Rio Grande do Sul (Tauffer & Zanella 1996). In this sense, the accidents took place with people ofa economically active age. In this study, we also noted the number of cases in other age groups: 17.08% under 15 years; 17.5% between 46 and 55 years and 15% over 55 years. This shows that a wide range of ages can be affected by snakebites in the region studied.

The concentration of accidents reaching the feet, legs and hands corroborate with the results of studies conducted in other states (Ribeiro *et al*. 1995, Feitosa *et al*. 1997, Borges 1999, Moreno *et al*. 2005) and in Rio Grande do Sul (Tauffer & Zanella 1996, Nicolella *et al*. 1997). This fact is probably related to a lack of the use of safety equipment, such as boots and gloves, by rural workers. The incidence of snakebites was higher in the months from December to April, possibly due to the activity patterns of snakes, which are partly dependent on environmental stimuli (Lillywhite 1997). Moreover, labor in the agricultural sector is increased in warmer seasons, which favors the possibility of human contact with serpents. This pattern can be extended to the south and southeast regions of Brazil, where seasonality is marked by variation in temperature and rainfall. In places with less pronounced seasonality in temperature, other factors may influence the frequency of snakebites. For example, in Bahia state (northeastern Brazil), the largest number of accidents occurred in the months from March to August, probably due to floods, which force the snakes to seek other hiding places, making them more likely to encounter humans (Mise *et al*. 2007).

As in other states of Brazil (Ribeiro *et al*. 1995, Moreno *et al*. 2005, Bernarde 2014), the species causing the most accidents in the study area belong to the genus *Bothrops*. The prevalence of accidents with *Bothrops* may be related to two factors: (1) the ability of the species to occupy different types of environments and (2) the defensive behavior characteristic of these species, which have a tendency to become aggressive when cornered (Martins *et al*. 2002, Bernarde 2014). Snakes of the genus *Bothrops* can inhabit rural areas and peripheries of large cities, occupying forest and disturbed environments, where there is high proliferation of rodents (Azevedo-Marques *et al*. 2003).

Two species of the genus *Bothrops* were registered in the region of the study: *Bothrops pubescens* and *B. alternatus* (Bencke 2009). Both species occur in disturbed areas (Martins *et al.* 2002), which increase the risk of accidents. The few records of accidents with snakes of the genus *Crotalus* and the absence of recorded accidents with *Micrurus* seem to have different causes. Snakes of the genus *Crotalus* are easy to identify because they have a rattle on the tail end (Nicolella *et al*. 1987). Rattlesnakes are rare in the region, and therefore, the chance of accidents is reduced. The species of *Micrurus* are minimally aggressive and tend to flee when encountered, which causes a low frequency of accidents (Carrera *et al.* 2005, Marques *et al*. 2006).

Most accidents caused by snakes of the *Bothrops* genus were considered mild, and the average number of ampoules used was higher than that recommended (BRASIL 2001b). This meant four ampoules for mild cases, eight ampoules for moderate and 12 to 16 ampoules for severe cases. This fact suggests the need for reassessment of current recommendations for the standardized number of ampoules of anti-ophidian to be used in treatment (Jorge & Ribeiro 1997). In this study, no clinical patient data were analyzed, so the number of ampoules applied may be directly linked to the symptoms. All cases of accidents with snakes analyzed in this study evolved to cure, which may be related to the availability of the serum and the ease of access to local health services.

The large number of records without information about the snake genus that caused the accident is probably due to the fact that those responsible for filling out the notification do not have the technical expertise to identify the snake species. This probably occurs due to the fact that most health professionals do not receive information regarding this topic in their training process (Barroso & Wolff 2012). Knowledge about the snake species that can potentially causeaccidents is important so that fundamental therapeutic measures can be taken in case of accidents (Lemos *et al.* 2009).

Noteworthy is the high number of cases where information was not included in the investigation records. That was clear in relation to occupation and the area that inhabits the region (rural/urban) and the snake genus. The lack of such information hinders real knowledge about snakebites. This is a relevant problem because these records are the main source of information used to establish strategies to prevent accidents caused by snakes.

In general, we realize that the records require greater precision, especially regarding the species that cause the accidents and the place of incident. The imprecision or lack of such information may compromise understanding of the epidemiology of these events, hindering possible preventive actions.

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