COMPARISON BETWEEN GROUPS IN THE MONTHLY OCCURRENCE OF SNAKEBITES, MUNICIPALITY OF RIO DE JANEIRO, BRAZIL, 2008-2017

COMPARAÇÃO ENTRE GRUPOS NA OCORRÊNCIA MENSAL DE PICADAS DE COBRA, MUNICIPIO DO RIO DE JANEIRO, BRASIL, 2008-2017

COMPARACIÓN ENTRE GRUPOS EN LA OCURRENCIA MENSUAL DE PICADURAS DE SERPIENTE, MUNICIPIO DE RÍO DE JANEIRO, BRASIL, 2008-2017

Ana Paula da Conceição Fernandes de Amorim[1], Luis Sauchay Romero[2], Moana Ferreira dos Santos[3], Maria Cristina Schneider[4], Simone Aranha Nouér[5], Ricardo Pereira Igreja[6]

ABSTRACT
Every year, an estimated 2.7 million people suffer snakebites, causing up to 138,000 deaths. The WHO aims to reduce snakebite-related deaths and disabilities by 50% by 2030. This study presents data on variables related to the snakebite cases in the city of Rio de Janeiro between 2008 and 2017. During this period, 495 cases were recorded, 89.1% caused by snakes of the genus Bothrops (B. jararaca and B. jararacuçu), whose venom has proteolytic and hemorrhagic effects. Half of the cases were mild (49.8%), and 86.7% received antivenom treatment. Only 9.9% of victims were treated within the first hour, 42.4% within three hours, 15.7% after six hours, and 21.1% had no recorded treatment time. Recovery occurred in 89.5% of cases. Most bites happened in urban areas (96.3%) and affected mainly men (68.1%) aged 19–59 years (mean 35 years). The lower limbs were the most affected sites, and 43.4% of victims had no recorded occupation. Local manifestations such as pain, edema, and erythema were most frequent, while systemic symptoms were rare. Coagulation tests showed abnormalities in 46.1% of cases, and 20.9% of victims did not undergo testing. Men

---

[1] Postgraduate Program in Medicine (Infectious and Parasitic Diseases). Universidade Federal do Rio de Janeiro (UFRJ). Brazil. E-mail: amorim.dip.ufrj@gmail.com Orcid: https://orcid.org/0000-0002-0774-7970 Lattes: http://lattes.cnpq.br/6202933910932933

[2] Doctoral student in Public Health and Environment. Escola Nacional de Saúde Pública (ENSP-FIOCRUZ). Brazil. E-mail: lusaurom@gmail.com Orcid: https://orcid.org/0000-0002-0607-4604 Lattes: http://lattes.cnpq.br/5726195787004238

[3] Postgraduate Program in Medicine (Infectious and Parasitic Diseases). Universidade Federal do Rio de Janeiro (UFRJ). Brazil. E-mail: moana@hucff.ufrj.br Orcid: https://orcid.org/0009-0004-5615-8971 Lattes: http://lattes.cnpq.br/6647941256766845

[4] Doctoral student in Public Health. Georgetown University. Washington, United States. E-mail: mcs368@georgetown.edu Orcid: https://orcid.org/0000-0001-8575-8002 Lattes: http://lattes.cnpq.br/1571087464929900

[5] Doctoral student in Medicine (Infectious and Parasitic Diseases). Universidade Federal do Rio de Janeiro (UFRJ). Brazil. E-mail: snouer@hucff.ufrj.br Orcid: https://orcid.org/0000-0002-3977-7680 Lattes: http://lattes.cnpq.br/2793101413226234

[6] Doctoral student in Medicine (Infectious and Parasitic Diseases). Universidade Federal do Rio de Janeiro (UFRJ). Brazil. E-mail: rpigreja@gmail.com Orcid: https://orcid.org/0000-0003-2541-3840 Lattes: http://lattes.cnpq.br/0245463254636042

had a higher hospitalization rate (67.3%) and an average hospital stay of seven days. The Lourenço Jorge Municipal Hospital accounted for 88.7% of treatments, followed by Pedro II Hospital (6.3%), both located in the West Zone, which recorded the highest number of cases.

Keywords: U Test. Poisoning. Neglected Tropical Disease. Antivenom. Botropic Accident.

RESUMO

Anualmente, 2,7 milhões sofrem picadas de cobra, causando até 138 mil mortes. OMS visa reduzir mortes e incapacidades em 50% até 2030. O objetivo deste trabalho é apresentar dados variáveis relacionadas com os casos de acidentes por serpentes ocorridos no município do Rio de Janeiro durante 2008-2017. Entre 2008 e 2017, o município do Rio de Janeiro registrou 495 picadas de cobra, sendo 89,1% causadas por serpentes do gênero Bothrops (B. jararaca e B. jararacuçu), cujo veneno tem ação proteolítica e hemorrágica. A metade dos casos foi leve (49,8%) e 86,7% receberam soro antibotrópico. Apenas 9,9% das vítimas foram atendidas na primeira hora e 42,4% até três horas, enquanto 15,7% tiveram atendimento após seis horas e 21,1% sem registro do tempo. A cura ocorreu em 89,5% dos casos. As picadas ocorreram principalmente na zona urbana (96,3%) e afetaram mais homens (68,1%) que mulheres (31,9%), predominando em adultos de 19 a 59 anos (média de 35 anos). Os membros inferiores foram os locais mais acometidos e 43,4% não tinham registro sobre ocupação. Manifestações locais, como dor, edema e eritema, foram as mais frequentes, enquanto as sistêmicas foram incomuns. O coagulograma mostrou alterações em 46,1% dos casos, e 20,9% das vítimas não realizaram o exame. Homens também tiveram maior taxa de internação (67,3%) e média de sete dias de permanência. O Hospital Municipal Lourenço Jorge concentrou 88,7% dos atendimentos, seguido pelo Hospital Pedro II (6,3%), ambos na Zona Oeste, região com maior número de ocorrências.

Palavras-chave: Teste U. Envenenamento. Doença Tropical Negligenciada. Antiveneno. Acidente Botrópico.

RESUMEN

Cada año 2,7 millones de personas sufren accidentes por serpiente en el mundo, causando 138 000 muertes. La OMS busca reducir en un 50% las muertes y discapacidades por envenenamiento antes de 2030. Este estudio presenta datos variables relacionadas con los casos de accidentes de serpiente en el municipio de Río de Janeiro entre 2008-2017. En este período se registraron 495 casos, de los cuales el 89,1% fueron causados por serpientes del género Bothrops (B. jararaca y B. jararacuçu), cuyo veneno tiene acción proteolítica/hemorrágica. La mitad de los accidentes fueron leves (49,8%) y el 86,7% de las víctimas recibió suero antibotrópico. Solo el 9,9% fue atendido en la primera hora y el 42,4% en las tres primeras horas, mientras que el 15,7% recibió atención después de seis horas, 21,1% no tenía registro del tiempo. La curación se produjo en el 89,5% de los casos. Las picaduras ocurrieron en áreas urbanas (96,3%), afectaron más a hombres (68,1%) que a mujeres (31,9%), con predominio en adultos de 19 a 59 años (media=35 años). Las extremidades inferiores fueron las más afectadas. Las manifestaciones locales, como dolor, edema y eritema, fueron frecuentes, mientras que las sistémicas fueron raras. El coagulograma mostró alteraciones en el 46,1% de los casos. Los hombres tuvieron mayor tasa de hospitalización (67,3%) y estancia media de siete días. El Hospital Municipal Lourenço Jorge concentró el 88,7% de los atendimientos, seguido por el Hospital Pedro II (6,3%), ambos ubicados en la Zona Oeste, región con mayor número de casos.

Palabras clave: Prueba U. Envenenamiento. Enfermedad Tropical Desatendida. Antídoto. Accidente Botrópico.

1 INTRODUCTION

Snakebites are a major cause of morbidity and mortality in many regions of the world, especially in tropical rural areas, and are a significant public health problem, including in Brazil (Abdullahi, 2022; Aragon, 2016). It is a potentially fatal medical emergency that requires immediate treatment and has significant economic consequences for victims due to hospitalization costs and loss of productivity (Harrison, 2019; Pejak, 2022).

Recognized by the World Health Organization (WHO) as a Neglected Tropical Disease (NTD), snakebite poisoning affects poor rural populations in tropical and subtropical regions, contributing to the perpetuation of the cycle of poverty (Schneider *et al.* 2021; Abdullahi *et al.*, 2022; Warrell, 2023; Pejak, 2022; Bravo-Veja *et al.*, 2022). Estimates indicate that, globally, approximately 2.7 million people suffer snakebites annually, resulting in 100,000 to 138,000 deaths and approximately 400,000 cases of permanent disability (Chippaux et al. 2019; Gutiérrez 2020; WHO, 2018, Buitendag *et al.*, 2022). In addition, approximately 5.8 billion people live in areas at risk of these accidents (Minghui *et al.* 2019; Longbottom *et al.* 2018).

In 2017, the WHO formally included snakebite accidents in its list of NTDs, and in 2019, it launched the initiative "Snake envenomation: Strategy for prevention and control," with the goal of reducing mortality and disability related to snakebites by 50% by 2030. This goal reinforces the urgency of understanding the epidemiological determinants of these occurrences and improving public health surveillance strategies (Patikorn *et al.* 2022; Erickson *et al.* 2022; Schneider *et al.* 2021; WHO 2025; de Oliveira *et al.* 2022; Kanankege *et al.* 2023; Jenkins and Laustsen, 2020; Bhaumik *et al.* 2022; Amorim and Santos, 2021).

Antivenom serum is the only specific treatment available, acting by neutralizing the toxic components of the venom (Sagar, 2020; Parker-Cote *et al.*, 2015). In countries where antivenom and access to health services are adequate, lethality is low; however, in regions with poor infrastructure, serum shortages and transportation difficulties compromise treatment and worsen clinical outcomes (Parker-Cote *et al.*, 2015).

In Brazil, snakebites are a serious public health issue. Official data indicate between 27,000 and 30,000 cases annually (Ministry of Health, 2025; Aragon *et al.*, 2016; Cristina *et al.*, 2021), concentrated mainly in the Legal Amazon (Cristina *et al.*, 2021). Although antivenom serum is available free of charge through the Unified Health System (SUS), the vast territorial extension, limited production, and distribution challenges hinder adequate coverage, especially in remote areas. In addition, there is underreporting of cases due to difficulties in data collection and difficult access to health services, contributing to an underestimation of the real magnitude of the problem (Aragon *et al.*, 2016; Cristina *et al.*, over 2021).

In this context, it is essential to obtain more information about snakebite accidents throughout Brazil. Thus, the present study aims to analyze the differences between groups in a series of variables related to snake accidents, such as gender, age group, location of injury, time of care, and complications, which occurred in the municipality of Rio de Janeiro from 2008 to 2017. in the municipality of Rio de Janeiro from 2008 to 2017.

2 METHODOLOGY

2.1 VARIABLES

The variables were obtained from the dataset on snakebites that occurred and were reported in the municipality of Rio de Janeiro between 2008 and 2017 through the Notifiable Diseases Information System (SINAN). The data were provided through the Access to Information System, protocol number 25820.001698/2019, from 2019.

2.2 GROUP COMPARISON ANALYSIS

With the aim of further investigating the characteristics of snakebites, in order to identify differences between two groups of variables, these were transformed into groups according to the number of monthly occurrences by: gender = male and female; age group = childhood and adolescence (0 to 19 years), adult (20 to 59 years), and elderly (≥60 years); area of occurrence of the accident = North, South, West, and Central; season = hot (November-April) and cold (May-October); medical care = immediate (≤3 hours) and delayed (>3 hours); location of injury = lower limb and rest of the body (head, trunk, and upper limb); type of manifestations = local and systemic; coagulation profile = normal and altered; severity of clinical condition = severe and non-severe (mild or moderate); serotherapy = with serotherapy and without serotherapy.

Subsequently, measures of central tendency and ratios of gender, age group, area of occurrence, season, medical care, location of injury, type of manifestations, coagulation profile, severity of clinical condition, and serotherapy were calculated.

For the comparison analyses between two groups, the Wilcoxon-Mann-Whitney test was applied, a nonparametric test that compares statistical differences between the medians of two independent data groups. A hypothesis test was previously formulated to evaluate the difference in the parameters measured for each group using the null hypothesis (H0) and the alternative hypothesis (H1), as follows:

a) Gender:

H0: There are no differences between males and females in the occurrence of snakebites in the city of Rio de Janeiro.

H1: There are differences between males and females in the occurrence occurrence of snakebites   in the city of Rio de Janeiro.

b) Age group:

H0: There are no differences between adults and children (infancy and adolescence) in the occurrence of occurrence of snakebites in the municipality of Rio de Janeiro.

H1: There are differences between adults and children (infancy and adolescence) in the occurrence of occurrence of snakebites in the municipality of Rio de Janeiro.

H0: There are no differences between adults and the elderly in the occurrence of occurrence of snakebites in the municipality of Rio de Janeiro.

H1: There are differences between adults and the elderly in the occurrence of occurrence of snakebites in the municipality of Rio de Janeiro.

c)   Area of occurrence:

H0: There are no differences between residents of the western and northern areas of the municipality of Rio de Janeiro in terms of the occurrence of snakebites.

H1: There are differences between residents of the western and northern areas of the municipality of Rio de Janeiro in terms of the occurrence of occurrence of snakebites.

H0: There are no differences between residents of the western and southern areas of the municipality of Rio de Janeiro in terms of the occurrence of occurrence of snakebites.

H1: There are differences between residents of the western and southern areas of the municipality of Rio de Janeiro in terms of the occurrence of occurrence of snakebites.

H0: There are no differences between residents of the western and central areas of the municipality of Rio de Janeiro in terms of the occurrence occurrence of snakebites.

H1: There are differences between residents of the western and central areas of the municipality of Rio de Janeiro in terms of the occurrence of occurrence of snakebites.

d) Season:

H0: There are no differences between the occurrence of occurrence of snakebites in the warm seasons (November-April) and the cold seasons (May-October) in the city of Rio de Janeiro.

H1: There are differences between the occurrence of occurrence of snakebites in the warm seasons of the year (November-April) and the cold seasons (May-October) in the municipality of Rio de Janeiro.

e) Medical care:

H0: There are no differences between people who receive immediate care (≤ 3 hours) and those who receive delayed care (> 3 hours) after occurrence of snakebites in the city of Rio de Janeiro.

H1: There are differences between people who receive immediate care (≤ 3 hours) and those who receive delayed care (> 3 hours) after occurrence of snakebites in the city of Rio de Janeiro.

f) Location of injury:

H0: There are no differences between the location of injury, the lower limb, and the rest of the body in people after occurrence of snakebites in the city of Rio de Janeiro.

H1: There are differences between the location of injury, the lower limb, and the rest of the body in people after occurrence of snakebites in the city of Rio de Janeiro.

g) Type of manifestations:

H0: There are no differences between the type of clinical manifestations, local and systemic, in people who suffer occurrence of snakebites in the city of Rio de Janeiro.

H1: There are differences between the type of clinical manifestations, local and systemic, in people who suffer occurrence of snakebites in the municipality of Rio de Janeiro.

h) Coagulation profile:

H0: There are no differences between people with normal coagulation profiles and those with altered coagulation profiles after occurrence of snakebites in the city of Rio de Janeiro.

H1: There are differences between people with normal coagulation profiles and those with altered coagulation profiles after occurrence of snakebites in the city of Rio de Janeiro.

i) Severity of clinical condition:

H0: There are no differences between people who are not seriously ill and those who are seriously ill after occurrence of snakebites in the city of Rio de Janeiro.

H1: There are differences between people who are not seriously ill and those who are seriously ill after occurrence of snakebites in the city of Rio de Janeiro.

j) Serotherapy:

H0: There are no differences between people who use serotherapy and those who do not use serotherapy after occurrence of snakebites in the city of Rio de Janeiro.

H1: There are differences between people who use serotherapy and those who do not use serotherapy after occurrence of snakebites in the city of Rio de Janeiro.

Hypothesis testing is a way of making statistical inferences, which allows conclusions to be drawn and statements to be made based on information obtained from the sample being analyzed, which is extracted from the study population (NORDNESS, 2006; TOMCZAK *et al.*, 2014). The Wilcoxon-Mann-Whitney U test was described by Wilcoxon in 1945 and by Mann and Whitney in 1947, and is equivalent to the parametric Student's t-test. As a

nonparametric test, it assumes that the data do not have a normal distribution, but it can also be used in this type of distribution. Homogeneity of variances is not necessary, and it implies that the samples are independent and random. This type of statistical test allows the determination of exact p-values and confidence intervals, which are easy to apply and interpret, being less sensitive to outliers, allowing for more general results.

In the Wilcoxon-Mann-Whitney U statistic, which is the basis for accepting or rejecting the null hypothesis, the original data from the two groups are first converted into ranks (orderings) and the value is calculated as follows: i. formation of set W with all data from groups A and B; ii. set W is ordered in ascending order; iii. the order of each element in the set is noted; iv. the samples are separated again into the two groups A and B; the value of U is calculated, which is the sum of the orders of group A. The lower the value of U, the greater the evidence of the difference between the study populations (Hollander, *et al*., 2014).

The effect size statistics for the Mann-Whitney test, defined as r, report the degree to which one group has data with higher ratings than the other group. They are related to the probability that a value in one group will be greater than a value in the other group. Unlike p-values, they are not affected by sample size. It is calculated by dividing the z-value of the test by the total number of observations (Mangiafico, 2023). According to Cohen (1988), the results can be interpreted in a similar way to the interpretation of Pearson's correlation values: small [0.10 - <0.30], moderate [0.30 - <0.50], and large [≥0.50].

3 RESULTS

3.1 QUALITATIVE AND QUANTITATIVE DATA RESULTS

Table 1 shows the qualitative and quantitative analyses of a study on snakebites in the city of Rio de Janeiro between 2008 and 2017.

The city of Rio de Janeiro had 495 snakebites reported between 2008 and 2017. Of the total number of poisonings, 89.105 were caused by snakes of the genus *Bothrops (B. jararaca or B. jararacuçu),* whose venom is proteolytic and anticoagulant/hemorrhagic. 49.80% of the poisonings were classified as mild, and 86.70% of the victims received specific treatment with antivenom, the most commonly used antivenom during this period being Anti-Botropic Serum (SAB). Regarding the time elapsed between the bite and treatment at the hospital, only 9.90% were treated within the first hour after the poisoning, 42.40% were treated within the ideal period of up to 3 hours, and 11.00% within 6 hours, which is still a safe period for a good prognosis after the accident. However, 15.70% were treated more than 6 hours after the bite and another 21.10% have no information on the time elapsed before treatment, totaling 36.80%. It is important to remember that prompt treatment is essential for

a better prognosis, lower incidence of sequelae and death, and faster recovery of snakebite victims. After treatment, 89.50% of victims recovered from the poisoning and its deleterious effects.

Most bites occurred in urban areas (96.30%), affecting more men (68.10%) than women (31.90%) at a ratio of two men bitten for every woman bitten. Both men and women who were victims of snakebites in the municipality of Rio de Janeiro were of productive adult age, between 19 and 59 years old, with an average age of 35 years for both sexes (49.10% and 21.60%, respectively), reflecting the socioeconomic impact of the injury.

The most affected site of snakebites was the lower limbs in both sexes, and poisoning was not related to work activities, but a significant percentage of victims did not provide information on this aspect of their work (43.40%).

As for the symptoms presented by snakebite victims, local symptoms were the most common in both sexes, occurring in 66.90% of men and 30.20% of women. The most common symptoms were pain, edema, erythema, and ecchymosis. Local complications included secondary infection, necrosis, and compartment syndrome. Systemic manifestations were less frequently reported in both sexes, with 3.60% of complaints in men and 1.00% in women, and the most frequently cited were hemorrhages, vagal, renal, and neurological manifestations. Systemic complications such as pulmonary edema, septicemia, shock, and renal complications were all equally cited.

As for coagulation time or coagulogram, an extremely important test due to the hemorrhagic/anticoagulant nature of the venom, 46.10% of accident victims in general presented abnormalities, but 20.90% of victims did not undergo the test or did not have their results recorded. This may indicate a failure in the care provided to these victims or in the completion of the mandatory notification form for accidents involving venomous animals.

As for hospitalization, just as men were the most affected, they also had the highest hospitalization rate (67.30%), with 8.50% being elderly people over 60 years of age. The minimum hospitalization period was zero (0) days and the maximum was 214 days, both for male patients. The average length of hospitalization per patient of both sexes was 7 days. The healthcare facility that treated the most snakebite victims was the Lourenço Jorge Municipal Hospital, located in the Barra da Tijuca neighborhood, with 88.70% of cases, followed by the Pedro II Municipal Hospital, located in Santa Cruz, with 6.30%. Both units are located in the West Zone of the municipality of Rio de Janeiro, the region with the highest incidence of snakebites in the city during the study period.

Table 1

Qualitative and quantitative analyses of snakebites in the city of Rio de Janeiro between 2008 and 2017

Variable	Result
Total accidents	495 (2008–2017 period)
Etiology	botropic accident (*B. jararaca e B.jararacuçu*) - 89,10%
Poison action	proteolytic (proteases, hyaluronidases, and phospholipases) anticoagulant (jararagina)
Accident zone	urban = 96,30%
Classification	light = 49,80%
Sorotherapy	86,70% received serum
Most commonly used serum	Antibotropic Serum - SAB
Progression	cure = 89,50%
Gender	male = 68.10% / female = 31.90% Wilcoxon-Mann-Whitney U test = 2M/1F youngest = 4 months, oldest = 81 years (men)
Age	adult - 19 to 59 years old (F = 21,6% e M = 49,1%) average age = 35 years (both genders)
Location of the injury	lower limbs = F (26,10%) e M (47,00%)
Related to work	No = 51,50% No information = 43,40%
Response time	less than 1 hour = 9,90% 1 to 3 hours = 42,40%
Local manifestations	F (30,20%) e M (66,90%)
	pain = 98.10% edema = 81.40% erythema = 29.10% ecchymosis = 19.80%
Local complications	secondary infection = 88.00% necrosis = 8.00% compartment syndrome = 8.00%
Systemic manifestations	F (1,00%) e M (3,60%) hemorrhagic = 36.40% vagal = 36.40% renal = 18.20% neurological = 13.60%
Systemic complications	renal = 0.20% pulmonary edema = 0.20% septicemia = 0.20%

	shock = 0.20%
Coagulation test	changed by 46.10%/normal = 37.40%
	not realized by 16.50%/ignored = 4.40% (20.90%)
Hospitalization	men = 67.30% (elderly = 8.50%)
	women = 31.60% (elderly = 4.20%)
Period of hospitalization	from 0 days to 241 days (D_p= 19,57)
	average of 7 days/patient
Medical care unit	Lourenço Jorge Municipal Hospital - 88.70%

Source: SINAN-DATASUS. Produced by the authors 2025.

3.2 GROUP COMPARISON

Considering the reports during the period, Table 2, which compares the median differences between variables grouped into two independent samples using the Wilcoxon-Mann-Whitney U test, shows that, with the exception of the coagulation profile, the rest of the variables had a statistically significant difference between the compared groups. The male gender, which was predominantly affected, had a mean of 3.33 accidents per month (Md = 3), which was proportionally double the number of cases when compared to the female gender, i.e., for every 2 cases of accidents in men, there was 1 accident in women. This difference was remarkably significant (p-value = < 0.001), but with a small effect size (r = 0.138) from a statistical point of view, being related to the probability that a value in the male group is greater than the probability of a value in the female group.

The age group also showed significant differences when comparing the adult group, which had the highest average number of monthly accidents, corresponding to 3.33 (Md = 3) of the other age groups, childhood/adolescence and the elderly, in this case, with a ratio of 4 to 2, the effect size was very significant (-0.003).

The area of occurrence also showed statistical significance when compared to other territorial areas of the municipality under study. The western area had the highest monthly occurrence averages, corresponding to 2.96 (Md = 3), when correlated with other municipal areas such as north, south, and center. The strongest relationship was the comparison between the western and central areas, which had a ratio of 25 to 2. However, the best result for the effect size was the comparison between the western and northern zones, with an r = 0.021.

In relation to the hot season (November to April) and cold season (May to October), the highest monthly averages were in the hot season, with a value of 5.40 (Md = 6), with many more occurrences in the hottest and most humid months. The effect size in this comparison was r = -0.163.

Regarding medical care, the study prioritized immediate care, i.e., the victim treated within 3 hours after the bite, and delayed care, when the victim is treated more than 3 hours after the bite. In this case, immediate care showed better results with averages of 2.47 (Md = 2). Even with an effect size of r = 0.201, this result was statistically significant in relation to the other victims treated beyond the time considered for better recovery and prognosis of snakebite victims.

When comparing the locations of the injuries, the lower limbs were the most affected by snakebites, with an average of 3.30 (Md = 3), a statistically significant result with a size ratio of 0.027.

Regarding manifestations, the study compared two groups: local and systemic manifestations. In this case, local manifestations were the most significant, with an average of 4.15 (Md = 4), showing statistical significance in relation to the set of systemic manifestations.

Regarding the severity of the clinical condition, the correlation occurred between non-severe (mild or moderate cases) and severe cases. Most snakebite victims did not present severity in the evolution of the accident, with an average of 3.82 (Md = 3) and an effect size of r = 0.057, resulting in statistical significance in this comparison.

Finally, the comparison related to specific treatment with antivenom, victims who received antivenom and victims who did not receive antivenom. Most victims received antivenom, with an average of 3.82 (Md = 3), which is extremely important in improving the condition of poisoning and the prognosis of snakebite victims. This comparison also showed statistical significance and an effect size of r = 0.046.

The only comparison that did not show statistical significance was that of the coagulation test with its respective results, altered and normal. This was probably due to underreporting, as 16.50% of accident victims did not undergo the test, and 4.40% had no records of the results, which were considered unknown. These two groups totaled 20.90% of all accident victims. This is a serious fact, as we are talking about poisoning by snakes of the genus Bothrops spp, which have hemorrhagic venoms and caused 89.10% of accidents in this period in the municipality of Rio de Janeiro.

Table 2

Median difference of variables grouped into two independent samples (Wilcoxon-Mann-Whitney U test) of the monthly occurrence of snakebites, according to: gender, age group, area of occurrence, season, clinical characteristics and medical care, location of the injury, type of manifestations, coagulation profile, severity of the injury, and serum therapy. Calculation of measures of central tendency and ratio for the study period. Neighborhoods in the city of Rio de Janeiro, 2008-2017.

Variable		Mean / Median	Reason	W / p-value	Effect size*r* (95% IC)
Gender	Male	3,33 / 3	2,1	5768 / < 0,001*	0,138 (-0,74;0,315)
	Female	1,98 / 2			
Age group	Adult	3,33 / 3	4,2	4490 / < 0,001*	-0,003 (-0,199;0,184)
	Childhood and adolescence	1, 51 / 1			
	Adult	3,33 / 3	5,6	3867 / < 0,001*	-0,006 (-0,182;0,167)
	Elderly	1,37 / 1			
Occurrence area	West	2,96 / 3	2,5	5251 / < 0,001*	0,021 (-0,170;0,186)
	North	1,70 / 1			
	West	2,96 / 3	5,8	3408,5 / < 0,001*	0,144 (-0,307;0,057)
	South	1,27 / 1			
	West	2,96 / 3	25,2	957 / < 0,001*	-
	Central	1,09 / 1			
Season	Heat (November-April)	5,40 / 6	1,9	2739 / < 0,001*	-0,163 (-0,522;0,257)
	Cold (May–October)	2,85 / 3			
Medical care	Immediate (≤ 3 hours)	2,47 / 2	1,8	4974,5 / < 0,001*	0.201 (0,009;0,364)
	Late (> 3 hours)	1,69 / 1			
Site of injury	Lower limb	3,30 / 3	2,9	5437 / < 0,001*	0,027 (-0,230;0,152)
	Rest of the body	1,80 / 1			
Type of manifestations	Locations	4,15 / 4	14,9	1850,5 / < 0,001*	-
	Systemic	1,55 / 1			
Coagulation test	Changed	2,36 / 2	1,2	4133 / 0,201	0,182 (-0,006;0,365)
	Normal	2,10 / 2			
Clinical severity	Not serious (mild or moderate)	3,82 / 3	6,9	3785,5 / < 0,001*	0,057 (-0,258;0,159)
	Serious	1,46 / 1			

Serotherapy	With antivenom	3,82 / 3	6,2	4592 / < 0,001*	0,046 (-0,225;0,137)
	Without antivenom	1,37 / 1			

W= Wilcoxon-Mann-Whitney U test value; * = Statistical Significance; CI = Confidence Interval. Produced by the authors, 2025.

4 DISCUSSION

Comparisons between different population groups, therapeutic protocols, and epidemiological contexts have led to significant advances in understanding the factors that influence severity, prognosis, and response to treatment in cases of snake venom poisoning. Comparative studies reveal that different approaches to clinical and therapeutic management, such as the use of different antivenom administration protocols, contribute to reducing mortality and standardizing more effective practices (Daswani *et al.*, 2017; Sagar, 2020).

Clinical and physiological differences have also been observed between age groups. Analyses comparing accidents between adults and children indicate that, although demographic profile and occupational exposure influence incidence, both groups may present similar forms of systemic toxicity and hematological complications, even with variation in the initial response (Buitendag *et al.*, 2022; Levine *et al.*, 2020). A US study based on the North American Snakebite Registry showed that adults had a higher incidence of local edema, while early hematological toxicity was more common among pediatric patients. However, there was no significant difference in the rates of necrosis or late hematological toxicity, showing that the prognosis tends to be comparable when treatment is instituted appropriately (Levine *et al.*, 2020).

With regard to clinical management, early administration of antivenom is the main determinant of a favorable outcome. Patients treated within the first six hours after the accident recover more quickly and are less likely to experience systemic complications (Magalhães *et al.*, 2022). Antivenom serum is still the only specific treatment for poisoning and should be administered according to the species involved and the clinical severity (Mise *et al.*, 2018). In addition, therapeutic management should include pain control, hemodynamic stabilization, and prolonged monitoring, even in apparently mild cases, according to observation protocols recommended by specialized clinical units (Wittler *et al.*, 2025).

The correct use of antivenom in appropriate doses substantially reduces morbidity and mortality from accidents, contrary to the popular perception of high lethality (Daswani *et al.*, 2017). This finding reinforces the importance of serum availability in healthcare facilities, especially in rural areas.

Additionally, studies suggest that individual factors may influence recovery. In an analysis conducted with patients poisoned by copperhead snakes (*Agkistrodon spp*.), it was found that age, anatomical location of the bite, and initial severity were not associated with therapeutic response, but gender and treatment group were significantly related to the final outcome. Men had better functional status and faster recovery, returning to normal activities between two and four weeks after the accident, especially when treated with antivenom (Lavonas *et al*., 2019).

However, regional disparities in access to health services and antivenom distribution remain significant obstacles, especially in low- and middle-income countries, where poisonings are more frequent.

In Brazil, although antivenoms are distributed free of charge by the Unified Health System (SUS), (Schneider *et al.,* 2021) challenges remain, such as transportation logistics, stock shortages in certain regions, lack of technical training for professionals to immediately handle serious cases, and failures in reporting (Brazil, M da S. 2023). The lack of timely access to treatment, combined with inadequate practices prior to arrival at the hospital, contributes to preventable complications that could be minimized through prevention measures, education, and the structuring of local services. (Schneider *et al*., 2021; BRAZIL M da S., 2025)

5 CONCLUSION

Men were the most affected, at a ratio of 2:1 compared to women, meaning that for every woman bitten, there were two men bitten. The productive age in both sexes was also significant in relation to the elderly, children, and adolescents, showing an impact on the socioeconomically productive age group. In relation to municipal zoning, the western zone had the most occurrences, especially in the hot and humid months.

The lower limbs were the most affected, and most cases were considered non-serious in both sexes.

The only comparison that was not statistically significant was that of the coagulation test with its respective results, altered and normal. This was probably due to underreporting or failure to perform the test. This inconsistency in the results is relevant given that we are talking about poisoning by snakes of the genus *Bothrops spp*, which have hemorrhagic venoms and caused 89.10% of accidents in this period in the municipality of Rio de Janeiro.

Half of the reported cases were treated within three hours after the accident; proper management and rapid access to treatment are essential for reducing morbidity and mortality in snakebite poisoning. Early administration of antivenom, combined with continuous clinical

observation and the adoption of standardized therapeutic protocols, significantly improves the prognosis for victims.

Even in a more structured municipality such as Rio de Janeiro, we observed a delay in the demand for appropriate treatment. Given this scenario, it is necessary to strengthen public policies aimed at the prevention and treatment of snakebites. It is recommended to: expand the coverage and distribution of antivenoms, ensuring minimum stocks in basic health units located in areas considered vulnerable; promote training for health professionals on diagnosis, severity classification, and standardized treatment protocols, with an emphasis on the importance of early care; implementing educational campaigns aimed at vulnerable populations, addressing preventive measures, myths about treatment, and the importance of seeking medical attention quickly; integrating epidemiological surveillance and zoonosis control programs into primary care networks, optimizing the recording, monitoring, and response to accidents, especially in areas with the highest incidence of poisoning.

Reducing the impact of snakebites requires an integrated approach combining science, health management, and social equity. Strengthening care networks, investing in environmental and health education, and implementing evidence-based policies are essential strategies for ensuring progress and better clinical outcomes and lives saved.

INSTITUTIONAL REVIEW BOARD STATEMENT

This doctoral project in the Postgraduate Program in Infectious and Parasitic Diseases at the School of Medicine of the Federal University of Rio de Janeiro, entitled "Epidemiological aspects of accidents by venomous snakes reported in the municipality of Rio de Janeiro between 2008 and 2017", was submitted, evaluated and approved by the Human Research Ethics Committee of the Clementino Fraga Filho University Hospital of the Federal University of Rio de Janeiro (CEP/HUCFF/FM/UFRJ), Brazil. It is registered under the protocol CAAE: 70667423.9.0000.5257.

ACKNOWLEDGMENTS

CONFLICTS OF INTEREST

The authors declare that they have no competing interests.

REFERENCES

Abdullahi, A., Yusuf, N., Debella, A., et al. (2022). Seasonal variation, treatment outcome, and its associated factors among snakebite patients in Somali Region, Ethiopia. Frontiers in Public Health, 10, 1–10. https://doi.org/10.3389/fpubh.2022.901414

Amorim, A. P. da C. F. de, & Santos, M. F. dos. (2021). Ofidismo: Doença tropical negligenciada de grande impacto na saúde mundial. In G. M. da Costa One (Org.), Saúde: Os desafios da pesquisa na atualidade (pp. 421–443). João Pessoa, PB. https://cinasama.com.br/wp-content/uploads/2021/09/LIVRO-SAÚDE-I-2021.pdf

Aragon, D. C., de Queiroz, J. A. M., & Martinez, E. Z. (2016). Incidence of snakebites from 2007 to 2014 in the State of São Paulo, Southeast Brazil, using a Bayesian time series model. Revista da Sociedade Brasileira de Medicina Tropical, 49(4), 515–519. https://doi.org/10.1590/0037-8682-0138-2016

Bhaumik, S., Beri, D., Tyagi, J., Clarke, M., Sharma, S. K., Williamson, P. R., et al. (2022). Outcomes in intervention research on snakebite envenomation: A systematic review. F1000Research, 11, 628. https://doi.org/10.12688/f1000research.122116.1

Brasil. Ministério da Saúde. (2025). Acidentes por animais peçonhentos. https://www.gov.br/saude/pt-br/assuntos/saude-de-a-a-z/a/animais-peconhentos

Brasil. Ministério da Saúde. (2025). SINAN–DATASUS. https://datasus.saude.gov.br/informacoes-de-saude-tabnet/

Brasil. Ministério da Saúde. (2023). Informe de distribuição de imunobiológicos aos estados. https://www.gov.br/saude/pt-br/vacinacao/distribuicao-de-imunobiologicos/situacao-da-distribuicao-de-imunobiologicos-aos-estados-para-a-rotina-do-mes-de-jul-2023

Bravo-Vega, C., Santos-Vega, M., & Cordovez, J. M. (2022). Disentangling snakebite dynamics in Colombia: How does rainfall and temperature drive snakebite temporal patterns? PLoS Neglected Tropical Diseases, 16(3). https://doi.org/10.1371/journal.pntd.0010270

Buitendag, J., Variawa, S., Madeira, D., & Oosthuizen, G. V. (2022). A comparison between adult and paediatric snakebites and their outcomes in North Eastern South Africa. Toxicon, 208, 13–17. https://doi.org/10.1016/j.toxicon.2021.12.009

Chippaux, J. P., Massougbodji, A., & Habib, A. G. (2019). The WHO strategy for prevention and control of snakebite envenoming: A sub-Saharan Africa plan. Journal of Venomous Animals and Toxins Including Tropical Diseases, 25, e20190083. https://doi.org/10.1590/1678-9199

Cohen, J. (1988). Statistical power analysis for the behavioral sciences (2nd ed.). Routledge. https://doi.org/10.4324/9780203771587

Daswani, B. R., Chandanwale, A. S., Kadam, D. B., Ghongane, B. B., Ghorpade, V. S., & Manu, H. C. (2017). Comparison of different dosing protocols of anti-snake venom (ASV) in snakebite cases. Journal of Clinical and Diagnostic Research, 11(9), FC17–FC21. https://doi.org/10.7860/JCDR/2017/20132.10670

Erickson, L. T., Litschka-Koen, T., Pons, J., Bulfone, T. C., Bhendile, G., Fuller, S., et al. (2020). The 'Snake song': A pilot study of musical intervention in Eswatini. Rural and Remote Health, 20(3). https://doi.org/10.22605/RRH5494

Gutiérrez, J. M. (2020). Snakebite envenoming from an ecohealth perspective. Toxicon: X, 7, 100043. https://doi.org/10.1016/j.toxcx.2020.100043

Harrison, R. A., Casewell, N. R., Ainsworth, S. A., & Lalloo, D. G. (2019). The time is now: A call for action to translate recent momentum on tackling tropical snakebite into sustained benefit for victims. Transactions of the Royal Society of Tropical Medicine and Hygiene, 113(12), 834–837. https://doi.org/10.1093/trstmh/try134

Hollander, M., Wolfe, D. A., & Chicken, E. (2014). Nonparametric statistical methods (3rd ed.). John Wiley & Sons.

Jenkins, T. P., & Laustsen, A. H. (2020). Cost of manufacturing for recombinant snakebite antivenoms. Frontiers in Bioengineering and Biotechnology, 8, 703. https://doi.org/10.1371/journal.pntd.0009880

Kanankege, K., Turner, M., Moos, B., Ruiz de Castaneda, R., Nikiema Nidjergou, Y. N., Seidu Korkor, A., et al. (2023). Interim report on snakebite incidence and case fatality rates in sub-Saharan Africa. Weekly Epidemiological Record, 98(18), 185–194. https://doi.org/10.1186/s40249-025-01385-7

Lavonas, E. J., Burnham, R. I., Schwarz, J., Quackenbush, E., Lewis, B., Rose, S. R., et al. (2020). Recovery from Copperhead snake envenomation: Role of age, sex, bite location, severity, and treatment. Journal of Medical Toxicology, 16, 17–23. https://doi.org/10.1007/s13181-019-00733-y

Levine, M., Ruha, A. M., Wolk, B., Caravati, M., Brent, J., Campleman, S., et al. (2020). When it comes to snakebites, kids are little adults: A comparison of adults and children with rattlesnake bites. Journal of Medical Toxicology, 16, 444–451. https://doi.org/10.1007/s13181-020-00776-6

Magalhães, S. F. V., Peixoto, H. M., Freitas, L. R. S., Monteiro, W. M., & Oliveira, M. R. F. (2022). Snakebites caused by the genera Bothrops and Lachesis in the Brazilian Amazon: A study of factors associated with severe cases and death. Journal of the Brazilian Society of Tropical Medicine, 55, e0558-2021. https://doi.org/10.1590/0037-8682-0558-2021

Mangiafico, S. S. (2023). Summary and analysis of extension program evaluation in R (v. 1.20.05). https://rcompanion.org/handbook/F_04.html

Mary, A., Wittler, B., Hiestand, B., Bantikassegn, A., Cline, D. M., & Hannum, J. L. (2025). Outcomes of Copperhead snake envenomation managed in a clinical decision unit. Western Journal of Emergency Medicine, 26(4). https://doi.org/10.5811/westjem.20369

Minghui, R., Malecela, M. N., Cooke, E., & Abela-Ridder, B. (2019). WHO's snakebite envenoming strategy for prevention and control. The Lancet Global Health, 7(7), e837–e838. https://doi.org/10.1016/S2214-109X(19)30225-6

Mise, Y. F., Lira-da-Silva, R. M., & Carvalho, F. M. (2019). Fatal snakebite envenoming and agricultural work in Brazil: A case–control study. American Journal of Tropical Medicine and Hygiene, 100(1), 150–154. https://doi.org/10.4269/ajtmh.18-0579

Patikorn, C., Ismail, A. K., Abidin, S. A. Z., Blanco, F. B., Blessmann, J., Choumlivong, K., et al. (2022). Situation of snakebite, antivenom market and access to antivenoms in ASEAN countries. BMJ Global Health, 7(3), e007639. https://doi.org/10.1136/bmjgh-2021-007639

Pejak, D. T., Adam, V. N., & Srzić, I. (2022). Venomous snakebites in Croatia: Clinical presentation, diagnosis and treatment. Acta Clinica Croatica, 61, 59–66. https://doi.org/10.20471/acc.2022.61.s1.10

Sagar, P., Bammigatti, C., Kadhiravan, T., Harichandrakumar, K. T., Swaminathan, R. P., & Reddy, M. M. (2020). Comparison of two anti–snake venom protocols in hemotoxic snakebite: A randomized trial. Journal of Forensic and Legal Medicine, 73, 101996. https://doi.org/10.1016/j.jflm.2020.101996

Schneider, M. C., Min, K. D., Hamrick, P. N., Montebello, L. R., Ranieri, T. M., Mardini, L., et al. (2021). Overview of snakebite in Brazil: Possible drivers and a tool for risk mapping. PLoS Neglected Tropical Diseases, 15(1). https://doi.org/10.1371/journal.pntd.0009044

Schneider, M. C., Vuckovic, M., Montebello, L., Sarpy, C., Huang, Q., Galan, D. I., et al. (2021). Snakebites in rural areas of Brazil by race: Indigenous people as the most exposed group. International Journal of Environmental Research and Public Health, 18(17). https://doi.org/10.3390/ijerph18179365

Warrell, D. A., & Williams, D. J. (2023). Clinical aspects of snakebite envenoming and its treatment in low-resource settings. The Lancet, 401(10385), 1382–1398. https://doi.org/10.1016/S0140-6736(23)00002-8

World Health Organization. (2025). Snakebite envenoming. https://www.who.int/news-room/fact-sheets/detail/snakebite-envenoming

World Health Organization. (2019). Snakebite: WHO targets 50% reduction in deaths and disabilities. https://www.who.int/news/item/06-05-2019-snakebite-who-targets-50-reduction-in-deaths-and-disabilities

World Health Organization. (2018). Addressing the burden of snakebite envenoming. https://doi.org/10.20471/acc.2022.61.s1.10