Original Article

THE EPIDEMIOLOGY OF SNAKEBITE ACCIDENTS IN THE CITIES OF SOUTHEAST GOIAS FROM 2007 TO 2011

EPIDEMIOLOGIA DE ACIDENTES OFÍDICOS NO SUDESTE GOIANO ENTRE 2007 A 2011

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ABSTRACT: Knowing the epidemiology of snakebite poisoning is essential for planning prevention and treatment strategies for such accidents. However, epidemiological data concerning snakebite accidents remain limited, especially in certain regions of Brazil. Thus, this study aimed to understand the epidemiology of snakebites in four cities of Southeast Goiás from 2007 to 2011. In total, 182 snakebites were reported during this time period, resulting in an incident rate ranging between 32 and 74/100,000 inhabitants and a mortality rate of 1.64%. The accidents were most common in men and occurred primarily in the countryside. The genera *Bothrops* and *Crotalus* (in this order) were responsible for the most bites, and the lower limbs were the most commonly affected bodily regions. The incidence and mortality rates of snakebites in these cities were high compared with regional and national statistics. Public health agencies require the data obtained in this study to subsidize a strategic plan aimed at preventing these accidents and providing appropriate treatments.

KEYWORDS: *Bothrops; Crotalus.* Public health. Snakes.

INTRODUCTION

Snakebite accidents are a serious public health problem in tropical countries due to their high frequency as well as the associated sequelae and mortality rates (LEMOS et al., 2009; PINHO; PEREIRA, 2001). The World Health Organization (WHO) estimates that 2.5 million accidents involving venomous snakes occur throughout the world each year, resulting in 125,000 deaths (CHIPPAUX, 1998). According to the Ministry of Health (MH), 19,000 to 22,000 snakebites occur each year in Brazil alone, approximately 115 of which are fatal (BRASIL, 2001).

Two families of venomous snakes are a public health concern in Brazil: Viperidae, which is composed of the genera *Crotalus* (Rattlesnake), *Bothrops* (Pit viper, lanceheads, jararacussu, urutu, caiçaca, and combóia), and *Lachesis* (Bushmaster), and Elapidae, which is composed of the genus *Micrurus* (true coral snakes; ZUG et al., 2001). Snakebites due to the genera *Bothrops*, *Crotalus*, and *Micrurus* (but not *Lachesis*) were reported in Goiás (LIMA, 2009).

Due to the importance of snakebites with regard to public health policy, since 1986, health units are required to notify the MH of snakebites. This requirement has given rise to a dynamic diagnosis and improved knowledge concerning snakebite cases (MISE et al., 2007). As such, data concerning accidents involving poisonous animals are collected through reporting systems such as the Information System for Notifiable Diseases (Sistema de Informação de Agravos de Notificação; SINAN), the National System for Toxic-Pharmacological Information (Sistema Nacional de Informações Tóxico-Farmacológicas; Sinitox/Fiocruz/MS), the System for Hospital Information of the Unified Health System/MH (Sistema de Informações Hospitalares do Sistema Único de Saúde/MS), and the Mortality Information System/MH (Sistema de Informações sobre Mortalidade/MS; LEMOS et al., 2009). Mandatory reports of snakebite data provide greater awareness of the epidemiology of this type of accident across different regions of the country. Moreover, reporting allows the MH to monitor the local needs for antivenom to subsidize appropriate preventive and care strategies for this type of injury.

Bochner and Sruchiner (2003) provided an overview of the epidemiological profile of snakebite accidents in Brazil over the past 100 years. However, specific knowledge regarding snakebites across the different regions of Brazil is heterogeneous and limited in certain areas. Thus, the present study aimed to determine the epidemiological profile of snakebite accidents in the cities of Pires do Rio, Ipameri, Orizona, and Urutaí, which are located in the middle region of Southeast Goiás from 2007 to 2011.

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METHODS

Study Design

The present study applied a prospective and documental design using quantitative, exploratory, and descriptive approaches.

Study Area

The study area included four cities located in the middle region of Southeast Goias (Railway): Ipameri, Orizona, Pires do Rio, and Urutai. This 21,120.2-km^2 region comprises 7.4% of the state area and consists of 22 municipalities and 251,146 inhabitants (GOIÁS, 2013). Urutai is located in the center of southeast Goias; Ipameri, Orizona, and Pires do Rio are neighboring cities. According to the 2010 census (IBGE, 2012), the populations of Pires do Rio, Ipameri, Orizona, and Urutai are 28,762, 24,735, 14,300, and 3,074 people, respectively. These cities have a broad agricultural expansion and development that focuses on soybean production and livestock (MORAES, 2008).

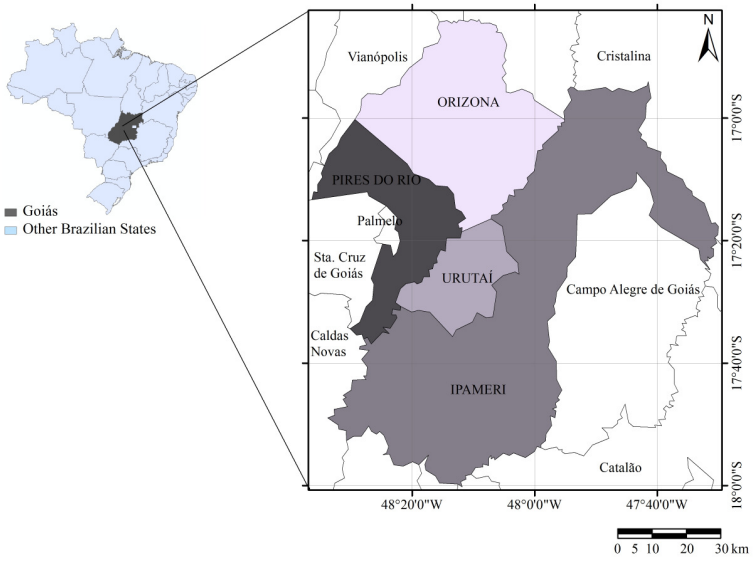

Figure 1. Geographical location of the cities included in this study in Goias, Brazil. Adapted from Goias (2013).

Data Collection and Analysis

The data were obtained from Individual Notification Sheets (Fichas Individuais de Notificação; FIN) regarding snakebite accidents from SINAN/MS from 2007 to 2011, which were provided by the epidemiological surveillance sector of the studied cities. Data collection occurred between October and November 2012.

The FIN data analyses examined variables related to the victims (i.e., sex, age, and occupation), accident (i.e., season, affected bodily region, and geographic location), snake (i.e., genus), and treatment (i.e., time between the accident and medical care, case development, and severity of poisoning). The poisoning severity classification was based on the recommendations of the MH: mild, moderate, or severe (BRASIL, 2001).

Data Analyses

Descriptive statistics such as relative frequencies, absolute values, means, and standard deviations were collected. The data were entered into Microsoft Excel 2007 worksheets. To calculate the incidence of accidents, the demographics data and the number of snakebites across the four cities were grouped into population data from 2007 (for accidents that occurred between 2007 and 2008) and 2010 (for accidents that occurred between 2009 and 2011; IBGE, 2012).

Ethical Considerations

The Research Ethics Committee (Comitê de Ética em Pesquisa; CEP) of the Federal Institute of Goias (Protocol nº 003/2012) approved this study, and the heads of the Health Departments of each city signed an informed consent form that authorized the collection and use of data as recommended by Resolution 196/96 of the National

Health Council (Conselho Nacional de Saúde; CNS; BRASIL, 1996).

RESULTS AND DISCUSSION

In total, 182 snakebite accidents were reported from 2007 to 2011, with an annual incidence between 32 and 74 cases per 100,000 inhabitants (mean=52.1±17.6 cases per 100,000 inhabitants). Given that the snakebite incidence was 13.8 cases per 100,000 inhabitants in Brazil in 2005 and 16.4 cases per 100,000 in the Midwest region (BRASIL, 2009), the cities of southeast Goias present a relatively high incidence. This high incidence might be due to the high percentage of the population living in rural areas. In the study area, 17.4% of the population resides in rural areas. In particular, 45% of the population of Orizona lives in rural areas (GOIÁS, 2013). Moreover, the strong agricultural expansion of the districts studied (MORAES, 2008) might increase the occurrence of such accidents because of the number of rural workers.

Of the reported snakebite accidents, 48.9% (n=89) occurred in Pires do Rio, 25.8% (n=47) occurred in Ipameri, 24.7% (n=45) occurred in Orizona, and 0.5% (n=1) occurred in Urutai (Table 1). The highest frequency of accidents occurred in 2010 when 29.1% (n=53) of all cases were reported, followed by 2011, when 24.7% (n=45) of all cases were reported. Although Pinho et al. (2004) identified Orizona as one of the cities in Goias with the highest snakebite incidence rates, the present study did not replicate this result. However, because Pires do Rio, Ipameri, Orizona, and Urutai are neighboring cities, snakebite victims might have received medical care in one of the neighboring city; therefore, the accident might have been reported elsewhere. This supposition is might be especially true for in cases in which the rural area is closer to the medical care of a neighboring city.

Table 1. The annual distribution of snakebite accidents in the cities of Southeast Goiás from 2007 to 2011.

Cities	2007		2008		2009		2010		2011		Total	
	n	%	n	%	n	%	n	%	n	%	n	%
Ipameri	8	17,0	7	14,8	15	32	5	10,6	12	25,5	47	25,8
Orizona	8	17,7	6	13,3	7	15,5	18	40	6	13,3	45	24,7
Pires do Rio	6	6,7	12	13,4	15	16,8	29	32,5	27	30,3	89	48,9
Urutaí	0	0,0	0	0	0	0	01	100	0	0	01	0,5
Total	22	12	25	13,7	37	20,3	53	29,1	45	24,7	182	100

The lowest frequency of snakebite notifications occurred in 2007, which might be due to the low rainfall and greater number of fires that occurred during this period, thereby contributing to the increased mortality due to snakebites (MELO et al., 2009).

In the present study, snakebite accidents were more frequent among males, who represented 73% (n=133) of all cases, compared with females, who represented only 27% (n=49) of all cases. This finding corroborates the epidemiological data reported by Pinho et al. (2004) in Goiás. The greater incidence of accidents in males has also been reported in several studies across Brazil (e.g., BARRETO et al., 2010; BONAN et al., 2010; OLIVEIRA et al., 2011; LEMOS et al, 2009; LIMA et al. 2009; MISE et al., 2007; MORENO et al., 2005; PIRES, 2004; WALDEZ; VOGT, 2009). As Barreto et al. (2010) and Pires (2004) discussed, this finding is due to the higher percentage of males working in rural occupations. Moreover, the majority of accidents reported occurred in rural areas (82.4%, n=150) compared with urban (11%, n=20) and suburban (3.2%, n=6) areas; 3.2% (n=6) of cases lacked this information.

The recurrence of an epidemiological scenario that greatly affects male rural workers reinforces the need to include snakebites in the list of occupational diseases, thereby increasing the likelihood for financial support to victims in cases of temporary or permanent sequela (see MELO et al., 2009). Likewise, given that the highest frequency of accidents occurs in rural areas also reflects a standard profile for studies in the cities of other Brazilian states (BARRETO et al., 2010; BONAN et al., 2010; LEMOS et al, 2009; LIMA et al. 2009; MISE et al., 2007; MORENO, 2005; PINHO et al., 2004; PIRES, 2004). Pires (2004) highlighted that the lack of basic preventive care was due to a lack of knowledge or to the omission

of snakebite victims, especially in rural areas. Although snakebites are more frequent in rural areas, Lima (1994) drew attention to the occurrence of these accidents in urban areas, thereby emphasizing the importance of an adequate infrastructure so that snakes do not meet the synanthropic conditions that the proliferation of rodents might increase.

A higher frequency of accidents was observed among individuals over 29 years old for both sexes, representing 70.3% of all cases (n=128). In total, 8.2% (n=15) of individuals were between 1 and 9 years old, 10.4% (n=19) were between 10 and 19 years old, and 11% (n=20) were between 20 and 29 years old. These data suggest that snakebites are more common in younger populations. Data concerning the age of those affected by snakebites reveal a population younger than the economically active group (i.e., between 16 and 60 years old) in which the largest workforce is concentrated (PINHO et al., 2004; MORENO, 2005; MISE et al., 2007; LIMA et al. 2009; LEMOS et al, 2009; BARRETO et al., 2010).

In this study, 55.5% (n=101) of all victims labeled themselves white, 28.6% (n=52) labeled themselves brown, and 7.7% (n=14) labeled themselves black, and 8.2% (n=15) of the sample did not provide this information. With regard to occupation and occupational characteristics, many victims were employed as agricultural workers (35.1%, n=64); others were students (11%, n=20), housewives (8.8%, n=16), or retirees (3.3%, n=06). The FIN data did not provide occupational information for 41.8% (n=76) of the sample. The highest incidence of snakebites involved rural workers, which corroborates the finding showing that more accidents occurred in rural areas.

The genus *Bothrops* was responsible for a majority of the bites (55%, n=100), followed by *Crotalus* (27.5%, n=50), and *Micrurus* (0.55%, n=01). Reports of *Lachesis* snakebites were not found. The high prevalence of *Bothrops* spp. snakebites (followed by *Crotalus* spp.) is a typical finding (BONAN et al., 2010; BARRETO et al., 2010; MELO et al., 2009; LIMA, 2009; VALDEZ; VOGT, 2009; MARTINS et al., 2006). Approximately 90% of all snakebites in Brazil are caused by *Bothrops* (BRASIL, 2001). The highest incidence of accidents involving *Bothrops* spp. might be related to the aggressiveness of these snakes and their adaptability to different environments (MORENO et al., 2005). The accidents involving *Crotalus* snakes are less frequent due to the presence of the rattle at the end of their tails and their proclivity to announce their presence before they strike (PIRES, 2004). The low rate of accidents involving *Micrurus* spp. is likely related to their less aggressive behavior compared with other snakes, their fossorial habits, the reduction and location of their fangs, and their smaller jaw flexibility (BRASIL, 2009).

Of the FIN data, 17% (n=31) did not reference the genus of the snake involved; therefore, these cases were characterized as "unknown". According to Barreto et al. (2010) and Pires (2004), the victims' inability to properly identify the snakes combined with the intense feelings of anxiety and pain usually experienced at the time of the accident (which might interfere with accurate recall) might explain the absence of this information. According to Pinho et al. (2004), the inability to identify snake genus might also be related to the habit of victims killing the snakes by destroying their heads, the body segment essential for proper identification. In the absence of a snake, genus recognition is based on the symptoms present in the victim as a result of the toxic effects caused by the inoculation of a certain type of venom (MARQUEZ; SAZIMA, 2003).

With regard to seasonality, the months with the highest temperatures and rainfall had the highest prevalence of snakebites: 11.5% (n=21) of cases were reported in December, 11% (n=20) were reported in January, and 18.7% (n=34) were reported in April (see Table 2). The remaining 58.8% (n=107) of accidents were reported in the other months combined. In tropical regions, December and January are typically characterized by high temperatures and rainfall that increase the occurrence of snakebites because snakes are more active under these conditions, thereby increasing the chance of contact with humans (FEITOSA et al., 1997). Several studies support the data found in this study by showing that the period of greatest risk for snakebites in rural and urban areas are the hot months with the highest amount of rainfall (PINHO et al., 2004; MORENO, 2005; MISE et al., 2007; LIMA et al., 2009; BARRETO et al., 2010; BONAN et al., 2010; OLIVEIRA et al., 2011). Another explanation for the influence of rainfall on snakebites is related to the increased water level of rivers: Snakes that live in regions near river banks move in search of solid land, there increasing the likelihood of contact with humans and the occurrence of accidents (PARDAL et al., 1995). A confounding but important fact is that the period of highest rainfall coincides with the greatest agricultural activity (PIRES, 2004); again, this co-occurrence increases the chance of contact between rural workers and snakes. In months with milder

temperatures, a lower prevalence of accidents was observed (Table 2), which might be due to the subsequent decrease in reptile metabolism, which reduces the chance of contact with humans and the occurrence of accidents (ROJAS et al., 2007).

Table 2. The distribution of snakebites based on seasonality from 2007 to 2011.

Month	Seasonality of snakebites						
	2007	2008	2009	2010	2011	n total	(%)
January	2	2	6	4	6	20	11
February	5	2	4	4	4	19	10,4
March	1	0	6	3	5	15	8,2
April	3	7	4	11	9	34	18,7
May	1	2	2	4	4	13	7,1
June	1	0	2	1	1	5	2,7
July	1	0	4	3	2	10	5,5
August	0	2	2	2	1	7	3,8
September	1	0	1	4	0	6	3,3
October	0	5	3	3	7	18	9,9
November	3	3	1	4	3	14	7,7
December	4	2	2	10	3	21	11,5
Total	22	25	37	53	45	182	100

The anatomical regions most frequently affected by snakebites were the limbs, which comprised 95.5% of all cases (n=173); legs were the most frequent area bitten (67.6%, n=123), followed by the arms (27.4%, n=50). Similar studies have corroborated these findings (NASCIMENTO, 2000; PINHO et al., 2004; MORENO, 2005; MISE et al., 2007; LEMOS et al, 2009; LIMA et al. 2009; BARRETO et al., 2010; OLIVEIRA et al., 2011; Table 3).

Table 3. The distribution of snakebites based on the bodily region affected.

Bodily region affected	Distribution of snakebites	
	Absolute frequency (n)	Relative frequency (%)
Lower limbs		
Leg	57	31,3%
Foot	56	30,7%
Toe	10	5,4%
Upper limbs		
Arm	04	2,1%
Forearm	06	3,2%
Hand	22	12%
Finger	18	9,8%
Head	04	2,1%
Trunk	01	0,5%
Ignored	04	2,1%
Total	182	100%

The predominance of snakebites affecting the arms is related to the terrestrial habits of most venomous snakes in Brazil and the distance reached by the strikes (which does not usually exceed one-third of the snake's body length; ROSENFELD, 1982). Oliveira et al. (2011) argued that the extremities are most often bitten due to their greater exposure during agricultural work; thus, appropriate clothing such as shoes, long boots, leggings, and leather gloves (FEITOSA et al., 1997; PIRES, 2004) as well as the use of hoes and shovels in labor (OLIVEIRA et al., 2011) might substantially reduce the frequency of accidents.

The time between the snakebite and medical care at a health unit was approximately 1 hour in 58.2% (n=106) of the cases and between 1-3 hours

in 31.3% (n=57) of the cases; 8.2% (n=15) of the victims received medical care 3 hours after the accident, and the FIN data did not provide this information for 2.2% (n=4) of the cases. These results corroborate those found in the study performed in the state of Goiás showing that most snakebite victims (69.5%) received care in less than 3 hours (PINHO et al*.,* 2004). Mise et al. (2007) suggested that late medical care indicates a lack of patient knowledge, an unpredictable healthcare system, or both. The increase in the time that elapses between the bite and its treatment (which depends on the type of poison) can increase mortality rates up to eight times (BARRETO et al., 2010).

With regard to poisoning severity, a majority of cases were classified as mild (69%, n=125), followed by moderate (27%, n=49) and severe (1%, n=2). These results are similar to those found in other studies (NASCIMENTO, 2000; MORENO, 2005; MISE et al., 2007; LEMOS et al, 2009; LIMA et al. 2009; BARRETO et al., 2010). The severity of the snakebite depends on the amount of venom inoculated, the time between the accident and treatment, the anatomical region affected, and the type of victim (e.g., pregnant women, the elderly, and children are at-risk groups because they might have immature or weakened immune systems; MELO et al., 2009). The high prevalence of mild cases is consistent with the data on the time between the accident and treatment, which highlights the importance of this variable.

With regard to case development, three deaths were reported, resulting in a fatality rate of 1.64% during the study period. The lethality rate of the study area was four times higher than the national average (0.4%, BRASIL, 2009), which indicates the need for strategic planning as well as educational, preventive, and healthcare-related activities. Feitosa et al. (1997) argued that the reduction of snakebite-related mortality depends on how early medical care is provided, the availability of antivenom in the health units, and public awareness of the importance of serotherapy. Thus, these data are essential to establish policies that reduce the number of snakebite accidents and deaths.

CONCLUSIONS

The epidemiological scenario of snakebite accidents presented in the current study area revealed high mortality and incidence rates compared with the data reported in the rest of Brazil. In other aspects, the study area matches the national epidemiological profile that shows a higher frequency of accidents in males and rural workers over the age of 16; a higher frequency of accidents during hot and rainy periods; more snakebites involving the limbs and bodily extremities; and more accidents caused by the *Bothrops* and *Crotalus* genera.

This epidemiological survey may be extremely useful to the state and local Departments of Health (Secretarias de Saúde) located in the study area to prevent and minimize the damage caused by snakebites, especially the high rates of incidence and mortality. Future studies should expand the epidemiological study of snakebites, especially to the regions that were not sampled, to support medical care strategic planning that seeks to prevent this type of accident and to manage the availability of adequate amounts of serum.

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RESUMO: O conhecimento sobre a epidemiologia dos envenenamentos ofídicos é essencial para o planejamento de estratégias de prevenção e tratamento a esses acidentes. Porém, os dados epidemiológicos dos acidentes ofídicos ainda são precários, sobretudo em algumas regiões brasileiras. Neste contexto, o presente estudo objetivou conhecer a epidemiologia dos acidentes ofídicos em quatro municípios do sudeste goiano, durante 2007 a 2011, período em que foram notificados 182 acidentes ofídicos, com incidência entre 32 a 74/100.00 habitantes e letalidade de 1,64%. Os acidentes predominaram em adultos, do sexo masculino, sendo o principal local de ocorrência a zona rural. Os gêneros *Bothrops* e *Crotalus* foram, respectivamente, responsáveis pela maior frequência dos casos, sendo os membros inferiores as regiões anatômicas mais atingidas. A incidência e letalidade dos acidentes ofídicos nos municípios estudados foram altas, contrastando com o cenário regional e nacional. Os dados obtidos são essenciais para os órgãos públicos de saúde para subsidiar o tanto o planejamento de ações que visem a prevenção destes acidentes quanto o tratamento adequado.

PALAVRAS-CHAVE: *Bothrops*. *Crotalus*. Saúde pública. Serpente.

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