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**CLINICAL, EPIDEMIOLOGICAL AND BIOLOGICAL CHARACTERIZATION OF
SCORPION ACCIDENTS IN RORAINÓPOLIS**

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Master's dissertation submitted in partial fulfilment of the requirements for the degree of Master of Science in Health and Biodiversity in the Post-graduation Program in Health and Biodiversity of the Federal University of Roraima.

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*To my beloved mother, **Petal Ann Ramanan**,
With this dissertation, I proudly dedicate my
accomplishments to you, my source of inspiration, love, and
unwavering support. Thank you for being my rock, my
confidante, and my greatest cheerleader.
This is for you, Mom.*

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Beneath the sounds of the forests and the chaotic routine of humans, a tiny animal weaves a tale of venom and resilience, reminding us that even the most unassuming creatures can shape the destiny of a land.

RESUMO

O escorpionismo pode ser definido como o envenenamento ou a intoxicação causada pela picada de escorpiões. Assim, escorpiões são aracnídeos que estão entre os animais que compõem a fauna sinantrópica nociva, causando um importante agravo para a saúde pública. Apesar de ser uma problemática que começou a ser investigada há muitos anos no meio científico, acadêmico e em saúde pública, o escorpionismo é considerado um agravo mundialmente negligenciado, recebendo pouca atenção, investimento em pesquisa e desenvolvimento, e recursos para prevenção, tratamento e controle. Nesse contexto, diversas regiões do Brasil ainda carecem estudos para a promoção da saúde. O município de Rorainópolis, no sul do estado de Roraima, faz parte desse cenário. Com o objetivo de contribuir para o conhecimento do escorpionismo e da fauna escorpiônica do município, fez-se uma investigação através de consultas a fichas do Sistema de Informação de Agravos de Notificação, consulta aos prontuários de pacientes atendidos no hospital da região, entrevistas aos residentes e coleta de escorpiões com ênfase nos locais onde os acidentes ocorreram entre os anos de 2015 a 2022. Nesta dissertação, são informados e analisados o perfil socioeconômico dos pacientes, os dados temporais e climatológicos dos acidentes, os sintomas e outras reações fisiológicas, o tratamento, as espécies de escorpiões do município, e outros tópicos relevantes. Dessa forma, o objetivo central foi oferecer uma visão abrangente do escorpionismo nesta região, fornecendo informações substanciais para embasar decisões e diretrizes de políticas públicas.

Palavra-chave: Escorpionismo. Ecossistema amazônico. Envenenamento. Mitigação de riscos.

ABSTRACT

Scorpionism can be defined as envenomation or intoxication caused by the sting of scorpions. Thus, scorpions are arachnids that are among the animals that make up the harmful synanthropic fauna, causing significant detriment to public health. Despite being a problem that has been investigated for many years in the scientific, academic, and public health fields, scorpionism is considered a globally neglected condition, receiving little attention, research and development investment, and resources for prevention, treatment, and control. In this context, several regions in Brazil still lack studies for health promotion. The municipality of Rorainópolis in the southern state of Roraima is part of this scenario. With the aim of contributing to the understanding of scorpionism and the scorpion fauna of the municipality, an investigation was carried out through consultations of records from the Notifiable Diseases Information System, reviewing patient records from the hospital in the region, conducting interviews with residents, and collecting scorpions with emphasis on the locations where accidents occurred between the years 2015 and 2022. In this thesis, the socioeconomic profile of patients, temporal and climatological data of accidents, symptoms and other physiological reactions, treatment, scorpion species in the municipality, and other relevant topics are reported and analyzed. Thus, the main objective was to provide a comprehensive view of scorpionism in this region, supplying substantial information to support decisions and public policy guidelines.

Keywords: Scorpionism. Amazon ecosystem. Envenomation. Risk mitigation.

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1 INTRODUCTION

Globally, scorpion sting accidents pose a significant threat, with over 1.2 million cases reported annually, resulting in approximately 3,500 deaths. The majority of these incidents occur within the latitudes of 50°N and 50°S, where more than 2.5 billion people reside in areas with a high risk of scorpion envenomation (ABROUG et al., 2020).

Ciruffo et al. (2012) define scorpionism as envenoming caused by a scorpion sting or a clinical condition resulting from a scorpion accident. According to them, scorpionism has a high incidence and potential severity in cases, configuring a problem with important medical and health repercussions in Brazil.

Scorpions can be classified as a harmful synanthropic fauna, according to Normative Instruction no. 141/2006 of the Brazilian Institute of the Environment and Renewable Natural Resources (IBAMA, 2006). According to this normative, the synanthropic fauna comprises native or exotic wild animals that are permanently or temporarily in anthropic areas. Such fauna is considered harmful when it interacts with the human population causing significant economic, environmental or health disorders. For IBAMA, scorpions are invertebrates of epidemiological interest (IBAMA, 2006).

The World Health Organization recognized in 2019 that scorpionism is an emerging public health problem that is neglected (MACHADO, 2016; LOPES et al., 2017; CARMO et al., 2019), causing social impacts and significant economic costs (MONTEIRO et al., 2015). Abroug et al. (2020) discuss the state of the art of scorpionism in the world.

The prevalence of scorpion envenomation is closely linked to the remarkable adaptability of scorpions and the ongoing process of urbanization and human habitation in affected regions. In Brazil, for example, data from the Ministry of Health has revealed a worrisome increase in reported cases, with 141,400 occurrences in 2018 alone, indicating a rising trend over the years (BOGAZ, 2019).

The Notifiable Diseases Information System (SINAN), managed by the Ministry of Health, has highlighted a surge in scorpion-related accident reports in Roraima (TEIXEIRA et al., 2020). However, our understanding of scorpionism epidemiology in the Amazon Region is limited, with significant gaps in knowledge regarding scorpion health, ecology, biology, venom biochemistry, and pathophysiology (MONTEIRO et al., 2019). To address these gaps, further comprehensive studies are necessary.

Lopes et al. (2017) emphasize the critical need for such studies as they contribute to the development of strategies aimed at improving service conditions. These efforts involve

identifying deficiencies in accident data collection and notification systems, recognizing similarities between different regions in Brazil, and accounting for the unique characteristics of specific study areas. Understanding the epidemiology of accidents with venomous animals in the region can help to build strategies for better service conditions, identification of collection failures of information and notifications, and recognition of the differences of these points in relation to other regions of Brazil.

Despite the increasing incidence of scorpionism cases in Brazil in recent decades, there is a lack of available literature specifically focusing on Roraima. Data regarding scorpion accidents in the state, particularly concerning the diversity of scorpions and the clinical aspects of these incidents, remain scarce.

Remarkably, scorpions, alongside snakes, account for the highest number of fatalities caused by venomous animals in the Northeast and Southeast regions of Brazil between 2000 and 2017 (BOGAZ, 2019). Unfortunately, comprehensive studies on scorpion accidents in Rorainópolis, the second most populous municipality in southern Roraima, are lacking in the Ministry of Health databases (DATASUS/SINAN).

The Amazon region exhibits a significant variety of arachnid species, including medically important spiders and scorpions. Exploring the biodiversity of venomous animals, particularly scorpions, holds great significance due to its implications for public health. This research can provide insights into epidemiological patterns, taxonomic and systematic aspects, and the potent toxins possessed by various scorpion species, including those found in the Amazon.

Despite increasing in recent years and belonging to a priority region regarding the risk of accidents by species of medical relevance (AMADO et al., 2021), there is a shortage of detailed publications on the epidemiology of accidents by scorpions in the state of Roraima compared to the other states of Brazil, considering the studies found in the literature review in this work.

Teixeira et al. (2020), based on data made available in the Information System for Reportable Diseases of the Ministry of Health, like in all researches on the subject described here, considering the period 2011-2017, observed a higher concentration of accidents in the capital Boa Vista- RR. There are municipalities without cases registered in the period: Bonfim, Caroebe, Normandia, Pacaraima, Rorainópolis, São João da Baliza and São Luiz, and thus, raise the hypothesis of underreporting. Souza et al. (2019) demonstrated for the period from 2013 to 2016 that scorpionism was in second place among the causes of accidents by venomous animals in the state, accounting for almost 5% of these accidents.

Recently, there have been efforts to address this knowledge gap. Several works focused on scorpionism in Roraima were presented at a scientific event dedicated to the subject. For instance, Santos et al. (2022) investigated scorpionism in the state capital, Boa Vista, covering the years 2011 to 2021. Their study revealed that the majority of cases were mild, with no reported deaths. Similarly, Cruz et al. (2022) investigated accidents in Rorainópolis and obtained similar observations regarding the severity of cases. Furthermore, Martins et al. (2022) conducted a comprehensive review of cases in the state between 2019 and 2022. Their findings highlighted that most scorpion accidents occurred in urban areas, with the foot being the most affected body area among victims. The review identified a total of 476 cases, shedding further light on the epidemiological aspects of scorpionism in Roraima.

A deeper understanding of scorpionism incidence will be helpful in guiding public policy decisions related to health, safety, and environmental protection. Additionally, it will contribute to the management of synanthropic fauna in the region and the implementation of effective environmental education programs aimed at mitigating the risk of scorpion accidents among the population residing in southern Roraima.

Therefore, the objective of this study is to investigate scorpionism cases in Rorainópolis, Roraima, Brazil, and describe the clinical-epidemiological profile of these accidents over the past few years. This research is highly relevant as it provides valuable and detailed information for public representatives involved in prevention and health promotion in the region. Moreover, it contributes to the fields of Arachnology, Ecology, and Environmental Education by enhancing our knowledge of local scorpion species.

Concerning the municipality covered in this study, Rorainópolis, that is nestled within the heart of the Amazon rainforest, is a municipality of remarkable natural beauty and ecological significance. Located at coordinates 0°56'27.2" N 60°25'42.0" W, this vast expanse covers approximately 33,600 square kilometers, making it a substantial part of the Amazon basin. In 2028, it was home to a population of 30,782 inhabitants, a number that continues to grow steadily. The Human Development Index (HDI) for the municipality stands at 0.619. It experiences a hot climate, with an average annual temperature of 26°C. The region is also known for its ample rainfall, with an average of 1,750 millimeters per year, sustaining the luxuriant vegetation and vibrant ecosystems (SEPLAN, 2012; IBGE, 2023).

The defining feature of Rorainópolis is its dense rainforest vegetation, where towering trees dominate the landscape. This environment is home to a diverse and exuberant array of wildlife and plant species. The region primarily consists of moist tropical rainforest,

specifically the ombrophilous dense, with transitional forests that showcase a unique and characteristic ecosystem (NASCIMENTO; SENHORAS, 2020).

The municipality's economic backbone revolves around agriculture, mainly large-scale farming coupled with cattle, horse, and sheep ranching. These activities attract local laborers who engage in beef cattle farming, along with occasional rice cultivation, either directly or through land leasing. Small-scale farming is essential for producing crops such as rice, corn, cassava, and beans, among others. In addition to agriculture and livestock, reforestation, timber production, and fishing also contribute significantly to the local economy (NASCIMENTO; SENHORAS, 2020).

Rorainópolis has a unique history. It was originally established along the BR-174 highway as part of the INCRA Settlement Project. This project, known as Anauá, aimed to provide settlement and employment opportunities for thousands of families. However, the rapid influx of people led to unplanned settlements, environmental degradation, and a reliance on informal labor practices as the primary source of income for many residents. The lack of adequate infrastructure and basic sanitation facilities has posed persistent challenges. A significant portion of the population migrated from the state of Amazonas, exacerbating environmental issues within the municipality. Rorainópolis is a popular destination for eco-tourism and adventure tourism. It boasts numerous beaches and rapids that favor activities like canoeing and sport fishing (VERAS, 2013; NASCIMENTO; SENHORAS, 2020).

This study produced five articles that will be submitted to scientific journals (Table 1). They are pre-formatted according to the instructions of their respective journal. **Article 1** will present the analysis on the data provided by the Notifiable Diseases Information System, obtained from the Department of Informatics of the Unified Health System and the Municipal Superintendence of Health Surveillance. **Article 2** will discuss the findings from the patients records from the only hospital in the municipality. **Article 3** presents and analyses the interviews made to local residents on scorpionism. **Article 4**, in a format of brief report, will present the species found in Rorainópolis, especially in the locations where the accidents occurred. Finally, **Article 5** will present a brief review of the studies on scorpion venoms from the Brazilian Amazon.

Table 1 – Intended journals for publishing the articles of this thesis.

Article number	Intended journal (and address of instructions to authors)	Qualis¹
1 (page 16)	Revista Brasileira de Epidemiologia (https://www.scielo.br/journal/rbepid/about/#instructions)	A3
2 (page 33)	PLOS Neglected Tropical Diseases (https://journals.plos.org/plosntds/s/submission-guideline)	A1
3 (page 88)	Revista Brasileira de Epidemiologia (https://www.scielo.br/journal/rbepid/about/#instructions)	A3
4 (page 99)	Wilderness and Environmental Medicine (https://www.wemjournal.org/content/authorinfo)	A3
5 (page 108)	Frontiers in Pharmacology (https://www.frontiersin.org/journals/pharmacology/for-authors/author-guidelines)	A2

The attached appendices provide the forms employed for data collection and organization in this study. The annexes encompass essential approvals and permissions obtained for the execution of this research.

Therefore, this research holds significant potential by offering valuable and nuanced insights to public representatives engaged in regional prevention and health promotion efforts. Furthermore, it modestly contributes to the expanding horizons of Arachnology, Ecology, and Environmental Education, enriching our understanding of local scorpion species and the possibilities they present.

¹ Classification system developed by the *Coordination for the Improvement of Higher Education Personnel* of Brazil to assess the quality of scientific publications produced by researchers and academic institutions. It aims to provide a ranking of journals and conferences in various fields, helping researchers and institutions to make informed decisions about where to publish their work. Qualis assigns categories (such as A1, A2, B1, B2, B3, B4, B5, C) to journals and conferences based on their perceived quality and impact within specific academic areas.

2 ARTICLE 1

Clinical and epidemiological aspects of scorpionism in Rorainópolis, state of Roraima, Brazil, from 2015 to 2022

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CLINICAL AND EPIDEMIOLOGICAL ASPECTS OF SCORPIONISM IN RORAINÓPOLIS, STATE OF RORAIMA, BRAZIL, FROM 2015 TO 2022

ABSTRACT: Objective: this work a basic, quantitative, retrospective and descriptive epidemiological study of scorpion accidents that occurred in Rorainópolis between 2015 and 2022. **Methods:** data were collected from Notifiable Diseases Information System online and from the Municipal Health Surveillance Superintendence, and were tabulated and processed in statistical softwares through normality, comparative, correlation and trend tests. **Results:** a total of 62 accidents were recorded during this period, with an average incidence of 25.57 ± 18.43 per 100 thousand inhabitants/year, showing an increase in reporting within the period and a strong association between accidents and territorial settlement and deforestation. Among the municipalities of Roraima, Rorainópolis ranked 9th in average incidence and 4th in absolute number, representing 4.47% of cases in the state. The accidents affected all age groups, genders, and educational levels. However, the brown population was the most affected. Most cases were mild, with pain and edema and few systemic manifestations, without any type of complication and without deaths, indicating the low medical importance of the scorpions involved. **Conclusion:** although scorpions have limited medical significance in the region due to predominance of mild cases and no fatalities, improving reporting forms and studying species identification, ecological factors, and human-invertebrate relationship are crucial. Further studies in Roraima's municipalities and the region are needed for comparative analysis and comprehensive understanding. The data on scorpion stings in Rorainópolis is valuable for healthcare professionals, improving treatment and prevention. Ongoing monitoring, education, and timely interventions are crucial for positive outcomes and preventing complications.

Keywords: Scorpion accidents. Epidemiological study. Incidence rate. Territorial settlement. Intoxication. Rorainópolis.

RESUMO: Objetivo: este trabalho é um estudo epidemiológico básico, quantitativo, retrospectivo e descritivo dos acidentes escorpiônicos ocorridos em Rorainópolis no período de 2015 a 2022. **Métodos:** os dados foram coletados do Sistema de Informação de Agravos de Notificação online e da Coordenação Municipal de Vigilância em Saúde, tabulados e processados em Excel e BioEstat através de testes de normalidade, comparativos, de correlação e de tendência. **Resultados:** foram registrados 62 acidentes no período, com incidência média de $25,57 \pm 18,43$ por 100 mil habitantes/ano, evidenciando aumento de notificações no período e forte associação entre acidentes e ocupação territorial e desmatamento. Dentre os municípios de Roraima, Rorainópolis ocupou o 9º lugar em incidência média e o 4º em número absoluto, representando 4,47% dos casos do estado. Os acidentes atingiram todas as faixas etárias, sexos e níveis de escolaridade. No entanto, a população parda foi a mais afetada. A maioria dos casos foi leve, com dor e edema e poucas manifestações sistêmicas, sem nenhum tipo de complicação e sem óbitos, indicando a baixa importância médica dos escorpiões envolvidos. **Conclusão:** embora os escorpiões tenham importância médica limitada na região devido à predominância de casos leves e sem fatalidades, melhorar as formas de notificação e estudar a identificação de espécies, fatores ecológicos e relação humano-invertebrado são cruciais. Mais estudos nos municípios de Roraima e região são necessários para uma análise comparativa e compreensão abrangente. Os dados sobre picadas de escorpiões em Rorainópolis são valiosos para os profissionais de saúde, melhorando o tratamento e a prevenção. Monitoramento contínuo, educação e intervenções oportunas são cruciais para resultados positivos e prevenção de complicações.

Palavras-chave: Acidentes por escorpião. Estudo epidemiológico. Incidência. Ordenamento territorial. Intoxicação. Rorainópolis.

INTRODUCTION

Accidents caused by venomous animals pose a significant public health issue worldwide. Scorpion accidents, in particular, exhibit a higher incidence in tropical and subtropical regions. With an annual average of 1.2 million accidents and over 3,000 deaths, the World Health Organization has classified these incidents among the neglected tropical diseases¹. Scorpions, as small arachnids, encompass a diverse range of species, most of which are harmless to humans. They thrive in various environments, making them cosmopolitan creatures capable of adapting to different conditions. Currently, there are estimated to be over 2,000 species of scorpions, belonging to 19 families and 213 genera worldwide².

Brazil is home to several medically significant scorpion species, such as *Tityus bahiensis*, *T. stigmurus*, *T. obscurus*, and *T. silvestris*, which belong to the Buthidae family³. In 2018, Brazil recorded over 155,000 scorpion accidents, representing 52% of all reported cases of venomous animal accidents from 2010 to 2019^{3,4}. Recent years have witnessed a rise in the number of reported accidents in the country, with children and elderly individuals with comorbidities being the most severely affected. The majority of cases have been classified as mild⁵. Despite ongoing efforts by researchers to comprehend scorpionism, the subject still necessitates comprehensive and continuous investigations across different regions of Brazil. Fan and collaborators⁶ emphasize the need for in-depth research on scorpion species' biology, ecology, clinical and epidemiological aspects of accidents, venom biochemistry and pathophysiology, and improvements in antivenom therapy efficacy, particularly in the Amazon region.

In this context, epidemiological studies on scorpionism in Roraima, including the municipality of Rorainópolis, remain limited. Teixeira et al.⁷ have identified gaps in the available epidemiological data from health information systems, highlighting the need for further investigation and incentives in this area. So, the present study aims to describe the key clinical and epidemiological aspects of scorpionism in the municipality of Rorainópolis, state of Roraima using data obtained from health information systems. By understanding the local scenario, this research provides a foundation and guidance for future studies and governmental actions to promote, protect, and improve public health.

METHODS

The present study utilized a retrospective and descriptive approach to analyze data from the Notifiable Diseases Information System (SINAN) regarding scorpionism from 2015 to 2022. The research was conducted in Rorainópolis, a municipality located in the southern region of Roraima (Figure 1). The municipality's main town is situated at coordinates 0°56'27.2"N

60°25'42.0"W. Spanning an area of approximately 33,600 square kilometers, Rorainópolis was home to a population of 30,782 inhabitants in 2022⁸. The region is characterized by dense rainforest vegetation, predominantly tall trees. Rorainópolis experiences a hot climate, with an average annual temperature of 26°C and average rainfall of 1,750 millimeters per year⁹.

Rorainópolis was originally established along the BR-174 highway, through the efforts of the INCRA Settlement Project, ultimately achieving municipal status in 1995. The initial population influx was driven by employment opportunities, resulting in haphazard settlement, environmental deterioration, and a rise in informal labour practices, which have since become the primary income source for residents. However, this growth trajectory has been beset by inherent structural challenges, notably the absence of proper infrastructure and fundamental sanitation facilities. A significant portion of migrants originate from the state of Amazonas, and the population increase without proper planning has brought about notable environmental repercussions within the municipality (Veras et al., 2013).

A survey of accident notification forms from the SINAN at Health Surveillance Department of the Municipal Health Secretariat of Rorainópolis was carried out on January 9, 2023 and the DataSUS' Tabnet platform (<<https://datasus.saude.gov.br/informacoes-de-saude-tabnet/>>) was carried out on March 17, 2023. Important variables were analyzed, including age, gender, education, locality, occupation, pregnancy status, occurrence details, severity, manifestations, treatment, work-related accidents, and outcomes. Data from all the other 14 municipalities in Roraima were also collected for comparison from Tabnet. The completeness of SINAN forms was evaluated using completion rates categorized as poor, regular, or excellent¹⁰. Climatological data was obtained from the Visual Crossing platform (<https://www.visualcrossing.com/>) on May 2, 2023.

Tabulation and data processing used software applications such as Excel, Past 4.03, and Jamovi 2.3.26. Statistical tests, including Mann-Kendall, Shapiro-Wilk, Mann-Whitney U, Kruskal-Wallis, Spearman, Pearson, multiple regression analysis with principal components analysis, were employed to analyze the data. Population density calculations relied on data from DataSUS, IBGE^{11,12} and Secretary of State for Planning and Development⁹.

The maps were made using QGIS application software, version 3.22, with the Sirgas 2000 coordinate system, using *shapefile* archives downloaded from official websites and Affinity Designer, version 1.10.6, to complement the composition of the maps for this study.

RESULTS

The most recent epidemiological data available on DataSUS is from February 2023, showing 62 reported cases of scorpionism in Rorainópolis. However, the Municipal Health Surveillance Superintendence in Rorainópolis officially notified only 60 cases, accounting for 96.77% of DataSUS data. This discrepancy may be due to the lack of updates or revisions in the Superintendence's data, making DataSUS the primary data source for the study. The distribution of scorpionism cases in Rorainópolis, according to DataSUS, is shown in Tables 1 and 2, which reveals a statistically significant increasing trend in case notifications ($S=22$ and $p=0.0054$), with the highest number of cases occurring in 2020, which may be due to various reasons, such as the Coronavirus pandemic dynamics.

Scorpionism accounted for an average of 14.25% of toxic animal accidents in the municipality per year, with the highest percentage in 2020. However, there is no statistically significant growth trend in this percentage according to the Mann-Kendall test results ($S=12$, $p=0.089$). Rorainópolis ranked 4th among Roraima's municipalities in scorpionism notifications, representing 4.47% of total cases in the state from 2015 to 2022. The incidence of scorpion stings in Rorainópolis is increasing significantly ($S=22$, $p=0.0028$), with an average incidence of 46.77 ± 25.57 cases per 100,000 inhabitants per year, peaking in 2020. Figures 2 and 3 depict the scorpionism incidence by municipalities.

Deforestation in Rorainópolis ranged from 3.44% to 4.65% of its territory (Table 3), resulting in a loss of approximately 406 square kilometers (1.21%, Figure 4). Spearman correlation test indicates a statistically significant strong correlation between number of cases and the deforested area in the year ($r_s=0.8330$, $p=0.0102$), and between the number of cases and the accumulated area of deforestation ($r_s=0.9048$, $p=0.0020$). Furthermore, the Spearman correlation test showed a statistically significant strong correlation between number of cases and population density ($r_s=0.8571$ and $p=0.0065$). Considering all venomous animals, the correlation is still significant ($r_s=0.7619$ and $p=0.0280$).

Multiple regression analysis yielded the equation: $n = -73.3 + 54.5p + 886d$, where n represents the number of cases, p represents population density, and d represents the percentage of deforestation, with p-values of 0.249 and 0.050, respectively. Thus, based on the coefficients of the equation, deforestation could have had a greater impact on the annual case numbers during the period considered in this study. However, it was also noted that there was a significant correlation between these independent variables ($r_s = 0.830$, $p\text{-value} = 0.01$), indicating collinearity, which raises doubts about this conclusion. combine these variables into Through principal component analysis (PCA), a new linear regression was formed: $n = 7.750$

+ 0.0376x, where x represents the degree of anthropization (the first component of PCA, combining deforestation and population density), and the p-value is equal to 0.001, with a strong correlation of $r_s = 0.90$ (p-value = 0.0033).

Consequently, in the annual context of the analysis, rainfall did not appear to be significant in explaining the growth in the number of scorpion sting cases. The recent anthropization in the municipality, as represented by deforestation and population growth, better explains the observed behavior in the number of cases, aligning with existing literature.

However, significant differences in rainfall were found among months, with April to July experiencing the highest levels ($H=56.9976$, $p<0.0001$ and $H=58.9654$, $p<0.0001$). There was a statistically significant moderate correlations between scorpion-related accidents and monthly rainfall mean values ($R=0.734$, p-value=0.007). Monthly temperatures varied from 23.7°C to 33.3°C, with significant differences between certain months. Spearman correlation test showed a statistically non-significant negative correlation between mean monthly temperatures and monthly mean accidents ($r_s=-10.74$ and $p=0.7398$, Figure 41)

The analysis of scorpionism cases in Rorainópolis, based on DataSUS, indicates that individuals across various age groups were affected, except for infants under 1 year and elderly individuals over 69 years. The distribution is as follows: children (0-11 years) accounted for 20% of victims, teenagers (12-18 years) comprised 31.67%, young adults (15-29 years) comprised 31.7%, adults (30-59 years) comprised 43.3%, and elderly individuals (60 years and older) comprised 5%.

Analyzing scorpionism data from DataSUS (2015-2022), a notable trend emerges. Out of the total cases, 13 children were affected, with 84.6% occurring during school holidays. DataSUS shows 55% male and 45% female scorpionism victims in Rorainópolis, but statistical analysis ($U=30.00$, $p=0.4168$) found no significant difference in accident rates between genders.

No pregnant women suffered scorpion accidents during this study. Regarding the victims' ethnicity, 95.16% of the victims were *pardos* (mixed), 3.22% were *white* and 1.61% were of unknown ethnicity. Thus, the group of *pardos* victims was the largest group affected by scorpionism ($H=11.2483$ and $p=0.0036$). Victims belonged to all educational levels. The statistical analysis conducted did not show any significant differences in the incidence of scorpionism among the educational levels considered ($H=11.7949$ and $p=0.2251$).

According to data from the Municipal Health Surveillance Superintendence of Rorainópolis, which totaled 60 cases, 37 (61.67%) occurred in the rural area, 11 (18.33%) in the urban area, 2 (3.33%) in the peri-urban area, and 10 (16.67%) did not include the area where the accident

occurred. The location information included in the notification forms was scarce and insufficient to understand the spatial distribution of accidents in the municipality as a whole. The majority of cases (54.84%) received medical attention within 3 hours after the scorpion bite occurred. However, it is concerning that a significant proportion of cases (12.90%) sought medical care after a longer period.

Most stings (46.77%) affected victims' hands or feet. Other body parts affected were finger (19.3%), toe (6.45%), arm (4.8%), forearm (4.8%), head (3.2%), trunk (3.23%), thigh (3.2%), leg (3.2%), and other parts were ignored in the form (16.1%). Concerning case severity, 83.87% of the cases was considered of mild severity, while 8.06% was of moderate severity, and 8.06% was ignored. Only 4 patients had systemic manifestations: neuromuscular and vagal manifestations and severe pain, while 91.67% of patients presented local pain, 58.33% presented edema, and 1.67% presented paresthesia.

The anti-scorpion serum was administered in two moderate cases in 2021 (4 ampoules in one case, 3 ampoules in the other) and in one mild case in 2022 (4 ampoules). Out of the 60 cases at the Superintendence, 5% required serum. According to Tabnet data, out of the 62 cases, 58 (93.5%) were cured and in 4 (6.5%) the evolution was unknown. No deaths from scorpionism were observed in Rorainópolis, resulting in a mortality rate of zero.

Analysis of the reporting forms showed that 50% of the variables were excellently filled, while 36.4% were categorized as regular. However, 13.6% of the variables were poorly filled, lacking essential data: location of accident, accident related to work, and clotting time test.

DISCUSSION

Some studies conducted in the Amazon region¹³⁻¹⁵ and Southeast Brazil¹⁶ have reported an increase in scorpion accident notifications. Collaborative efforts between the Brazilian Ministry of Health and state departments of health may have contributed to improvements in notification systems over time. However, specific areas, such as Santarém (state of Pará)¹⁷ and Atalaia do Norte (state of Amazonas)¹⁸, have observed a decrease or no significant change in notifications.

Various factors contribute to the prevalence of scorpionism in Brazil, including rapid urbanization, inadequate housing conditions, adaptability of scorpion species¹⁹, and social factors like low socioeconomic status, limited education, and inadequate infrastructure²⁰. Implementing public policies that address social determinants of health, along with prevention strategies, health education initiatives, and improved housing and infrastructure, is crucial for effective prevention and control of scorpionism.

Seasonality studies have identified higher incidence in certain months, such as March and May in Rondônia²⁰ and January to April in Amapá²¹. The present study shows a higher mean number of cases in June, similar to findings in the interior of Amazonas²². Scorpionism is the second most common cause of venomous animal accidents in the Legal Amazon region, ranking below snakebites¹³. However, Biz et al.²³ reported scorpionism as the highest proportion of venomous animal accidents in Brazil.

Certain municipalities in Roraima experienced higher rates of scorpionism, emphasizing the need for preventive measures in those areas. Data-driven visualizations, such as our map, aid in understanding the epidemiological landscape of scorpionism, informing public health policies, and identifying areas for further research and monitoring. Comparatively, the national incidence rate in 2018 was reported as 75 cases per 100,000 inhabitants²⁴. Therefore, the incidence of scorpion sting cases in Rorainópolis was 86% lower than the national incidence rate in 2018.

Rainfall has been considered a potential factor in scorpion accidents, the association between precipitation and accidents showed important statistical relevance, suggesting that higher levels of rainfall can contribute to an increase in accident totals. Studies in different municipalities have shown varying correlations between rainfall and accidents^{25,26}, highlighting the context-dependency of this relationship. It is important to note that more than 86% of accidents occurred on rainy days, suggesting a great influence of rainfall among other factors. Rainfall could increase scorpion activity, leading to a higher risk of encounters with humans. It is important to be aware of the potential association between rainfall and scorpion incidents and implement preventive measures specifically on rainy days.

Deforestation and land settlement contribute to scorpionism, and forest conservation is crucial to prevent venomous animal-related accidents^{6,27}. Efforts should focus on formulating policies to prevent deforestation and mitigate associated risks. The correlation between deforestation and accidents in Rorainópolis suggests a direct relationship, making it a key contributing factor to the accident rate. Collaboration between disciplines can lead to a holistic understanding and evidence-based interventions to reduce accidents and promote sustainable development.

The increase in scorpion accidents in Rorainópolis is also linked to population density, territorial settlement, urbanization, and environmental degradation^{22,28}. Population density correlates with scorpion accidents, supporting the Ecological Theory of Diseases²², which considers biological, behavioral, environmental, and social factors. Scorpion accidents are influenced by urbanization, habitat modification, proximity to scorpion habitats, socio-economic factors, public health infrastructure, and community awareness. An ecological

approach to prevention and control includes urban planning, educational campaigns, healthcare system strengthening, habitat conservation, and sustainable land use practices are relevant.

Vulnerable populations, such as children and the elderly, are at a higher risk of scorpionism and require targeted preventive measures. School holidays are associated with an increase in scorpion stings among children probably due to increased time at home and reduced vigilance^{1,29}. Awareness campaigns and educational programs can help prevent scorpion accidents during school holidays by promoting preventive measures and prompt medical attention. The findings underscore the importance of considering ecological factors and implementing evidence-based interventions to mitigate scorpion accidents and protect affected communities. It is important to note that scorpionism can still pose a significant risk to vulnerable populations within the age range covered by the data.

The limbs were the most affected in scorpion accidents, which was also observed by Maia and collaborators³⁰. The results of this study suggest that protective supplies should be worn in areas where scorpions are likely to be present.

The prevalence of patients of mixed ethnicity (“*pardo*”), similar to Silva et al.³¹ and other studies cited by them, may be attributed to the majority *pardo* population in the region (almost 70% of the population, according to DataSUS). Their higher risk of scorpion exposure could be linked to socioeconomic conditions and living environment.

Understanding the temporal association of scorpion accidents during high-risk periods allows for targeted interventions and educational efforts to mitigate incidents. Raising awareness and implementing preventive measures can reduce scorpion stings among children, especially during school holidays. Similar patterns were observed in Rio de Janeiro²⁹ and the Amazon¹³, emphasizing the correlation between accidents and tourism. Educational campaigns should inform residents and tourists about scorpion behavior and preventive measures. Collaboration between tourism agencies, educational institutions, and healthcare providers is crucial for the efficient dissemination of information. Comprehensive prevention and control measures should target the entire population, regardless of gender or age.

Detailed and standardized location information in scorpionism cases is vital for developing targeted interventions. Prompt medical care is crucial in managing scorpion envenomation effectively. Delayed attention can lead to more severe manifestations and complications. Early diagnosis, monitoring, and treatment are essential for reducing the impact of scorpionism. The severity of scorpion accidents depends on various factors, and early detection is crucial. While most cases are mild, important clinical manifestations were observed. Educational campaigns

should promote precautionary measures and first aid. Timely recognition of signs and symptoms helps minimize the consequences.

The healthcare system in Rorainópolis has shown positive results in treating scorpionism cases, with no reported deaths. However, the limitations of the SINAN database should be acknowledged, despite its value in identifying health problems and informing public health policies. Utilizing SINAN data provides accessibility and efficiency in analyzing epidemiological data related to venomous animal accidents. Recognizing the limitations, further studies are needed to improve understanding and develop effective interventions.

Thus, targeted interventions, awareness campaigns, and early medical care are essential for reducing scorpion accidents. Comprehensive prevention measures, access to quality care, and accurate data collection contribute to minimizing the impact of scorpionism and improving community well-being.

Unfortunately, 13.6% of variables from the notification forms lacked essential data, hindering a full understanding of scorpionism in Rorainópolis. Incomplete reporting limits accurate conclusions and subsequent analyses. To address this, focus on improving data quality and completion rates. Clear instructions and user-friendly formats can aid accurate responses. Educating participants on the significance of each variable motivates accurate reporting. Collaboration among authorities, healthcare professionals, and the community is vital. Open communication encourages feedback and addresses data gaps. Enhancing data quality and completion rates enables effective risk mitigation strategies. Despite its limitations, SINAN remains valuable for analyzing epidemiological data on venomous animal accidents. Complementing SINAN with other sources may maximize data usefulness.

By consulting the data available from Tabnet and the Municipal Health Surveillance Superintendence for the period from 2015 to 2022, it was found that scorpionism is a problem that affected all genders, all ages, and all levels of education, including groups of risk.

This research successfully establishes a robust and clear correlation between the frequency of accidents and human population density, deforestation evolution and rainfall, which sets it apart from previous studies conducted on this subject in Brazil and in the state of Roraima.

Probably, the scorpions do not have a great medical importance for the region, considering the predominance of mild cases and there were no fatalities. However, the completion of the reporting forms needs to be improved, as a significant number of fields in the forms were ignored.

Important issues not studied in this work still need attention, such as the identification and ecological and biochemical studies of the species causing the accidents, a more detailed

description of the human relationship with and knowledge of these invertebrates, and also an attempt to better understand the factors determining the number of accidents, including the dimension of evasion and the lack of interest of victims in seeking medical help. Similar studies for the other municipalities of Roraima and the region are needed to ensure comparability of results with current and future studies.

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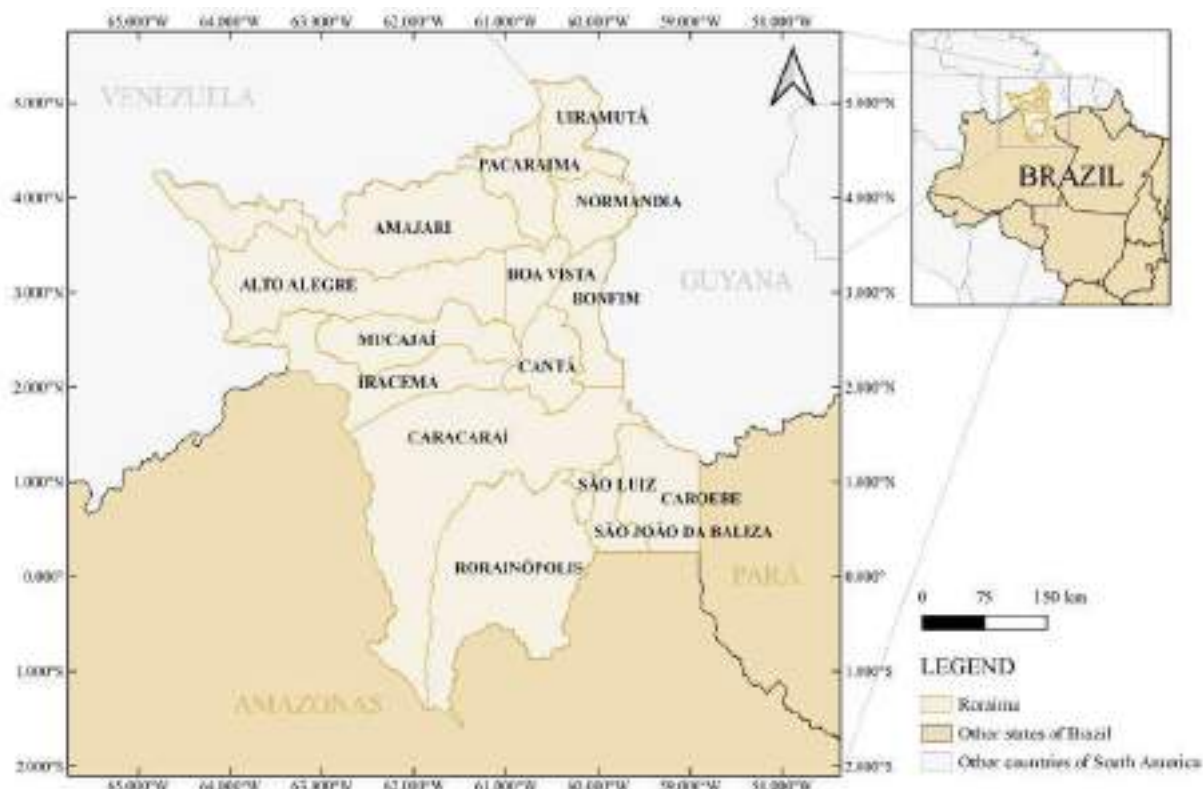


Figure 1 – The state of Roraima with its 15 municipalities. Source: the author, based on cartographic data provided by IBGE at <https://www.ibge.gov.br/geociencias/organizacao-do-territorio/malhas-territoriais/15774-malhas.html?=&t=acesso-ao-product>. Accessed on 03/04/2022. Author: Joel Ramanan.

Table 1– Number of inhabitants and reported cases of scorpion accidents and incidence of scorpionism in Rorainópolis-RR, from 2015 to 2022, based on DataSUS, from the Brazilian Ministry of Health. (Incidence of cases per 100 thousand inhabitants).

Year	Population	Population density (inhab./km ²)	Cases	Incidence
2015	27,681 ^a	0.824	0	0.00
2016	28,278 ^a	0.842	2	7.07
2017	28,898 ^a	0.860	5	17.30
2018	29,533 ^a	0.879	3	10.16
2019	30,163 ^a	0.898	9	29.84
2020	30,782 ^a	0.916	16	51.98
2021	31,387 ^b	0.934	13	41.42
2022	29,932 ^c	0.891	14	46.77

Source of notified cases: DataSUS (consultation carried out on March 17, 2023).

^aDataSUS System on March 25, 2022. ^bAccording to IBGE⁸. ^cAccording to IBGE¹².

Table 2 – Distribution of absolute frequencies of reported cases of scorpionism in Rorainópolis over the months of each year, from 2015 to 2022, based on DataSUS, from the Brazilian Ministry of Health.

Month	2015	2016	2017	2018	2019	2020	2021	2022	Total	Mean value
Jan.	–	–	–	–	1	1	3	–	5	0.63±0.99
Feb.	–	–	–	–	1	2	1	–	4	0.50±0.71
March	–	–	–	–	–	2	–	1	3	0.38±0.70
Apr.	–	–	1	1	–	1	2	4	9	1.13±1.27
May	–	–	1	–	1	–	2	4	8	1.00±1.32
June	–	–	1	1	3	2	1	–	8	1.00±1.00
July	–	–	1	–	–	2	2	–	5	0.63±0.86
Aug.	–	1	1	–	1	–	–	–	3	0.38±0.48
Sept.	–	–	–	1	–	1	–	1	3	0.38±0.48
Oct.	–	–	–	–	–	2	1	2	5	0.63±0.86
Nov.	–	–	–	–	1	3	–	–	4	0.50±1.00
Dec.	–	1	–	–	1	–	1	2	5	0.63±0.70
Total	–	2	5	3	9	16	13	14	62	

Source: DataSUS (consultation carried out on March 17, 2023).

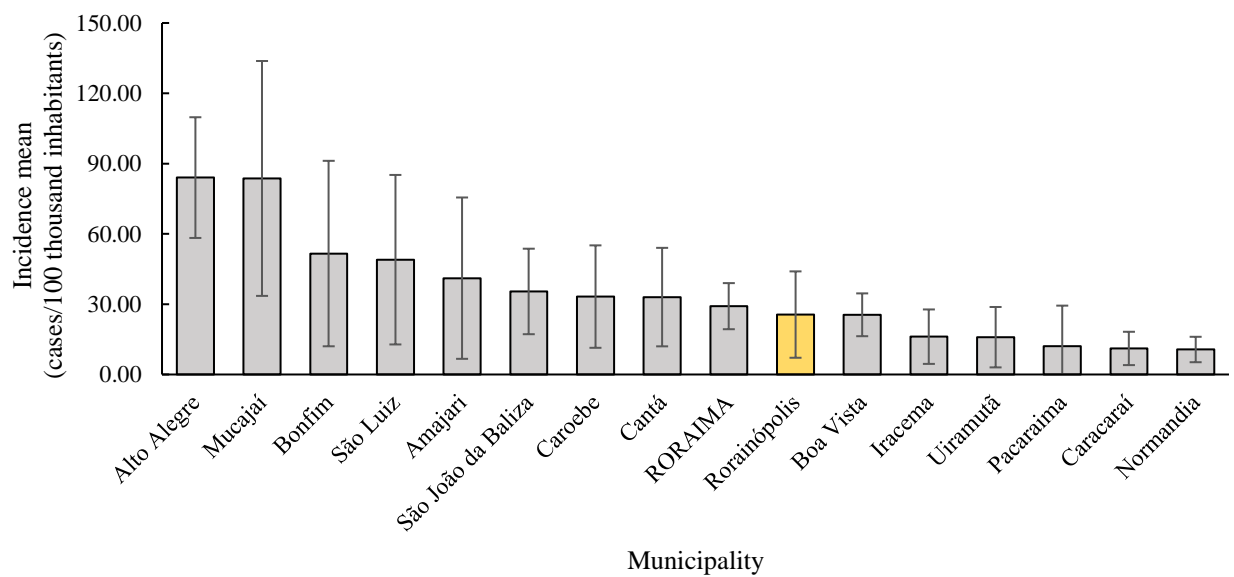


Figure 2 – Mean values of annual incidence per 100,000 inhabitants of reported cases of scorpion accidents that occurred in the municipalities of Roraima in the period from 2015 to 2022 in descending order of mean value, including the state of Roraima. Source: data calculated based on notification data available on DataSUS (consultation carried out on March 17, 2023) and on data from the resident population on DataSUS (resident population – study of population estimates by municipality, age and gender 2000-2020 – Brazil) at <https://datasus.saude.gov.br/população-residente>. Accessed on March 25, 2022) and IBGE^{11,12}.

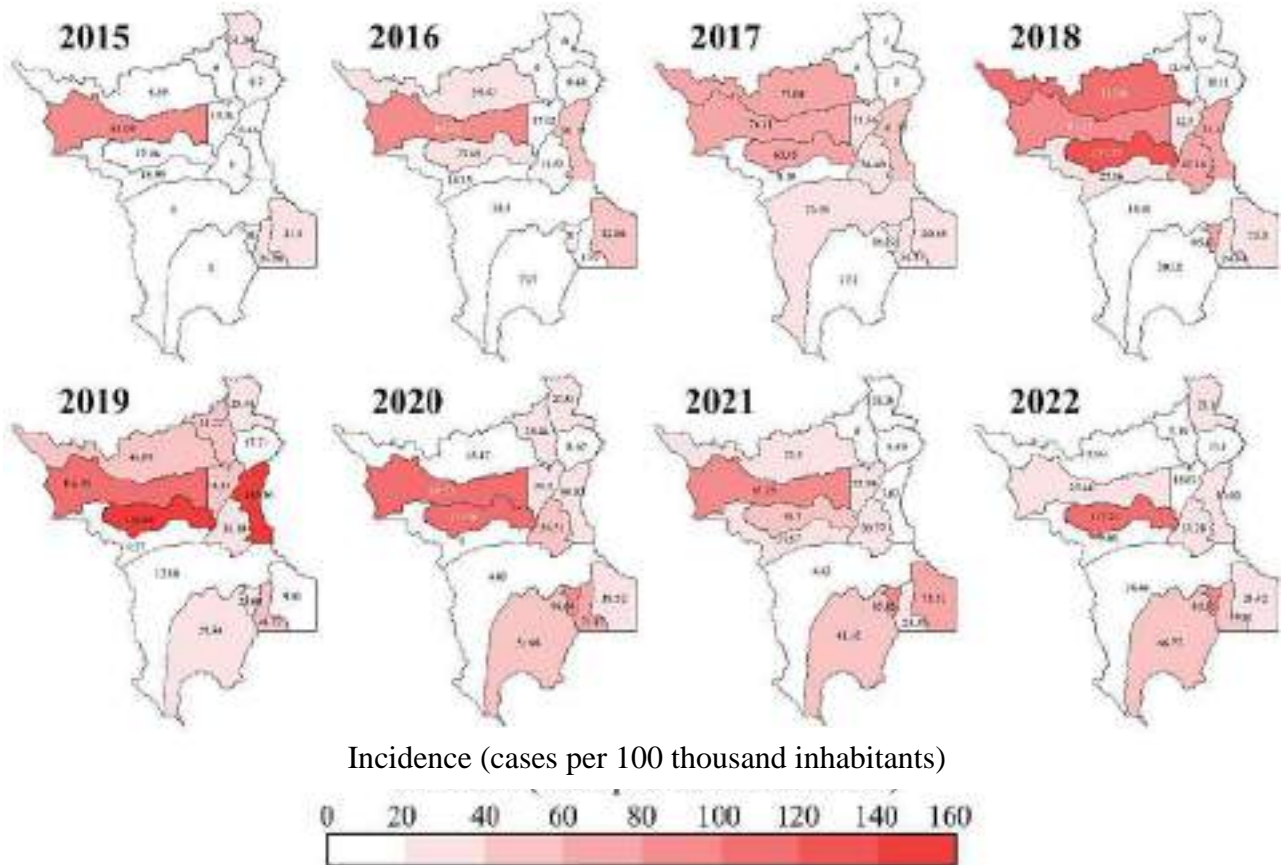


Figure 3 – Evolution of the incidence of scorpion bites per 100,000 inhabitants in the municipalities of the state of Roraima, from 2015 to 2022, based on Tabnet, from the Brazilian Ministry of Health. Source: elaborated by the author from data calculated based on notification data available in DataSUS (consultation carried out on March 17, 2023) and data from the resident population in DataSUS (resident population - study of population estimates by municipality, age and gender 2000- 2020 – Brazil) at <https://datasus.saude.gov.br/população-residente>. Accessed on March 25, 2022) and IBGE^{11,12}.

Table 3– Cumulative evolution of deforestation in the municipality of Rorainópolis.

Year	Historically accumulated deforested area (km ²)	Deforested area in the reference year (km ²)	Historically accumulated percentage of deforested area
2015	1,155.010	23.26	3.44%
2016	1,180.309	25.30	3.51%
2017	1,214.012	33.70	3.61%
2018	1,251.730	37.72	3.73%
2019	1,348.906	97.18	4.02%
2020	1,428.428	79.52	4.25%
2021	1,482.415	53.99	4.41%
2022	1,561.152	78.74	4.65%

Source: TerraBrasilis/INPE. Available at <http://terrabrasilis.dpi.inpe.br/>. Accessed on May 1, 2023.

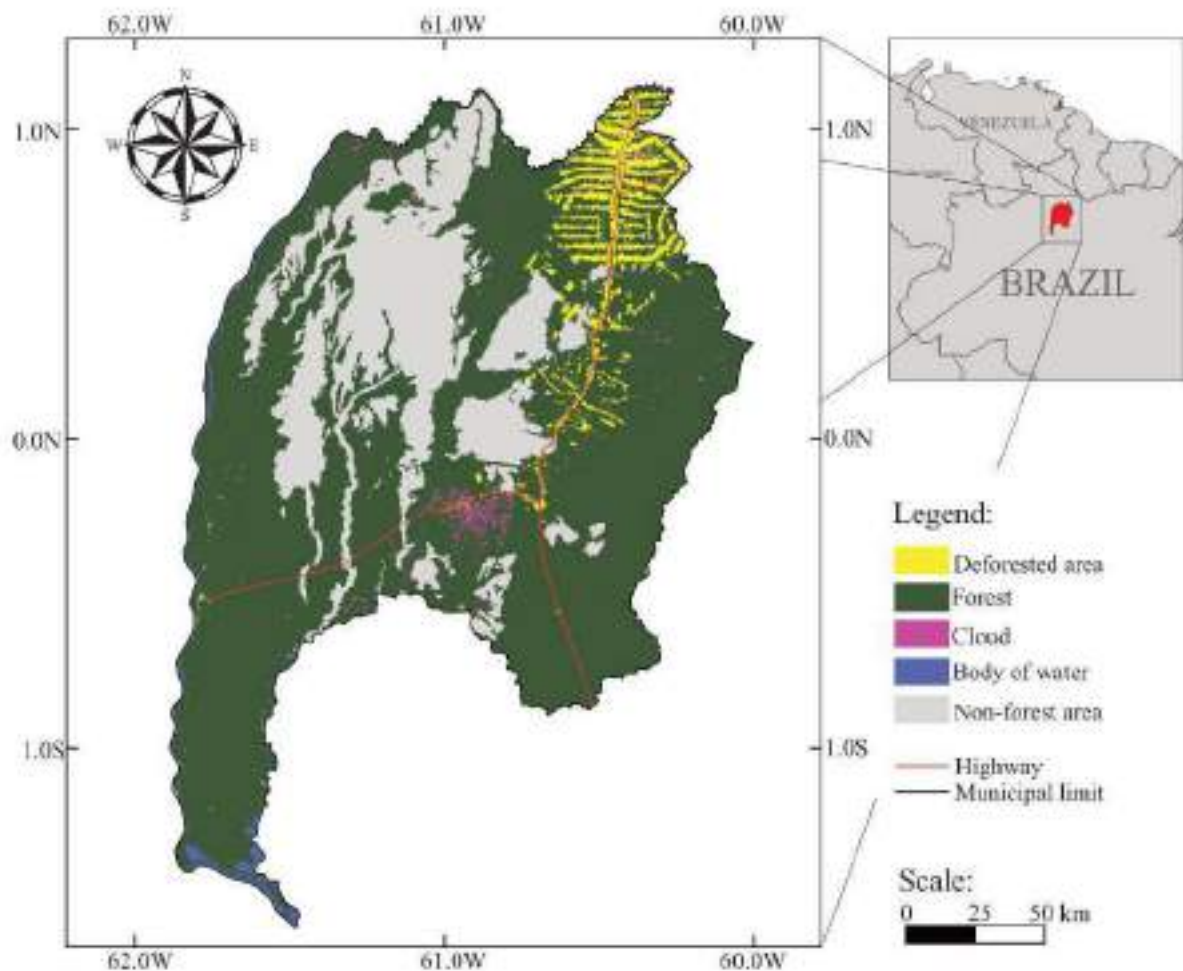


Figure 4 – Deforestation map in the municipality of Rorainópolis up to December 31, 2022. Source: by the author, based on data provided by the Image Processing Division (DPI), of the General Coordination for Earth Observation (OBT) of the National Institute for Space Research (INPE). Available at <http://terrabrasilis.dpi.inpe.br/app/map/deforestation?hl=pt-br>. Accessed on May 8, 2023. Geodetic coordinate system for Latin America - Central America and South America, SIRGAS 2000.

3 ARTICLE 2**Retrospective clinical and epidemiological analysis of scorpionism
in a hospital in Rorainópolis, Roraima, Brazilian Amazon**

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RETROSPECTIVE CLINICAL AND EPIDEMIOLOGICAL ANALYSIS OF SCORPIONISM IN A HOSPITAL IN RORAINÓPOLIS, RORAIMA, BRAZILIAN AMAZON

ABSTRACT

Scorpionism is a major health issue in Brazil, with over 170,000 recorded accidents in 2022 alone. Scorpion stings can cause a range of symptoms, from localized pain to severe complications, particularly in children. Research is needed to improve knowledge, data collection, and patient care in multiple regions, including Roraima. This article focuses on a study in Rorainópolis, south of Roraima, Brazil, analyzing scorpion and venomous animal accidents at Regional Hospital Ottomar de Sousa Pinto from 2015 to 2022. By examining patient records, including personal information, symptoms, examinations, and treatment, the study aims to gain insights into these incidents. Statistical analysis utilized software tools like Excel, Past, and Jamovi, with tests such as Mann-Kendall, Shapiro-Wilk, Mann-Whitney U, Welch, Kruskal-Wallis H, Spearman correlation, Pearson correlation, chi-square, and odds ratio. Out of the expected 60 records, 31 were included. Patients were mainly active males from rural areas with various occupations. Most admissions occurred in the afternoon, and the severity of cases varied, primarily affecting the upper limbs. Vital signs such as heart rate, respiratory rate, and axillary temperature were within normal ranges considering age and gender, and no significant correlation was found among these vital signs. Hospitalization duration did not align with Ministry of Health guidelines. Patients presented local pain varying in intensity, headache, local paresthesia, edema, erythema and warmth, sweating, nausea, vomiting, epigastralgia, and aphasia. Treatment involved analgesics, anti-inflammatories, antihistamines, antihypertensives, and warm compresses. This study provides valuable insights into scorpion envenomation in Rorainópolis, but further research is needed to understand scorpionism in this region better.

Author Summary

Scorpions are creatures with venom, a harmful substance they can inject into humans. When a scorpion stings someone, it can cause serious problems, including intense pain, swelling, allergic reactions, and issues with the nervous system. It can happen anywhere in the world and affect many people, sometimes leading to deaths. Unfortunately, this issue hasn't received much attention from industries. However, governments are starting to pay more attention to the problem. There are still many places, like the municipality of Rorainópolis in the Brazilian Amazon, where we don't know enough about the symptoms and how to treat patients. During our study, we found that more than 60 people were affected by scorpion stings between 2015 and 2022. We analyzed the medical records of half of these people, from the only hospital there. The affected people ranged from children to elderly people, from different backgrounds, jobs, genders, educational levels, and ethnicities. They experienced symptoms like pain, numbness, swelling, headaches, and other related issues, even difficulty speaking. To treat these patients, they were given different medications, including antivenom, a special product used to neutralize the venom. There is still much more to learn about the scorpion problem in Brazil.

INTRODUCTION

Scorpionism, which refers to the condition resulting from scorpion stings, presents significant challenges in the field of medicine and public health in Brazil. It is characterized by a high incidence rate and potential severity in the world [1]. Scorpions are classified as harmful synanthropic fauna [2], posing risks to the economy, environment, and human health in populated areas. The Buthidae family of scorpions is of particular concern due to the composition of their venom and the severity of their envenomation [3].

The World Health Organization recognizes scorpionism as a neglected emerging public health problem with social and economic implications [4–7]. Globally, approximately 1.2 million scorpion accidents occur annually, primarily in tropical regions, and is primarily neglected in low- and middle-income countries, with Mexico having the highest number of accidents [3]. Brazil witnessed over 170,000 accidents in 2022[8].

Scorpion envenomation triggers the release of neurohormonal mediators with systemic vasoconstrictor effects. A critical concentration of venom in the victim's plasma is required to observe typical envenomation characteristics [3]. The venom's action begins immediately after the sting, with symptoms starting as local pain and potentially progressing to serious complications within hours. The effects of released neurotransmitters include sweating, nausea, vomiting, hypersalivation, and restlessness. In severe cases, arrhythmia, unconsciousness, and heart failure can occur, which may be fatal [9]. The venom predominantly affects organs and tissues such as the kidneys, blood, liver, spleen, lung, and heart [10].

The venom's hyaluronidases and other enzymes enhance tissue permeability, facilitating the rapid spread of toxins. Neurohormonal mediators such as epinephrine, norepinephrine, endothelin, and neuropeptide Y contribute to increased arterial and ventricular filling pressure and decreased cardiac output, making children more vulnerable [3,10]. Systemic envenoming can be divided into two phases: the vascular phase, characterized by a transient increase in arterial pressure followed by a hypotensive state, and the myocardial phase, marked by altered contractility, low cardiac output, and hypotension. Although the majority of scorpion sting cases exhibit limited clinical manifestations, around 5% of cases can lead to severe systemic complications, requiring intensive care admission in some instances [3].

In Brazil, according to severity, scorpionism can be classified as mild, moderate, and severe. Mild cases present symptoms such as local pain and paresthesia, while moderate cases involve severe pain accompanied by additional manifestations such as nausea, vomiting, sweating, sialorrhea, agitation, tachypnoea and tachycardia. Severe cases may exhibit profuse vomiting, sweating, sialorrhea, prostration, convulsion, coma, bradycardia, heart failure, pulmonary edema, and/or shock [11]. The release of acetylcholine leads to increased secretions and muscle spasms, while the release of adrenaline and noradrenaline results in increased blood pressure, arrhythmias, vasoconstriction, heart failure, pulmonary edema, and shock. Complications in children often involve pulmonary and cerebral edema [12]. A study by Fereidooni [13], analyzing 703 case reports, identified common symptoms such as pain, swelling, restlessness, fever, sweating, vomiting, priapism, respiratory distress, pulmonary edema, and cardiac abnormalities. Increased troponin T levels were associated with myocarditis.

Torrez et al. [14] emphasize that scorpionism is also a neglected public health issue in Brazil, with increasing cases over time. The fatality rate for victims under 10 years old is 0.32%, while for victims over 75 years old, it is 0.13%. The Cerrado and Caatinga biomes were the most affected by scorpionism from 2010 to 2019, while the Amazon region primarily faced incidents related to snake bites [15]. Guerra-Duarte et al. [16] also observed an upward trend in scorpionism notifications in Brazil. Lopes et al. (2017) conducted an epidemiological study on venomous animal accidents in the North region, emphasizing the need for a better understanding of epidemiology to enhance service conditions and information collection. In western Pará, Oliveira [17] reported a high incidence of scorpion accidents from 2011 to 2015, presenting symptoms resembling electric shocks. In Tocantins, Gonçalves, Vieira, and Modesto [18] found that 80% of cases were mild, primarily affecting adults, between 2007 and 2017.

Despite the recent increase in scorpionism cases, particularly in high-risk regions, comprehensive studies focusing on scorpion accidents in Roraima, compared to other Brazilian states, are deficient. Teixeira and collaborators [19] noted a higher concentration of accidents in the capital, Boa Vista, and hypothesized underreporting in several municipalities. Scorpionism ranked as the second leading cause of venomous animal accidents in the state, accounting for nearly 5% of cases from 2013 to 2016 [20]. Efforts have been made to address the knowledge gap in Roraima, with studies investigating scorpionism in Boa Vista [21] and Rorainópolis [22] revealing mostly mild cases and no deaths. Martins et al. [23] conducted a comprehensive review of cases in the state between 2019 and 2022, identifying 476 cases and highlighting the prevalence of scorpion accidents in urban areas, particularly affecting the feet of victims.

Monteiro et al. [7] emphasize several areas for improvement in understanding and treating scorpionism in the Amazon biome, including describing clinical complications caused by different scorpion species, accurately differentiating clinical presentations in children, identifying risk factors associated with complications, and evaluating the effectiveness of health units in interior municipalities, among others.

Given the limited understanding of scorpionism in the state of Roraima, primarily due to a lack of comprehensive investigations, relying mainly on secondary data made available by the Brazilian Ministry of Health's information systems for all citizens, this study aims to conduct a comprehensive investigation of scorpionism in Rorainópolis beyond the systems, by analysing patient records from the only local hospital available in the municipality. The objective is to gain a pioneering and deeper understanding of scorpionism in the region and its implications in recent years.

METHODS

The research was conducted in the Brazilian Amazon, in the southern region of the state of Roraima, in the municipality of Rorainópolis (Fig. 1). Rorainópolis, with main town located at coordinates 0°56'27.2"N 60°25'42.0"W, covers an extensive area of approximately 33,600 square kilometers and is home to a population of 29,932 inhabitants[24] in the Amazon biome. The municipality is characterized by its dense rainforest vegetation, which exhibits a remarkable abundance of flora. The vegetation is primarily composed of tall, towering trees

that dominate the landscape. Rorainópolis experiences a hot climate, with an average annual temperature of 26°C[25]. The amount of rainfall reaches 1,750 millimeters per year. The northeast region has an equatorial climate with an Af equatorial dry season. Farming and timber industry are the main economic sectors of the municipality [25].

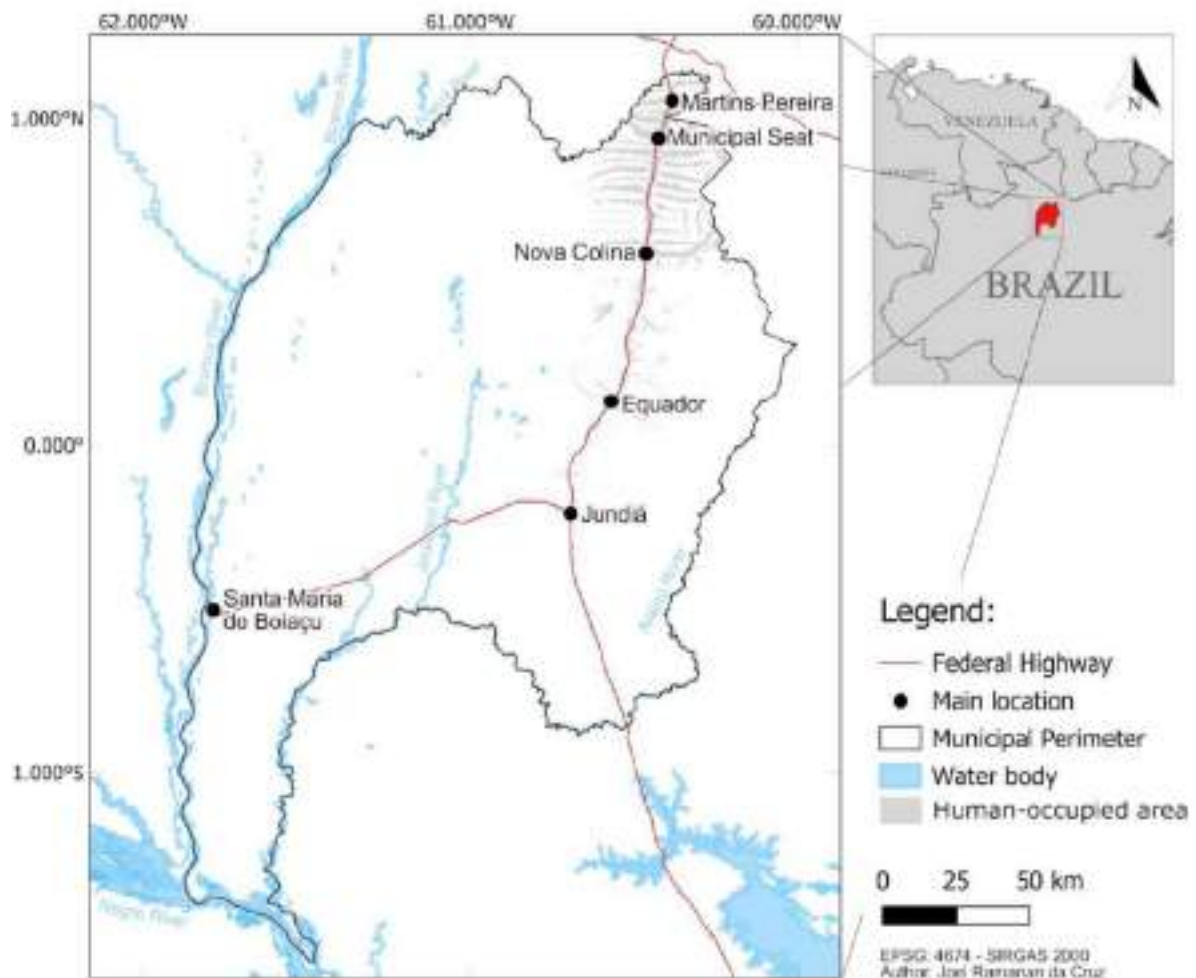


Fig 1 – Map of Rorainópolis

The patient's medical records were consulted regarding cases of accidents by scorpions and other venomous animals reported at the Regional Hospital Ottomar de Sousa Pinto, that is registered in National Registry of Health Establishments under the number CNES 2566141, in the period from 2015 to 2022. The consultation was performed from March 20, 2023 to May 24, 2023. According to the State Health Planning 2020-2023[26], the Ottomar de Sousa Pinto Regional Hospital, located by BR 174, km 461, is managed by the state, performing procedures of up to medium complexity. It performs outpatient, inpatient, therapeutic diagnostic support, emergency and health surveillance services, with a total of 23 registered offices. It is always open and welcomes patients with a flow of spontaneous and referenced demands.

The Hospital does not have an electronic medical record system. The consultation was carried out based on data on accidents previously obtained from the Municipal Health Surveillance on January 9, 2023, based on the names of the patients. Due to the way in which the records are

organized by Medical and Statistical Filing Service, the records were searched according to the following access hierarchy: year of care >> physician responsible for patient care >> month of care >> date of care >> patient's name.

The following variables were surveyed were the patient's personal data (date of birth, age, gender, occupation), and other relevant ones if available, such as: assessment of pain upon admission, local, systemic, autonomic manifestations, neurological exams, physical exams, accident severity classification, premedication, complementary exams, specific treatment, adverse reactions to serum therapy, complementary treatment, hospital discharge conditions. Tabulation and data processing were conducted utilizing some software applications. The Excel application software from the Microsoft Office Professional Plus 2016 package was employed for tabulation purposes. Furthermore, statistical analysis was performed using a combination of software tools, namely Past version 4.03 and Jamovi version 2.3.26. Excel provided a reliable platform for organizing and tabulating the data, while Past and Jamovi offered advanced statistical capabilities for analyzing and interpreting the dataset.

Mann-Kendall test was used to analyze case trends over time. In the statistical tests [27], the Shapiro-Wilk test was used to verify the normality of the data and, for variables with non-normal distribution, the non-parametric Mann-Whitney U and Welch tests were used for two groups and Kruskal-Wallis H for more groups. Comparing data from variables with more than two groups, when non-parametric tests showed significant differences, the Dunn test was used [28]. The Spearmann correlation test [29] was performed for variables with non-normal distribution, and Pearson correlation test was performed for variables with normal distribution, to determine the correlation between the variables considered in this study. The chi-square test was utilized in this analysis to examine the potential associations or dependencies between categorical variables. Odds ratio was used to quantify the strength and direction of the association between two categorical variables. The statistical probability adopted for all tests was " $p < 0.05$ ".

The periods of the day were classified according to the Brazilian culture and to the Brazilian Federal Senate (Available at: <https://www12.senado.leg.br/manualdecomunicacao/estilos>. Accessed on June 1, 2023): morning (6h00-11h59), afternoon (12h00-17h59), evening/night (18h00-23h59), and late night (0h00-5h59).

Blood pressure and respiratory rate classification was made according to Table 1 and 2, respectively.

Table 1– Blood pressure classification.

Category	Systolic pressure (mmHg)	and/or	Diastolic pressure (mmHg)
Low	<90	or	<60
Normal	<120	and	<80
Elevated	120-129	and	<80
Hypertension Stage 1	130-139	or	80-89
Hypertension Stage 2	≥ 140	or	≥ 90
Hypertensive crisis	>180	and/or	≥ 120

Sources: American Heart Association [30] and Gardner [31]

Table 2 – Range of age and the normal respiratory rates.

Age range	Normal respiratory rate values (breaths per minute)
<1 year	30 a 60
1-3 years	24 a 40
4-5 years	22 a 34
6-12 years	18 a 30
13-18 years	12 a 16
Adults	12 a 20

Source: Potter, Perry (2017) *apud* [32].

None of the victims transported the scorpions responsible for the accidents to the hospital, and the specific species of scorpions involved remains unidentified. Moreover, the present study adhered to the ethical guidelines set forth by the Brazilian National Health Council. Prior to commencing the study, approval was obtained from the ethics committee at the Federal University of Roraima (Approval number: 5.251.710).

RESULTS

Patient's records quantity

The search for medical records spanned a duration of 12 days, resulting in the identification of valid 31 records. These records were sourced from various years, comprising 8 records from 2020, 11 records from 2021, and an additional 12 records from 2022. Considering the expected total of 60 records based on the reported number of scorpion accidents by the Municipal Health Surveillance, the discovered records accounted for 51.7% of the anticipated total for the period spanning from 2015 to 2022, specifically from 2020 to 2022.

The systematic search of the medical records was conducted, involving at least three rounds of examination. However, some challenges were encountered during the process. The medical records from 2019 and previous years and part of 2020 were stored separately in a different room, and unfortunately, they had suffered damage due to exposure to rain and mould. As a result, it was challenging to access and search for at least 19 records, which accounted for approximately 31.67% of the expected total.

Profile of victims

Data extracted from the patient's records are part from SINAN (Tables 3 and 4). It is noteworthy that the majority of individuals identified as victims in these records belonged to the active working group, constituting 80.6% of the total cases in patient's records. Most of the patients were from rural areas and most also were male people (Fig. 2).

Table 3 – Age group of all victims of scorpions that occurred in Rorainópolis-Roraima in the period from 2020 to 2022, with their absolute frequency (F_i) and relative frequency over the total number of cases (FR%), based on the medical records from the Ottomar de Souza Pinto General Hospital.

Age group	F_i	FR%
1 – 4	2	6.25%
5 – 9	3	9.68%
10 – 14	0	0.00%
15 – 19	4	12.90%
20 – 39	12	38.71%
40 – 59	9	29.03%
60 – 64	0	0.00%
65 – 69	1	3.23%
Total	31	100.00%

Source: this study

Table 4 - Absolute frequency (F_i) and percentage of age groups victims of scorpionism in Rorainópolis from 2020 to 2022, based on the medical records from the Ottomar de Souza Pinto General Hospital. The percentage values are for the group in relation to the total number of accidents ($n=31$).

Group	Age range (years)	Classification reference	F_i	Percentage
Early children	0-6	Federal Law no. 13,257/2016	3	9.67%
Children	0-11	Federal Law no. 8.609/1990	5	16.13%
Teenagers	12-18	Federal Law no. 8.609/1990	4	12.90%
Young people	15-29	Federal Law no. 12.852/2013	10	32.26%
Adults	30-59	By exclusion and convention	15	48.39%
Elderly	≥ 60	Federal Law no. 10.741/2003	1	3.22%

Source: this study.

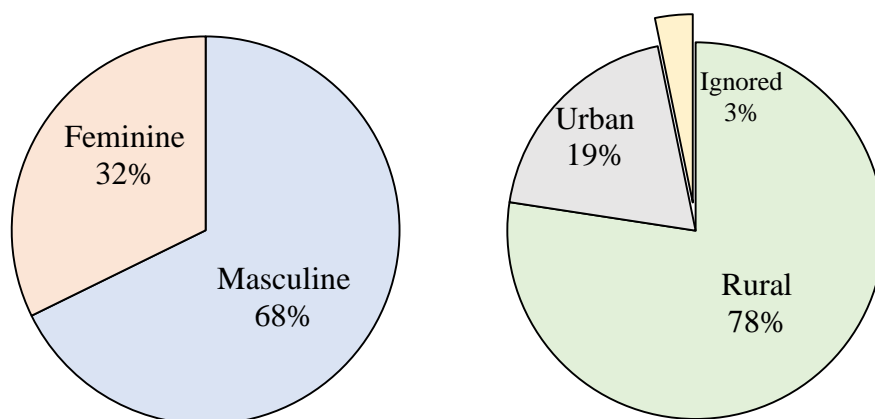


Fig 2 – Gender and residence area distribution of scorpionism victims based on the medical records collected at the Ottomar de Souza Pinto General Hospital from 2020 to 2022 ($n=31$). Source: this study.

Scorpionism affected a great diversity of workers (Fig. 3). Among these, farmers and students stood out, accounting for approximately 25% of the total number of victims. Notably, 35.5% of the records did not inform the victim's occupation. Despite these data, only one case (3.2%) was reported as a work accident.

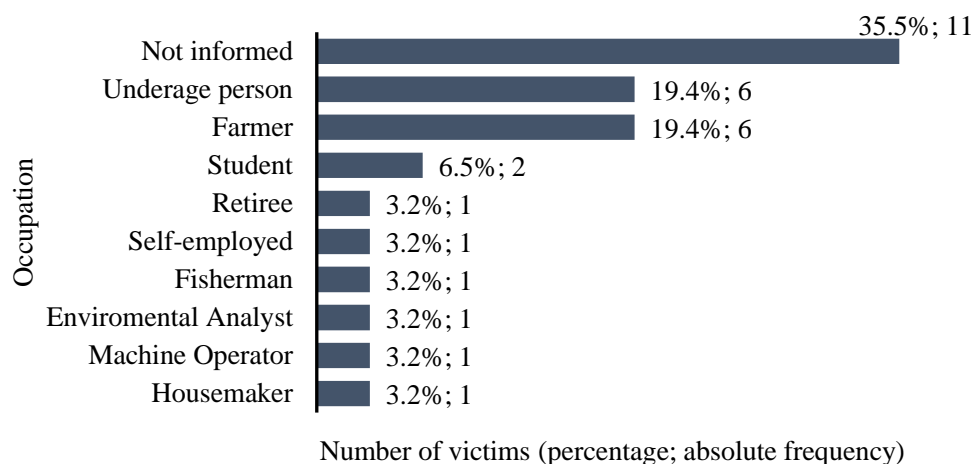


Fig 3 – Occupation distribution of scorpionism victims based on the medical records collected at the Ottomar de Souza Pinto General Hospital from 2020 to 2022 (n=31). Source: this study.

Time of admissions of accidents

Based on the comprehensive analysis of scorpionism patient records, it was observed that admissions were recorded for every month throughout the year, with exceptions being the month of August and December (Table 5).

Table 5 - Absolute frequency of scorpionism victim's admittance in Rorainópolis from 2020 to 2022, based on the medical records from the Ottomar de Souza Pinto General Hospital (n=31).

Month	2020	2021	2022	Total	FR%
January	1	3	-	4	12.9%
February	1	1	-	2	6.5%
March	2	-	1	3	9.7%
April	-	2	4	6	19.4%
May	-	2	4	6	19.4%
June	-	1	-	1	3.2%
July	-	2	-	2	6.5%
August	-	-	-	-	0.0%
September	-	-	1	1	3.2%
October	2	-	2	4	12.9%
November	2	-	-	2	6.5%
December	-	-	-	-	0.0%
Total	8	11	12	31	100.0%

Source: this study.

According to the data represented in Fig. 4 and 5, the majority of scorpion victims were admitted to the hospital during the afternoon period, constituting 49% of the cases. Subsequently, the evening/night period accounted for 26% of admissions, while the morning period represented 19% of cases. Remarkably, the late-night period had the lowest admission rate, comprising only 3% of the total. It is worth noting that one medical record did not provide information regarding the specific time of admission, which could potentially impact the accuracy of the distribution across time periods.

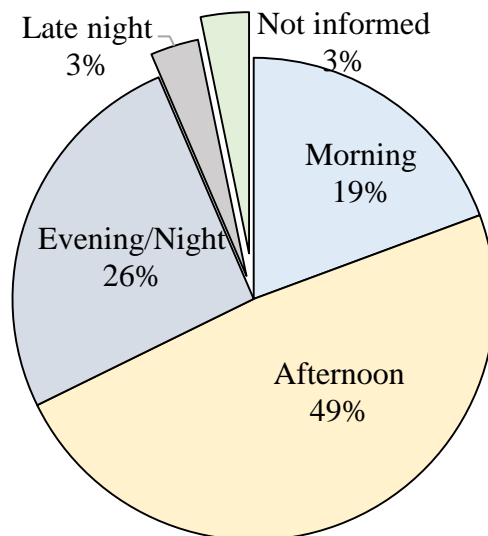


Fig 4 – Admittance period of the day and into the Hospital of scorpionism victims based on the medical records collected at the Ottomar de Souza Pinto General Hospital from 2020 to 2022 (n=31). Source: this study.

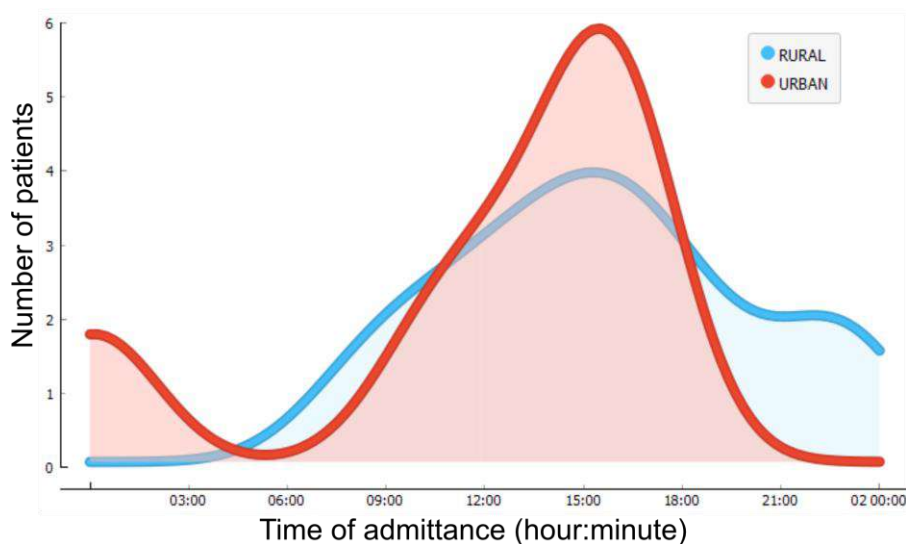


Fig 5– Time of admittance into Hospital of scorpionism victims according to home zone, based on the medical records collected at the Ottomar de Souza Pinto General Hospital from 2020 to 2022 (n=31). Source: this study.

Case severity

Several factors contribute to the severity of envenomation, including the age and weight of the victim, as well as the development of systemic manifestations [10]. In the context of scorpionism severity, out of the 31 patients' records analysed, 21 cases (67.74%) were classified as mild, while 10 cases (32.26%) were considered moderate (Fig. 6), considering Brasil [11]'s classification guidelines. Among these cases, the involvement of a “black scorpion” (*escorpião preto* in Portuguese) was noted in four instances, with two being classified as mild and two as moderate.

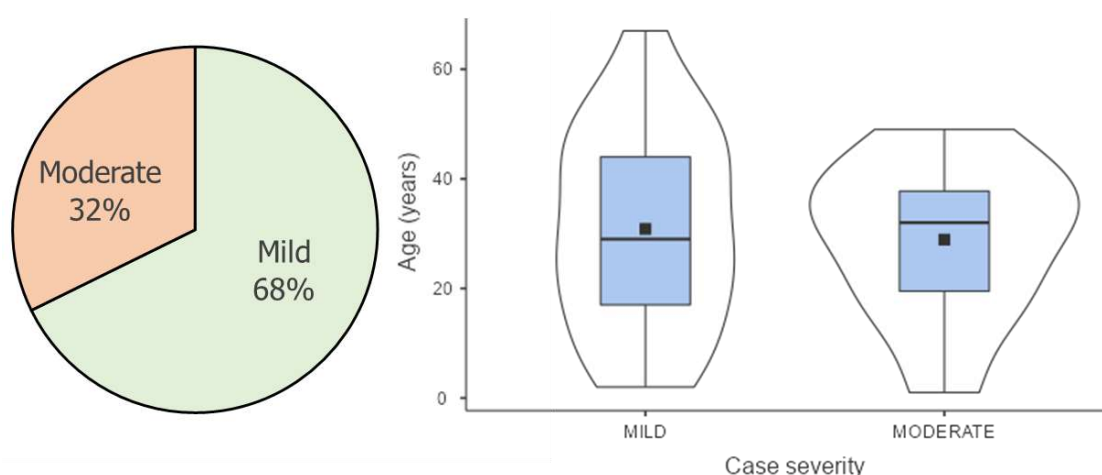


Fig 6 – Case severity (left) and patients' age distributed by case severity (right), based on the medical records collected after first medication at the Ottomar de Souza Pinto General Hospital in Rorainópolis/Roraima from 2020 to 2022. Source: this study.

The results of both the Welch-t and Mann-Whitney tests indicated that there were no statistically significant differences in ages between the two severity categories. The Welch-t test yielded a t-value of 0.322 and a p-value of 0.750, while the Mann-Whitney test produced a U-value of 99.5 and a p-value of 0.833. The chi-square test was conducted to investigate the relationship between the victim's gender and the severity of envenomation. The results of the test revealed a chi-square statistic of $\chi^2=1.1744$, accompanied by a p-value of 0.27849.

Anatomical sting site

According to the records, in most of the cases, the patient's upper limbs were the most affected anatomical site in scorpionism (Fig. 7).

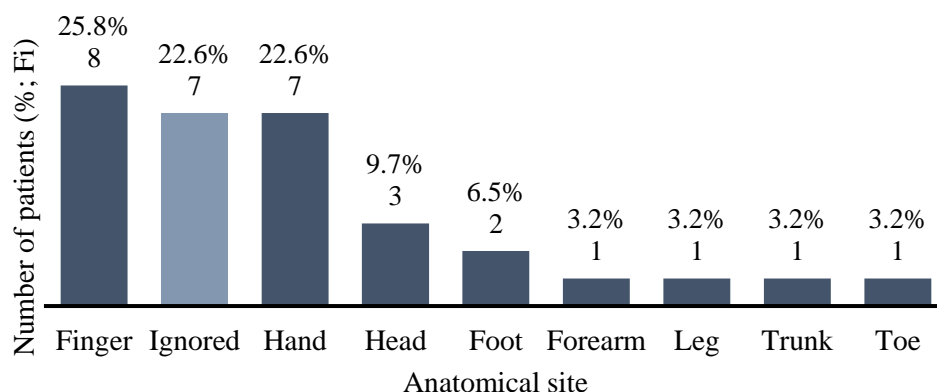


Fig 7 – Victim’s body parts affected by scorpionism based on the medical records collected at the Ottomar de Souza Pinto General Hospital from 2020 to 2022 (n=31). Source: this study.

Vital signs measurements

As part of standard procedure, vital signs of all patients were recorded by the professionals upon their admission to the hospital, as well as after the administration of their initial medication. These vital signs can be found in Table 6.

Table 6 – Vital sign values from scorpion patients in Rorainópolis from 2020 to 2022, based on the medical records from the Governor Ottomar de Souza Pinto General Hospital (n=31).

Patient's record number	Age (year)	Gender	Blood pressure upon admittance (Syst./Diast.) (mmHg)	Temperature upon admittance (°C)	Systolic pressure* (mmHg)	Diastolic pressure* (mmHg)	Temperature* (°C)	Heart beat rate* (bpm)	Respiratory rate* (bpm)
1	17	F	116/65	36	–	–	–	–	–
2	43	M	150/80	36	120	80	36	64	20
3	18	M	140/80	–	120	60	36	78	20
4	44	M	130/80	36	130	90	36	85	–
5	21	F	120/80	36	–	–	–	–	–
6	53	M	–	–	–	–	–	–	–
7	15	M	100/60	36.2	–	–	–	–	–
8	24	M	130/70	–	100	70	36.7	77	20
9	21	M	126/66	36	120	90	36.1	78	20
10	37	M	120/70	36.6	–	–	–	–	–
11	7	F	–	36	–	–	35.6	109	26
12	42	M	150/90	36.2	115	74	36.6	89	19
13	33	M	137/97	35.5	–	–	–	–	–
14	27	F	130/80	–	–	–	–	–	–
15	1	M	–	35.2	–	–	–	–	–
16	31	F	120/90	35	–	–	–	–	–
17	31	M	140/80	37.1	140	70	37.1	80	24
18	15	M	110/80	36.4	–	–	–	–	–
19	2	F	–	–	–	–	36	119	40
20	48	M	115/100	32.1	–	–	–	–	–
21	5	F	–	–	–	–	–	–	–
22	67	M	150/90	36.3	–	–	–	–	–
23	50	M	160/90	36.3	156	90	–	–	–
24	27	F	110/70	37	110	70	35.8	93	20
25	29	F	130/90	–	–	–	–	–	–
26	37	M	90/60	36	–	–	–	–	–

Patient's record number	Age (year)	Gender	Blood pressure upon admittance (Syst./Diast.) (mmHg)	Temperature upon admittance (°C)	Systolic pressure* (mmHg)	Diastolic pressure* (mmHg)	Temperature* (°C)	Heart beat rate* (bpm)	Respiratory rate* (bpm)
27	38	M	120/80	—	—	—	—	—	—
28	42	M	112/80	36.4	—	—	—	—	—
29	54	M	110/70	36.2	—	—	—	—	—
30	9	M	—	—	—	—	36.1	81	23
31	49	F	120/70	36	—	—	—	—	—

*Values from the first measurement taken after the first medication administration. Source: this study.

Blood pressure

The systolic pressure among the scorpion patients ranged from 90 mmHg to 160 mmHg, with a median value of 125.44 mmHg (Figures 8-11). On the other hand, the diastolic pressure exhibited a variation from 60 mmHg to 100 mmHg, with a median value of 78.72 mmHg. The mean systolic pressure was measured to be 125.44 ± 16.82 mmHg, while the mean diastolic pressure was recorded as 78.72 ± 10.93 mmHg.

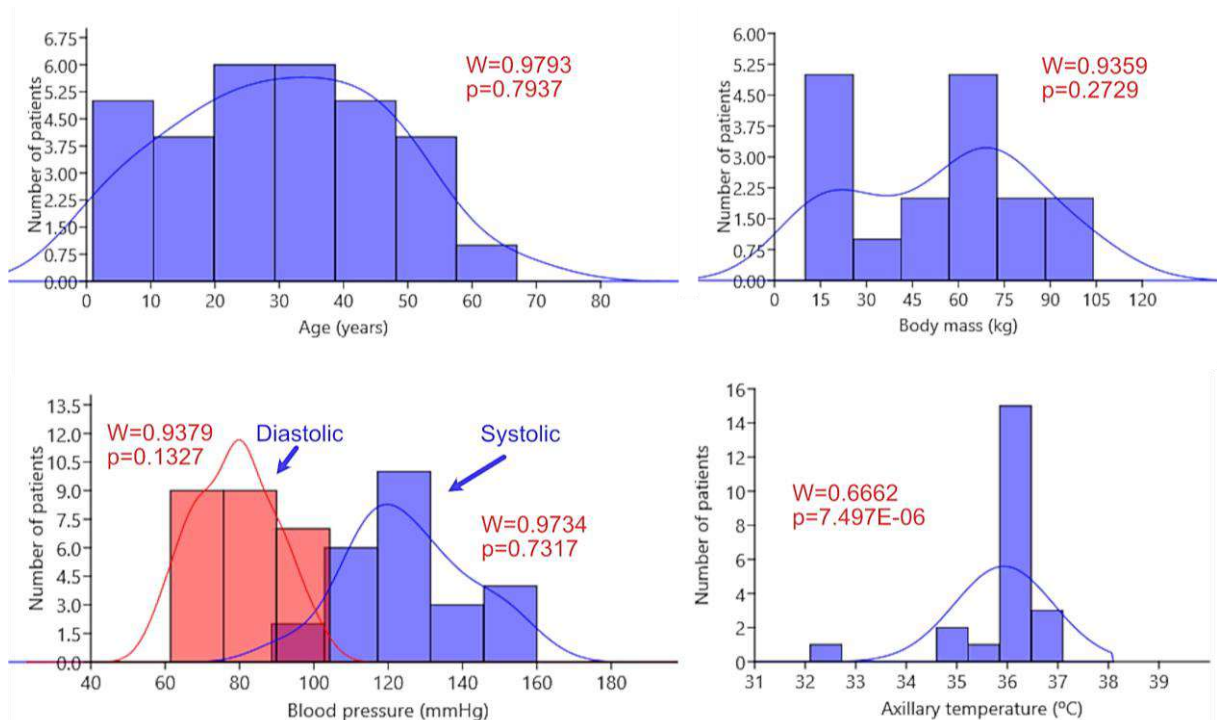


Fig 8 - Vital signs and other characteristics of scorpion patients in Rorainópolis from 2020 to 2022, extracted from records of Ottomar de Souza Pinto General Hospital, with Kernel-density curves and normality curve, and Shapiro-Wilk test results (in red). The patient count for each parameter is as follows: temperature (n=22), body mass (n=17), systolic blood pressure (n=25), diastolic blood pressure (n=25), and age (n=31). Source: this study.

The systolic pressure among the scorpion patients ranged from 90 mmHg to 160 mmHg, with a median value of 125.44 mmHg. On the other hand, the diastolic pressure exhibited a variation from 60 mmHg to 100 mmHg, with a median value of 78.72 mmHg.

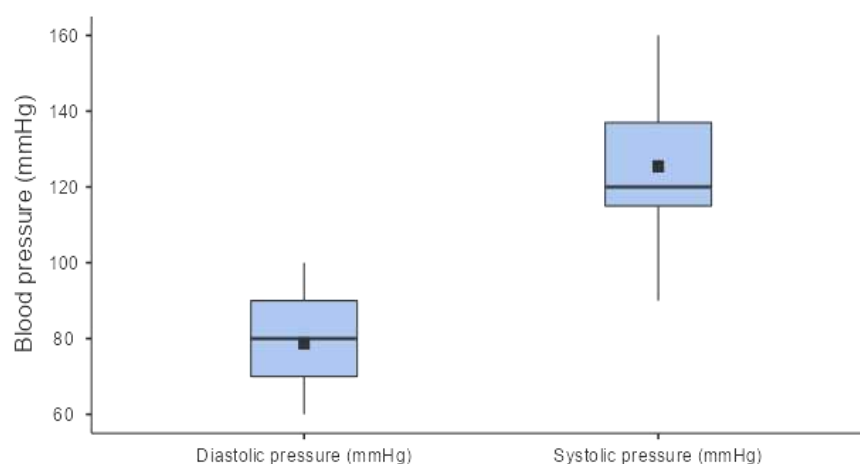


Fig 9 – Scorpionism victim’s blood pressure based on the medical records collected at the Ottomar de Souza Pinto General Hospital from 2020 to 2022 (n=26). Source: this study.

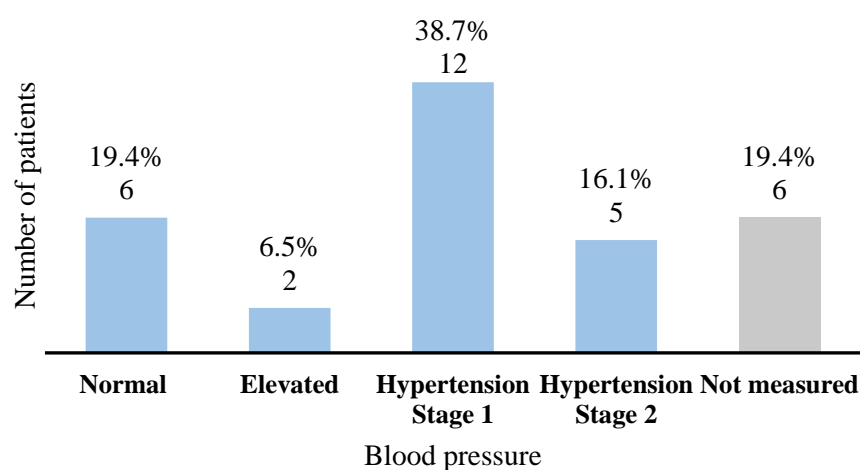


Fig 10 – Scorpionism victim’s blood pressure according to the medical records collected at the Ottomar de Souza Pinto General Hospital from 2020 to 2022 (n=31). Classification according to the American Heart Association [30]. Source: this study.

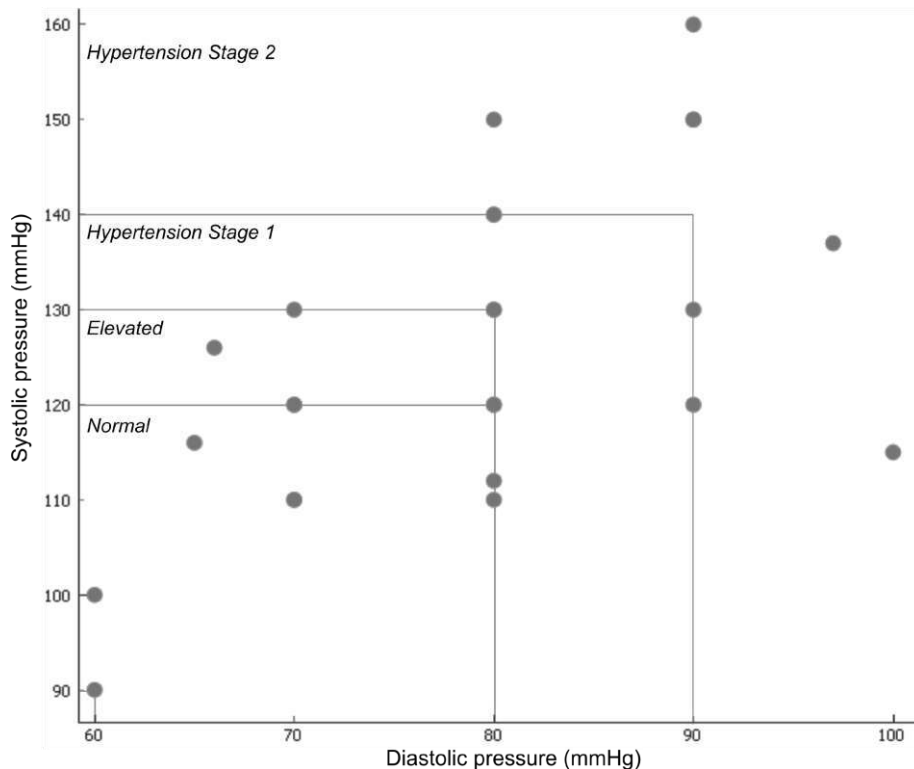


Fig 11 – Scorpionism victim’s blood pressure based on the medical records collected at the Governor Ottomar de Sousa Pinto South Regional Hospital from 2020 to 2022 (n=25).
Source: this study.

Based on the results of the Spearman correlation test, there was no statistically significant correlation found between age and systolic/diastolic pressure values. The Spearman correlation coefficient (r_s) for age and systolic pressure was 0.272 with a p-value of 0.188, suggesting a weak positive correlation that did not reach statistical significance. Similarly, the correlation coefficient for age and diastolic pressure was 0.378 with a p-value of 0.063, indicating a weak positive correlation that also did not reach statistical significance.

No statistically significant gender differences were found in systolic pressure (Mann-Whitney $U = 50.0$, p-value = 0.446) and diastolic pressure (Mann-Whitney $U = 59.0$, p-value = 0.827) using the Mann-Whitney test. Similarly, the Welch-T test did not reveal any significant differences in systolic pressure ($t = -1.205$, $p = 0.241$) and diastolic pressure ($t = -0.258$, p-value = 0.800) when considering 18 male patients and 8 female patients. The chi-square test was conducted to assess the relationship between case severity and blood pressure classification. The test yielded a chi-square statistic of 5.8929 with a corresponding p-value of 0.11694. The chi-square test was also performed to examine the relationship between gender and blood pressure classification. The test revealed a chi-square statistic of 1.9225 with a corresponding p-value of 0.58812. The relationship between blood pressure and case severity is illustrated in the following figures.

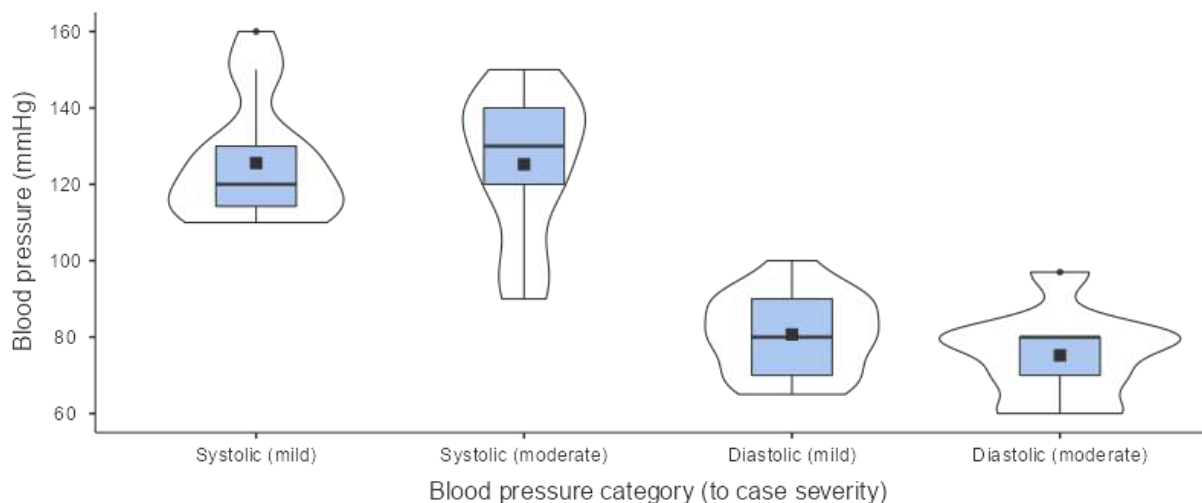


Fig 12 – Scorpionism victim’s blood pressure values at admittance according to case severity (n=26), based on the medical records collected at the Governor Ottomar de Sousa Pinto South Regional Hospital in Rorainópolis from 2020 to 2022. Source: this study.

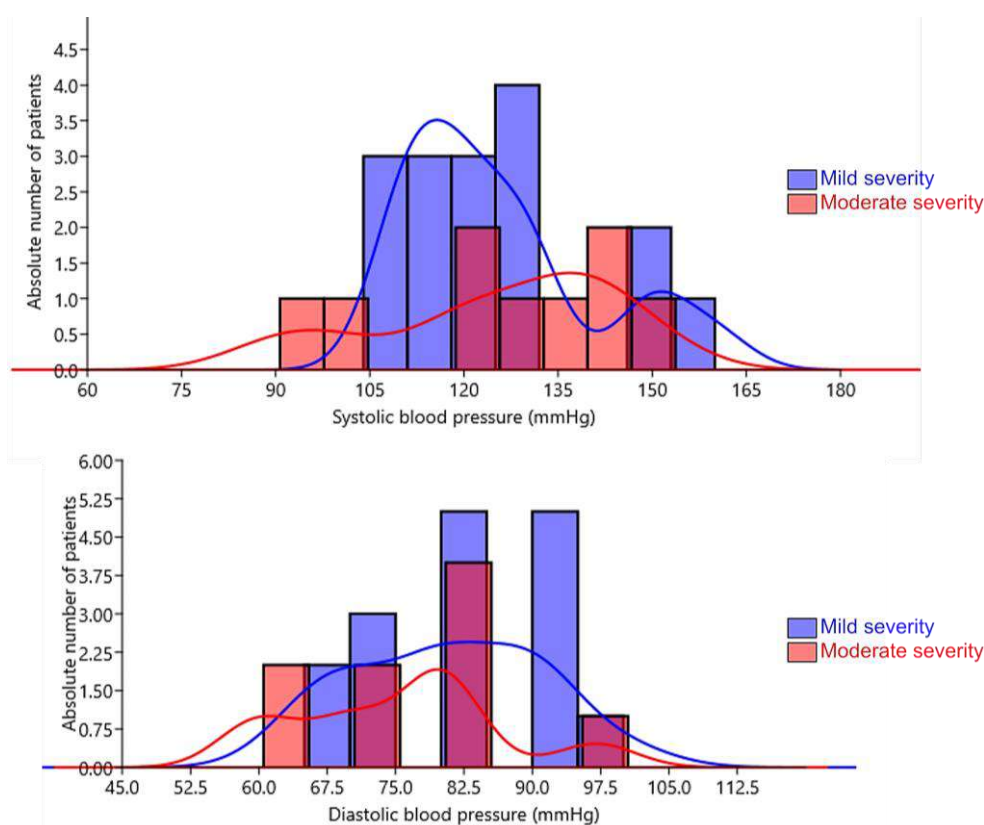


Fig. 13 – Scorpionism victim’s blood pressure values at admittance according to case severity (n=26), based on the medical records collected at the Governor Ottomar de Sousa Pinto South Regional Hospital in Rorainópolis from 2020 to 2022. Source: this study.

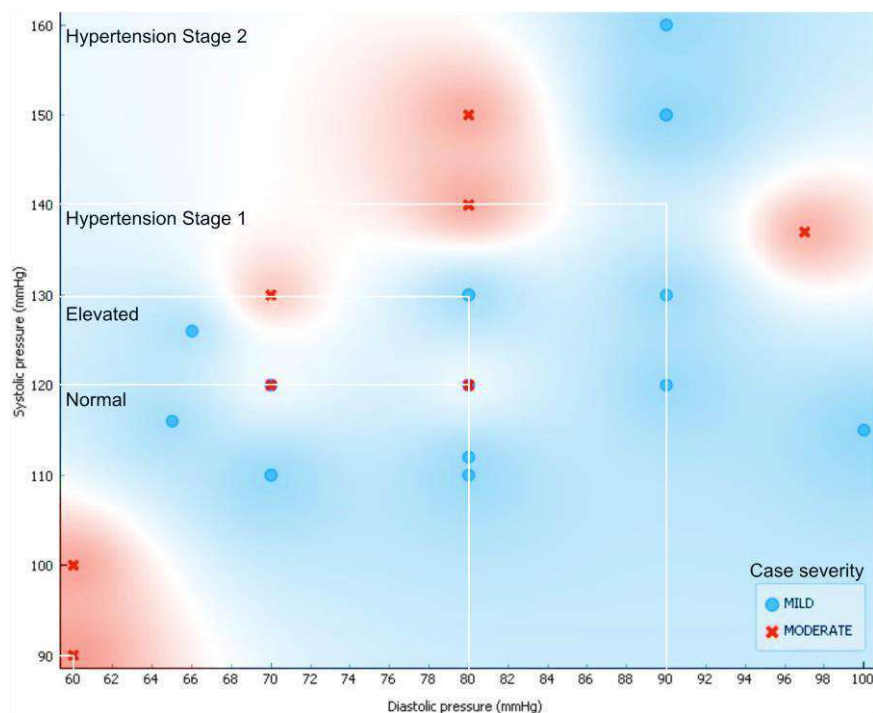


Fig 14 – Scorpionism victim’s blood pressure values at admittance according to case severity (n=26), based on the medical records collected at the Governor Ottomar de Sousa Pinto South Regional Hospital in Rorainópolis from 2020 to 2022. Source: this study.

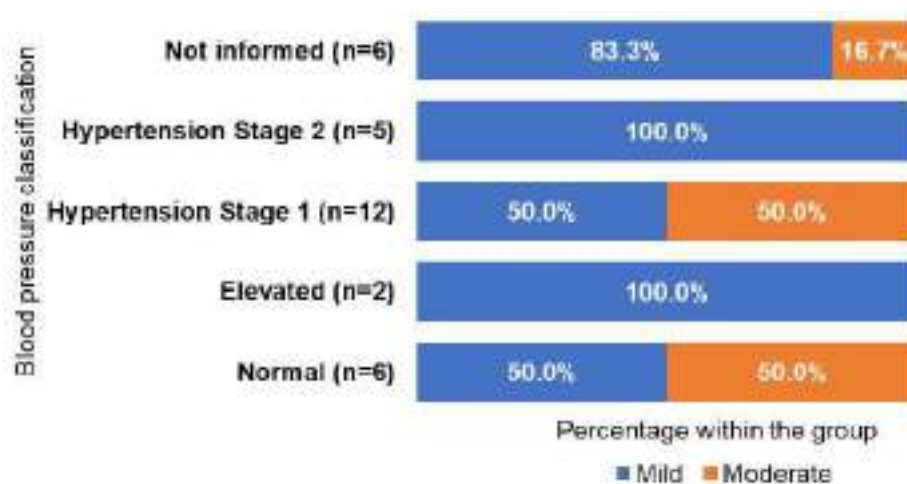


Fig 15 – Scorpionism victim’s blood pressure values at admittance according to case severity (n=31), based on the medical records collected at the Governor Ottomar de Sousa Pinto South Regional Hospital in Rorainópolis from 2020 to 2022. Source: this study.

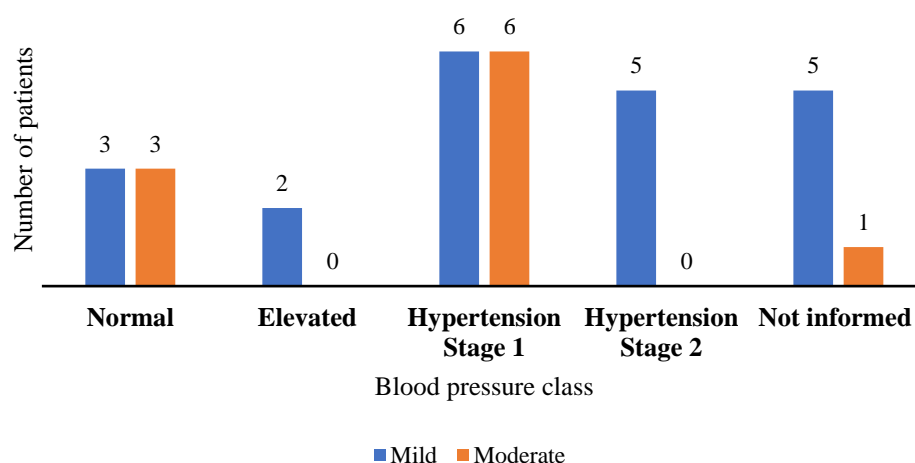


Fig 16 – Scorpionism victim’s blood pressure values at admittance according to case severity (n=31), based on the medical records collected at the Governor Ottomar de Sousa Pinto South Regional Hospital in Rorainópolis from 2020 to 2022. Source: this study.

Based on the data presented in Figures 12-16, a noticeable trend emerges, suggesting that scorpion patients with moderate severity cases exhibit higher systolic blood pressure compared to those with other severity levels. Additionally, patients with moderate severity cases also displayed the lowest values of blood pressure. However, systolic blood pressure analysis revealed no statistically significant differences based on the severity of the cases, as indicated by both the Welch t-test ($t=0.0444$, $p\text{-value}=0.965$) and the Mann-Whitney test ($U=64.5$, $p\text{-value}=0.690$). Similarly, the analysis of diastolic blood pressure in scorpion patients did not exhibit any significant variations (Welch t-test: $t=1.1713$, $p\text{-value}=0.260$; Mann-Whitney test: $U=52.0$, $p\text{-value}=0.254$).

The odds ratio test was performed to examine the relationship between the patient’s blood pressure (normal and high) and case severity (mild and moderate). The resulting odds ratio was 1.8, indicating that patients with moderate severity of scorpionism have 1.8 times higher odds of having high blood pressure compared to those with mild clinical manifestations. The association between the severity of scorpionism and high blood pressure is not statistically significant based on the sample of this study. The odds ratio was calculated with a 95% confidence interval of 0.3044 to 10.64, a z-score of 0.64822, and a p-value of 0.517.

Body temperature

According to the survey of 31 scorpion patients’ records, temperature measurements were taken for 22 of them at hospital admittance. It was found that all 22 patients had normal body temperature, ranging from 32.1°C to 37.1°C, indicating a mean value of approximately 35.9°C±0.98°C (Fig. 17). Moreover, the temperatures of 11 patients were measured after the administration of medication, ranging from 35.6°C to 37.1°C, with a mean value of 36.2±0.438.

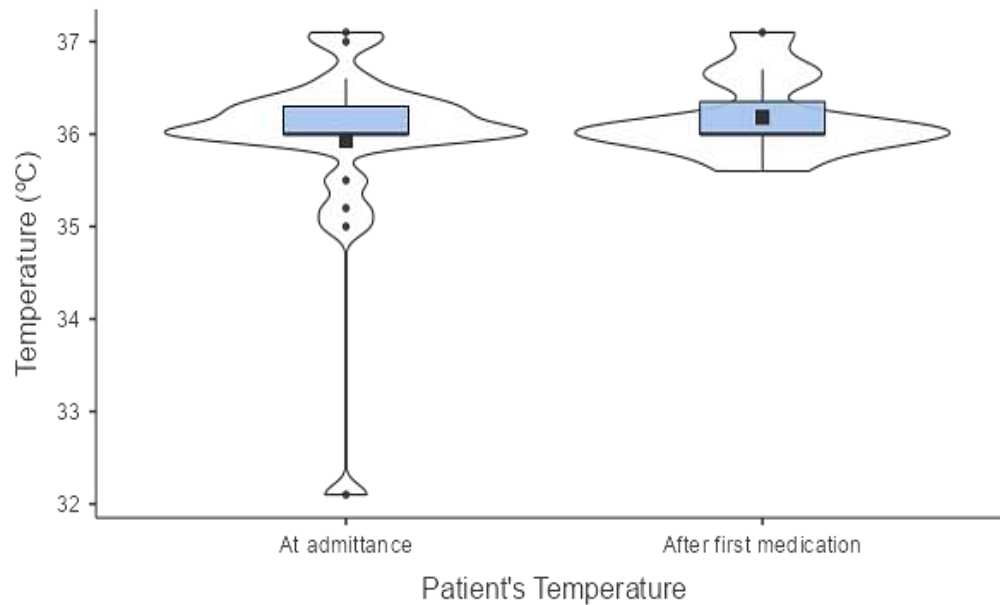


Fig 17 – Scorpionism victim’s temperature based on the medical records collected at the Governor Ottomar de Sousa Pinto South Regional Hospital from 2020 to 2022 (n=22 and n=11, respectively). Source: this study.

The temperature of patients upon admission was found to follow a normal distribution ($W=0.6733$, $p<0.001$). Both Welch test and Mann-Whitney U test did not show any statistically significant differences of temperature at admittance according to gender ($t=0.249$ and $p=0.807$, and $U=36.0$ and $p=0.384$).

Seven patients, which accounted for 35.48% of the total sample, had their temperatures carefully monitored upon admission and following the initial administration of medication (Fig. 56). The recorded temperature fluctuations varied between -1.2°C and $+0.4^{\circ}\text{C}$, demonstrating a range of responses. The mean temperature change observed among these patients was $-0.157^{\circ}\text{C} \pm 0.516^{\circ}\text{C}$.

A specific subset of the patient records, consisting of six cases out of the total 31 (thus, 19.35%), was analysed to evaluate temperature variations over time. This analysis focused on the elapsed time between the initial temperature measurement upon admission and the subsequent measurement following the administration of the first medication. The findings from this subset reveal that there is no statistically significant correlation between these variables ($r_s=0.7333$ and $p\text{-value}=0.212$).

Heart beat rate

In addition to temperature measurements, heart rate data was also collected from a subset of scorpion patients. Out of the total 31 patients, heart rate measurements were available for 11 individuals. Following medication administration, the recorded heart rates exhibited a range of variability, spanning from 64 beats per minute (bpm) to 119 bpm. The mean heart rate observed among these 11 patients was approximately $86.63 \text{ bpm} \pm 15.57 \text{ bpm}$ (Fig. 18).

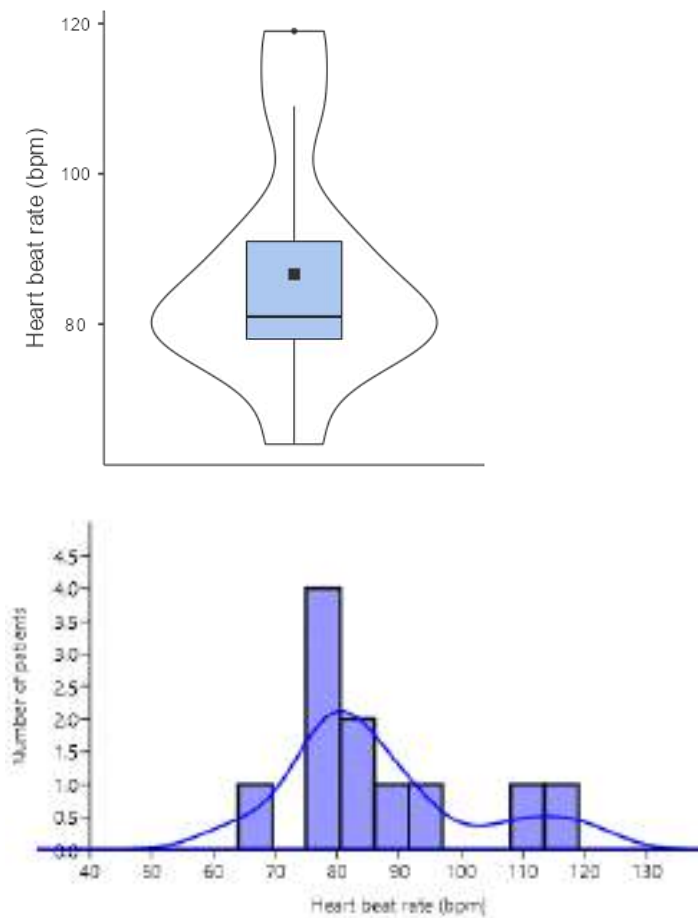


Fig 18 - Heart beat rate from scorpion patients after the first administration of medication (n=11), based on the medical records collected at the Governor Ottomar de Sousa Pinto South Regional Hospital from 2020 to 2022. Source: this study.

Based on the data presented in Table 6 and Fig. 18, a detailed analysis of the heart rate measurements after medication administration from the 11 patients revealed interesting patterns related to the patients' age and the occurrence of bradycardia and tachycardia. Notably, no instances of bradycardia or tachycardia were observed among the 11 patients as a whole. However, when considering the specific age groups, it was observed that adult scorpion patients displayed relatively lower heart rates, with readings above 70 beats per minute (bpm). In one particular case, an adult patient exhibited bradycardia, with a heart rate of 59 bpm recorded six hours after the initial measurement, indicating a significant decrease in heart rate.

Respiratory rate

The respiratory rates of 10 patients were measured after the first medication (Fig. 19), yielding a mean value of 21.33 ± 2.40 breaths per minute. All of them were normal, except one (10%) 31-year-old patient with 24 breaths per minute rate, thus, with tachypnoea. It is worth noting that one outlier was observed, with a normal respiratory rate of 40 breaths per minute, which belonged to a 2-year-old patient. This exceptional value highlights the importance of considering age-specific variations in respiratory rates.

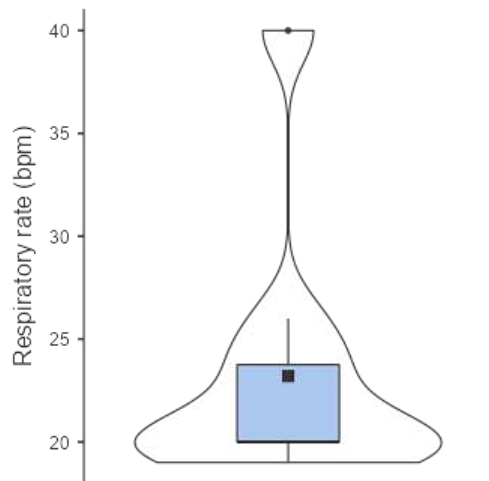


Fig 19 – Respiratory rate from scorpion patients after the first administration of medication (n=10), based on the medical records collected at the Governor Ottomar de Sousa Pinto South Regional Hospital in Rorainópolis from 2020 to 2022. Source: this study.

Correlation between variables

The correlation test between respiratory and heart beat rates was possible for 10 patients (32.26%, Fig. 20). Although it is widely recognized that there is a direct correlation between these variables [33], the findings from our research did not demonstrate a statistically significant correlation by Spearman's test ($r_s=0.512$ and $p\text{-value}=0.130$). The correlation between heart beat rates and body temperature was possible for 11 patients (34.37%, Fig. 21). However, the Spearman's test results indicated that there was no statistically significant correlation between these variables either ($r_s=-0.453$ and $p\text{-value}=0.161$).

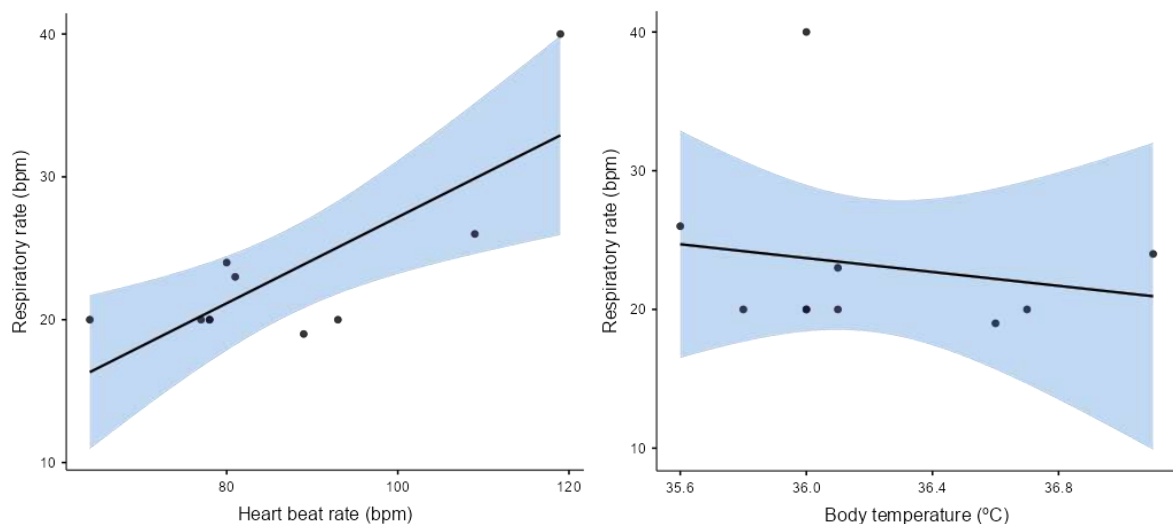


Fig 20 – Dispersion between respiratory and heart beat rates, and body temperature values, based on the medical records collected after first medication at the Governor Ottomar de Sousa Pinto South Regional Hospital in Rorainópolis from 2020 to 2022. Source: this study.

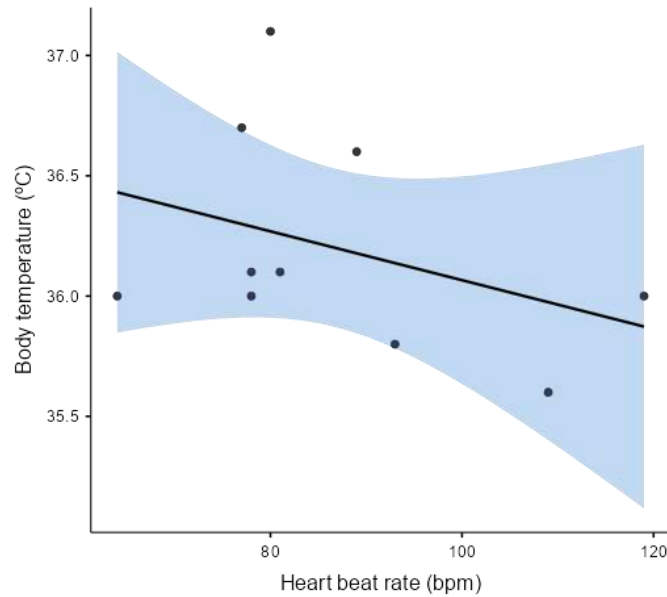


Fig 21 – Dispersion between heart beat rate and body temperature values based on the medical records collected after first medication at the Governor Ottomar de Sousa Pinto South Regional Hospital in Rorainópolis from 2020 to 2022. Source: this study.

When assessing the correlation between the heart beat rate and body temperature from the 10 available scorpion patients, no statistically significant correlation is observed either ($r_s = -0.181$ and $p\text{-value} = 0.617$), despite heart beat rate tends to correlate more to respiratory rate than body temperature tends. Similarly, the heart beat rate and systolic/diastolic pressure values obtained from the available sample of 9 patients did not exhibit a statistically significant correlation ($p\text{-values}$ of 0.954 and 0.942, respectively), despite the finding of Christofaro et al. [34]

Time spent by the patient at hospital

The records indicated the duration of patients' stay at the hospital, with 13 records providing data. On average (mean values), patients stayed for approximately 4.61 ± 4.77 hours, with a range of 0.8 to 17.4 hours. Notably, patients with moderate severity had a higher average stay of 7.10 ± 7.52 hours compared to those with mild severity, whose average stay was 0.87 ± 1.07 hours (Fig. 22).

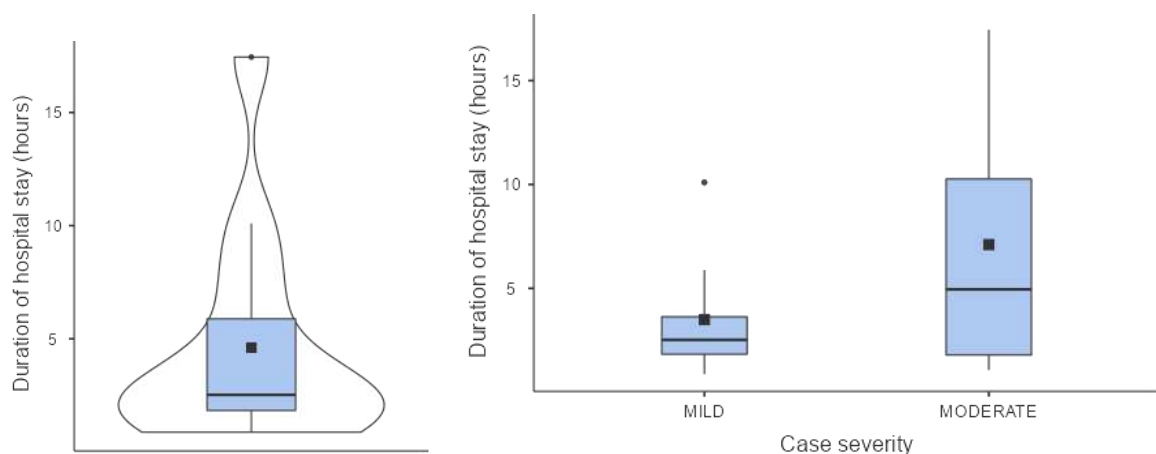


Fig 22 – Duration of hospital stay of scorpionism patients admitted at Governor Ottomar de Sousa Pinto South Regional Hospital in Rorainópolis from 2020 to 2022 (n=13). Source: this study.

Adults' clinical aspects

This section presents and discusses the clinical aspects of adult patients (individuals that were 18 years old and older), comprising a total of 23 patients (74.19% of all patients). Among these 23 patients, 6 (26.1%) were women, and 17 (73.9%) were men.

Table 8 and Figures 23-25 presents descriptive statistics for adult scorpionism patients upon hospital admittance. The results from Mann-Whitney and Welch tests indicate that there were no statistically significant differences in systolic and diastolic pressures, axillary temperature and age values based on gender, even though the mean systolic pressure was higher among men and the mean diastolic pressure was higher among women. Across all patients, the mean systolic pressure value was higher than the normal range, indicating an **elevated systolic pressure** reading.

Table 8 – Clinical values from adult patient's upon hospital admittance at the Governor Ottomar de Sousa Pinto South Regional Hospital in Rorainópolis from 2020 to 2022.

		Male	Female	All
	Adult patients (Fi)	17	6	23
	Adult patients (FR%)	73.9%	26.1%	100%
Systolic pressure upon admittance	Mean value (mmHg)	130	122	128
	Standard deviation (mmHg)	18.5	7.53	16.5
	Median (mmHg)	130	120	128
	Variance (mmHg)	341	56.7	271
	Minimum value (mmHg)	90	110	90
	Maximum value (mmHg)	160	130	160
	Ignored patients	1	0	1
	Mann-Whitney test	U=32.5, p=0.264		
	Welch test	t=-1.503, p=0.149		
Diastolic pressure upon admittance	Mean value (mmHg)	79.4	82.6	80.1
	Standard deviation (mmHg)	10.3	11.7	10.4
	Median (mmHg)	80.0	80.0	80.0
	Variance (mmHg)	106	138	109
	Minimum value (mmHg)	60.0	60.0	60.0
	Maximum value (mmHg)	100	97.0	100
	Ignored patients	1	0	1
	Mann-Whitney test	U=36.0, p=0.626		
	Welch test	t=0.548, p=0.603		
Axillary temperature upon admittance	Mean value (°C)	35.9	36	35.9
	Standard deviation (°C)	1.20	0.816	1.10
	Median (°C)	36.2	36.0	36.0
	Variance (°C)	1.44	0.667	1.21

	Minimum value (°C)	32.1	35.0	32.1
	Maximum value (°C)	37.1	37.0	37.1
	Ignored patients	4	2	6
	Mann-Whitney test	U=51.0, p=0.758		
	Welch test	t=0.531, p=0.602		
	Mean value (years)	40.1	30.7	37.7
	Standard deviation (years)	12.6	9.58	12.4
	Median (years)	42.0	28.0	37.0
	Variance (years)	159	91.9	18.0
	Minimum value (years)	18.0	21.0	18.0
Age	Maximum value (years)	67.0	49.9	67.00
	Ignored patients	0	0	0
	Mann-Whitney test	U=27.0, p=0.082		
	Welch test	t=1.90, p=0.099		

Source: this study.

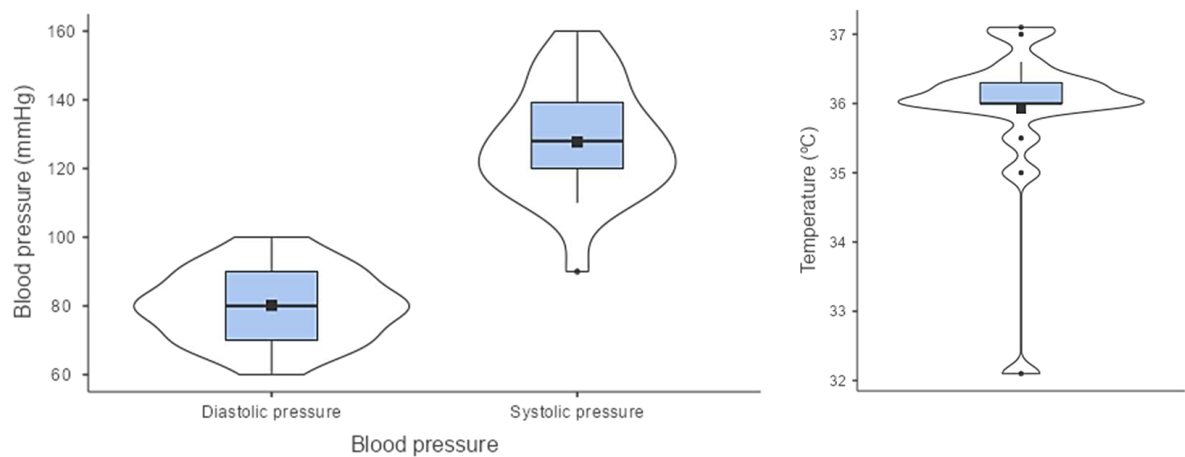


Fig 23– Blood pressure (n=22) and axillary temperature (n=17) values from scorpion patients upon hospital admittance, based on the medical records collected at the Governor Ottomar de Sousa Pinto South Regional Hospital in Rorainópolis from 2020 to 2022. Source: this study.

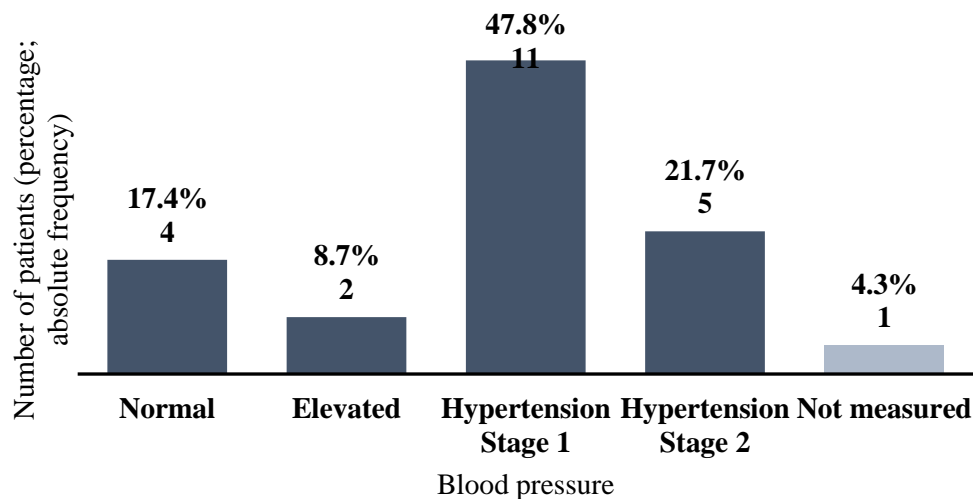


Fig 24 – Scorpionism adult victim’s blood pressure according to the medical records collected at the Governor Ottomar de Sousa Pinto South Regional Hospital in Rorainópolis from 2020 to 2022 (n=23). Classification according to the American Heart Association [30]. Source: this study.

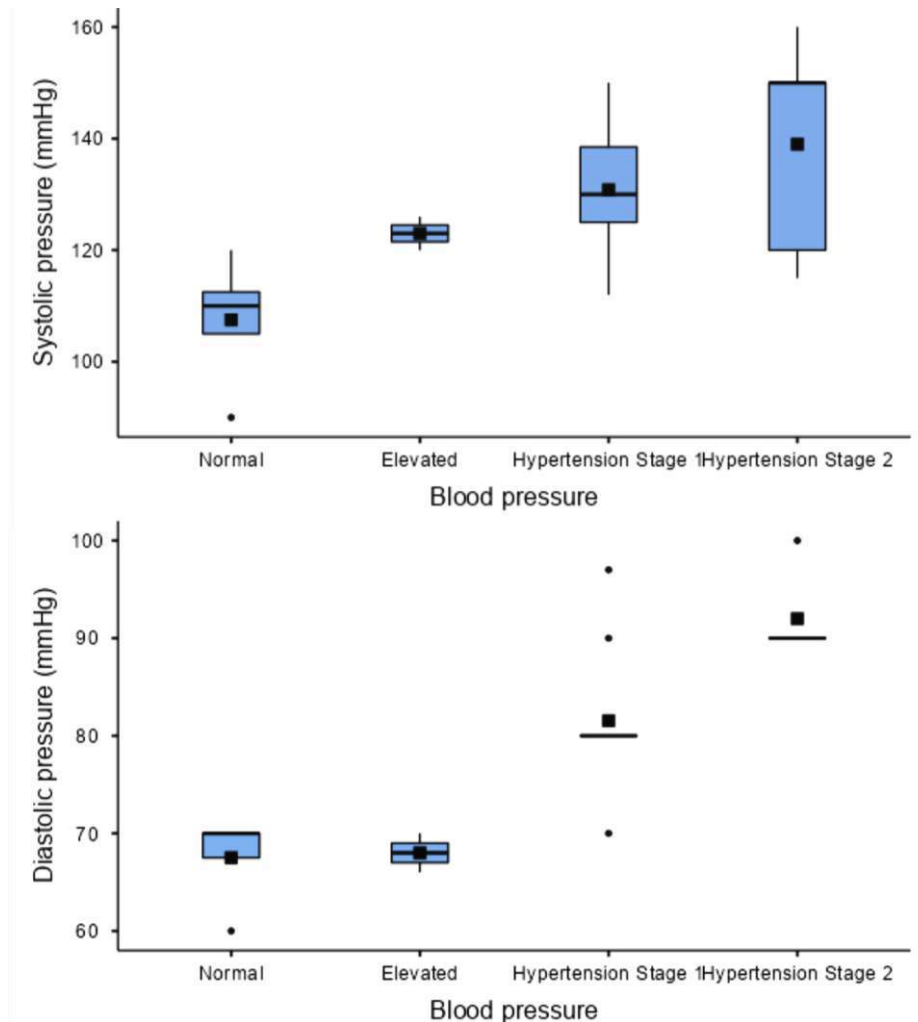


Fig 25– Scorpionism adult victim’s systolic (S) and diastolic (D) blood pressure values upon hospital admittance according to the medical records collected Governor Ottomar de Sousa Pinto South Regional Hospital in Rorainópolis from 2020 to 2022 (n=22). Classification according to the American Heart Association (2023). (H.St1=hypertension stage 1; H.St2=hypertension stage 2). Source: this study.

No statistically significant correlation between age and the vital signs systolic pressure ($R=0.162$, $p=0.470$), diastolic pressure ($R=-0.075$, $p=0.740$) and axillary temperature ($R=-0.135$, $p=0.607$) values was observed (Fig. 26).

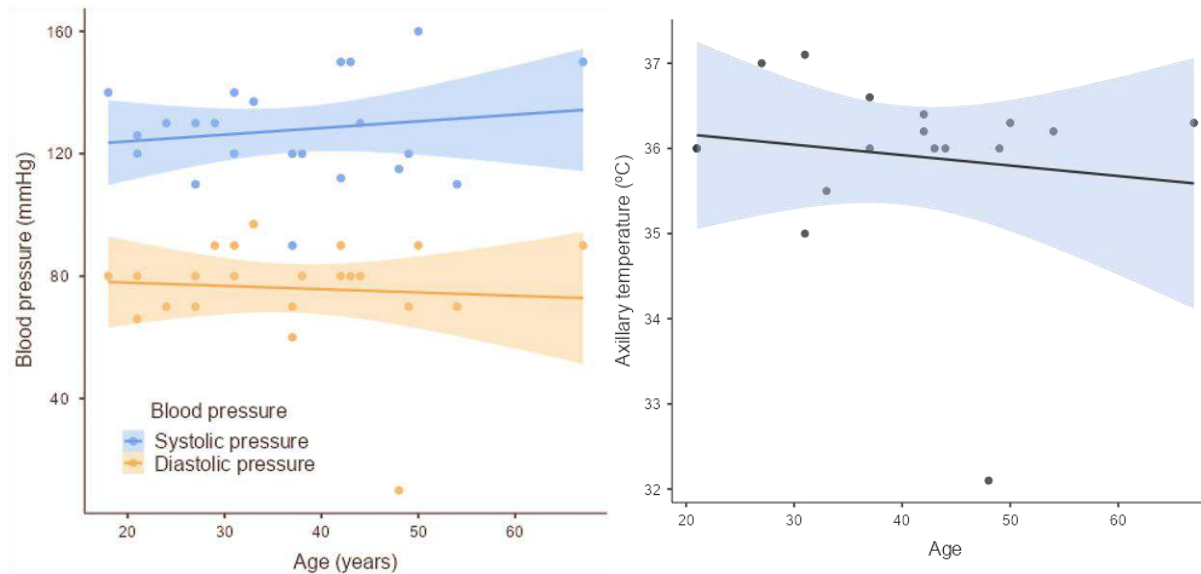


Figure 26 – Dispersion of blood pressure (n=23) and axillary temperature (n=17) values by age from scorpion adult patients over 18 years old upon hospital admittance, based on the medical records collected at the Governor Ottomar de Sousa Pinto South Regional Hospital in Rorainópolis from 2020 to 2022. Source: this study.

The analysis observed normal mean values of vital signs in adult patients following the initial administration of medication (Table 9). Additionally, no statistically significant correlation was found between these vital signs (p -values>1.96, Fig. 27).

Table 9 – Clinical values from scorpion adult patient's after the first medication Governor Ottomar de Sousa Pinto South Regional Hospital in Rorainópolis from 2020 to 2022.

Statistics	Systolic pressure (mmHg)	Diastolic pressure (mmHg)	Heart beat rate (bpm)	Respiratory rate (bpm)
Number of patients	9	9	8	7
Ignored patients	14	14	15	16
Mean	123	77.1	80.5	20.4
Median	120	74	79	20
Standard deviation	16.6	11	8.83	1.62
Variance	277	120	78	2.62
Minimum value	100	60	64	19
Maximum value	156	90	93	24

Source: this study.

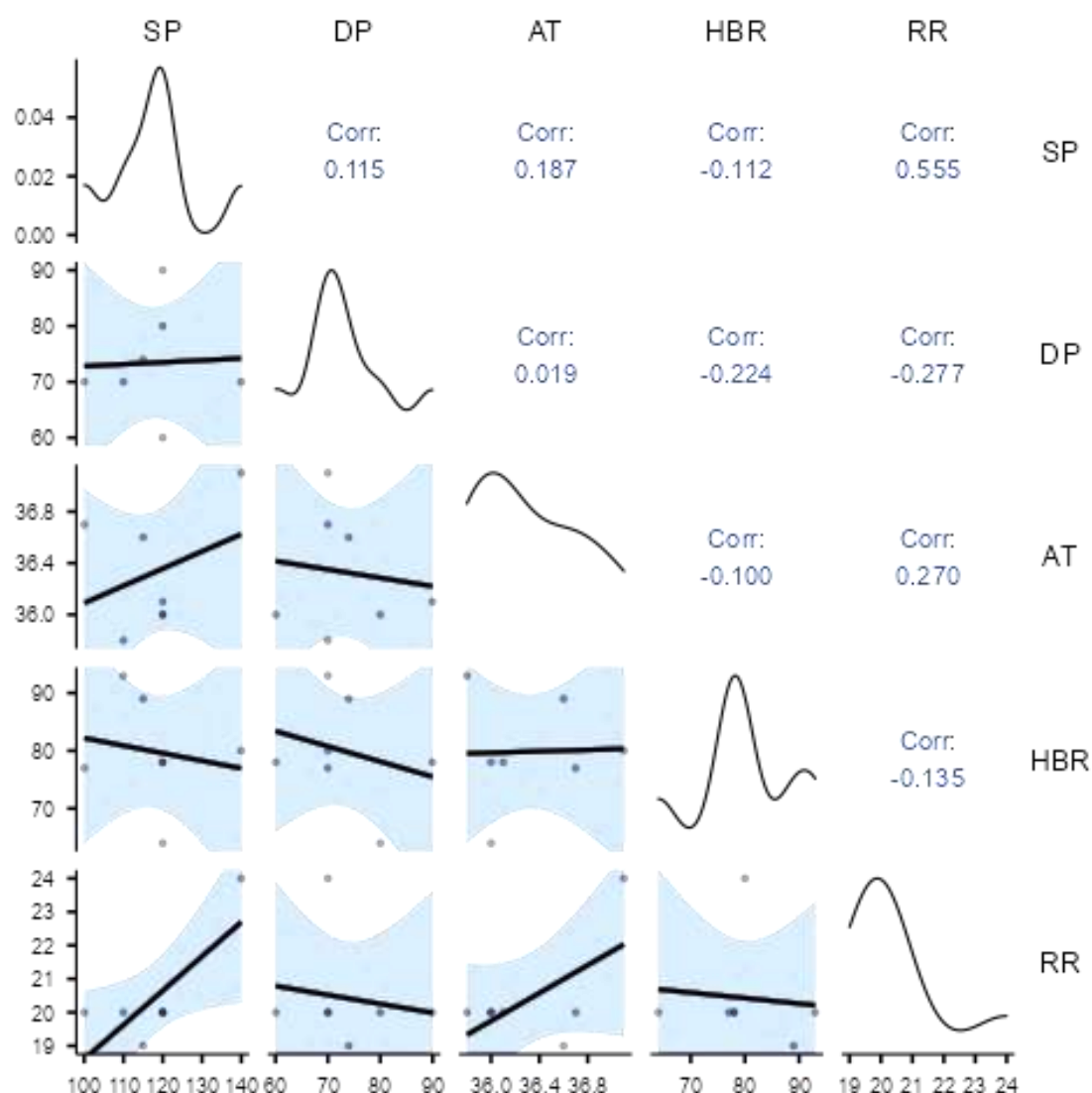


Fig 27 – Spearman's correlation matrix of vital signs from scorpion adult patients after first medication administration, based on the medical records collected at the Governor Ottomar de Sousa Pinto South Regional Hospital in Rorainópolis from 2020 to 2022 (n=7). None of them is statistically significant, with p-value higher than 1.96. **Legend:** **SP**=systolic pressure; **DP**=diastolic pressure; **AT**=axillary temperature; **HBR**=heart beat rate; **RR**=respiratory rate.

Among the adult patients who were stung by scorpions, a total of seven individuals had their blood pressure levels assessed. Remarkably, six of these patients exhibited normalized blood pressure readings, indicating a positive response to the treatment they received. However, it is worth noting that one particular patient, aged 31, who had been diagnosed with stage 2 hypertension, did not experience the same level of improvement in blood pressure despite the treatment administered, as illustrated in Table 10.

Table 10 - Scorpionism adult victim's vital signs before and after medication administration at Governor Ottomar de Sousa Pinto South Regional Hospital in Rorainópolis, from 2020 to 2022.

Patient number	Systolic pressure upon admittance	Systolic pressure after medication	Diastolic pressure upon admittance	Diastolic pressure after medication	Systolic pressure variation	Diastolic pressure variation	Blood pressure upon admittance	Blood pressure after medication
2	150	120	80	80	-30	0	H.Tens.2	Normal
3	140	120	80	60	-20	-20	H.Tens.2	Normal
8	130	100	70	70	-30	0	H.Tens.1	Normal
9	126	120	66	70	-6	4	Elevated	Normal
12	150	115	90	74	-35	-16	H.Tens.2	Normal
17	140	140	80	70	0	-10	H.Tens.2	H.Tens.2
24	110	110	70	70	0	0	Normal	Normal

Source: this study.

Descriptive statistics for blood pressure and case severity are presented in Table 11, while Figures 28 and 29 provides a visual representation of these statistics.

Table 11 - Scorpionism adult victim's blood pressure and temperature (Temp.) upon admittance at Governor Ottomar de Sousa Pinto South Regional Hospital in Rorainópolis, from 2020 to 2022.

	Case severity	Systolic pressure (mmHg)	Diastolic pressure (mmHg)	Axillary temperature (°C)
Number of patients	Moderate	8	8	5
	Mild	14	14	12
Ignored patients	Moderate	0	0	3
	Mild	1	1	3
Mean value	Moderate	128	77.1	36.1
	Mild	127	81.9	35.8
Median	Moderate	134	80	36
	Mild	123	80	36.2
Standard deviation	Moderate	18.6	10.8	0.589
	Mild	15.9	10.2	1.27
Variance	Moderate	347	118	0.347
	Mild	251	104	1.61
Minimum	Moderate	90	60	35.5
	Mild	110	66	32.1
Maximum	Moderate	150	97	37.1
	Mild	160	100	37

Source: this study.

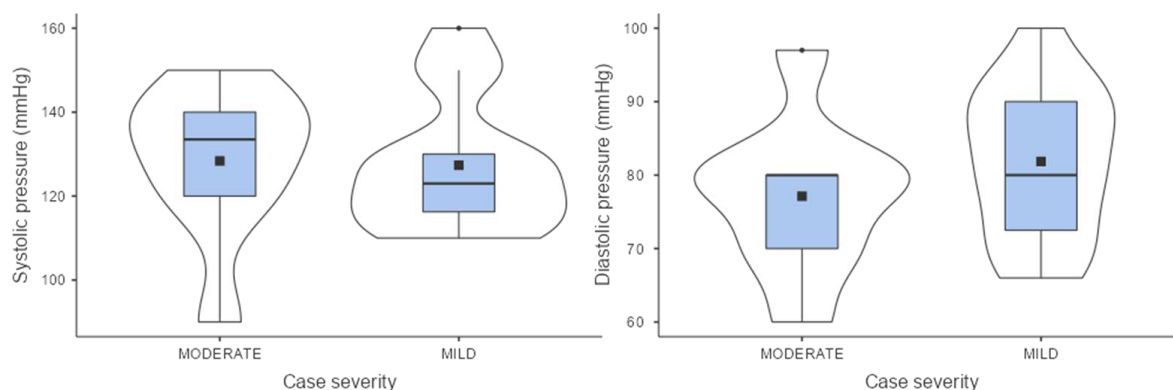


Fig 28 - Scorpionism adult victim's blood pressure upon admittance at Ottomar de Sousa Pinto General Hospital, Rorainópolis by case severity, from 2020 to 2022. Source: this study.

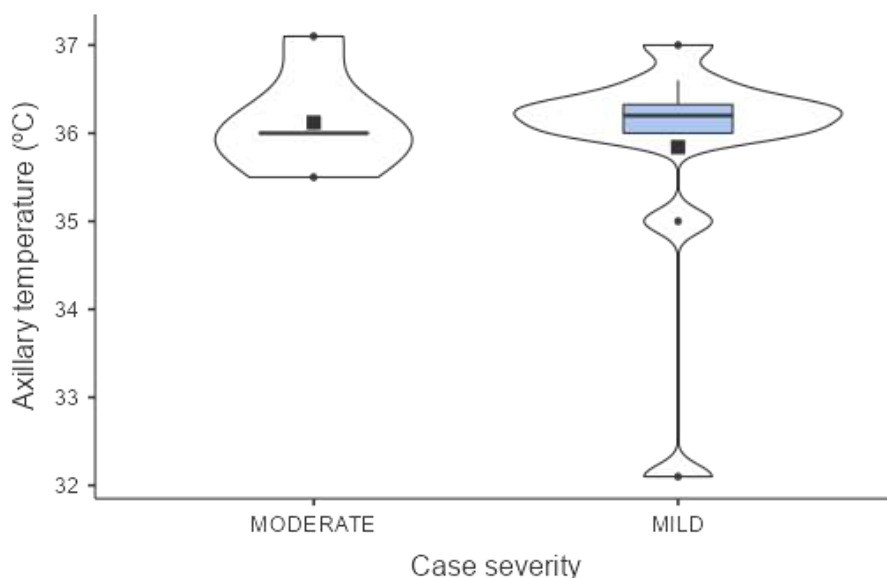


Fig 29 - Scorpionism adult victim's axillary temperature upon admittance at Governor Ottomar de Sousa Pinto South Regional Hospital in Rorainópolis by case severity, from 2020 to 2022. Source: this study.

Upon analyzing the data, it is observed that the mean values of blood pressure in individuals with moderate scorpionism cases are higher than those with mild cases. However, both the Welch test and Mann-Whitney test did not identify any statistically significant differences in systolic/diastolic pressure and temperature between individuals with mild and moderate scorpionism case severity in adults (Table 12).

Table 12 - Vital signs mean values comparison statistics **according to case severity** of scorpionism victims from 2020 to 2022, based on patient's records from Governor Ottomar de Sousa Pinto South Regional Hospital in Rorainópolis.

Vital sign	Test	Result	Degrees of freedom	<i>p</i> -value
Systolic pressure (mmHg)	Welch t	0.13	12.8	0.899
	Mann-Whitney U	46.5		0.535
Diastolic pressure (mmHg)	Welch t	-1.007	13.9	0.331
	Mann-Whitney U	42		0.339
Temperature	T-test	0.464	15.0	0.650

Source: this study.

Children's clinical aspects

According to the patient records surveyed, two children were stung on their hand, while one patient was stung on his foot. Among them, temperature measurements were taken from 2 patients upon hospital admittance, and their readings indicated normal temperatures of 35.2°C and 36°C, respectively. The scorpion species identified in two cases was the “black scorpion”. Out of all the cases, four were classified as mild, while one case was considered moderate and was caused by a “black scorpion”, affecting a 1-year-old child.

Teenager's clinical aspects

Among the surveyed records, four were aged from 12 and 17 years old. Specifically, there were two 15-year-olds, one 16-year-old, and one 17-year-old from rural areas. Two of them were stung on their foot, while one was stung on their finger. The patients' blood pressure upon admission showed variation, with systolic pressure ranging from 100 to 116 mmHg and diastolic pressure ranging from 60 to 80 mmHg, with two patients with normal blood pressure, and one with hypertension stage 1. The recorded body temperature ranged from 36 to 36.4°C. All of the cases could be classified as mild.

Elderly people's clinical aspects

There was only one belonging to an elderly male patient who presented with hypertension stage 2 but exhibited mild severity of envenomation. The patient received treatment consisting of promethazine, hydrocortisone, and dipyrone. Following the administration of these medications, the patient experienced relief from pain and was lucid, and oriented in time and space. As a result, the patient was deemed stable and fit for discharge.

Symptomatology and medications

Table 13 and Figures 30-32 provide an overview of the medications administered to the patients in this study.

Table 13 – Medication administered to scorpionism patients admitted at the Governor Ottomar de Sousa Pinto South Regional Hospital in Rorainópolis, according to medical records from 2020 to 2023.

Drug classification	Drug name	Adult's usual dosage
Aminoglycoside antimicrobial	Neomycin	500mg orally every 6 h
Analgesic	Dipyrone	1000-2500mg IM or IV every 6 h
Antiemetic/ antispasmodic	Butilscopolamine	20-40mg IV/IM/SC every 6-8 h
Antihypertensive agent	Captopril	25mg every 12h or 50mg every 24h orally, increase to 100mg every 24h or to 50mg every 12h if needed
Antipyretic	Dipyrone	1000-2500mg IM or IV every 6 h
Antiulcer	Pantoprazole	40mg a day, IV, single dose, or as directed by the physician
H1 antihistamine	Promethazine	at the discretion of the physician
Narcotic analgesic	Tramadol	50-100mg orally every 4-6h
Penicillin antimicrobial	Ampicillin	1-3g IV every 6-4h; 500mg-1.5g IM every 6-4h
Prokinetic antiemetic	Metoclopramide Ondansetron	<u>Metoclopramide</u> : 10mg IV/IM every 8h; <u>Ondansetron</u> : 8mg orally every 8h starting 30 min. before chemotherapy and 8mg orally every 12h for 1-2 days after the end of the cycle.
Systemic non-steroidal anti-inflammatory	Diclofenac Tenoxicam Ketoprofen	<u>Diclofenac</u> : 75mg/day in the gluteal region (exclusively); 100-150 mg/day, orally, divided into 8-12 hours. <u>Tenoxicam</u> : 20mg IV/IM every 24h. <u>Ketoprofen</u> : 100-300 mg/day, IV (slowly), for a maximum of 48h.
Systemic steroidal anti-inflammatory	Dexamethasone Hydrocortisone	<u>Dexamethasone</u> : 0.5 to 20mg/day, IM/IV, depending on the pathology. <u>Hydrocortisone</u> : 25 to 50mg/kg/day, IV, in a single or divided dose.
Topical local anaesthetic	Lidocaine	3-5g, topical, apply until adequate anaesthesia is achieved
Venom neutralizer*	SAEsc (scorpion antivenom) *	2-6 ampoules, according to case severity*

Source: this study. Medication facts according to *Hospital Alemão Oswaldo Cruz's* Comissão de Farmácia e Terapêutica (2021). *Information according to Brasil (2019).

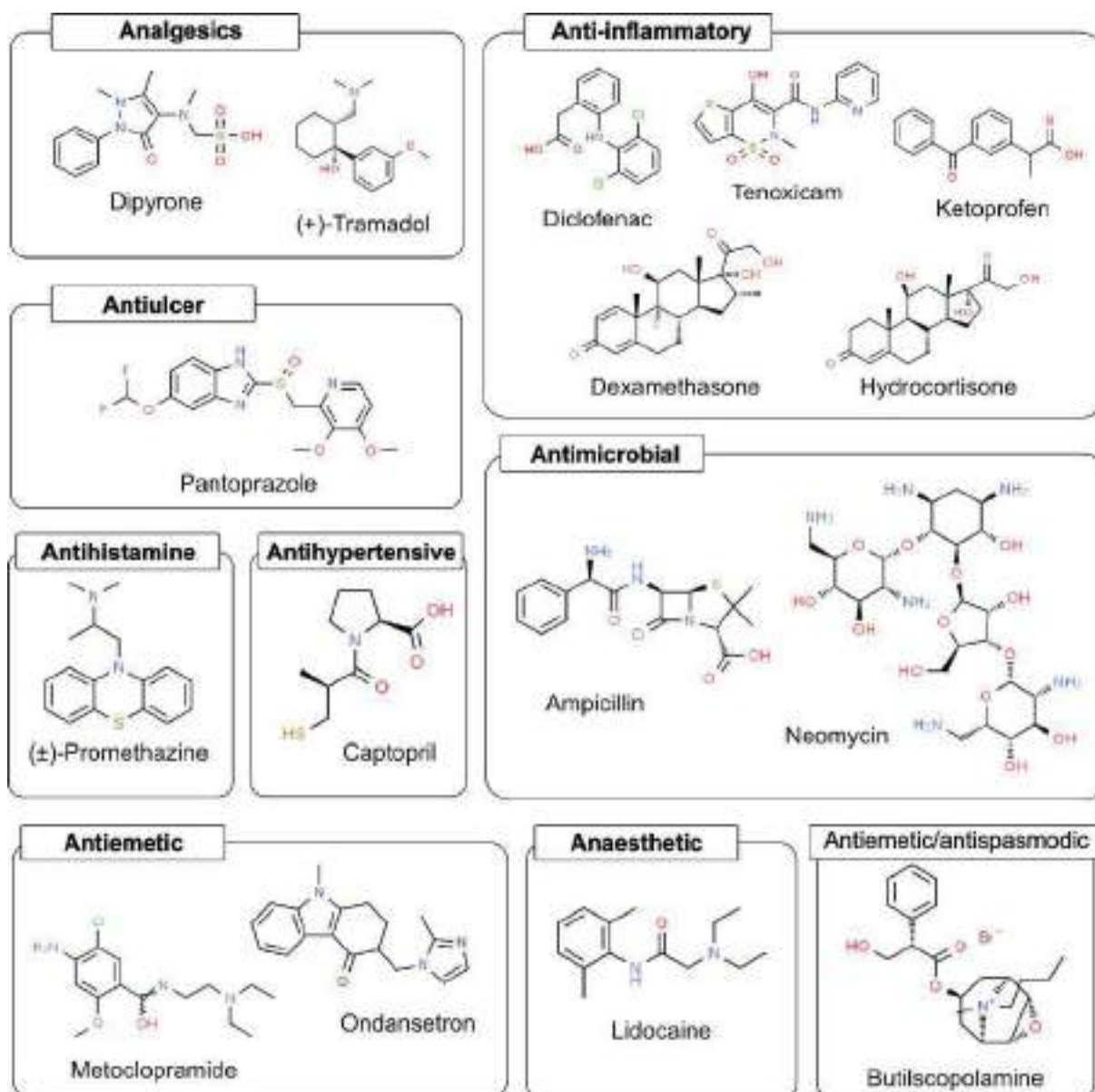


Fig. 30 – Structural formulas of medication administered to scorpionism patients admitted at the Governor Ottomar de Sousa Pinto South Regional Hospital in Rorainópolis according to their main purpose, based on the medical records from 2020 to 2023. Source: Medication purposes according to Hospital Alemão Oswaldo Cruz's Comissão de Farmácia e Terapêutica [35]. Structural formulas extracted from ChemSpider platform, available at: <https://www.chemspider.com/>. Accessed on June 19, 2023.

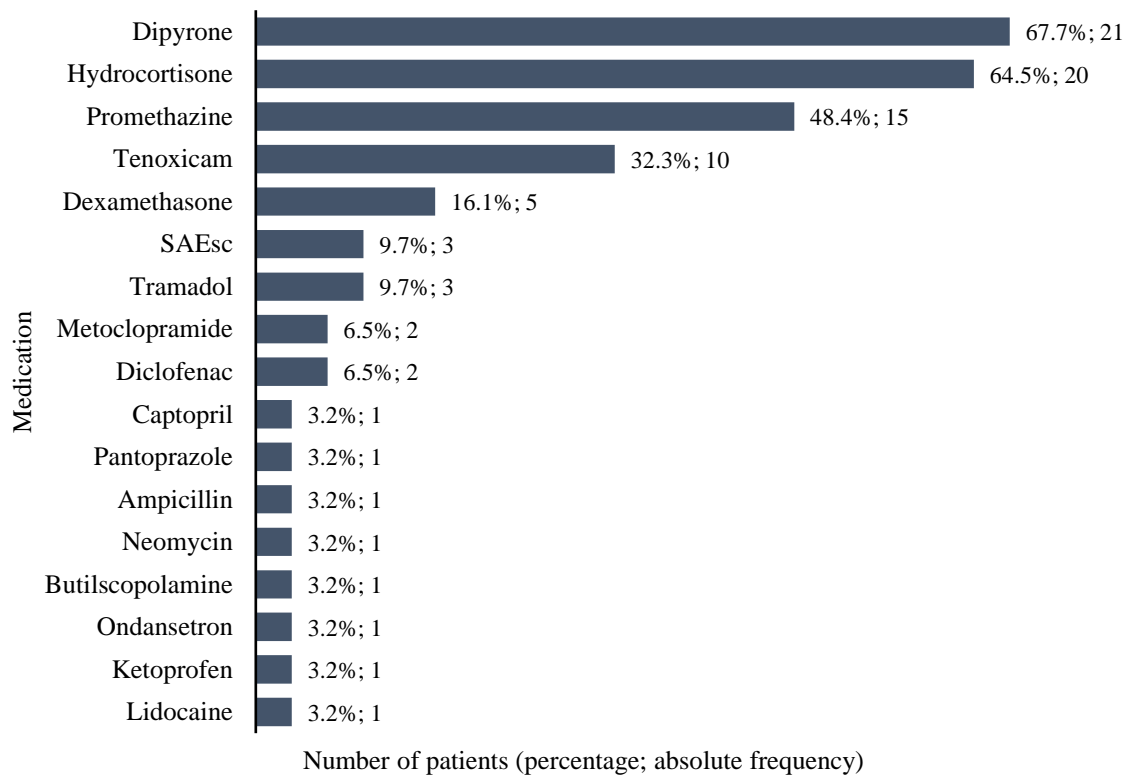


Fig. 31– Medication administered to scorpionism patients admitted at the Governor Ottomar de Sousa Pinto South Regional Hospital in Rorainópolis, according to medical records from 2020 to 2023 (n=31). Source: this study.

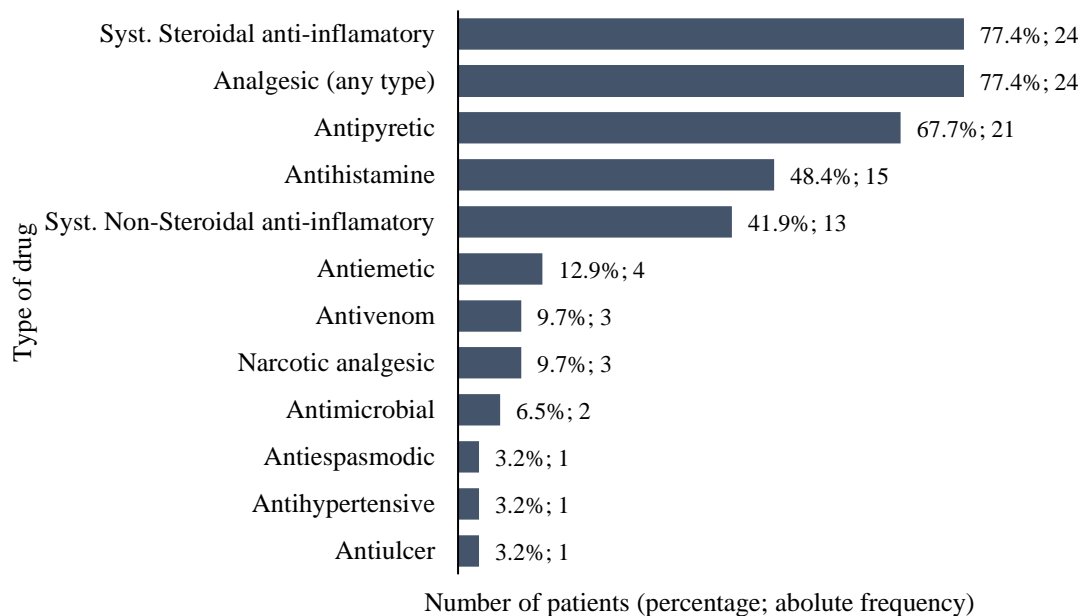


Fig 32 – Types of medication according to their **main purpose** administered to scorpionism patients (n=31) admitted at the Governor Ottomar de Sousa Pinto South Regional Hospital in Rorainópolis, based on the medical records from 2020 to 2023. Source: this study.

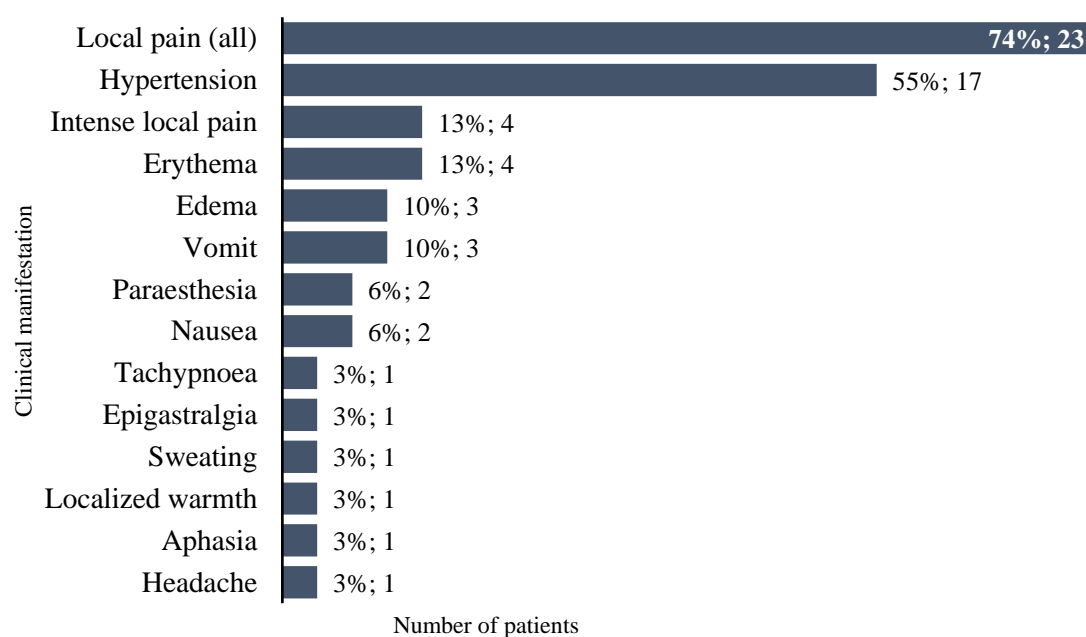


Fig. 33 – Clinical manifestations from scorpionism patients admitted at Ottomar de Sousa Pinto South Region Hospital in Rorainópolis, based on the medical records and SINAN, from 2020 to 2023 (n=31). Source: Rorainópolis Municipal Health Surveillance Superintendence (consultation carried out on December 16, 2022) and the patients records.

Among the records of scorpionism patients surveyed in this study, it was found that 17 records (54.8%) reported pain. Specifically, among the cases categorized as moderate in severity, 3 records (9.7%) indicated intense pain. However, in these cases, in addition to dipyrone, four patients (12.90) were prescribed tramadol, ranging from 50 to 100mg, a potent narcotic analgesic, more potent than common dipyrone. Based on the available records, specifically those indicating the presence of pain (mild or intense), the chi-square test results failed to demonstrate a significant association between blood pressure and the severity of pain in scorpionism patients ($\chi^2=1.95$, p-value=0.583). In the subset of patients who were prescribed analgesics, thus implying their experience of pain, dividing them into two groups based on pain intensity (mild and intense) did not yield a significant association between pain intensity and blood pressure according to the chi-square test ($\chi^2=2.667$, p-value=0.446). Moreover, when patients were classified into two groups based on the presence or absence of pain, and subsequently tested for association with blood pressure, the chi-square test did not reveal a statistically significant relationship either ($\chi^2=2.8476$, p-value=0.4157).

Similarly, when patients were categorized based on the use or non-use of analgesics and further classified into groups of normal blood pressure, elevated blood pressure, and hypertension, the chi-square test failed to demonstrate a significant relationship between these variables ($\chi^2=2.753$, p=0.252). Additionally, when patients were categorized into groups based on the presence or absence of pain, as well as the presence or absence of blood pressure elevation, both the chi-square test ($\chi^2=1.028$, p-value=0.3105) and Fisher's exact test (p-value=0.395) did not indicate a significant relationship between these variables.

DISCUSSION

Records consultation

Despite the difficulties, the search efforts produced a significant portion of the expected medical records, particularly those from the more recent years. This suggests that the accessibility and preservation of medical records could vary depending on the year of occurrence, with more recent records being more readily available. Moving forward, it is important to address the problems of storage and preservation of older medical records, warranting their accessibility for future research and analysis. So, maintaining and safeguarding medical records in a suitable environment at the Ottomar de Sousa Pinto General Hospital is very important to ensure their availability for retrospective studies, epidemiological analyses, and informed decision-making in addressing health issues such as scorpionism.

General results

The higher number of admissions during the afternoon period may be attributed to the fact that this is a time when people are engaged in various activities such as work, outdoor and indoor tasks, or leisure pursuits. Increased human presence during this period can inadvertently lead to greater encounters with scorpions and subsequent incidents.

Furthermore, the evening/night period accounted for a significant portion of admissions, representing 26% of cases. This observation aligns with the nocturnal habits of scorpions, as they tend to be more active during the darker hours [36]. Factors such as insufficient illumination or reduced visibility during this time can contribute to an increased risk of scorpion encounters and consequent accidents. Equally, the morning period accounted for 19% of admissions.

The low admission rate of only 3% during the late-night period can be attributed to several factors. These factors include reduced human activity, as people tend to be indoors during that time, minimizing their exposure to outdoor environments where scorpions are less likely to be found in areas that are difficult for scorpions to access within homes.

Thus, not considering the time elapsed from the occurrence of accident to medical care, these findings indicate that scorpion accidents primarily occurred when people were most active during the day, particularly in the afternoon. This can suggest a correlation between human activity levels and the occurrence of scorpion incidents.

Age and case severity

Contrary to previous findings, our study revealed that age does not appear to be a significant factor in determining the severity of scorpionism cases. This unexpected result may challenge the prevailing notion that children are inherently at a higher risk of developing severe complications [37]. By analyzing a diverse range of age groups, we demonstrate that the severity of scorpionism is not disproportionately influenced by age.

Furthermore, our findings indicate that gender does not exert a significant impact on scorpionism severity. These results emphasize the need for further exploration of alternative factors that might contribute to scorpionism severity.

Our study challenges the conventional understanding of scorpionism severity in relation to age and gender. The findings indicate that age is not a significant factor in Rorainópolis, contrary

to prevailing beliefs that children are at a higher risk. Furthermore, gender does not appear to impact scorpionism severity. These results highlight the need for continued research to uncover additional factors that contribute to the severity of scorpionism cases. By revisiting established assumptions, we pave the way for a more nuanced understanding of scorpionism and provide a foundation for future investigations to improve clinical outcomes and public health interventions.

Anatomical sting site

Increased scorpion exposure heightens vulnerability to limb stings, as limbs frequently come into direct contact with scorpions during daily activities or in natural and man-made habitats. Statistics and SINAN data support the prevalence of upper limb-related scorpion stings, emphasizing the need to understand contributing factors. Scorpion behavior, such as hiding during the day and becoming active at night, contributes to the high incidence of limb stings. Human behavior, including outdoor activities without proper protection, further increases the risk. The records and data confirm that limbs are the most commonly affected body part, given their exposure and scorpion behavior [38]

Scorpionism and blood pressure

Concerning blood pressure, it's well-known that several factors can increase it. Certain risk factors, such as unhealthy behaviors and habits, and certain diseases, have the potential for modification. Equally, other risk factors, such as advancing age, family medical history, genetic predisposition, racial or ethnic background, and biological sex, are beyond one's control and cannot be altered [39].

Scorpion envenomation is a well-documented phenomenon associated with various systemic effects, including circulatory disturbances. The venom injected by scorpions can contain a variety of toxins that affect different physiological systems, including the cardiovascular system. These toxins can lead to significant alterations in blood pressure and contribute to the development of several circulatory problems [3,40].

One of the circulatory issues commonly observed in scorpion envenomation is the occurrence of bradycardia or tachyarrhythmias [40]. Bradycardia refers to an abnormally slow heart rate, while tachyarrhythmias involve irregular and rapid heart rhythms [30]. The venom's impact on the autonomic nervous system and cardiac conduction pathways can disrupt the normal electrical impulses that regulate heart rate, leading to these disturbances. In addition to cardiac rhythm abnormalities, scorpion envenomation can also cause hypertension, which is characterized by high blood pressure [3,40].

The alterations in blood pressure and the associated circulatory problems caused by scorpion envenomation can have profound effects on the neurological status of affected individuals. The brain relies on a constant and adequate blood supply to function optimally, and disruptions in blood pressure can compromise cerebral perfusion. This can lead to neurological symptoms such as dizziness, confusion, loss of consciousness, and, in severe cases, even coma [3,39,40]. This analysis shed light on the blood pressure status of scorpion patients upon their arrival at the hospital. Despite slightly higher, these findings align closely with the values reported in the Brazilian literature for three scorpion species and fall within the mid-range of the global literature reviewed (Table 14).

Table 14 – Scorpion patient’s blood pressure data at hospital admittance from some scientific articles.

Reference	Location	Scorpion	Systolic pressure (mmHg)	Diastolic pressure (mmHg)
This study	Rorainópolis/Brazil	“Black scorpion”	125±16.8	80±10.1
[7]	Manaus/Brazil	<i>Tityus silvestris</i>	110	70
[14]	Santarém/Brazil	<i>Tityus obscurus</i>	120	80
[41]	São Paulo/Brazil	<i>Tityus serrulatus</i>	30-120	0-80
[42]	Guanajuato/México	<i>Centruroides sp.</i>	140±8.94	88.18±9.81
[40]	Beer-Sheva/Israel	<i>Buthus sp.</i>	140±48.58	84±16.29
[43]	Turkey	<i>Mesobuthus sp.</i>	120	80
[44]	Maharashtra/India	<i>Mesobuthus sp.</i>	130--170	90--130
[45]	Tel Aviv/Israel	<i>Buthus sp.</i>	150	100
[46]	India	<i>Mesobuthus sp.</i> <i>Heterometrus sp.</i>	60	Not informed
[47]	Morona Santiago, Ecuador	<i>Tityus obscurus</i>	98	60

Source: this study.

The agreement between these results and the values reported in the Brazilian literature provides valuable confirmation of the consistency and reliability of these findings. These consistent measurements not only strengthen the validity of this study but also contribute to the overall understanding of scorpion physiology.

Notably, 19.4% of the patients exhibited normal blood pressure levels, indicating a healthy cardiovascular state. On the other hand, 6.5% of the patients presented with elevated blood pressure. Alarming, 38.7% of the scorpion patients presented hypertension stage 1, indicating the presence of sustained high blood pressure. This stage serves as an early warning sign, emphasizing the need for prompt medical intervention to prevent the progression of hypertension [30].

Additionally, a significant portion of scorpion patients, 16.1%, displayed hypertension stage 2, signifying a more severe and advanced form of the condition. Hypertension stage 2 is characterized by substantially elevated blood pressure, posing a considerable threat to the patients’ cardiovascular health and necessitating immediate medical attention [30].

These findings highlight the importance of regular blood pressure monitoring and early intervention for scorpion patients. Early identification and management of elevated blood pressure can effectively prevent the development and progression of hypertension, reducing the risk of related complications and improving patient outcomes [30]

The lack of blood pressure measurement for some scorpion patients upon admission raises concerns about potential risks. Blood pressure is a vital indicator of cardiovascular health and plays a crucial role in diagnosing and managing conditions such as hypertension. Without measuring blood pressure, it becomes challenging to assess the patients’ cardiovascular status accurately.

These results indicate that there is no statistically significant relationship between case severity and blood pressure classification in this study, there is no statistically significant relationship between gender and blood pressure classification in this study.

The results also suggest that the systolic blood pressure readings remained relatively stable across different levels of scorpion envenomation, and that the diastolic pressure remained relatively consistent regardless of the severity of scorpion envenomation.

While the lack of statistically significant differences in both systolic and diastolic blood pressure may seem counterintuitive, it is important to consider other factors that could contribute to blood pressure regulation. These factors might include the patient's overall health, underlying medical conditions, and individual physiological responses to scorpion venom.

Scorpionism and body temperature

Body temperature is regulated by a complex physiological process known as thermoregulation. The human body aims to maintain a stable core temperature of approximately 37°C, despite changes in the external environment or internal metabolic activity. This regulation is essential for the proper functioning of various bodily processes. The hypothalamus, a region in the brain, plays a crucial role in controlling body temperature. It acts as the body's thermostat and receives signals from temperature sensors located throughout the body. The body's thermoregulation system operates in a feedback loop, continuously monitoring and adjusting to maintain the core temperature within a narrow range. Various factors, including ambient temperature, humidity, physical activity, illness, and hormonal fluctuations, can influence the body's thermoregulatory responses [48].

The normal body temperature of a healthy individual can vary depending on factors such as age and weight, typically up to 36°C. Fever, on the other hand, can be classified into three categories: mild fever (up to 37.5°C), moderate fever (37.5°C-38.5°C), and high fever (above 38.5°C) [49].

The lack of statistically significant gender-based temperature differences at admission suggests gender does not significantly affect initial temperature in scorpionism cases. A relatively small average temperature change also occurred. These findings offer valuable insights into scorpion envenomation's temperature dynamics and the effects of medication on thermoregulation. Time elapsed between measurements appears to have minimal impact on observed temperature changes in these patients. However, due to the limited sample size, further research is needed to comprehensively understand temperature variation and its relationship with time and medication in scorpion envenomation.

Heart beat rate

Bradycardia is characterized by a regular heart rhythm with a low frequency rate below 60 beats per minute (bpm). On the other hand, tachycardia is defined as a regular rhythm with a high heart rate exceeding 100 bpm for adults [50]. Among other important problems, these physiological responses are well-established consequences of scorpion envenomation [3,9,11,12].

Despite normal heart beat rates were observed in all patients which had been measured, it is noteworthy one case of bradycardia. While this occurrence is rare within the sample, it underscores the importance of closely monitoring patients after medication administration, particularly in the adult population.

These findings suggest that while bradycardia and tachycardia were not commonly observed in the overall group, certain subgroups, such as adult patients, may be more prone to experiencing deviations in heart rate to bradycardia. Further analysis and a larger sample size would be necessary to establish statistically significant correlations between age groups and the occurrence of abnormal heart rate patterns in scorpion patients after medication administration. Such insights into heart rate dynamics can contribute to a better understanding of the physiological responses associated with scorpion envenomation and guide appropriate treatment strategies.

Specifically, one scorpion infant patient's heart rate was found to be in close proximity to the tachycardia zone. This indicates that their heart rate was nearing or approaching a level that is considered abnormally high. Although this patient's heart rate did not exceed the threshold for tachycardia, it is a crucial finding that warrants close monitoring to ensure that the heart rate remains within a safe range and does not escalate into tachycardia.

In addition, two patients (one child and one adult) exhibited heart rates that were very close to the bradycardia zone. Although these patients did not meet the criteria for bradycardia, it raises concerns about the possibility of their heart rates dropping further. It is essential to closely observe these patients to detect any potential deterioration in heart rate and take appropriate actions if necessary.

These findings emphasize the importance of closely monitoring scorpion patients whose heart rates are in close proximity to the tachycardia and bradycardia zones. Even if they do not currently meet the diagnostic criteria for these conditions, the proximity indicates a heightened risk and the need for ongoing assessment.

The proximity of heart rates to the tachycardia and bradycardia zones serves as a valuable alert for healthcare professionals, prompting them to exercise extra vigilance and act appropriately to ensure the well-being of scorpion patients.

The absence of heart rate measurements at the time of hospital admittance for scorpion patients raises several considerations. Firstly, measuring heart rate at the time of admittance is crucial for establishing a baseline and understanding the initial physiological condition of the patients. This baseline measurement allows for comparisons with subsequent heart rate readings after medication administration, enabling the identification of any changes or abnormalities.

By not having heart rate measurements at admittance, it becomes challenging to determine the precise heart rate status of the patients upon arrival at the hospital. This lack of initial data restricts the ability to assess the immediate impact of scorpion envenomation on heart rate and discern any pre-existing conditions that may have influenced the subsequent heart rate measurements. Additionally, heart rate measurements at admittance can provide valuable insights into the severity of envenomation and aid in risk stratification. Elevated or low heart rates at admission, for example, could indicate a more severe envenomation and prompt the medical team to administer appropriate treatments on time.

The absence of heart rate measurements at admittance may be due to various reasons, such as logistical constraints, time constraints, or clinical priorities. However, it is important to recognize that this limitation may impact the comprehensiveness of the analysis and the ability to draw accurate conclusions regarding the relationship between heart rate dynamics and scorpion envenomation. To mitigate this limitation in future studies, it is advisable to prioritize the collection of heart rate measurements at the time of hospital admittance for scorpion

patients. This would provide a more comprehensive understanding of the initial heart rate status, facilitate accurate assessments of heart rate variations following medication administration, and enhance the overall validity and reliability of the study findings.

Respiratory rate

Scorpion envenomation can imply respiratory distress, such as *dyspnea* and *tachypnoea*, and other problems [11,13]. Dyspnea is the perception of insufficient air intake and the feeling of being unable to breathe deeply or rapidly enough. It arises from complex interactions involving signals and receptors in the central nervous system, as well as chemoreceptors and mechanoreceptors in the upper airway, lungs, and chest wall [51]. Also, scorpion envenomation can result in hemoptysis [40], which refers to the coughing up of blood from the respiratory tract [52]. Although less commonly reported, certain scorpion venoms can have direct toxic effects on lung tissues, leading to inflammation and rupture of blood vessels within the respiratory system. This can cause bleeding and the presence of blood in the mucus [40]. Tachypnoea (opposite to *bradypnea*) refers to a rapid or accelerated breathing rate. It is characterized by an increase in the number of breaths per minute beyond the normal range. In adults, tachypnoea is generally defined as a respiratory rate exceeding 20 breaths per minute. Tachypnoea can be a physiological response to exercise or exertion, but it can also indicate an underlying medical condition, such as lung diseases, heart failure, anxiety, metabolic disorders, or certain infections [53].

The absence of respiratory rate measurements upon hospital admittance for scorpion patients has significant implications. Without these initial measurements, several crucial aspects of their respiratory health and care are affected.

The lack of a baseline respiratory rate makes it challenging to establish a reference point for evaluating subsequent changes in respiratory status. A baseline measurement is essential for accurately assessing the impact of medications, interventions, or the progression of any respiratory conditions throughout the patients' hospital stay. Without this reference point, it becomes difficult to differentiate between normal variations and potential abnormalities.

The accurate evaluation of medication effects is compromised. Respiratory rate is an important indicator of a patient's response to treatment, particularly in cases where respiratory distress or complications may arise from scorpion envenomation. Without initial measurements, it becomes challenging to determine the specific effects of medications on respiratory function and whether any adjustments or alternative treatments are required.

Given these implications, it is of greatest importance to prioritize the inclusion of respiratory rate measurements upon hospital admittance for scorpion patients. By establishing a baseline, accurately evaluating medication effects, and monitoring respiratory trends, healthcare professionals can provide a comprehensive assessment of respiratory status, enabling prompt and appropriate interventions to optimize patient care and outcomes.

Correlation between variables

The lack of a significant correlation between respiratory rate and both body temperature and heart beat rate may be influenced by various factors, such as individual variations in response to scorpion venom, the severity of the sting, or other underlying physiological conditions. It is important to consider that scorpion stings can elicit a range of systemic effects, including

changes in heart rate and body temperature [3], but these effects may not necessarily exhibit a clear and consistent correlation in every patient. Additionally, factors such as the timing of measurements, treatment received, and individual variations in physiological response can contribute to the lack of observed correlation. Moreover, the small sample size of 10 patients may limit the statistical power to detect significant correlations.

The lack of a statistically significant correlation among temperature, heart beat rate, and respiratory rate, and heart beat rate and blood pressure, suggests that these variables do not exhibit a consistent and significant relationship in the studied population. These variables may be independent of each other. This means that changes in one of these variables are not strongly associated with changes in the other variables. The scorpion envenomation, the time of medical care and the medications may play a more prominent role in determining variations. It is important to explore additional factors that could influence these physiological measurements. The results highlight the complexity of the physiological mechanisms involved in temperature regulation, heart beat rate, respiratory rate, and blood pressure. These variables are likely influenced by a combination of internal and external factors that were not adequately captured or controlled for in this study. Further research with a larger sample size, diverse population, and consideration of additional variables may be needed to gain a comprehensive understanding of the relationships among temperature, heart beat rate, and respiratory rate.

Time spent by the patient at hospital

According to Circular Note No. 04/2016-CGDT/DEVIT/SVS/MS, it is advised that scorpionism patients who do not show signs of envenomation should undergo a minimum observation period of 4 hours. However, for patients who display clinical manifestations of envenomation, the recommended observation period is extended to at least 6 hours.

Upon reviewing the records pertaining to the time of discharge, it is evident that only 4 out of the total number of records surveyed (30.8%) indicate that the minimum observation time was met. This finding highlights a potential discrepancy between the recommended guidelines and the actual practice in the observed cases. Thus, increasing awareness among healthcare professionals regarding the importance of adhering to the recommended observation periods is vital.

Adults' clinical aspects

The analysis demonstrated that adult patients exhibited a higher prevalence of hypertension stage 1. This demonstrates the unique physiological responses associated with scorpionism and highlight the significance of blood pressure abnormalities in this condition.

The observation of a higher proportion of normal blood pressure among adult patients suggests that scorpionism may not uniformly result in hypertensive episodes. This implies that the effects of scorpion venom on blood pressure regulation may vary among individuals, possibly due to factors such as age, underlying health conditions, or venom dosage. Further investigation is necessary to understand the mechanisms underlying these differing responses and their implications for scorpionism management.

Moreover, the increased prevalence of hypertension stage 2 among adult patients with scorpionism emphasizes the potential severity of the condition. The association between scorpionism and hypertension stage 2 highlights the importance of closely monitoring blood

pressure levels in scorpionism patients, particularly in the adult population, to promptly identify and manage potential complications.

This study provides valuable insights into the blood pressure distribution in scorpionism patients, especially among adults. These findings can assist healthcare professionals in diagnosing, treating, and managing scorpionism, leading to improved patient outcomes and reduced morbidity and mortality. Further research is needed to fully understand the complexities of scorpionism and enhance our ability to mitigate its impact. The observed alterations in vital signs may be attributed to factors such as medication, scorpion venom, or other potential factors. The results also underscore the complexity of managing hypertension in scorpion sting cases and highlights the need for further investigation and personalized interventions for patients with pre-existing conditions.

Our findings suggest that, despite the apparent differences in mean values, the variations in blood pressure and temperature observed between individuals with mild and moderate scorpionism cases may not be statistically significant. It is important to note that statistical significance is crucial in determining whether the observed differences are likely due to chance or are representative of a true association with case severity. Further research is needed to explore other potential factors that might contribute to the differences in blood pressure and temperature among scorpionism cases, due to limitations of number of patients.

Symptomology and medication

Scorpion venom presents neurotoxic and cytotoxic effects [54], and stimulates receptor channels in various regions of the body, leading to depolarization of cell membranes. This results in a significant release of catecholamines and acetylcholine, which are responsible for most of the observed clinical effects. Catecholamines can elevate victim's systemic blood pressure, constrict peripheral blood vessels, induce cardiac arrhythmias, cause acute pulmonary edema, heart failure, and shock occasionally. Acetylcholine, on the other hand, stimulates secretions in the nose, tears, saliva, bronchi, stomach, and sweat glands. It also contributes to muscle spasms, tremors, and a decrease in heart rate. Neuropeptides release induced by the venom can cause contraction of intestinal smooth muscles and trigger inflammation. Hyaluronidases and metalloproteinases degrade the extracellular matrix of the skin, while vasoactive amines enhance blood flow to the affected area, intensifying redness and swelling. Many toxic components of the venom prompt the release of neurotransmitters, including cholinergics that lead to vomiting, abdominal pain, and diarrhea, as well as adrenergics, thus, producing sympathetic and parasympathetic effects. Furthermore, numerous peptides in the venom provoke an inflammatory response. The toxins also activate the body's innate immune cells through interactions with pattern recognition receptors [10,55].

The diagnosis of scorpionism relies primarily on clinical and epidemiological assessments, with routine laboratory tests typically not employed to confirm the specific type of venom in circulation. However, certain complementary exams can be valuable in aiding the diagnosis and monitoring of patients presenting with systemic manifestations [11].

While laboratory tests may not directly confirm the scorpion venom type, they can provide supportive information and assist in evaluating the overall health status of the patient, as well as assessing the severity of systemic effects. Complementary exams that prove useful in this regard include coagulation profile assessments, and electrocardiograms. These tests help

evaluate potential complications, such as organ dysfunction, coagulation abnormalities, or cardiovascular involvement [11]. Furthermore, additional diagnostic tools, such as imaging studies like X-rays or ultrasounds, can be employed to assess specific complications or injuries resulting from scorpion stings. X-rays are helpful in identifying fractures or the presence of foreign bodies, while ultrasounds can aid in evaluating tissue damage or the accumulation of fluids [11].

As recommended by the *Brazilian Health Surveillance Guide* [11], for the majority of cases characterized by a localized presentation, the recommended approach involves symptomatic treatment focused on pain management. This typically includes the use of an anesthetic without vasoconstrictor, such as 2% lidocaine, administered through infiltration. Alternatively, a systemic analgesic like dipyrone at a dosage of 10mg/kg can be utilized to alleviate pain.

The recommended treatment for patients classified as moderate or severe involves the administration of either antiscorpion serum (SAEsc) or antiarachnidic serum (SAA). In scorpion accidents, priority should be given to the use of SAEsc. SAA is prescribed in situations where it is difficult to distinguish between accidents caused by spiders of the *Phoneutria* genus and scorpions of the *Tityus* genus, or when SAEsc is unavailable [11].

In scientific literature surveyed by Martins et al. [56], two important “black scorpions” are considered medically relevant in the Amazon region, and possibly for Rorainópolis: *Tityus metuendus* Pocock 1897 and *Tityus obscurus* Gervais 1843, belonging to the subgenus *Atreus* which comprises large and dark scorpions important in medical field in Brazil [57].

The envenomation symptomology of the above-mentioned scorpions includes various manifestations. These encompass local pain, paresthesia (abnormal sensations like tingling or numbness), edema (swelling), tachypnoea (rapid breathing), sweating, sialorrhea (excessive salivation), dyspnea (difficulty breathing), nausea, vomiting, and tachycardia (elevated heart rate) [56].

Specifically, for *T. metuendus*, the literature also reports additional symptoms such as hyperemia (increased blood flow resulting in redness), lethargy (general feeling of fatigue, sluggishness, and a decreased level of alertness or responsiveness), psychomotor agitation, mental confusion, and myoclonia (involuntary muscle twitches) [56].

For *T. obscurus*, the literature indicates the occurrence of radiating pain, piloerection (raising of hair on the skin), burning sensation, electric shock-like sensations, dysdiadochokinesia (impaired ability to perform rapid alternating movements), dysmetria (lack of coordination and precision in voluntary movements), dysarthria (speech disorder due to muscle problems), dyslalia (difficulties in pronouncing or articulating vocal sounds), and acute cerebellar dysfunction – resulting in symptoms such as unsteady gait, tremors, lack of coordination, and difficulties with motor control) [56].

Medical records offer valuable insights into the diverse range of local and systemic neurological symptoms observed in patients affected by scorpionism. These symptoms encompass varying degrees of pain severity, ranging from mild discomfort to intense agony, accompanied by elevated blood pressure. Additionally, patients commonly exhibit signs such as erythema, edema, nausea, vomiting, fluctuations in heart rate and respiratory rate, including instances of tachypnoea, sweating, localized warmth, headaches, and difficulty speaking. To effectively manage the scorpionism syndrome, a wide variety of medications were prescribed,

including antiemetics, anti-inflammatories, anesthetics, and other relevant treatments. The clinical manifestations observed align with those reported in existing literature [56].

Local pain

The combination of neurotoxins targeting ion channels, direct activation of pain receptors, and the induction of an inflammatory response collectively contribute to the pain experienced following scorpion envenomation [54,58].

The use of tramadol suggests the need for a stronger pain relief intervention due to the severity of pain experienced by these individuals.

Dipyrone (metamizole) was used in 21 patients (dosage: 0.3-2g) as a non-opioid analgesic and antipyretic for pain relief [59]. Tramadol, a centrally acting synthetic opioid, was used to manage moderate to moderately severe pain by binding to opioid receptors in the brain [60]. Lidocaine, a local anesthetic, was administered to one patient to induce numbness and alleviate pain [61]. Analgesics were used in at least 24 patients (77.4%), emphasizing the importance of pain management in scorpionism cases [10].

Pain perception and absence can be influenced by various factors, including “dry sting” without venom injection, stress-induced hormonal responses, and individual variations [3,62–64]. Pain experienced in scorpionism cases can be associated with increased blood pressure due to sympathetic nervous system activation and stress hormones release, causing vasoconstriction and elevating cardiac output [65]. Although statistical analysis did not reveal a significant association, approximately 81% of patients with pain and measured blood pressure exhibited elevated levels upon admission [66]. It is important to acknowledge limitations in the data, including possible downplaying of pain symptoms in medical records and uncertain statistical factors [67].

Headache

In the present study, one patient (3.2%) reported a headache and was treated with dipyrone, supporting the idea that headaches can accompany scorpion envenomation. Previous studies [68–70] also provide evidence of headaches as a systemic effect of scorpion venom. However, headaches following scorpion stings are relatively infrequent compared to other symptoms, possibly due to underreporting or their less common occurrence.

Local paresthesia

Scorpion venom, containing neurotoxins, can disrupt the nervous system and cause paresthesia - abnormal sensations like tingling or numbness. This occurs due to interference with ion channels responsible for nerve signal transmission [54]. Two patients (6.4%) in the study experienced paresthesia, regardless of severity or age, indicating local sensory abnormalities and highlighting the impact of scorpion venom on sensory nerves.

Local erythema

Scorpion venom triggers an immune response and affects blood vessels, leading to erythema (redness of the skin). It does so by activating inflammatory mediators and causing blood vessel dilation, as well as disrupting endothelial cells. This disruption increases vessel permeability, resulting in fluid leakage and contributing to swelling and redness [3,10]. Among the patient

records analyzed, 3 (9.6%) with mild envenomation showed evidence of local erythema, while 4 (12.9%) did not. This suggests that erythema is not consistently present following scorpionism envenomation, indicating variations in the inflammatory response.

Local edema

Edema may occur by the action of the inflammatory mediators that lead to erythema. These substances cause vasodilation, widening the blood vessels, and increase the permeability of blood vessel walls. Consequently, fluid from the bloodstream can leak into the surrounding tissues, resulting in edema. Furthermore, scorpion venom can directly impact the endothelial cells that line the blood vessels, disrupting their normal function and compromising the barrier function of the blood vessel walls. This disruption contributes to increased permeability and fluid leakage into the surrounding tissues, further intensifying the edematous response [3,10]. Three patient records (9.8% of the surveyed records) indicated the absence of edema. It is important to note that edema is a common manifestation in scorpionism, and it is possible that other patients experienced edema without it being documented in their medical records. Additionally, despite the lack of supporting data in the medical records of this study regarding the occurrence of edema in scorpionism patients, previous sections have discussed data from SINAN, which reported 35 cases of edema among 60 patients reported by the system from 2015 to 2020.

Localized warmth

Several studies have reported the occurrence of heat or burning sensation in scorpion sting victims [56]. For instance, a study conducted by Roodt et al. [68] investigated the clinical manifestations of accidents involving the scorpion *Tityus trivittatus* Kraepelin 1898 in Argentina, revealing that 24.7% of patients experienced local heat sensation. Similarly, a study conducted by Sanaei-Zadeh, Marashi, and Dehghani [71] in Iran also documented similar findings.

In the present study, one patient (3.2%) reported localized warmth in the affected area of their body, which is likely attributed to inflammation in that specific area. Inflammation triggers a cascade of physiological changes, including increased blood flow to the affected region. This augmented blood flow, known as hyperemia, can result in the perception of heat or warmth in the local area[72].

Sweating

Scorpion venom has the potential to induce sweating as one of its systemic effects, and may impact the autonomic nervous system. This system controls involuntary functions, including sweating. Specific components within scorpion venom can interfere with the normal operation of the autonomic nervous system, resulting in changes in sweat production. Consequently, individuals may experience increased sweating as a response to the venom [54,72].

Sweating was reported in only one record (3.2%) among the patients, suggesting that this symptom was not prevalent in the study population. The affected individual was a 43-year-old man with a body weight of 66kg, presenting with a temperature of 36°C and hypertension stage 1 blood pressure. Furthermore, this patient was classified as having a moderate severity of envenomation.

Nausea and vomiting

Scorpion venom has specific components that can interact with the gastrointestinal system, causing physiological changes like nausea and vomiting. It affects the smooth muscles of the digestive tract, leading to abnormal contractions and spasms that disrupt normal digestion and induce feelings of nausea. Additionally, the venom stimulates the release of substances such as neurotransmitters or hormones that can trigger vomiting [10,55]. In this study, 6.4% experienced nausea, while 9.7% exhibited vomiting, indicating the occurrence of these gastrointestinal manifestations. The patients with nausea and vomiting fell within the moderate severity category of envenomation, with blood pressure ranging from normal to hypertension stage 2. Medical management for these symptoms involved prescribing antiemetic medications such as Plasil (metoclopramide) and ondansetron to alleviate the distressing gastrointestinal effects.

Metoclopramide is commonly used to manage nausea and vomiting associated with various conditions. It acts as a dopamine antagonist and a prokinetic agent. By blocking dopamine receptors in the chemoreceptor trigger zone of the brain, metoclopramide inhibits the sensations of nausea and vomiting. Additionally, it stimulates muscular contractions in the gastrointestinal tract, improving motility and relieving symptoms like delayed gastric emptying and reflux. This normalizes motility patterns and contributes to the relief of nausea and vomiting [73,74]. Ondansetron, on the other hand, is a selective serotonin 5-HT₃ receptor antagonist primarily used as an antiemetic agent. It works by blocking serotonin activity, particularly at the 5-HT₃ receptors. Serotonin release can trigger nausea and activate these receptors, leading to the vomiting reflex. Ondansetron competes with serotonin for receptor binding, reducing the transmission of signals associated with nausea and vomiting. By interfering with serotonin-mediated pathways, ondansetron effectively alleviates these distressing symptoms [74].

Epigastralgia

Scorpion venom components can interact with the gastrointestinal tract, leading to inflammation, irritation, and alterations in the normal functioning of the digestive system [10]. These changes can manifest as epigastralgia, causing pain or discomfort in the upper abdomen. Epigastralgia was observed by Rosário et al. [75,76] in a child from Montes Claros, State of Minas Gerais, and by Cardoso [76] in Rurópolis, state of Pará, in Brazil.

In this study, one patient (3.2%) presented with epigastralgia and received treatment with Buscopan at 2.5g, that is a medication widely utilized for the management of diverse gastrointestinal conditions. It falls under the category of antispasmodics or anticholinergics, exerting its therapeutic effects by antagonizing the action of acetylcholine, a neurotransmitter involved in smooth muscle contraction. By inhibiting the effects of acetylcholine, butylscopolamine effectively induces relaxation of smooth muscles in the gastrointestinal tract, encompassing the stomach, intestines, and bladder. The primary indication for butylscopolamine revolves around alleviating abdominal cramps and pain associated with various gastrointestinal disorders, including irritable bowel syndrome, gastrointestinal spasms, biliary colic, and menstrual cramps. Through its ability to mitigate excessive smooth muscle

contractions within the gastrointestinal tract, butylscopolamine offers relief from discomfort and facilitates the betterment of symptoms.

Aphasia/Dysphasia or Difficulty in speaking

One 31-year-old patient of this study presented aphasia, when the patient may have difficulty finding specific words or constructing complex sentences or may be unable to communicate verbally or comprehend written language [77], but the patient's record did not provide much detail about the case, and should be deeper investigated. In addition to the aforementioned symptoms, the patient also presented with anxiety, vomiting, thoracic pain, and epigastralgia. As part of the treatment protocol, the patient received antivenom. Aphasia and difficulty in speaking seems to be not common in scorpionism patients.

In the northern state of Pará, Torrez et al. [14] observed that some patients had difficulty in speaking, which is a manifestation compatible with motor coordination dysfunction, dependent on the cerebellum. In Canada, Whyshynsky and Little [78] described the first case of scorpionism in the country, and pointed out that difficulty in speaking was developed by the patients.

Extreme cases also have been reported in literature. According to the study conducted by Farghly and Ali [79,80] in Egypt, two children exhibited complete right hemiplegia and aphasia as a consequence of cerebral infarction. In a historical account by Mody [80] in India, an 11-year-old patient experienced aphasia, which was attributed to the venom. Nagaraja and collaborators [81] also reported a case of an Indian patient who developed vomiting and lost the ability to talk and walk within fifty minutes after being stung. Additionally, Kshirsagar, Minhajuddin, and Sylvia [82] presented a case study involving a 9-year-old boy from India who initially developed pulmonary edema, followed by progressive cytotoxic cerebral edema and infarction. As a result, the patient developed motor aphasia accompanied by upper motor neuron facial palsy. This case serves as a poignant example of the intricate neurological implications that can arise from pulmonary edema and cerebral edema, leading to impairments in both motor function and language expression. Thus, aphasia represents a severe neurological complication associated with scorpionism.

Anti-inflammatory usage

Several anti-inflammatory drugs were used in scorpionism patients, suggesting that the use of anti-inflammatory drugs is very common: diclofenac (1g) in 2 patients (6.4%); tenoxicam (40mg) in 10 patients (32.2%); ketoprofen (200mg) in 1 patient (3.2%); dexamethasone (6-25mg) in 5 patients (16.1%); and hydrocortisone (100-500mg) in 20 patients (64.5%).

Diclofenac, tenoxicam, and ketoprofen are nonsteroidal anti-inflammatory drugs that inhibit the production of prostaglandins, reducing inflammation, pain, and swelling. Diclofenac specifically targets the COX-2 enzyme associated with inflammation and pain, minimizing gastrointestinal side effects[83]. Dexamethasone is a synthetic corticosteroid that binds to glucocorticoid receptors, suppressing inflammation, immune response, and allergic reactions[84]. Hydrocortisone, a synthetic form of cortisol, acts similarly to dexamethasone by binding to glucocorticoid receptors and modifying gene expression[85].

Antihistamine usage

Fifteen patients (48.9%) received administration of an antihistamine, specifically promethazine. Promethazine is classified as a phenothiazine antihistamine and is frequently utilized in the treatment of several conditions, including allergies, motion sickness, nausea, vomiting, and sedation. Its mechanism of action involves blocking the effects of histamine, a naturally occurring substance in the body responsible for allergic reactions. By inhibiting histamine activity at specific receptors, promethazine effectively alleviates allergy symptoms like itching, sneezing, runny nose, and watery eyes [86].

Anti-hypertensive usage

Captopril was administered in one patient with blood pressure 160x90mmHg (hypertension stage 1). Although, patient's blood pressure was classified as hypertensive crisis by the physician. Captopril is a medication classified as an angiotensin-converting enzyme (ACE) inhibitor. It is commonly used in the treatment of high blood pressure, heart failure, and certain kidney disorders. It works by inhibiting the action of an enzyme called angiotensin-converting enzyme that plays a crucial role in the renin-angiotensin-aldosterone system (RAAS), which regulates blood pressure and fluid balance in the body. By reducing the levels of angiotensin II, captopril causes vasodilation, leading to a decrease in peripheral resistance and a lowering of blood pressure. Additionally, captopril helps to decrease sodium and water retention by reducing the release of aldosterone, which further contributes to its blood pressure-lowering effects [87].

Antimicrobials usage

In scorpionism cases, doctors may use antibiotics as a preventive measure or to treat secondary bacterial infections that can occur as a result of scorpion stings. Although scorpion venom primarily contains neurotoxic components that affect the nervous system, the sting itself can cause tissue damage and create an entry point for bacteria to enter the body. Additionally, some scorpion species may have bacteria on their stingers that can be introduced into the wound during the sting [88].

The antibiotic ampicillin was used in one case. Ampicillin is a broad-spectrum antibiotic that inhibits bacterial growth by interfering with the synthesis of bacterial cell walls. It targets an enzyme called transpeptidase, which is responsible for cross-linking peptidoglycan strands during cell wall synthesis. Ampicillin weakens the cell wall, leading to bacterial cell death. By its turn, neomycin is an aminoglycoside antibiotic used topically. It inhibits bacterial protein synthesis by binding to ribosomes, disrupting the decoding of genetic information in bacterial RNA. This prevents the assembly of proteins necessary for bacterial growth and survival [89]. Neomycin was also used in one patient. It is an antibiotic belonging to the aminoglycoside class of medications, and primarily used as a topical antibiotic. It is effective against a wide range of bacteria, including both Gram-positive and Gram-negative bacteria. Neomycin works by inhibiting bacterial protein synthesis. It does so by binding to the bacterial ribosomes, which are the cellular structures responsible for synthesizing proteins. By binding to the ribosomes, neomycin interferes with the decoding of the genetic information contained in the bacterial RNA, preventing the proper assembly of proteins necessary for bacterial growth and survival [90].

Warm compress

One record (3.2%) of a moderate severity case involved a patient who presented with symptoms related to a scorpion sting. To address the patient's condition, a multi-faceted treatment approach was implemented, incorporating warm compresses, anti-inflammatories, analgesics, and scorpion antivenom. The warm compress therapy was prescribed to alleviate pain and promote local vasodilation, which can help reduce swelling and improve blood circulation around the sting site, as recommended by the Brazilian Ministry of Health [91].

Final words

In this study, a comprehensive analysis was conducted to investigate the range of neurological symptoms experienced by patients affected by scorpionism, including varying levels of pain, headaches, and speech difficulties. The treatment approach employed a combination of analgesics, anti-inflammatories, antihistamines, antihypertensives, and warm compresses. As a result, this study provides valuable insights into the clinical manifestations, diagnosis, and treatment of scorpion envenomation in Rorainópolis. These findings significantly contribute to the understanding of scorpionism, encompassing its clinical aspects and the factors that influence its severity.

Furthermore, these findings have implications for patient care, preventive measures, and the development of effective interventions and public health strategies. The knowledge gained from this study can guide healthcare professionals in providing optimal care to scorpionism patients, while also highlighting the importance of preventive measures to reduce the incidence and impact of scorpion envenomation. Additionally, these findings underscore the need for the development of targeted interventions and robust public health strategies to address scorpionism at both the individual and community levels.

To further enhance our comprehension and address potential gaps in knowledge, it is imperative to conduct additional research that delves deeper into these findings. Further investigations should explore the findings in greater depth, considering other potential factors that contribute to scorpionism and its associated complications. By expanding our understanding of scorpionism through continued research efforts, we can ultimately enhance patient outcomes, develop more effective treatments, and implement proactive measures to minimize the impact of scorpion envenomation on affected populations.

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4 ARTICLE 3**Epidemiological aspects of scorpionism: survey applied to the citizens from Rorainópolis, Roraima, Brazilian Amazon**

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EPIDEMIOLOGICAL ASPECTS OF SCORPIONISM: SURVEY APPLIED TO THE CITIZENS FROM RORAINÓPOLIS, RORAIMA, BRAZILIAN AMAZON

ABSTRACT: Objective: Scorpionism involves complex medical, economic, and social challenges. Scorpion venom can cause varied health issues, from discomfort to toxicological emergency. The Amazon's diverse ecosystem magnifies the problem, housing medically significant scorpion species with poorly understood venoms. Roraima's municipalities lack studies on envenomation incidents, species distribution, and risk mitigation. This knowledge gap endangers local populations. Our study aims to give some insights by gathering data from Rorainópolis residents and contributing to a comprehensive description about scorpionism in Roraima. **Methods:** The residents were invited to an online survey from June 2022 to June 2023, primarily targeting those aged 18 to 59. A printed version was also distributed locally, with participants providing voluntary consent. The survey engaged 341 volunteers. The questionnaire covered demographics, scorpion encounters, stings, symptoms, medical attention, and acquaintances' experiences. Data underwent analysis in appropriate software, including chi-square and Mann-Kendall tests for insights. **Results:** The group who answered the questionnaires was composed mostly by citizens from agriculture, education, business, and healthcare. Scorpion incidents heavily affected agriculture, followed by other sectors. Incidents increased over the years. Few victims sought medical care. Stings occurred during various activities in different locations. Symptoms varied, with local pain, numbness, and fever being notable. Some were aware of others stung, highlighting a communal impact. Comments revealed perceptions of danger, encounter areas, and treatment approaches. **Conclusion:** By addressing these unique challenges, the study contributes to the formulation of comprehensive occupational guidelines and strategies. By presenting a fresh perspective on scorpionism in Rorainópolis, this study provides a foundation for future research endeavors and policy formulation.

Keywords: Scorpionism. Amazon ecosystem. Envenomation. Risk mitigation.

RESUMO: Objetivo: O escorpionismo envolve desafios médicos, econômicos e sociais complexos. O veneno de escorpião pode causar diversos problemas de saúde, desde desconforto até emergências toxicológicas. O ecossistema diversificado da Amazônia amplia o problema, abrigando espécies de escorpiões de importância médica com venenos pouco compreendidos. Os municípios de Roraima carecem de estudos sobre incidentes de envenenamento, distribuição de espécies e mitigação de riscos. Essa lacuna de conhecimento coloca em perigo as populações locais. Nosso estudo visa fornecer algumas perspectivas, coletando dados dos residentes de Rorainópolis e contribuindo para uma descrição abrangente sobre o escorpionismo em Roraima. **Métodos:** Os moradores foram convidados a participar de uma pesquisa online de junho de 2022 a junho de 2023, com foco principalmente na faixa etária de 18 a 59 anos. Uma versão impressa também foi distribuída localmente, e os participantes forneceram consentimento voluntário. A pesquisa envolveu 341 voluntários. O questionário abordou dados demográficos, encontros com escorpiões, picadas, sintomas, atenção médica e experiências de conhecidos. Os dados foram analisados em software apropriado, incluindo testes qui-quadrado e Mann-Kendall para obter insights. **Resultados:** O grupo que respondeu aos questionários era composto principalmente por cidadãos da

agricultura, educação, negócios e saúde. Incidentes com escorpiões afetaram principalmente a agricultura, seguida por outros setores. Os incidentes aumentaram ao longo dos anos. Poucas vítimas buscaram atendimento médico. As picadas ocorreram durante diversas atividades em locais diferentes. Os sintomas variaram, sendo notáveis a dor local, dormência e febre. Alguns tinham conhecimento de outras pessoas picadas, destacando o impacto comunitário. Comentários revelaram percepções de perigo, áreas de encontro com escorpiões e abordagens de tratamento. **Conclusão:** Ao abordar esses desafios únicos, o estudo contribui para a formulação de diretrizes e estratégias ocupacionais abrangentes. Ao apresentar uma perspectiva nova sobre o escorpionismo em Rorainópolis, este estudo fornece uma base para futuras pesquisas e formulação de políticas.

Palavras-chave: Escorpionismo. Ecossistema amazônico. Envenenamento. Mitigação de riscos.

INTRODUCTION

Scorpionism global health issue that continues to be inadequately addressed by public authorities, a multifaceted problem encompassing scorpion-related accidents, their venom, and the profound consequences they impose on both health and socioeconomics¹. Despite its significant impact, this issue often remains in the shadows of public awareness and comprehensive research¹. In Brazil, scorpionism poses a considerable threat, particularly in ecologically diverse regions like the Amazon¹. One specific area that exemplifies the shortage of research is the state of Roraima, the northernmost state of Brazil.

Scorpionism, the result of scorpion envenomation, is a complex challenge that demands a multifaceted approach. It is not merely a medical dilemma but also an economic and social one, reverberating across communities and industries². The venom of scorpions can cause a range of adverse health effects, from localized pain and discomfort to severe systemic reactions that can be life-threatening if not treated promptly and appropriately².

In the intricate ecosystem of the Amazon, where biodiversity thrives, scorpionism represents a critical concern. The Amazon region hosts medically important scorpion species, each with its own unique venom composition and potential health impacts. Despite this richness, our understanding of these species and their venoms remains elementary, with many complicating factors that are intricately tied to this predominant rural biome³.

The municipalities in Roraima lack comprehensive studies on envenomation incidents, the distribution and behavior of scorpion species, and the most effective ways to mitigate the risks they pose⁴. This knowledge gap hampers our ability to safeguard the health and well-being of the local population.

In this particular context, the current study endeavors to enhance our understanding of this issue by collecting first-hand data from the residents of Rorainópolis. This initiative is intended

to serve as a supplementary resource, aiding in the comprehensive analysis and effective resolution of this challenge.

METHODS

The current study was conducted within the municipality of Rorainópolis, which is situated in the southernmost region of the Brazilian state of Roraima (Figure 1). Encompassing an extensive territorial area of 33,579.739 square kilometers, inhabited by an estimated population of 32,647 residents, according to Brazilian Institute of Geography and Statistics⁵.

The residents of Rorainópolis were individually extended invitations to participate in an online survey employing the Google Forms platform, from June 2022 to June 2023 and was predominantly targeted at individuals aged 18 to 59. Furthermore, a printed version of the survey was made available and circulated within Rorainópolis, with responses collected after participants endorsed a Term of Free and Informed Consent, indicating their voluntary involvement. The survey, through a simple random sampling, garnered active engagement from a total of **341 volunteers**.

Considering the total 18 to 59-year-old population of 20,027 residents in Rorainópolis, as reported by DataSUS in 2023, the research meticulously calculated an admissible margin of error using the EpiInfo software. This precision yielded a margin of error of 5.26% based on Slovin's formula with a confidence level set at 95%^{6,7}.

The comprehensive questionnaire encompassed a spectrum of inquiries, pivotal in collecting significant data points. These encompassed demographic details such as age, educational attainment, occupation, gender, racial or ethnic background, residential locality, alongside pertinent information concerning scorpions and scorpion-related incidents. Participants were probed regarding any prior encounters with scorpions within Rorainópolis, including specifics such as the occurrence, location, frequency of stings, temporal context, anatomical site of the sting, concurrent activities during the incident, resultant symptoms, pursuit of medical attention, and the duration taken to receive appropriate care. Furthermore, participants were also prompted to indicate acquaintance with others who had experienced scorpion stings, while also being afforded an opportunity to provide any additional noteworthy commentary.

The acquired data underwent integration and analysis within information systems, including Epi Info and Microsoft Excel. Furthermore, statistical analysis was conducted employing advanced software tools such as Past4 and Jamovi version 2.3.26, making graphics, tables, and performing appropriate tests (chi-square of adherence and Mann-Kendall test).

Prior to implementation, the current research obtained formal approval from the Ethics Committee in Research at Federal University of Roraima, granted under Report number 5.251.710.

RESULTS

In terms of participant age, those 20 and above accounted for 8.2%, while individuals aged 21-30 represented 25.8%. The 31-40 age group constituted 31.1%, followed by 18.2% in the 41-50 range, 14.7% above 50, and a minor proportion (2.1%) who did not provide age information. Concerning gender distribution, 40.5% identified as masculine, while 59.5% identified as feminine. In terms of ethnicity, the majority (70.7%) were of mixed ethnicity. Additionally, 15.0% identified as black, 11% as white, 1.2% as yellow, and 0.3% did not specify their ethnicity. In relation to residential location, 61% resided in urban areas, 32.6% in rural areas, and 4.1% in periurban regions. The remaining 2.1% did not provide this information.

Regarding educational attainment, 17 (5.0%) had completed only early childhood level, 40 (11.7%) had finished Elementary I, 26 (7.6%) had accomplished Elementary II, 104 (30.5%) had attained Secondary education, and 108 (31.7%) had reached Tertiary level. Additionally, 46 (13%) of participants did not provide information about their educational level.

The participants' occupations mirror the municipality's diverse scenery. Specifically, 70 (20.5%) were engaged in agriculture and farming, 53 (15.5%) in education and teaching, 33 (9.7%) in business and finance, 30 (8.8%) in public service and government roles, 24 (7.0%) in family and home-related activities, 24 (7.0%) were students, and 24 (5.3%) were in health care and medicine. Moreover, 53 (15.2%) pursued various other fields, while 37 (10.9%) did not disclose their occupation.

Thirty (8.8%) stated that has been stung by scorpion at least once, suggesting an estimated range of 3.5% to 14.1% of Rorainópolis' 18-59-year-old population having been stung by a scorpion at some point in their lives. In terms of the occupational fields impacted by scorpionism, agriculture and farming demonstrated the highest prevalence, accounting for 40% of the affected individuals (n=12). This category encompassed agricultural workers, cattle herders, and individuals involved in fishing. Additionally, 3 (10%) of those affected were housemakers. Other impacted occupations included physical therapists, surveillance coordinators, soldiers, teachers, public employees, housekeepers, students, policemen, and self-employed individuals.

The majority of participants (n=192, 56.3%) encountered scorpions in Rorainópolis, while 149 (43.7%) did not. Regarding the timing of incidents, most accidents occurred in the morning

(43.3%), with 23.3% happening in the afternoon and the same percentage in the evening/night. Interestingly, 10% of respondents stated they had been stung at least twice, while 7% indicated being stung three times. Among those affected, 46.6% experienced stings on their upper limbs, while 20.0% were stung on their lower limbs. Notably, 33.3% either did not specify the location of the sting or could not recall it. For the anatomical site of sting, chi-square resulted $\chi^2=6.826$, and no significant difference between the observed distribution of body sites was pointed out.

The year of accident varied among the participants (Figure 2), with a statistically significant increasing trend in those accidents over the years ($S=347$; $Z=3.5982$; $p\text{-value}=0.0003$).

Out of the participants who were stung by a scorpion, only 13.3% indicated that they sought medical care, with 86.7% stating that they did not. Among those who sought medical attention, the time taken to reach the hospital varied from 10 to 60 minutes, with a mean duration of 36.3 ± 27.5 minutes.

When asked about their activities when they were stung by a scorpion, several respondents mentioned they were engaged in tasks like working in the woods—collecting vines, branches, and wood, sawing, and transporting these materials. Additionally, some reported being stung while constructing gates, gathering stakes, collecting bricks, or working at the market. Others recounted instances of getting stung while playing, sleeping in bed or hammocks, dressing (putting on shoes and pants), or gathering clothing. Some mentioned dark places, like when reaching for a cord. These incidents occurred across various locations, encompassing workplaces, markets, and homes.

Regarding symptoms, half (50.0%) of the affected individuals reported experiencing local pain, while 13.3% described it as intense. An additional 20.0% noted experiencing local numbness at the site of the sting. Other noteworthy symptoms included fever (6.7%), a burning sensation (6.7%), generalized pain (3.3%), localized sweating (3.3%), tongue numbness (3.3%), cognitive symptom of fear (3.3%), bodily discomfort (3.3%), rapid heartbeat (3.3%), tingling (3.3%), dizziness (3.3%), and an absence of pain (3.3%). Approximately 6.7% of affected participants stated they could not recall their symptoms.

One-quarter (24.9%) of all participants also shared that they were aware of others who had been stung by scorpions, which included friends (22.9%), children (14.6%), spouses (12.5%), siblings (8.3%), parents (7.5%), and various other individuals.

Furthermore, 19.1% of participants provided intriguing comments. Some individuals highlighted specific areas in Rorainópolis where scorpions are commonly found and expressed concerns about the perceived high danger associated with these creatures, with the black

scorpion being the most frequently mentioned. Participants also shared details about the circumstances of the incidents. As for treatment, some mentioned consuming water with sugar, using painkillers, applying gasoline to the sting site, and employing natural botanical remedies and indigenous medicines.

DISCUSSION

The results of this study present a comprehensive overview of various demographic and contextual aspects related to scorpionism in Rorainópolis. Participant demographics revealed a diverse age distribution, with notable proportions in the 21-40 age range, and a relatively balanced gender representation. The ethnic makeup predominantly consisted of mixed ethnicity, with varying percentages for other groups. Educational attainment demonstrated a varied range, highlighting the municipality's diverse educational landscape. Occupations echoed the municipality's multifaceted nature, encompassing roles in agriculture, education, business, and health care, among others.

The notable influence of scorpionism on various occupational fields presents a crucial insight into the real-world impact of envenomation. Agriculture and farming emerged as the most heavily affected sector, with 40% of the affected individuals reporting incidents within this category, which was also observed in similar studies in other regions of Brazil^{8,9}. This finding is consistent with the known habitats of scorpions and the potential for encounters during outdoor activities such as collecting vines, branches, and wood, as well as other tasks commonly associated with agricultural work. The presence of agricultural workers, cattle herders, and individuals engaged in fishing within this category underscores the potential risks faced by those whose livelihoods are directly tied to outdoor environments related to forest which is natural home to scorpions. Moreover, 10% of those affected were housemakers, highlighting the potential for scorpion encounters even within domestic settings. This observation emphasizes the broad spectrum of scenarios in which scorpionism can occur, not solely restricted to outdoor or occupational contexts.

The increasing trend of scorpion incidents in Rorainópolis corresponds with the predominant discourse in the literature¹⁰, reinforcing the hypothesis that the heightened notifications could be attributed not solely to improvements in scorpionism notification policies and performance, but also to a genuine increase in cases throughout the last years.

The presence of scorpionism across a range of diverse occupations, including physical therapists, surveillance coordinators, soldiers, teachers, public employees, housekeepers, students, policemen, and self-employed individuals, raises questions about the extent to which

certain professions might expose individuals to higher scorpion-related risks. This variability in affected occupations suggests that scorpionism can impact individuals across different careers, irrespective of their specific roles in Rorainópolis.

The diversity of impacted occupations underlines the importance of public awareness and education about scorpion encounters and envenomation. Adequate knowledge and preventive measures are essential not only for individuals in high-risk occupations but also for those in seemingly unrelated fields, such as teaching or public service. Furthermore, these findings might prompt the development of personalized safety guidelines and educational campaigns for different professional groups, enhancing preparedness and reducing the incidence of scorpion-related incidents.

The findings regarding sought medical care and response time underscore potential gaps in medical attention and urgency. Participants' activities during stings reflect a diverse array of scenarios, highlighting potential risk factors associated with different tasks and environments. The decision of many people not to seek medical care when stung by a scorpion can have several implications, both at an individual and community level¹¹. Scorpion stings can lead to a range of health complications, varying from mild symptoms to severe reactions. Without proper medical evaluation and treatment, individuals may experience prolonged pain, allergic reactions, infections, or even life-threatening complications. Lack of awareness about the potential risks of scorpion envenomation and the available medical treatments could contribute to the decision not to seek care. When people do not seek medical care, opportunities for researchers and healthcare providers to study and improve treatment strategies are limited. To address these implications, it is important to promote public education about scorpion stings, their potential risks, and the importance of seeking timely medical care. Healthcare systems should be equipped to handle scorpion envenomation and provide accessible and appropriate treatment options.

Symptoms reported by participants mirror the diverse nature of scorpion envenomation, encompassing localized pain, numbness, fever, and various sensations, which are very common in scorpionism in Amazon biome, specially that is caused by the species *Tityus metuendus*, referred as the black scorpion, that can be found in Rorainópolis³. Tongue numbness as scorpionism symptom is not common to be indicated in Brazilian literature, but it was observed in other parts of the world, such as in Nicaragua¹² and Middle East¹³.

The awareness of others being stung underscores the communal impact of scorpionism. The range of symptoms reported by scorpionism victims provides valuable insights into the diverse physiological responses triggered by scorpion envenomation. The prevalence of local pain

aligns with the known effects of scorpion venom on the nervous system, causing localized discomfort and irritation. Moreover, the presence of a subset reporting intense local pain indicates the variability in pain perception and potentially reflects the potency of different scorpion species' venom. The occurrence of local numbness adds another layer to the symptomatology, suggesting potential neurological involvement beyond pain sensation. This numbness could signify a broader impact on nerve function, possibly influenced by venom composition and the specific interaction between venom components and neural pathways².

Thus, the varied symptoms reported by scorpionism victims emphasize the complexity of scorpion envenomation and their potential to affect multiple physiological systems. This diversity underlines the importance of a comprehensive medical approach to scorpionism cases, addressing both local and systemic symptoms to ensure appropriate and effective treatment. Further research into the underlying mechanisms of these symptoms could contribute to improved understanding and management of scorpion envenomation.

Furthermore, participant comments shed light on perceptions of scorpion danger, common areas of encounters, and varying treatment approaches. These insights offer valuable contextual understanding and potential avenues for public health interventions.

This study is an important tool for researchers, healthcare providers, and policymakers. It offers a unexplored view of scorpionism, and highlighted that scorpionism is an important public health problem in the municipality, helping to create effective solutions that address the various issues caused by scorpion stings in Rorainópolis and beyond. Importantly, this study looks into a topic that has not been studied in this geographic area before, adding a fresh perspective.

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Figure 1 – Map of the municipality of Rorainópolis, state of Roraima, Brazil.

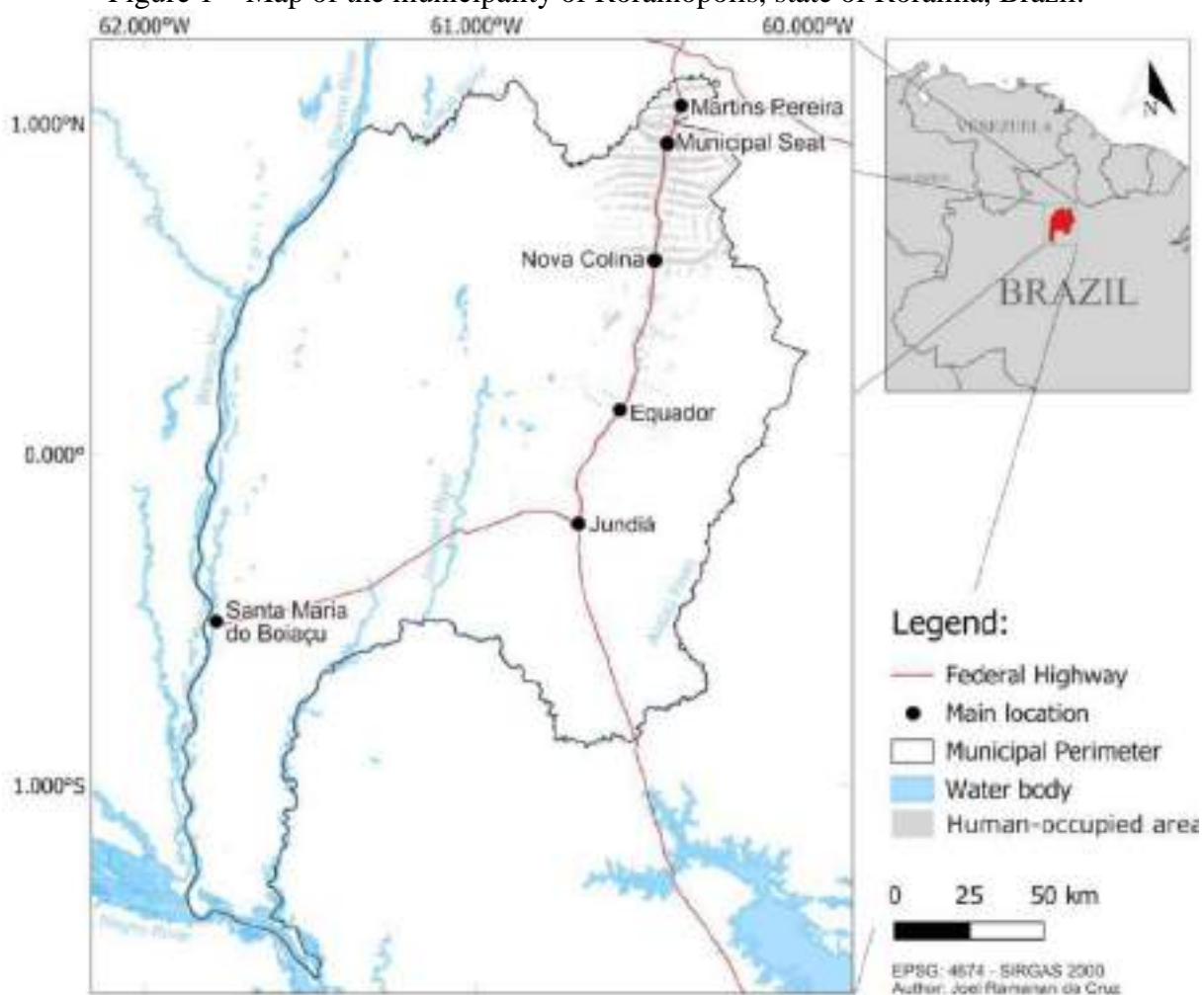
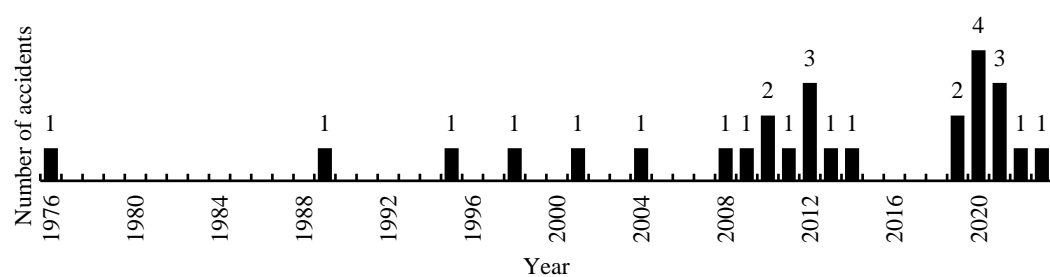


Figure 2: Years of occurrence of scorpion accidents according to the participants.



5 ARTICLE 4**Scorpiofauna related to scorpionism in Rorainópolis, Roraima, Brazil, in the recent decades**

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SCORPIOFAUNA RELATED TO SCORPIONISM IN RORAINÓPOLIS, RORAIMA, BRAZIL, IN THE RECENT DECADES

ABSTRACT

Introduction

Scorpions have significant public health impact, causing neurotoxic stings using their telson. Regions like the Brazilian Amazon lack important scorpion studies. Globally, 2,766 species are catalogued, including 160 in Brazil. Roraima, lacking diversity and scorpionism research, prompts this report for insights, aiding regional biodiversity understanding.

Methods

The study was conducted in the municipality of Rorainópolis, state of Roraima. Scorpions were actively searched for across 18 sites using UV flashlight, pincers, and containers, from April 2022 to May 2023, guided by scorpionism data. Specimens were identified at Health Sciences Center using Olympus SZ2-LGB Stereoscopic Microscope and photographed with smartphone and camera, and processed in photo editor software.

Results

Thirty-three scorpions yielded 3 species: *Tityus metuendus*, *Tityus silvestris*, and *Brotheas amazonicus*. *T. metuendus* showed color variations and inhabited various locations, with a length of up to 70.81 mm. *T. silvestris* had yellow coloration, observed at elevations of 93-95 m, reaching 30.66 mm. *B. amazonicus* displayed dark brown coloration, robust chelae, and appendages, reaching up to 65.09 mm at elevations of 95-99 m.

Conclusion

Rorainópolis hosts three scorpion species, notably *T. metuendus* linked to human life and urban areas, while *T. silvestris* and *B. amazonicus* favor forests. *Tityus* species are medically important in the Amazon biome, posing envenomation risks with varied symptoms. This study raises awareness among health professionals and society about these species' significance, emphasizing *T. metuendus*.

Keywords: Scorpion Envenoming. Scorpion stings. Arachnidism. Tropical Rainforest.

INTRODUCTION

Scorpions, ancient and very persistent small arachnids of significant importance in the field of public health, wield a substantial impact on human communities, particularly in the tropical and subtropical regions of our planet. Their stinging leads to noteworthy reactions within victims' organism, with neurotoxic, cardiovascular, local, systemic and allergic effects, making them a subject of considerable concern. The complex composition of their venom, consisting of a diverse mixture of proteins and peptides, is introduced into the victim's body through their sting apparatus, known as telson, located at the extremity of their abdomen¹.

The intricate relationship between scorpions and humans extends back to the origins of our species. Nevertheless, despite this historical background, many parts of the world, including the Amazon biome in Brazil, still lack comprehensive studies and understanding of scorpionism. This knowledge gap underscores the urgency to delve into this subject further, in order to enhance our comprehension of the interactions between scorpions and humans, particularly in regions where their impact remains understudied².

According to the Catalogue of Life platform³, there are currently 2,766 known extant species of scorpions distributed across 22 families and 234 genera worldwide. In the case of Brazil, researchers have described approximately 160 species and 4 families thus far, encompassing the genera *Tityus* (C. L. Koch, 1836), *Ananteris* (Thorell, 1891), *Rhopalurus* (Thorell, 1876), *Bothriurus* (Peters, 1861), *Thestylus* (Simon, 1879), *Ischnotelson* (Lourenço & Monod, 1997), *Jaguajir* (Lourenço, 2002), *Troglorhopalurus* (Lourenço & Eickstedt, 2000), and *Brotheas* (C.L. Koch, 1837)⁴. Among these, the genus *Tityus* is particularly significant for scorpionism in the country⁴.

In Roraima, the northernmost state of Brazil, there is a notable scarcity of studies focused on scorpion diversity within its southern region. Similarly, research addressing scorpionism in this area is limited. This brief report, in this regard, seeks to proactively provide insights into the scorpion species inhabiting the municipality of Rorainópolis. By establishing this foundational knowledge, the report aims to contribute for forthcoming investigations into the broader biodiversity of the region and the details of scorpionism.

METHODS

This study was carried out in the municipality of Rorainópolis, which comprises a territorial area of 33,579.739 square kilometers, equivalent to 12,974.892 square miles, in the Brazilian Amazon Biome, with a population that was estimated to be 32,647 residents in 2022 and farming and public service as the main economic sectors⁵.

The vegetation is predominantly Dense Ombrophilous Forest, also known as tropical rainforest, characterized by Aluvial, Montana, Submontana, and Terras Baixas formations, and also features significant areas of wetlands and grassland formations, and many rivers. The municipality presents two Köppen climatic types: monsoonal tropical climate with a short dry season and average annual precipitation ranging from 1,700 to 2,000 mm, and humid tropical climate that encompasses the majority of the territory, characterized by high precipitation exceeding 2,000 mm and well-distributed humidity throughout the year⁶.

The scorpion species included in this study were captured through active searches during the late afternoons and evenings. These searches were facilitated by the use of an ultraviolet flashlight, 30-cm pincers, and appropriate plastic containers to safely store the collected specimens, conserved in 70% ethanol. The collection process spanned across 18 distinct sites and 29 searches, in private properties, public places and paths, and schools, as illustrated in Figure 1, encompassing the period from April 2022 to May 2023. The selection of these sites was primarily informed by prior scorpionism accident data provided by the Municipal Health Surveillance Superintendence (MHSS), which collection was approved by the Human Research Ethics Committee of the Federal University of Roraima through report number 5.251.710, allowing for a targeted and comprehensive approach to specimen collection. Prior to capturing the animals, the current study obtained the requisite authorization for capture and transportation from the Chico Mendes Institute for Biodiversity Conservation by the Authorization for Scientific Activities number 80432-1.

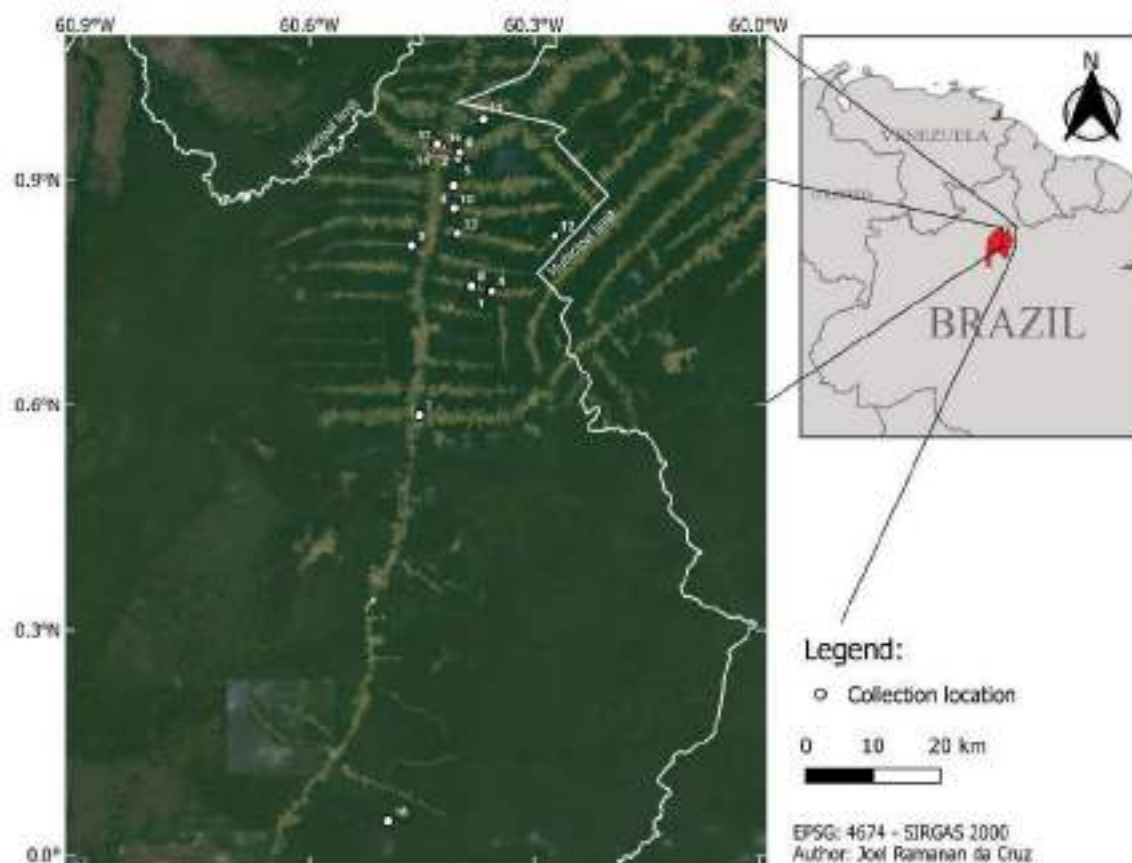


Figure 1 – Geographic distribution of scorpion collection sites for the study.

The specimens were identified, characterized and measured using the Binocular Olympus SZ2-LGB Stereoscopic Microscope in conjunction with pertinent literature⁷⁻¹¹ and a high-precision digital calliper 150mm/6 0,01mm 1108-150 Insize, at the Teaching Laboratory of the Health Sciences Center, CCS, at the Federal University of Roraima, UFRR, in Boa Vista, Roraima. The scorpions were photographed using the smartphone iPhone 13 Pro Max affixed to the stereoscopic microscope via an adapter, as well as a Nikon D-7100 camera paired with a 105mm macro lens SWM micro 1:61. The scene was illuminated with the Olanzi VL 120 RGB external light source. The resulting images underwent processing in Adobe Creative Cloud 2023 Photoshop. This photography process was executed at the Entomology Laboratory from the Center for Biodiversity Studies, CBio, at UFRR.

RESULTS

A total of 35 scorpions were collected in Rorainópolis, and 3 distinct scorpion species were identified among them (Table 1). These included *Tityus metuendus* (Pocock, 1897) and *Tityus silvestris* (Pocock, 1897), both members of the Buthidae family, as well as *Brotheas amazonicus* (Lourenço, 1988), member of the Chactidae family. Complete taxonomic details, and corresponding references for each scorpion can be found in Table 2. The scorpions' general external aspect is shown by Figures 2-4.

Table 1 – Data on collection and species from Rorainópolis.

Collection site	Number of searches	Coordinates	Elevation	Species (number of specimens)
01	4	0°45'07.5" N, 60°21'33.5" W	95 m	<i>Tityus metuendus</i> (12) <i>Brotheas amazonicus</i> (1) <i>Tityus silvestris</i> (1)
02	1	0°56'33.5" N, 60°25'57.8" W	78 m	<i>Tityus metuendus</i> (1)
03	2	0°53'31.8" N, 60°24'31.2" W	79 m	<i>Tityus metuendus</i> (1)
04	3	0°45'05.7" N, 60°21'25.3" W	93 m	<i>Tityus metuendus</i> (6) <i>Tityus silvestris</i> (1)
05	1	0°55'45.9" N, 60°24'6.9" W	94 m	<i>Tityus metuendus</i> (2)
06	2	0°56'12.6" N, 60°23'59.4" W	90 m	<i>Tityus metuendus</i> (1)
07	1	0°35'08.7" N, 60°27'15.3" W	76 m	<i>Tityus metuendus</i> (1)
08	1	0°45'29.6" N, 60°23'2.3" W	92 m	-
09	1	0°48'44.2" N, 60°27'50.6" W	83 m	<i>Tityus metuendus</i> (1)
10	1	0°51'41.2" N, 60°24'28.1" W	93 m	-
11	1	0°58'51.8" N, 60°22'7.2" W	109 m	-
12	1	0°49'30.8" N, 60°16'24.6" W	138 m	<i>Tityus metuendus</i> (2)
13	1	0°49'43.5" N, 60°24'11.2" W	96 m	-
14	2	0°56'35.7" N, 60°25'57.4" W	79 m	-
15	2	0°56'54.8" N, 60°25'32.4" W	85 m	-
16	2	0°56'36.4" N, 60°25'27.6" W	84 m	<i>Tityus metuendus</i> (1)
17	1	0°56'50.6" N, 60°25'47.2" W	85 m	-
18	2	0°2'40.19" N, 60°29'46.0" W	99 m	<i>Brotheas amazonicus</i> (4)

Table 2 – Classification of scorpion species collected in Rorainópolis.

Species	<i>T. metuendus</i>	<i>T. silvestris</i>	<i>B. amazonicus</i>
Kingdom	Animalia	Animalia	Animalia
Phylum	Arthropoda	Arthropoda	Arthropoda
Subclass	Arachnida	Arachnida	Arachnida
Order	Scorpiones	Scorpiones	Scorpiones
Family	Buthidae (C.L. Koch, 1837)	Buthidae (C.L. Koch, 1837)	Chactidae (Pocock, 1893)
Genus	<i>Tityus</i> (C. L. Koch, 1836)	<i>Tityus</i> (C. L. Koch, 1836)	<i>Brotheas</i> (C.L. Koch, 1837)
Total specimens	28	2	5
References	7–9	7–9	9–11

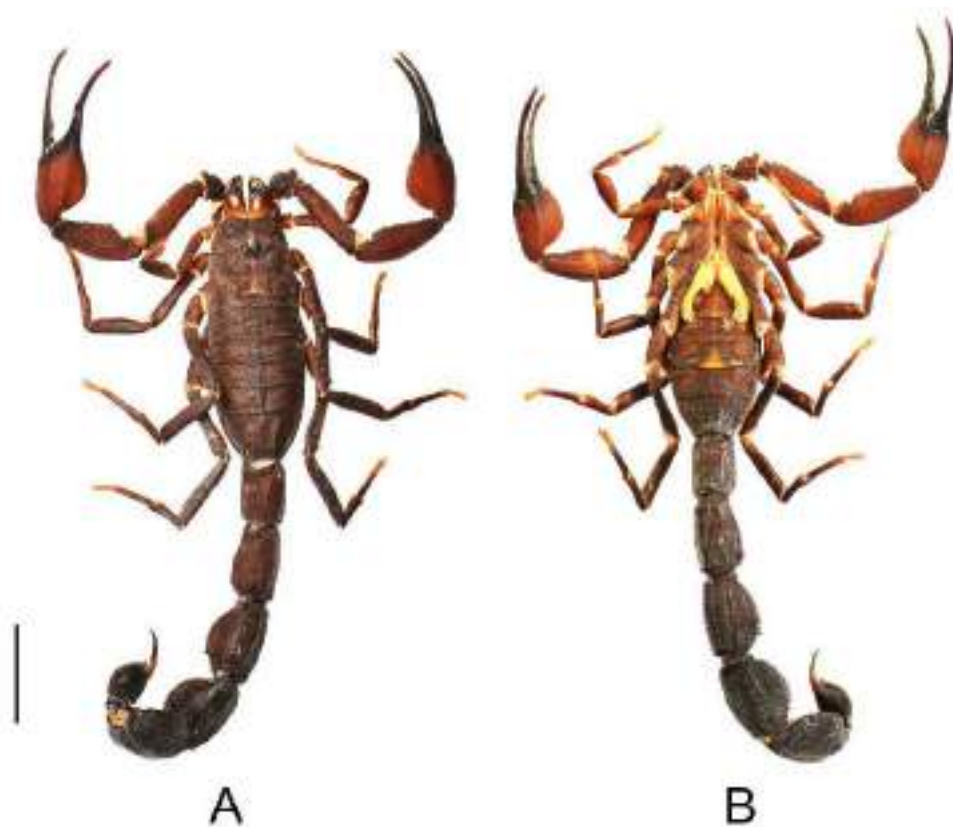


Figure 2 – General aspect of adult *Tityus metuendus* scorpion: (A) dorsal view and (B) ventral view. Bar = 1 cm.

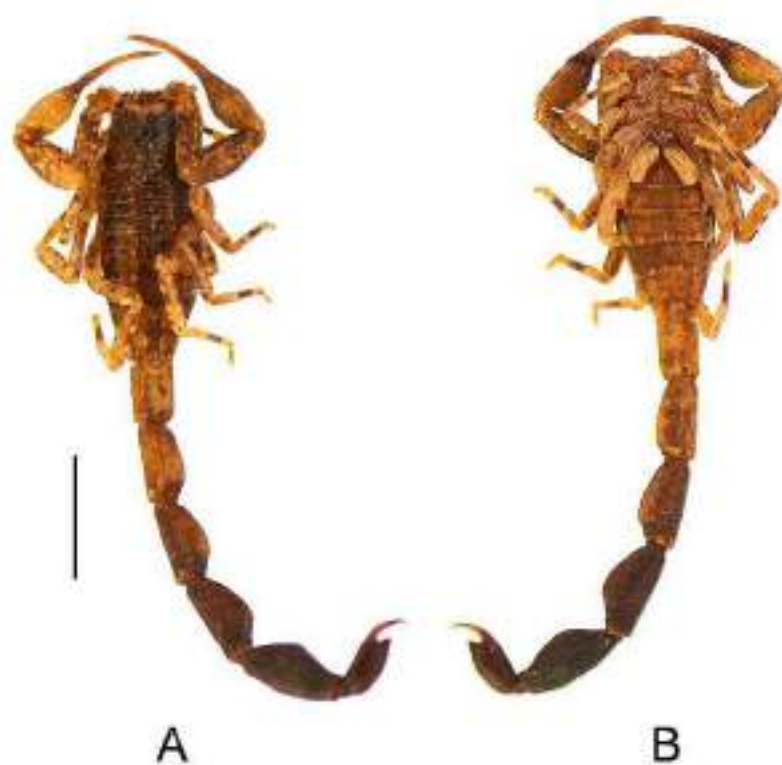


Figure 3 - General aspect of adult *Tityus silvestris* scorpion: (A) dorsal view and (B) ventral view. Bar = 0.5 cm.



Figure 4 - General aspect of adult *Brotheas amazonicus* scorpion: (A) dorsal view and (B) ventral view. Bar = 1 cm.

T. metuendus exhibited color variations based on their life stage. Typically, juveniles displayed a yellowish color with dispersed dark brown patches spanning their entire bodies. Adults featured a reddish-black appearance, accompanied by pectines displaying 20 teeth each, with movable fingers containing 17 to 18 rows of granules, and fixed fingers with 15 rows. The terminal metasomal segments were notably darker than their preceding counterparts. Their telson showcased a rounded vesicle with serrated carinae, a spinoid subaculear spine, and a distinctly curved stinger. This species could be found in the yard, walking freely; hidden beneath heaps of wooden boards and stacks of bricks; indoors; skittering across walls and roofs; by river shore; on city sidewalks; on the floor of public buildings; and in bedrooms. The species was observed within an elevation range of 76-138 m, and could attain a maximum body length of 70.81 mm.

T. silvestris presented a yellow general coloration, with dark brown patches and darker mesosoma. Their telson was globose, with a subaculear spine prominent and long, and serrated telson vesicle carinae, and crest-shaped subaculear spine. Their pectens presented 14 teeth each, and 16 granule rows on movable finger, and 15 granule rows on fixed finger. The final segments of the metasoma were distinctly darker compared to the other segments. The species was found in the yards, walking freely. The species was observed between 93-95 m of elevation, and reached up to 30.66 mm in body length.

B. amazonicus exhibited a consistent dark brown coloration that remained uniform across different life stages. In comparison to the other species, it displayed more robust chelae and appendages for movement, along with less pronounced granules and a more rounded carapace. The fifth metassomal segment was notably longer than the preceding segments, and their metassoma is lighter. The species had 9 teeth on each pectin without fulcra, 6 linear rows of

granules on the movable finger, and lacked a subaculear spine. Its habitat encompassed elevations ranging from 95-99 m, including beneath tree barks and walking freely in the yard. Additionally, it could reach a length of up to 65.09 mm.

DISCUSSION

At least three scorpion species can be found in Rorainópolis, with particular emphasis on the *T. metuendus* species, which appears to be most closely related to the context of human daily life. It appears to be the most medically relevant species in the municipality. It is commonly referred to as the “black scorpion,” by the data provided by the MHSS, and only that species could be found in the urban area. On the other hand, the *T. silvestris* and *B. amazonicus* species showed a greater affinity for forested areas.

Moreover, the *Tityus* species encompass medically relevant scorpions within the Amazon biome⁹. According to the relevant literature, these species exhibit a broad geographic distribution. *T. metuendus* has also been observed in other municipalities of Roraima.

Their proximity to human habitats also bears the potential for envenomation incidents, underscoring the vital need for understanding their potential effects. Encounters with *T. metuendus* may result in a constellation of clinical manifestations, including local pain, hyperemia, paresthesia, edema, tachypnea, lethargy, psychomotor agitation, mental confusion, myoclonia, sweating, sialorrhea, dyspnea, nausea, vomiting, and tachycardia⁹. Similarly, *T. silvestris*, has been known to induce local pain, paresthesia, and edema, accompanied by an assortment of distressing symptoms encompassing nausea, vomiting, somnolence, malaise, dyspnea, tachycardia, headache, myoclonia, hyper/hypotension, hypothermia, abdominal pain, and generalized muscle spasms, and there is a need for developing antivenom specific for that species⁹.

CONCLUSIONS

The current study provided valuable insights into the scorpion species present in Rorainópolis, aiming to raise awareness among health professionals, the public sector, and the general society. It is noteworthy that two species hold significant importance within the public health field. Therefore, special attention must be directed towards these species, particularly highlighting the significance of *T. metuendus*.

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6 ARTICLE 5**Brazilian Amazonian scorpion venom: a systematic review from 2001 to 2021**

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BRAZILIAN AMAZONIAN SCORPION VENOM: A SYSTEMATIC REVIEW FROM 2001 TO 2021

Abstract

The Amazonian biome hosts many scorpion species, some medically relevant. Approximately 200 scorpion species have been recorded in the Amazon region, including six of medical importance in the Brazilian portion: *Tityus apiacas*, *T. metuendus*, *T. obscurus*, *T. raquelae*, *T. silvestris*, and *T. strandi*. In this context, we propose to update the investigation of medically significant Amazonian scorpion species and highlight some of the detrimental and beneficial properties of scorpion venom toxins and their further application in drug product development. This systematic review collects and analyzes venom from Brazilian scorpions. Only works published from 2001 to 2021 (scientific articles, theses, and dissertations) that describe studies on Amazonian scorpion venom were selected, based on the lists of scorpions available in the literature. Studies involving species found in the Amazon but are not cited as Brazilian were not included in this review. Theses and dissertations were preferred over their derivative articles which were not included either. We identified 37 eligible studies among 17,880 studies (12 theses and 25 articles) and a basic statistical analysis was performed. The literature showed that the most studied venom was *Tityus obscurus* with 26 publications, followed by *Ophisthacanthus cayaporum* with 7 articles, *Brotheas amazonicus* with 3 articles, *Tityus metuendus* with 1 article and *Rhopalurus laticauda* with 1 article. Although the number of studies has increased during the period covered, there is still much more to investigate. Amazonian scorpions have great potential for pharmaceutical and clinical applications. However, funding and collaboration between institutions appear essential for research success and continuation.

INTRODUCTION

With an estimated 1.8 million species of organisms, the Amazon is notable for its unique and extensive biodiversity, high endemism, and importance as a source of genetic, chemical and ecological data, as well as feedstock for industry and pharmaceutical laboratories [1]. The biome covers nine Brazilian states (Acre, Amapá, Amazonas, Mato Grosso, Pará, Rondônia, Roraima, Tocantins, and a portion of Maranhão) representing 61 percent of the country's land area (approximately 5,217,423 km²). It contains a diverse range of ecosystems, human populations, cultures, and traditional communities [2]. The biome also features a large number of scorpion species, including some medically relevant [3]. Due to accidental envenomation caused by their sting, scorpions are a significant category of arthropods in the public health field, with reports of hospitalizations and deaths worldwide [4]. Approximately 200 scorpion species have been recorded in the Amazonian region, including six species exhibit medical importance in the Brazilian portion: *Tityus apiacas*, *T. metuendus*, *T. obscurus*, *T. raquelae*, *T. silvestris*, and *T. strandi* [5]. Scorpion venom is a complex mixture of compounds used for defense and prey capture [6]. Scorpion venom contains a heterogeneous cocktail of compounds, such as neurotoxins acting on different ionic channels through specific receptors. The three-dimensional structure of the toxins and the type of response elicited are features that can be used to classify their venoms.

In general, venom compounds are classified according to their nature/structure [7]: Table 1 shows the most common venom compositions:

Toxins from scorpions are grouped into four groups according to their pharmacological targets: sodium, potassium, chloride and calcium channels [8]. Toxins that have effects on sodium channels are referred to as NaTx. They are classified as α -NaTx if they bind to receptor site 3, or β -NaTx, if they bind to receptor site 4. Toxins that act on potassium channels are named KTx and are grouped into seven families: α -KTx, β -KTx, γ -KTx (Ergtoxins), δ -KTx, ε -KTx, κ -KTx (Hefutoxins), and λ -KTx. Toxins that have effects on calcium channels are called CaTx, and are classified as calcines, Liotoxins, and Omegascorpins. Toxins acting on chlorine channels are called ClTx with the single classification α -ClTx. Toxins that act on TRP channels are named TRPTx with the single classification α -TRPTx [8].

The venom of these arachnids is a mixture of proteins, peptides, nucleotides, and amines. It targets excitable and immunological cells, especially potassium, calcium, chlorine and sodium channels. They have been highlighted by an increasing number of scientific studies focusing on their composition and bioactivity. These studies suggest some applicability to medical treatments and drug development [9].

The mentioned relevance comes from findings in which scorpion venom toxins have demonstrated several important pharmacological and insecticidal characteristics so far, including analgesic, immune stimulator, anticoagulant, anti-thrombotic, antimalarial, antiproliferative, anti-inflammatory, antiviral, anti-infectious, antiepileptic, antihypertensive, anti-osteoporotic, and antitumor effects [7,9].

Providing an overview by compiling the findings of scorpion venom studies is a valuable approach to assess the current state of knowledge, identify research gaps, and provide guidance for future investigations [10]. This work is a literature review which aims to present and discuss the studies on Amazonian scorpion venom published from 2001 to 2021 in scientific articles and/or presented in theses and dissertations, available online, to understand how these studies have been performed and which of their results have been demonstrated so far.

MATERIAL AND METHODS

In order to retrieve the scientific works published or available online, Google Scholar, the Brazilian Digital Library of Theses and Dissertations (BDTD, <http://bdtd.ibict.br/vufind/>), the *Catálogo de Teses e Dissertações da CAPES*, PubMed, the Virtual Health Library, the *Rede Iberoamericana de Innovación y Conocimiento Científico - REDIB*, the Networked Digital Library of Theses and Dissertations – NDLTD, the EBSCO Open Dissertations and the Cochrane Library were consulted using the following keywords in English and Portuguese: “peçonha”, “venom”, “scorpion venom”, “peçonha de escorpião”; “scorpion venom + amazon”; “Amazon scorpion”, “peçonha de escorpião + amazônia”; “scorpion venom characterization”, scorpion species names and others related to the research.

We conducted a systematic review of publications from 2001 to 2021 that described studies on Amazonian scorpion venom. This was based on scorpion lists provided by Brazil & Porto [11] and Borges et al. [5]. Studies involving species found in the Amazon but were not cited as

Brazilian were not included in this review. Due to greater amount of information, theses and dissertations were preferred over their derivative articles which were not included either.

RESULTS

Literature selection

Google Scholar retrieved up to 2,650 results; the BDTD, 151 results; the Catálogo de Teses e Dissertações da CAPES, 396 results; PubMed, 24; the Virtual Health Library, 16; the Cochrane Library, 68; the NDLTD, 9,375; EBSCO, 62; and the REDIB, 138. Out of these results, 37 different works met the selection requirements for this review: 12 theses and dissertations, and 25 articles. All works retrieved by BDTD, CAPES, PubMed, the Virtual Health Library, and the Cochrane Library were found by Google. This proved to be the most effective search engine by covering more online scientific works than any other engine currently available [12]. The flow diagram (Figure 1) depicts the details of the selection process in the databases.

General information

Scorpion species and publications

The selected works covered five species, as shown in Table 2 and Figure 2. The species *Tityus obscurus* was named by its synonym *T. cambridgei* in 11 studies. The species *Rhopalurus laticauda* was presented by its synonym *R. crassicauda*. In the last two decades, the venom of about 3% of scorpion species from the entire Amazon region has been investigated. Two of them are of medical relevance. *T. obscurus* is the most researched species, observed by Martins et al. [13].

The studies were published homogeneously throughout the period considered in this review, as shown in Figure 3.

Study objectives

The studies objectives could be divided into five categories. As indicated in Figures 4 and 5, most of the investigations attempted to describe the molecular diversity of the venoms from *T. obscurus*, *O. cayaporum*, *B. amazonicus*, *T. metuendus* and *R. laticauda*, implemented with biological assays. *T. obscurus* appears to be the only comprehensive study in the region, as it is one of the species of high medical importance [52]. All five species underwent chemical characterization of their venom [14,17,24,25,45].

Material origin

Providing information on where scorpions were collected can be useful in making certain inferences that depend on scorpion distribution knowledge. This can guide future studies. Table 1 shows that the toxin from the Amazonian scorpions studied came from Pará, collected in Santarém, Benevides, Belterra, Marajó Island, and Floresta Nacional do Tapajós. From Tocantins, in Palmas and Roraima, collected at Boa Vista. Five studies (13.5%) focused exclusively on synthetic toxins. Unfortunately, twelve studies did not provide information about the origin of the scorpions and the toxins they investigated, which represents 32% of the studies. Two studies (5.4%) used scorpions kept at Instituto Butantan from the state of São Paulo. Scorpions from Amazonas were collected in Manaus and other unknown locations. Figure 6

shows the origin of the scorpions and toxins cited for each state. Table 3 provides details on the specimen origins and their associated toxins for each species.

Study location, funding and partnerships

A significant proportion of the studies conducted on Amazonian scorpion venom were led by Brazilian research institutions, comprising 73% of the total studies analyzed. These Brazilian institutions received funding from various sources, including institutions within Brazil itself (24 studies), Mexico (2 studies), and Belgium (2 studies). Furthermore, they formed partnerships with research institutions from multiple countries, including 11 collaborations within Brazil, 3 collaborations with Mexican institutions, and 1 collaboration each with institutions from Belgium, Italy, Germany, Colombia, the United States, and the United Kingdom. Three studies did not report any funding information, and 10 studies did not disclose any partnerships.

In contrast to the predominance of Brazilian research institutions, foreign institutions accounted for 27% of the studies conducted on Amazonian scorpion venom. These studies were primarily conducted by institutions from Mexico (4 studies) and Taiwan (4 studies), with additional contributions from institutions in Italy (1 study) and the United Kingdom (1 study). The funding for these foreign studies originated from various sources, including Mexico (3 studies), the United States (2 studies), Taiwan (1 study), and the United Kingdom (1 study). However, five studies did not provide information regarding their funding sources, and four studies did not disclose any partnerships.

Knowledge of scorpion species

Here we list the most investigated Amazonian scorpion species described in the literature during the period studied. In the next sections, we will describe and indicate the main characteristics observed in each Amazonian species investigated.

***Tityus obscurus* Gervais, 1843**

Tityus obscurus (family Buthidae), also known as *T. cambridgei*, *T. paraensis* and *T. amazonicus*, is a species of significant medical relevance [38]. Adults are black, and young ones have light spots. Its venom underwent deep studies, including toxin characterization, electrophysiological characterization, phylogenetic and structure analysis of the toxins, lethal activity analysis, antimicrobial, cytotoxicity and retroviral evaluation, molecular cloning and sequencing.

According to the reviewed literature, *T. obscurus* venom and their toxins are complex and can help improve and understand procedures for scorpionism treatment, antivenoms and epidemiology for the Amazonian population. *T. obscurus* venom induces a complex mechanism of envenoming pathogenesis. Furthermore, studies on *T. obscurus* venom help improve treatment for nervous and muscle system diseases, and infections caused by retroviruses, fungi and mycobacteria, and others diseases caused by enzymes, the idiopathic pulmonary fibrosis, and enhance immunity. Due to its toxins' activity, the venom has potential for treatments that target the release of neurotransmitters, hormonal secretion, regulation of fluid secretion and lymphocyte activation. Consequently, the promising research on *T. obscurus*' venom holds

potential to help develop treatments for a broad spectrum of diseases, from neurological and muscle system ailments to infections.

Batista and colleagues were the first researchers to study and chemically characterize its venom. They discovered the following toxins: Tc48a, Tc49a, Tc49b, and Tc54 which recognize sodium channels [26]. They also isolated and described the toxins Tc30 and Tc32 as potent suppressors of potassium currents in human T lymphocytes [27]. In 2004, this group identified and described 26 sodium channel toxins (Tc1, Tc27, Tc29-33, Tc35, Tc37, Tc39-41, Tc43, Tc46, Tc48a, Tc48b, Tc49a, Tc49b, Tc50, Tc54, Tc56, Tc58, Tc61, Tc64, Tc66, and Tc83). Murgia et al. [32] reported that Tc48b affects sodium permeability in pituitary GH3 cells. The toxin Tc54 was later renamed To4 by Duque et al. [43] when it was electrophysiologically characterized as acting on different human sodium channel isoforms, exhibiting a beta-type effect on those channels. Liu & Lin [30] observed that Tc1 prefers Kv1.1 potassium channel due to stronger electrostatic and hydrophobic interactions. Wang et al. [28] demonstrated that a synthetic version of Tc1 has the same functional properties as the natural toxin, being a stable potassium channel blocker. Grottesi & Sansom [29] studied Tc1's flexibility and discovered that it shares a common fold with agitoxin-2 and charybdotoxin from the scorpion *Leiurus quinquestriatus* var. *hebraeus*.

Guerrero-Vargas et al. [36] isolated 15 sodium channel toxins (To1–To15) and noted multiple names for the same toxins in the literature and theorized that there is a substantial cladistic difference between toxins produced by congeneric scorpions in south-eastern South America and toxins produced by northern Amazon basin scorpions. The authors also demonstrated that the alpha-class NaScTxS are strongly related to To6, To7, To9, To10, and To14, whereas the beta-class NaScTxS are more closely related to Tpa7, Tpa8, To4, To8, To12, and To15 sequences. To5 may be an arthropod-specific toxin. In *T. obscurus* venom, Dias [39] detected 517 peptides (27 sequenced) and 46 other non-peptidic compounds. Four peptides demonstrated hemolytic activity. Tibery et al. [48] isolated the beta-toxins Tc48b (or Tc49a) and Tc49b. Tc49b could alter the activity of most sodium channel isoforms by inhibition, changing the open probability during activation and steady-state inactivation in human cells. Dias et al. [45] detected 27 peptides ranging from 400 to 4,000 Daltons in *T. obscurus*. Thirteen underwent biological testing and caused hemolysis and lactate dehydrogenase release from the mast cell cytoplasm to the surrounding environment. This potentiated significant inflammatory processes and modifications to locomotion and lifting capabilities. Huang Yizhe [33] and Chang [34] studied the alpha-toxin Tc32 and demonstrated that this toxin blocks Shaker B and Kv1.x channels and described how the interaction occurs. Stehling et al. [37] compared the Tc32 to the TdK2 and TdK3 toxins. He hypothesized that toxins' affinity and selectivity are determined by differences in their electrostatic features, contact surfaces and total dipole moment orientations. Figure 6 shows the proteins and peptide components observed by De Oliveira and collaborators [44].

While the toxins shared some similarities with some putative toxins from other *Tityus* species, such as P84688, P84685, H1ZZH7, P60213, H1ZZIO, P60214, PO1496, H1ZZI3, H1ZZI2, and P60212, the authors highlight that the *Tityus obscurus* venom components are not recognized by anti-*T. serrulatus* venom serum.

Interestingly, Pardal [38] compared and observed differences between the venom of two populations of *T. obscurus* from two regions of Pará. The venom of western scorpions had more

components than the eastern scorpions, with more potassium and sodium modulators. This explains why accidents in the western region of Pará are more severe than those in the eastern region. Furthermore, the author recommends taxonomical revision. This indicates that studies on venom can also contribute to the species classification and phylogenetics.

Borja-Oliveira et al. [35] observed in rat skeletal muscles that a 10 g/mL venom solution generated a gradual and sustained increase in contractile force for 120 minutes. At higher concentrations only, temporary potentiation was promoted. They hypothesized that venom might have clinical applications. Additionally, Santos-Da-Silva et al. [42] demonstrated in rats that signs of envenomation appear about 30 minutes after injection, with a peak of systemic effects after 60 minutes of injection. This was done in rats using 0.1 mL/100 g of NaCl solution. Some of the effects observed were: hemorrhagic patches in the lung parenchyma and pleural regions at 10 mg/kg; also, extravasation of red blood cells in the parenchyma; decrease in general and locomotor activities after 60 minutes; breathing difficulty; piloerection; palpebral ptosis; excessive oral and nasal secretions; somnolence; photophobia; priapism; “wet dog shakes”, and immediate diuresis.

In biological tests from a biotechnological perspective, Marques-Neto et al. [46] demonstrated that ToAP2 suppresses the growth of four *Mycobacterium massiliense* strains at 200 micromolar. It reduces the bacterial load in mice's liver, lung, and spleen, and recruited monocytes, neutrophils and eosinophils. Guilhelmelli et al. [23] isolated and recorded that ToAP3, ToAP2-ToAP4, ToAcP, and NDBP-4.23 have antifungal properties against filamentous fungi and yeast such as *Candida*. Later, Carvalho [41] isolated P42 (probably To4 or another) and demonstrated its antifungal activity against yeast strains: *C. albicans*, *C. tropicalis* and *C. parapsilosis*, and antibacterial activity against *Escherichia coli* and *Staphylococcus aureus*. Da Mata et al. [50] tested eight synthetic peptides and demonstrated that the P6 peptide has low cytotoxic activity against primary human leukocytes. It also has high antiretroviral activity against simian immunodeficiency virus replication in the HUT-78 cell line. In turn, Veloso-Júnior [49] observed that ToAP3 and ToAP4 can suppress inflammatory responses and modulate the activation and maturation of dendritic cells in mice, making them suitable candidates for anti-inflammatory therapies. Simon et al. [47] tested these toxins also against idiopathic pulmonary fibrosis in rats at an early stage, and observed that the toxins stabilized lung damage, slowing the illness progression. Mourão [40] isolated ToPI1 and synthesized it (ToPIIs), and since it is active against trypsin in chromogenic assays and has no adverse effect in mice, it is a good candidate for therapeutic purposes.

***Opisthacanthus cayaporum* Vellard, 1932**

Opisthacanthus cayaporum (family Hormuridae) is a black scorpion from the south of Pará to the central region of Tocantins, reaching between 7 and 9 cm in length. It has no medical importance [18]. Its venom underwent purification and characterization of its peptides, functional characterization and evaluation of its antifungal activities, and transcriptomic studies. Most of the specimens studied were collected in Tocantins. Schwartz et al. [18] detected 250 different components in the venom, including a peptide with 65% similarity to the α -KTx 6.10 toxin (OcKTx5). They suggest that the venom is specific to insects, harmless to mammals, and exhibits phospholipase and antibacterial activity. Later, Schwartz et al. [23] studied the OcyKTx2 peptide, describing it with 34 amino acids, four disulfide bridges, and a molecular

weight of 3,807 Dalton. They compared it to other toxins and demonstrated that it acts on Shaker B and Kv1.3 channels at nanomolar concentrations.

Silva [19] characterized scorpion venom gland transcripts by building a cDNA library with 67 distinct sequences. This library included toxin-like sequences and others involved in gene and protein expression. The peptide Cayaporina (NDBP 3.7) exhibited antimicrobial activity against *E. coli* and *S. aureus*, with no hemolytic activity in human erythrocytes. Camargos [17] identified the potassium channel blocker κ -KTx 2.5 (3 kDa), and partially sequenced a Scorpine-like and a non-disulfide bridged peptide (NDBP) OcCT2f that exhibits antimicrobial activity and requires further investigation. The peptide κ -KTx 2.5 was later investigated by Camargos et al. [21] and had no effect on *E. coli* and *S. aureus* at 128 mM. Guilhelmelli et al. [23] studied the effects of three peptides from *O. cayaporum* as antifungals: Con10 (27 amino acids long), NDBP-5.7 (13 amino acids), and NDBP-5.8 (14 amino acids). Con10 demonstrated antifungal activities, notably against *C. albicans*. NDBP-5.7 and NDBP-5.8 displayed activity against *C. albicans* and *C. tropicalis*.

***Brotheas amazonicus* Lourenço, 1988**

Brotheas amazonicus (family Chactidae) is a black scorpion with reddish tips and telson [13], and can be found in Amazonas, Roraima, and Rondônia, and is known for its low lethality venom. Its venom underwent molecular characterization, biological activity analysis and evaluation of its potential biotechnological uses. Higa [14] demonstrated that its venom does not induce bleeding or blood coagulation in mice. It confirmed its low toxicity and that the toxins exhibit potent analgesic activity against inflammatory pain, suggesting an application to analgesic drug development. The author also found that its venom exhibits phospholipase A₂ activity. He suggests that its 7080 Da serine proteases are responsible for proteolytic activity. Higa, das Dores Noronha and López-Lozano [16] also demonstrated that venom can degrade bovine fibrinogen without fibrin clot formation. This makes it a candidate for antithrombotic drugs and vaccines against scorpion accidents. In turn, Ireno [15] detected 201 molecular species, including peptides ranging from 0.8 to 17 kDa, and sequenced eight peptides.

***Tityus metuendus* Pocock, 1897**

Tityus metuendus (family Buthidae) is a reddish-black species of medical relevance in the Amazon. Batista et al. [25] demonstrated that the venom of the species collected in Manaus (Amazonas) is very toxic to mammals and lethal to mice at low concentrations. It presents alpha and beta-toxins very similar to those found in *T. obscurus*. Among the many proteins and peptides, the authors could probably find sodium and potassium channel toxins, hyaluronidases, metalloproteinases, endothelin, and angiotensin-converting enzymes, allergens, and bradykinin-potentiating peptides in the venom. The study indicates that further investigations are needed.

***Rhopalurus laticauda* Thorell 1876**

Rhopalurus laticauda (family Buthidae) can be found in Roraima, south of Guyana and Venezuela, in deciduous forests and semi-arid regions. It varies from 45 to 70 mm in length and has a yellowish-brown coloration with a dark tail, and can be found under rocks, wood barks and fallen trunks [13]. Abreu et al [24] studied its venom, with samples from Boa Vista, Roraima's capital. The authors present an extensive study of its venom.

They isolated the major toxin Rc1, approximately 6.5 kDa. This toxin represented 24 percent of the total protein of the soluble crude venom and was classified as a beta-neurotoxin. The crude venom could not be recognized by Brazilian antivenoms. However, a fraction of the venom containing a hyaluronidase could be recognized by the general arachnid antivenom. It proved to be specific to mammalian and insect voltage-gated sodium channels, and exhibited cytotoxic effects and strong pro-inflammatory activities.

DISCUSSION

The study conducted by Martins et al. [13] sheds light on the limited research available on scorpion venom from the Brazilian Amazon prior to 2001. Their findings reveal that only one study, published in 2000, was dedicated to exploring this topic. This indicates that investigations into the venom of Amazonian scorpions likely gained momentum at the beginning of the twenty-first century. The relative scarcity of pre-2001 research underscores the relatively recent recognition of the importance and potential of studying scorpion venom in the Brazilian Amazon region.

While potent venomous scorpions often attract significant attention due to their potential harm to humans, it is important to note that harmless scorpion species also hold significant value in scientific research. One such example is *Brotheas amazonicus*, a species that has been studied despite posing no threat to humans. In their work, Ward, Ellsworth, and Nystrom [51] emphasize the continued relevance of investigating harmless scorpions for medicinal development. These harmless scorpion species represent a potentially unexploited source of valuable compounds and medicines.

The distribution of funding and collaborations highlights the primarily national focus of the Brazilian research institutions in studying Amazonian scorpion venom. Nevertheless, the involvement of foreign institutions from seven different countries demonstrates the international interest and collaboration surrounding this field of study. Particularly noteworthy is the widespread investigation of the scorpion species *Tityus obscurus*, which has attracted significant attention from the global scientific community. The research interest from multiple parts of the world underscores the recognition of *T. obscurus* venom as a valuable resource for scientific exploration and potential biotechnological applications.

The involvement of foreign institutions in studying Amazonian scorpion venom signifies the potential for international exchange of research and knowledge in this field. These collaborations offer opportunities to share expertise, methodologies, and resources, enriching the collective understanding of scorpion venom and its applications. The diverse range of countries involved in these collaborations reflects the global interest in exploring the unique properties and biotechnological potential of Amazonian scorpion venom. Such international

partnerships can foster cross-cultural scientific advancements and open doors to innovative research directions.

Documenting the collection locations of scorpions is important in venom studies, as this information plays a crucial role in understanding scorpion distribution and can inform future research directions. By knowing the specific regions where scorpions were collected, researchers can make valuable inferences about the habitats, ecological preferences, and potential variations in venom composition among different populations. Understanding the geographical origins of the scorpions studied allows researchers to consider regional differences in venom composition and potentially correlate these variations with ecological factors, such as habitat type, altitude, or climatic conditions. This information is valuable for designing targeted studies and expanding our knowledge about the diverse venom profiles of scorpions in different regions.

It is worth noting that some studies focused exclusively on synthetic toxins, indicating a distinct area of research where synthetic compounds are designed and investigated for their venom-like properties. However, there is a concerning gap in the available information, with twelve studies (32% of the total) omitting details about the origin of the scorpions and the specific toxins investigated. This lack of information can limit the ability to make accurate associations between venom characteristics and their geographical context. Providing complete and transparent information about specimen origins is crucial for reproducibility, comparability, and advancing our understanding of scorpion venoms.

Two studies (5.4%) utilized scorpions kept at Instituto Butantan in the state of São Paulo. This suggests the use of captive scorpions in research, which allows for controlled studies under laboratory conditions. While captive scorpions may not necessarily represent the full diversity of venom profiles found in the wild, they offer opportunities for controlled experiments, comparative analyses, and specific investigations on captive-bred individuals.

Thus, documenting collection locations is important in scorpion venom studies, as it enables researchers to make valuable inferences, understand regional variations, and guide future research. However, it is necessary to improve the there is a need for improved reporting standards, as a significant portion of the studies did not provide information about the origin of the scorpions and the toxins investigated. By addressing these gaps and ensuring transparent reporting, researchers can enhance the reproducibility and comparability of studies, ultimately advancing our understanding of the diverse and complex world of scorpion venoms.

Based on the comprehensive description and discussion provided thus far, along with the data presented in Tables 4 and 5, it is evident that extensive biochemical studies have been conducted on the venom of Brazilian Amazonian scorpions since the beginning of the 21st century. The scientific community has devoted significant efforts to unravelling the intricate nature of scorpion venom, aiming to decipher its composition, mode of action, and potential applications. However, it is essential to note that despite these endeavors, the scope of species investigated within the Amazonian biome remains limited, despite its incredible biodiversity that hosts hundreds of scorpion species.

The limited coverage of scorpion species within the Amazon rainforest presents a remarkable opportunity for further exploration and research. By delving into the uncharted territory of Amazonian scorpion venom, there is a vast wealth of untapped potential waiting to be

discovered. The intricate biochemical composition of scorpion venom, containing an array of peptides, enzymes, and other bioactive molecules, holds promise for a wide range of biotechnological applications.

Unleashing the untouched potential of scorpion venom could yield significant breakthroughs in various fields. Exploration of the biotechnological applications of scorpion venom constituents may lead to the development of novel therapeutic agents, such as potent analgesics, antimicrobial drugs, and anticancer treatments [7,9]. The unique properties exhibited by scorpion venom components, including their ability to target specific cellular receptors or ion channels, make them attractive candidates for drug development and the discovery of new therapeutic modalities.

Furthermore, investigating the bioactive molecules present in Amazonian scorpion venom could offer insights into their ecological roles within the complex rainforest ecosystem. Understanding how scorpions utilize their venom for predation, defense, or communication can contribute to our knowledge of the intricate dynamics of species interactions and ecosystem functioning.

While substantial progress has been made in unravelling the biochemistry of scorpion venom in Brazil and the Amazonian region, there is still much ground to cover. The immense biodiversity harbored within the Amazon rainforest presents a vast array of scorpion species that are yet to be explored. Harnessing the potential of scorpion venom and its constituents for biotechnological applications holds great promise for medical advancements and ecological insights. By expanding the scope of research to encompass a broader range of Amazonian scorpion species, we can unlock new horizons in the field of scorpion venom research and pave the way for transformative discoveries.

The exploration of scorpion venom's biotechnological potential has already yielded exciting discoveries, opening up new possibilities for the treatment of various medical conditions. In particular, scorpion venom has shown promise in addressing muscular and neurological diseases, thrombosis, and the development of region-specific antiscorpion serums tailored to the unique venom profiles found in the Amazon region. These findings highlight the potential of scorpion venom as a valuable resource for addressing medical challenges specific to the Amazonian context.

Moreover, the identification of twelve specific toxins within scorpion venom has revealed their potential in the development of therapeutics targeting a range of conditions. These toxins have demonstrated promise as antifungals, antibacterial, and antiparasitic agents, showcasing their potential to combat infectious diseases that pose significant global health challenges. Additionally, there is emerging evidence suggesting that certain scorpion venom toxins could be harnessed for their antiviral properties, including their effectiveness against viruses such as HIV. Such findings present exciting prospects for the development of novel antimicrobial strategies.

Intriguingly, scorpion venom has also shown potential in treating idiopathic pulmonary fibrosis, a progressive and debilitating lung disease with limited treatment options [53]. The identification of specific venom components that exhibit efficacy in combating this condition represents a significant advancement in the field, offering hope for improved therapeutic interventions for patients suffering from idiopathic pulmonary fibrosis.

However, to fully grasp the extent of scorpion venom's potential and to translate these discoveries into practical applications, further in-depth studies are imperative. Continued research efforts are necessary to better understand the mechanisms of action underlying the therapeutic properties of scorpion venom toxins. This includes elucidating their interactions with molecular targets, assessing their safety profiles, and optimizing their effectiveness through various delivery mechanisms.

Additionally, exploring the diversity of scorpion species within the Amazon rainforest and investigating their venom composition could uncover previously undiscovered toxins with remarkable therapeutic potential. By studying a wider range of scorpion species and their venom profiles, researchers can identify novel bioactive compounds that may have applications in fields such as drug development, biotechnology, and personalized medicine.

The ongoing research on scorpion venom's biotechnological potential has already yielded promising results, including its potential for treating muscular and neurological diseases, thrombosis, and the development of region-specific antiscorpion serums for the Amazon. Moreover, specific scorpion venom toxins have shown potential as antifungals, antibacterial, antiparasitic agents, and even antivirals, with efficacy demonstrated against HIV. The potential application of scorpion venom in treating idiopathic pulmonary fibrosis adds to its versatility as a therapeutic resource. However, to fully harness the scope of scorpion venom's potential and develop new technologies and treatments, further dedicated studies are crucial.

The field of research on scorpion venom in the Brazilian Amazon is still in its early stages, highlighting the vast potential for further exploration. Despite the wealth of known pharmacological characteristics associated with scorpion venom and its toxins, many of these properties remain largely unexplored within the specific context of the Brazilian Amazon. Promising avenues for investigation include untapped areas such as antiosteoporotic, antimalarial, anti-inflammatory, antiepileptic, analgesic, antineoplastic, and other potential therapeutic properties [7,9]. Given the region's rich biodiversity and the presence of numerous scorpion species, there is an urgent need for focused studies to shed light on the venom and toxins found in this unique biome [13]. However, the successful realization of such studies hinges on the availability of adequate equipment, infrastructure, research resources, and trained personnel. It requires the collaborative efforts of dedicated researchers and research institutions working in tandem to drive these research endeavors forward. The outcomes of these studies hold significant implications not only for enhancing our understanding of the diversity and evolutionary aspects of venomous species in the region but also for the development of more effective treatments for scorpion victims and various diseases prevalent in the Amazonian context. Thus, securing sufficient funding and fostering collaborations are of paramount importance to ensure the progress and success of these critical research endeavors.

To advance the research on scorpion venom in the Brazilian Amazon, it is essential to address the challenges associated with funding and collaboration [54]. Securing adequate funding is crucial for conducting comprehensive studies that encompass the range of unexplored pharmacological properties within scorpion venom. Such funding would support the acquisition of state-of-the-art equipment, the establishment of research facilities, and the availability of necessary research materials. Moreover, fostering collaboration among researchers and research institutions is vital to pool expertise, share resources, and tackle the multifaceted nature of scorpion venom research effectively. Collaborative efforts would enable the exchange of

knowledge and methodologies, facilitate access to diverse scorpion species across different regions, and promote synergistic research initiatives. By combining resources and expertise, researchers can navigate the challenges posed by the vast and diverse Amazonian biome, leading to more impactful scientific discoveries and innovations in the field of scorpion venom research. Consequently, both securing adequate funding and fostering strong collaborations are integral to ensuring the advancement and success of research endeavors in this critical area.

CONCLUSION

During the timeframe examined in this review, only a limited number of Amazonian scorpions from Brazil have been subjected to venom studies. There is still a substantial amount of work to be undertaken in this region. The venom of these scorpions holds significant potential for pharmaceutical and clinical applications, yet it remains largely unexplored and poorly understood. Within the rich biodiversity of the Amazon, there exists the possibility of discovering novel bioactive compounds that can shed light on envenomation processes specific to the region. These compounds could not only enhance the effectiveness of antivenoms but also contribute to the development of new technologies and therapeutics, aligning with the goals of the Global One Health initiative.

Securing adequate financing and fostering collaboration between institutions are crucial for the success and continuity of research efforts. The Amazon rainforest is a habitat to an immense array of species, both known and unknown, many of which possess unique compounds that hold potential for therapeutic applications. Through collaborations with other institutions and the provision of necessary funding, we can identify and harness these compounds to improve treatments for venomous stings while also developing novel technologies and therapies that can benefit the global health sector.

Conflict of Interest

The authors declare that the research was conducted in the absence of any commercial or financial relationships that could be construed as a potential conflict of interest.

Author Contributions

J. R. da Cruz and C.M. de Moraes conceived the research. J. R. da Cruz conducted the research. C. M. de Moraes and P. Bullet advised the first author, commented and reviewed the text.

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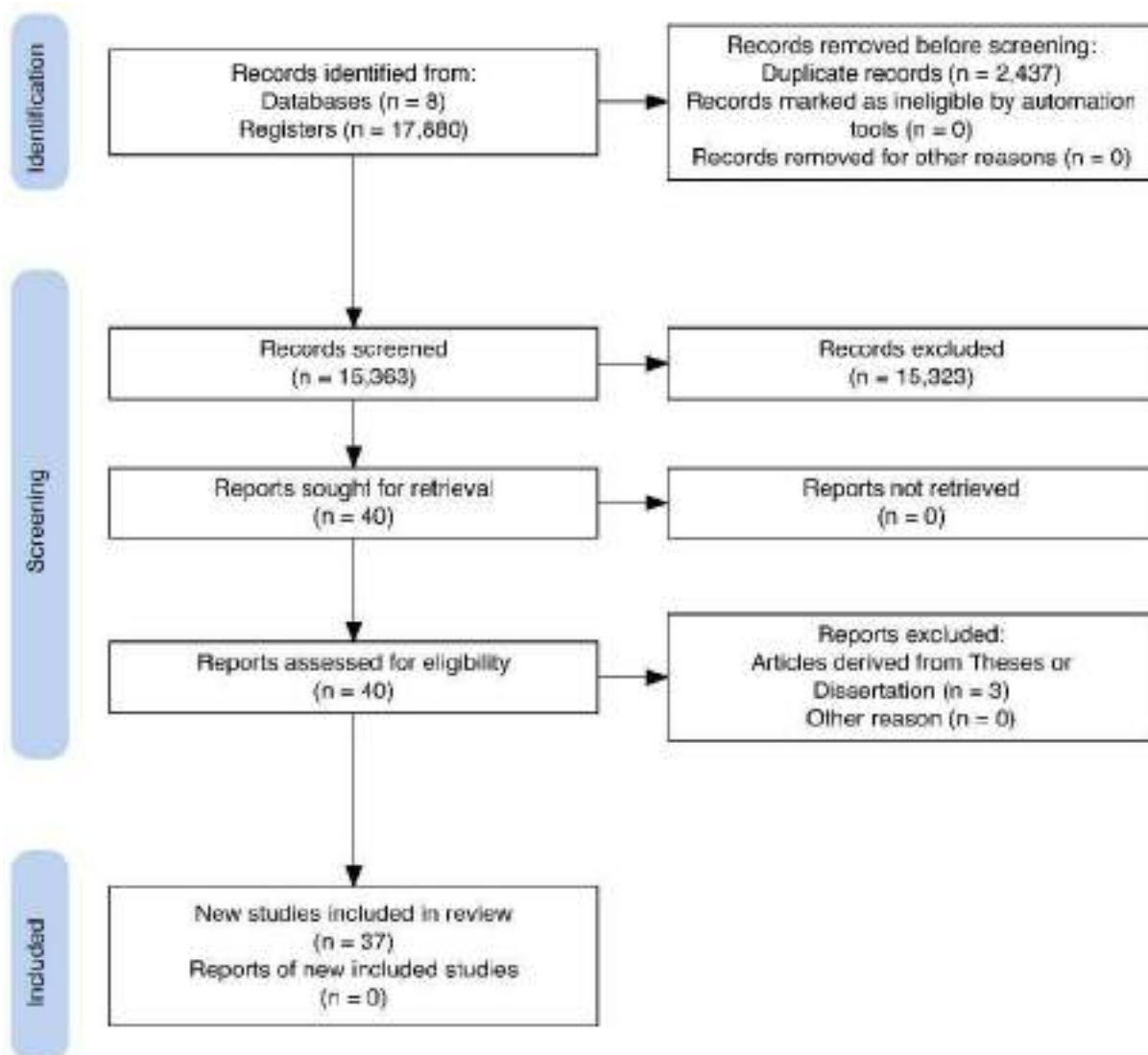


Figure 1. Flowchart showing the research design process of the study.

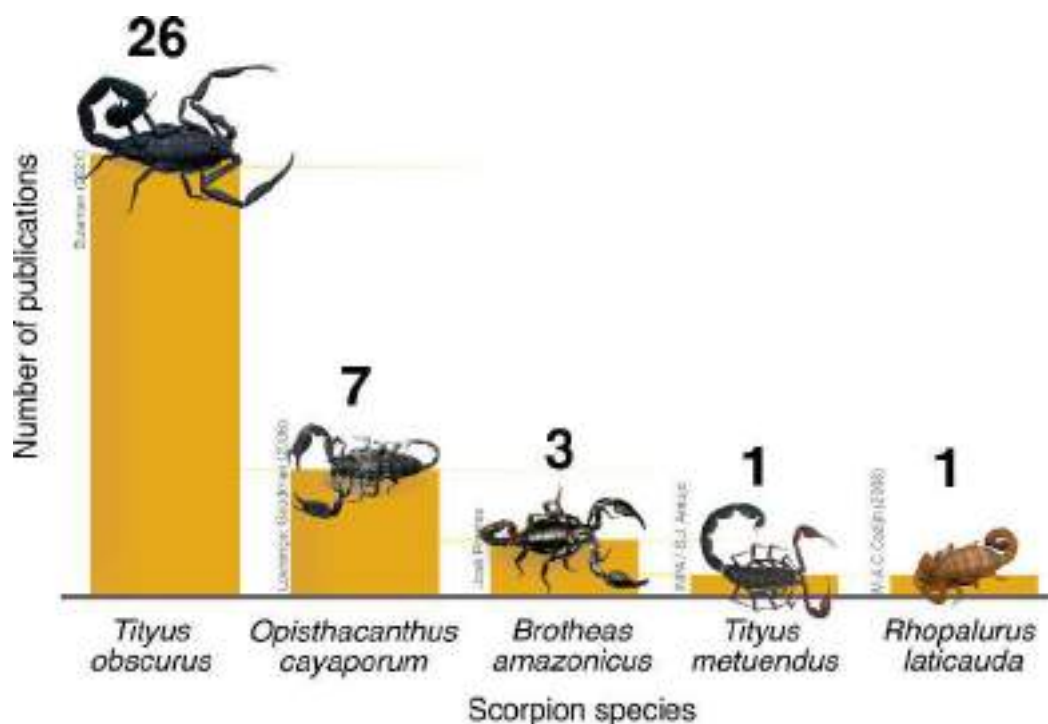


Figure 2. Number of studies on scorpion venom from the Brazilian Amazon from 2001 to 2021 depending on species. Since one research can cover multiple species, the sum does not reflect the total number of studies, $n=37$.



Figure 3. Studies on scorpion venom from the Brazilian Amazon grouped by publication year.

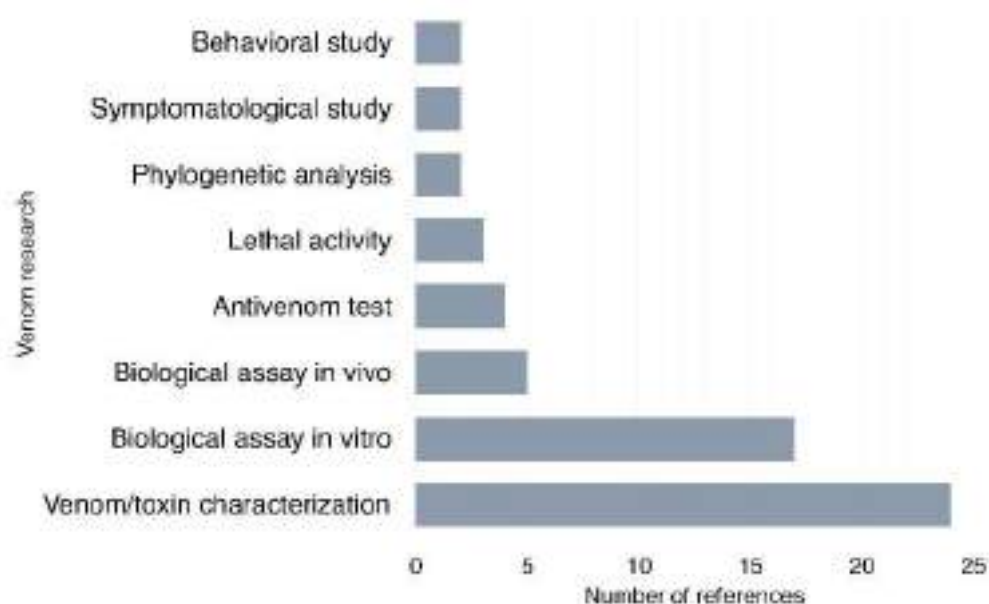


Figure 4. Number of studies on scorpion venom from the Brazilian Amazon from 2001 to 2021 grouped by objective. (Since one study can have multiple objectives, the sum does not reflect the total number of studies, n=37.)

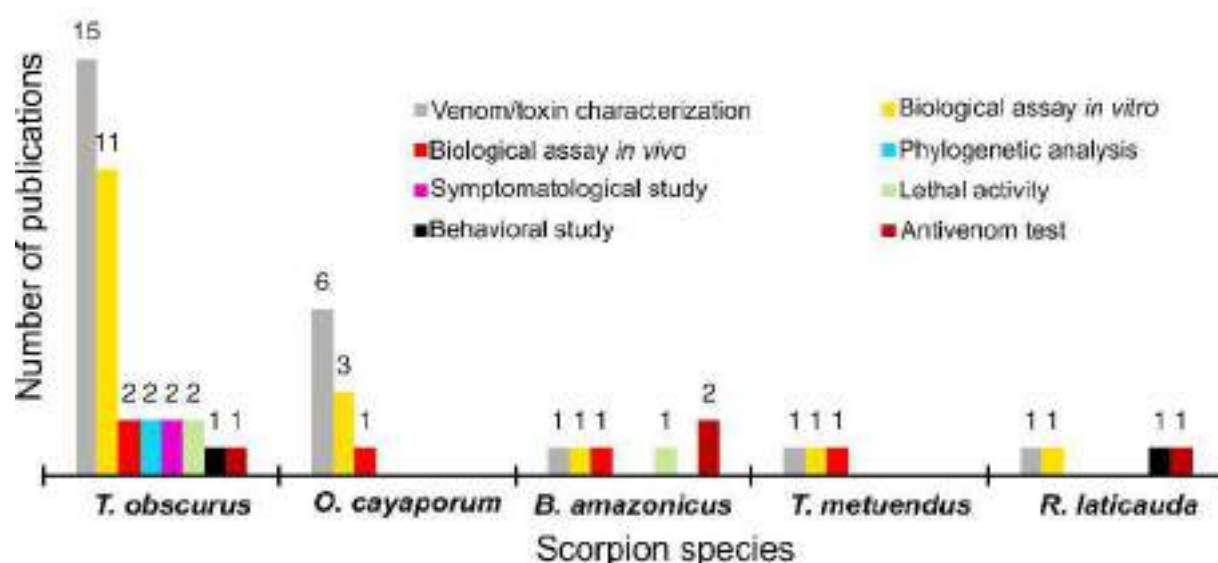


Figure 5. Number of different objectives of studies on scorpion venom from the Brazilian Amazon from 2001 to 2021 depending on species in each work. (Since one study can have multiple objectives, the sum does not reflect the total number of studies, n=37).

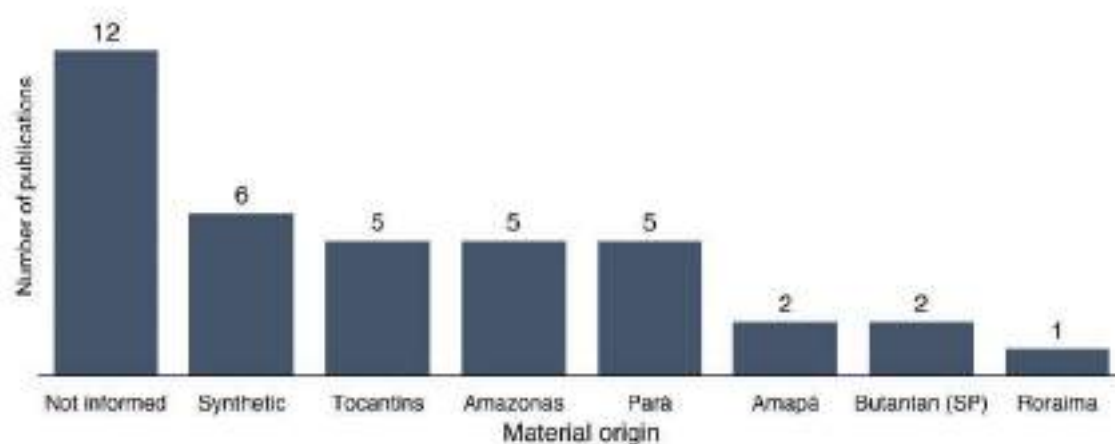


Figure 6. Absolute frequencies of studies on scorpion venom from the Brazilian Amazon from 2001 to 2021 grouped by the origin of scorpions and toxins studied (n=37).

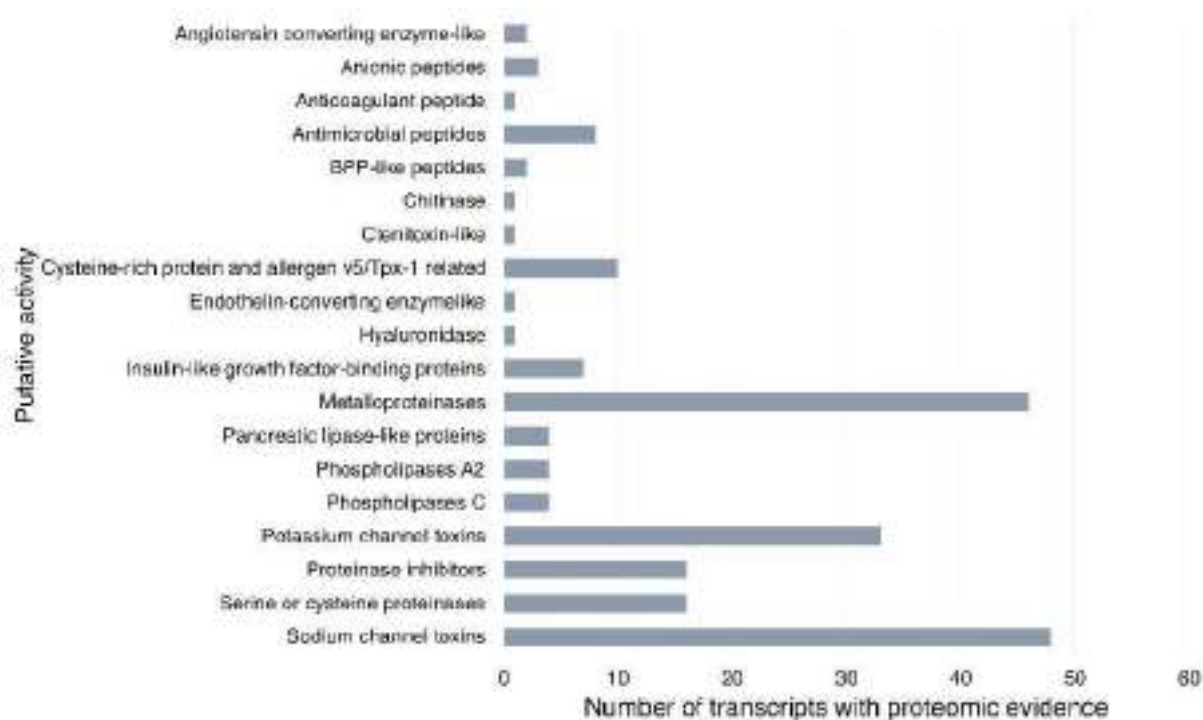


Figure 7. Proteinaceous components described by De Oliveira et al. [44].

TABLES:**Table 1.** Classification of venom compounds according to their nature and structure

Composition	
Non-proteinaceous components	water, mucosa, nucleotides, mucopolysaccharides, lipids, metals, and inorganic compounds
Proteinaceous components	<p><i>non-disulfide bridged peptides, NDBP</i>: small peptides with 13 to 56 amino acids with no predictable structure-function relationship.</p> <p><i>peptides containing cystine-stabilized alpha/beta scaffold</i>: a disulfide bridge connects an α-helix to a double or triple-stranded β-sheet.</p> <p>Short toxins, with 23 to 64 residues, commonly potassium channel toxins</p> <p>Long toxins: with 55–76 residues, commonly sodium channel toxins;</p> <p><i>Calcines</i>: a family of calcium channel-modulating peptides, which interestingly can pass through cell membranes without triggering their rupture.</p> <p><i>enzymes</i>: commonly hyaluronidases, phospholipases, metalloproteases and serine proteases</p>

Table 2. Scorpions from the Brazilian Amazon whose venoms have been studied from 2001 to 2021 and their references.

Scorpion species	Reference
<i>B. amazonicus</i>	Higa [14]; Ireno [15]; Higa, das Dores Noronha & López-Lozano [16].
<i>O. cayaporum</i>	Camargos [17]; Schwartz et al. [18]; Silva [19]; Silva et al. [20]; Camargos et al. [21]; Schwartz et al. [22]; Guilhelmelli et al. [23].
<i>R. laticauda</i>	Abreu et al. [24].
<i>T. metuendus</i>	Batista et al. [25].
<i>T. obscurus</i>	Batista et al. [26]; Batista et al. [27]; Wang et al. [28]; Grottesi & Sansom [29]; Liu & Lin [30]; Batista et al. [31]; Murgia et al. [32]; Huang Yizhe [33]; Chang [34]; Borja-Oliveira et al. [35]; GuerreroVargas et al. [36]; Stehling et al. [37]; Pardal [38]; Dias [39]; Guilhelmelli et al.[23]; Mourão [40]; Carvalho [41]; Santos-da-Silva et al. [42]; Duque et al. [43]; De-Oliveira et al. [44]; Dias et al. [45]; Marques-Neto et al. [46]; Simon et al. [47]; Tibery et al. [48]; Veloso-Júnior [49]; Da-Mata et al. [50].

Table 3. Scorpions from the Brazilian Amazon studied from 2001 to 2021, including origin of specimens and their toxins. (Since one research can cover multiple species, the sum does not reflect the total number of investigations, n=37).

Scorpion	Origin (Number of studies)
<i>B. amazonicus</i>	Amazonas (1); Not informed (2)
<i>O. cayaporum</i>	Tocantins (5); Not informed (1); Synthetic (1)
<i>R. laticauda</i>	Roraima (1)
<i>T. metuendus</i>	Amazonas (1)
<i>T. obscurus</i>	Amazonas (2); Amapá (2); Pará (5); Not informed (9); Synthetic (5); Instituto Butantan (2)

Table 4. Venom's main properties and potential biotechnological application of Brazilian Amazonian scorpions.

Scorpion	Physiological properties of the venom	Potential biotechnological application
<i>T. obscurus</i>	Haemorrhagic patches in the lung parenchyma [42]; Edematogenic and moderate nociceptive activity [42]; No pulmonary edema in mice [42]; Immobility, piloerection, breathing and locomotion difficulty, somnolence, photophobia, priapism, “wet dog shakes”, immediate diuresis [42]; Lethal dose: 3.13 mg/kg [42]; Uncomfortable pain and inflammatory actions [45]; Twitch augmentation [35]; Not recognized by <i>T. serrulatus</i> antivenom [44].	Muscle strength improvement [35]; Neurological treatments [35]. <i>T. obscurus</i> antivenom [44];
<i>T. metuendus</i>	Restless, piloerection, sialorrhea, hyperactivity, respiratory difficulties, paralysis of limbs, exophthalmos, loss of equilibrium, convulsions and death in mice [25]. Toxic to mammals [25]; Affects hNav 1.3 the most [25]; Bradykinin-potentiating [25].	-
<i>R. laticauda</i>	Induces hypernociceptive response in mice [24]; Increases IL6 production [24]; Not recognized by Brazilian antivenoms [24].	<i>R. laticauda</i> antivenom [24];
<i>O. cayaporum</i>	APs reduction of cockroach nerve chord at 22 mg/ml [18].	-

<i>B. amazonicus</i>	Low toxicity to humans [14]; Phospholipase A2 activity [14]; Serine proteases rasing 70-80kDa gives proteolytic activity to the venom [14]; Neutralized by <i>T. serrulatus</i> antivenom [14]; Degrades A α and B β subunits of fibrinogen [15].	Medicines to humans [14]; Analgesic drugs [14]; Antithrombotic drugs [15].
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Table 5. Toxins' main properties and potential biotechnological application of Brazilian Amazonian scorpions. Scorpions: *Oc*= *O. cayaporum*; *To*= *T. obscurus*; *Rl*=*R. laticauda*.

Toxin	Scorpion	Properties	Biotechnological application tested
Con10	<i>Oc</i>		Antifungal against <i>Candida. albicans</i> [23]
NDB-4.23	<i>To</i>	1733.0 Da [50];	
NDBP 3.7	<i>Oc</i>	4675 Da [19]; no haemolytic activity [19]; positive antibiotic activity [19].	Antibiotic against <i>Staphylococcus aureus</i> and <i>Escherichia coli</i> [19]
NDBP-5.5	<i>Oc</i>	1332.0 Da [50];	
NDBP-5.7	<i>Oc</i>	1434.0 Da [50];	Antifungal against <i>Candida. albicans</i> , <i>C. tropicalis</i> [23]
NDBP-5.8	<i>Oc</i>	1512.86 Da [50].	Antifungal against <i>Candida. albicans</i> , <i>C. tropicalis</i> [23]
OcCT2f	<i>Oc</i>	1511.913 Da [17]; antimicrobial activity [17];	Antibiotic [17];
Ocy37.75	<i>Oc</i>	Phospholipase activity [18].	
Ocy39.10	<i>Oc</i>	Phospholipase activity [18].	
Ocy39.87	<i>Oc</i>	[18]	Antibiotic against <i>Staphylococcus aureus</i> [18]
OcyC10	<i>Oc</i>	[20]	
OcyC7	<i>Oc</i>	[20]	Potential antimicrobial and antiparasitic [20]
OcyC8	<i>Oc</i>	3136.36 Da [17]; Csa/ α fold family [20]. Potassium channel toxin kappa-KTx 2.5 [21]	
OcyKTx2	<i>Oc</i>	3875 Da [22]. Reversibly blocks Shaker B potassium-channels (expressed in insect Sf9 cells) with a Kd of 96.6 nM, and presents an even better affinity toward hKv1.3 (KCNA3), blocking it with a Kd of 17.7 nM. [22]; inhibits the proliferation of effector memory T cells in humans and rats [22]	
Rc1	<i>Rl</i>	Sodium-channel toxin [24]; induce hypernociceptive response in mice [24];	

Toxin	Scorpion	Properties	Biotechnological application tested
		stimulates TNF- α production [24]; potent inflammatory toxin [24].	
Tc1	<i>To</i>	Potassium-channel peptide [29, 30]; Tc1 binds preferentially towards Kv1.1 than KcsA due to the stronger electrostatic and hydrophobic interactions [30]	
Tc30	<i>To</i>	3871.8 Da [31]; α -KTx4.4 [26]; <i>Shaker</i> B potassium channels blockage [26]	
Tc32	<i>To</i>	3521.5 Da [31]; <i>Shaker</i> B potassium channels blockage [26, 33, 34].	
Tc41	<i>To</i>	7109.4 Da [31];	
Tc43	<i>To</i>	7266.0 Da [31];	
Tc48a	<i>To</i>	7319.3 Da, sodium-channel peptide [36];	
Tc48b/Tc49a	<i>To</i>	7385.4 Da, sodium-channel peptide [36];	
Tc50	<i>To</i>	7073.0 Da [31];	
Tc54	<i>To</i>	7253.2 Da [31];	
Tc66	<i>To</i>	6935.3 Da [31];	
To1 / Tc49b	<i>To</i>	7400.2 Da; beta-toxin activity on VdNav1 and BgNav1; reduces the peak of Na ⁺ currents [48]; 7404.5 Da, <i>bonafide</i> sodium-channel peptide [27, 36]; it produces excitability, respiratory problems, convulsions, death in mice [27].	
To10	<i>To</i>	6940.9 Da, sodium-channel peptide [36];	
To11	<i>To</i>	7154.2 Da, sodium-channel peptide [36];	
To12	<i>To</i>	7171.2 Da, sodium-channel peptide [36];	
To13	<i>To</i>	8054.0 Da, sodium-channel peptide [36, 44];	
To14	<i>To</i>	7953.0 Da, sodium-channel peptide [36];	
To15	<i>To</i>	7195.1 Da, sodium-channel peptide [36];	
To27 / Tc27	<i>To</i>	1075 Da [45] / 4103.1 Da [31];	
To29 / Tc29	<i>To</i>	917 Da [45] / 4150.3 Da [31];	
To31 / Tc31	<i>To</i>	866 Da [45] / 4304.4 Da [31];	
To33 / Tc33	<i>To</i>	1179 Da [45] / 3807.9 Da [31];	
To35 / Tc35	<i>To</i>	995 Da [45] / 3926.2 Da [31];	
To37 / Tc37	<i>To</i>	1159 Da [45] / 7265.6 Da [31];	
To39 / Tc39	<i>To</i>	1141 Da [45] / 2744.1 Da [31];	
To4	<i>To</i>	7249.44 Da. Inhibits mammalian and insect's sodium channels. Related to beta-NaScTxS [43].	Antifungal against <i>Candida. albicans</i> , <i>C. tropicalis</i> and <i>C. parapsilosis</i> [41]
To40 / Tc40	<i>To</i>	1049 Da [45] / 7796.4 Da [31];	
To46 / Tc46	<i>To</i>	1113 Da [45] / 6032.0 Da [31];	
To5	<i>To</i>	6937.7 Da, sodium-channel peptide [36, 44];	
To56 / Tc56	<i>To</i>	1114 Da [45] / 7299.0 Da [31];	
To58 / Tc58	<i>To</i>	1132 Da [45] / 5504.1 Da [31];	
To6	<i>To</i>	7266.3 Da, sodium-channel peptide [36];	
To61 / Tc61	<i>To</i>	1079 Da [45] / 7105.0 Da [31];	
To64	<i>To</i>	1127 Da [45] / 7628.7 Da [31];	

Toxin	Scorpion	Properties	Biotechnological application tested
To7	<i>To</i>	7074.1 Da, sodium-channel peptide [36];	
To8	<i>To</i>	7050.0 Da, sodium-channel peptide [36];	
To83 / Tc83	<i>To</i>	1159 Da [45] / 25402.0 Da [31];	
To9	<i>To</i>	7155.2 Da, sodium-channel peptide [36];	
ToAcP	<i>To</i>	2757.0 Da [50];	
ToAP2	<i>To</i>	3000.7 Da [50]; antiretroviral [50] and antibiotic [46] activity.	Antiretroviral [50]; Anti- <i>Mycobacterium massiliense</i> [46];
ToAP3	<i>To</i>	1700.1 Da [50]; toxic at 50 μ M [49]; reduce TNF- α secretion [49];	Idiopathic pulmonary fibrosis treatment [47]. Anti- <i>Cryptococcus neoformans</i> [49]
ToAP4	<i>To</i>	1762.1 Da [50]; toxic at 50 μ M [49]; reduce TNF- α secretion [49];	Idiopathic pulmonary fibrosis treatment [47]. Anti- <i>Cryptococcus neoformans</i> [49].
ToPI1s	<i>To</i>	3756.2 Da; potent trypsin inhibitory activity [40]	CD4 cells stimulation against HIV [40].
κ-KTx2.5	<i>Oc</i>	Sodium-channel blockage at high concentrations [17]. No antibacterial activity [17].	

7 CONCLUSIONS

- i. From 2015 to 2022, a total of 62 scorpion accidents were reported in Rorainópolis, Roraima.
- ii. Scorpionism in Rorainópolis does not exhibit significant seasonality, indicating that it can occur throughout the year with no noticeable variation between months.
- iii. There has been a significant trend of increase in the reporting of scorpion accidents in Rorainópolis, with annual incidences ranging from 0 to 51.9 cases per 100,000 inhabitants.
- iv. Rorainópolis ranks 9th among the municipalities in the state of Roraima in terms of average annual incidence of scorpion accidents from 2015 to 2022. This mean value is similar to that of the state as a whole during the same period.
- v. The occurrence of scorpion accidents in Rorainópolis shows a correlation with human territorial occupation, deforestation and rainfall.
- vi. The school vacation period can have a significant impact on scorpion accidents, particularly among children.
- vii. The majority of scorpion accidents in Rorainópolis presented mild clinical symptoms.
- viii. There was a significant level of incompleteness in the completion of notification forms for venomous animal incidents in Rorainópolis.
- ix. Based on medical records, 68% of cases exhibited mild severity, while 32% were of moderate severity.
- x. Patients presented diverse blood pressure readings, with a prominence of Stage 1 Hypertension.
- xi. No statistically significant correlation was observed between vital signs.
- xii. A wide range of medications was administered to the patients, including antimicrobials, analgesics, antipyretics, antiemetics, antispasmodics, antiulcer, antihistamines, anti-inflammatories, anesthetics, and antivenom.
- xiii. The symptoms included localized and intense pain, hypertension, erythema, edema, vomiting, paresthesia, nausea, tachypnoea, epigastralgia, sweating, localized warmth, difficulty in speaking, and headaches. Remarkably, these symptoms align with those described in the existing literature;
- xiv. Additional symptoms such as dizziness, fear, bodily discomfort, generalized pain, and tongue numbness were also reported by the residents;
- xv. Scorpionism demonstrated a higher prevalence among agricultural workers.

- xvi. It has been estimated that between 3.5% and 14.1% of the local residents have been stung by a scorpion at least once in their lifetime.
- xvii. A significant portion of victims do not seek medical care after the accident.
- xviii. These accidents occurred during a diverse range of daily activities.
- xix. Some residents opt for alternative methods of scorpionism treatment; however, it is important to note that these approaches are not endorsed by the medical community.
- xx. Rorainópolis is home to two medically significant scorpion species: *Tityus metuendus* and *T. silvestris*, along with the presence of the *Brotheas amazonicus* species.
- xxi. *T. metuendus* was by far the most abundant in this study, being the most relevant scorpion for the Rorainopolitan public health.
- xxii. Between 2001 and 2021, research has focused on the venom of five distinct Amazonian scorpion species, with two of these species being present in Rorainópolis.
- xxiii. The venom from these scorpions has undergone examination for applications in neurological treatments, antivenom effectiveness, antibiotics synthesis, and drug development.
- xxiv. A limited number of studies have delved into the intricacies of Amazonian Brazilian scorpion venom. This underscores the substantial scope for further investigation in this field.
- xxv. In Rorainópolis, it is essential to implement strategies for both health education and scorpion control.
- xxvi. Scorpionism stands as public concern that demands the full attention of public authorities, given the integral role that scorpions play in the daily lives of residents.
- xxvii. Health surveillance teams must take immediate action to control and intervene in high-risk areas while also fostering health education and preventive measures among the population.
- xxviii. It is important for medical professionals to remain well-informed about the treatment protocols outlined by the Ministry of Health. Their dedication to completing comprehensive forms can significantly enhance our grasp of the issue at hand.
- xxix. The present study can be used to develop assistive and educational technological tools in healthcare services.
- xxx. The clinical insights shared by residents, and documented in medical records, contribute valuable new perspectives to the existing medical literature.

- xxxi. While a limited number of studies have ventured into the complexities of Amazonian Brazilian scorpion venom, this scarcity underscores the vast potential for further exploration.
- xxxii. The current study acknowledges its inherent limitations and strongly advocates for further comprehensive investigations to unveil a deeper understanding of the subject matter.
- xxxiii. Sustaining this study's momentum is imperative to ensure ongoing vigilance and comprehensive monitoring of scorpionism in the region.

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APPENDIX A – QUESTIONNAIRE TO LOCAL RESIDENTS

Título do projeto: “Caracterização clínico-epidemiológica dos acidentes escorpiônicos em Rorainópolis”

Pesquisadores responsáveis: a: Prof^a Cléria Mendonça de Moraes, Prof^a Kristiane Alves de Araujo, o discente Joel Ramanan Cruz do curso stricto sensu do Programa de Pós-Graduação em Saúde e Biodiversidade da Universidade Federal de Roraima, e professor Bruno Rafael Ribeiro de Almeida da Universidade Estadual do Pará.

Este questionário será aplicado online por meio do google forms e presencialmente

Seção 1 – Perfi, do(a) voluntário(a)

1. E-mail: _____
2. Telefone: _____
3. Idade (anos): _____
4. Gênero:

<input type="checkbox"/> masculino	<input type="checkbox"/> feminino	<input type="checkbox"/> Ignorado
------------------------------------	-----------------------------------	-----------------------------------
5. Cor ou raça:

<input type="checkbox"/> branca	<input type="checkbox"/> preta	<input type="checkbox"/> parda	<input type="checkbox"/> amarela	<input type="checkbox"/> outra
---------------------------------	--------------------------------	--------------------------------	----------------------------------	--------------------------------
6. Escolaridade

<input type="checkbox"/> Primário	<input type="checkbox"/> Fundamental I	<input type="checkbox"/> Fundamental II
<input type="checkbox"/> Ensino Médio	<input type="checkbox"/> Ensino Superior	<input type="checkbox"/> Ignorado
7. Profissão: _____
8. O(A) Senhor(a) mora em Rorainópolis?

<input type="checkbox"/> sim	<input type="checkbox"/> não
------------------------------	------------------------------
9. Qual é a área que o(a) Senhor(a) mora?

<input type="checkbox"/> urbana	<input type="checkbox"/> periurbana/periferia	<input type="checkbox"/> rural
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Seção 2: Identificação da localização e/ou escorpião

10. O(A) Senhor(a) já avistou algum escorpião em Rorainópolis?

<input type="checkbox"/> sim	<input type="checkbox"/> não
------------------------------	------------------------------
11. Em que lugar de Rorainópolis você avistou o escorpião? _____
12. Você já foi picado por escorpião em Rorainópolis?

<input type="checkbox"/> sim	<input type="checkbox"/> não
------------------------------	------------------------------

Seção 3: Descrição do acidente e/ou escorpião

13. Quantas vezes você foi picado por escorpião?

<input type="checkbox"/> 1	<input type="checkbox"/> 2	<input type="checkbox"/> 3	<input type="checkbox"/> 4 ou mais vezes	<input type="checkbox"/> não lembro
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14. Em que ano(s) você foi picado? _____

15. Em que período do dia você foi picado?

<input type="checkbox"/> manhã	<input type="checkbox"/> tarde	<input type="checkbox"/> noite	<input type="checkbox"/> não lembro
--------------------------------	--------------------------------	--------------------------------	-------------------------------------

16. Em que parte do corpo você foi picado?

<input type="checkbox"/> cabeça	<input type="checkbox"/> braço	<input type="checkbox"/> antebraço	<input type="checkbox"/> mão
<input type="checkbox"/> dedo da mão	<input type="checkbox"/> tronco	<input type="checkbox"/> coxa	<input type="checkbox"/> perna
<input type="checkbox"/> pé	<input type="checkbox"/> dedo do pé	<input type="checkbox"/> ignorado	<input type="checkbox"/>

17. Onde o(a) senhor(a) estava e o que estava fazendo quando foi picado?

18. O que você sentiu depois da picada?

19. Você procurou atendimento médico depois da picada?

<input type="checkbox"/> sim	<input type="checkbox"/> não
------------------------------	------------------------------

20. Caso tenha respondido positivamente à questão 18, então quanto tempo levou para o(a) Senhor(a) chegar no local de atendimento depois da picada?

Seção 4: Informações adicionais

21. Você conhece alguém que foi picado por escorpião em Rorainópolis nos últimos anos?

<input type="checkbox"/> sim	<input type="checkbox"/> não
------------------------------	------------------------------

22. Você tem alguma informação importante e gostaria de compartilhar sobre os escorpiões e picadas que possam auxiliar esta pesquisa?

<input type="checkbox"/> sim	<input type="checkbox"/> não
------------------------------	------------------------------

23. Deixe seus comentários e sugestões.

APPENDIX B – FORM FOR MEDICAL RECORDS

Número de controle _____:

Data de admissão hospitalar: ____/____/____

Setor de Internação: _____

Data do acidente: _____

Idade: _____

Sexo: () M () F () ignorado

Endereço:

Zona: _____

Ocupação: _____

Região anatômica da picada:

() cabeça	() braço	() antebraço	() mão
() dedo da mão	() tronco	() coxa	() perna
() pé	() dedo do pé	() ignorado	()

Manifestações locais:

() dor	() edema	() equimose	() necrose
() sem manifestação	(.....) ignorado	() outras:	_____

Manifestações clínicas sistêmicas:

Manifestações gerais			
() prostração	() tremores	() astenia	() hipertermia

Manifestações autonômicas	
() taquicardia	() sudorese
() sialorréia	() náusea
() hipertensão arterial	() vômitos

Manifestações neurológicas	
Sintomas neurológicos	
() sensação de “choque elétrico” pelo corpo	() sensação de parestesia em todo corpo

Sinais neurológicos		
() mioclonias	() dismetria	() agitação
() disartria	() ataxia de marcha	() romberg
() hiperreflexia	() espasticidade	() sonolento
() hiperalerta	() babinski	

Classificação do caso:

() leve	() moderado	() grave	() ignorado
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APPENDIX C – INFORMED AND FREE CONSENT FORM (DIGITAL)

TERMO DE CONSENTIMENTO LIVRE E ESCLARECIDO (DIGITAL)

Pesquisadores responsáveis: a: Prof^a Cléria Mendonça de Moraes, Prof^a Kristiane Alves de Araujo, o discente Joel Ramanan Cruz do curso stricto sensu do Programa de Pós-Graduação em Saúde e Biodiversidade da Universidade Federal de Roraima, e professor Bruno Rafael Ribeiro de Almeida da Universidade Estadual do Pará.

O(a) senhor(a) está sendo convidado(a) a participar da pesquisa intitulada “Caracterização clínico-epidemiológica dos acidentes escorpionicos em Rorainópolis”.

Para participar desta pesquisa o(a) senhor(a) deve ser morador(a) do município de Rorainópolis e ter entre 18 e 59 anos, não ser indígena, não ser gestante, se estrangeiro ser fluente no português e não apresentar doença hepática ou renal prévia. O questionário será aplicado através de um formulário eletrônico, alocado no website do google. A pesquisa tem como objetivo: Descrever o quadro dos acidentes envolvendo escorpiões no município de Rorainópolis entre 2015 e 2022 e identificar as espécies de escorpião da região relacionadas aos acidentes. É necessário que o(a) senhor(a) leia este documento com atenção (caso tenha dificuldade de ler, peça para um parente ler para o(a) senhor(a), pois pode conter palavras que o(a) senhor(a) não entenda. Caso isso aconteça se preferir, o(a) senhor(a) pode também escrever ou ligar aos pesquisadores que estarão disponíveis, via e-mail e por telefone para explicar-lhe qualquer palavra ou procedimento que o(a) senhor(a) não entenda claramente. O propósito deste documento é dar o(a) senhor(a) informações sobre a pesquisa e, se assinando, o(a) senhor(a) estará permitindo a sua participação no estudo. Esta pesquisa tem como uma das finalidades produzir conhecimento científico para população e poder ajudar os profissionais da área de saúde a ter um conhecimento mais claro e amplo sobre as manifestações epidemiológicas, clínicas dos envenenamentos por escorpiões em Rorainópolis, cujos dados servirão para futuras ações de saúde tanto no município quanto no Estado de Roraima. Todos os dados obtidos serão utilizados exclusivamente com finalidades científicas conforme previsto no consentimento do participante. Os pesquisadores se comprometem a utilizar os dados coletados somente para a pesquisa que, depois de finalizada, terá seus resultados veiculados no meio acadêmico e científico. Não serão divulgados dados que permitam a sua identificação. Os dados serão analisados em conjunto, guardando sob absoluto sigilo das informações pessoais. Não existe benefício ou vantagem direta em participar deste estudo. Os benefícios e vantagens em participar são indiretos, proporcionando retorno social e promoção da saúde através de melhorias na caracterização do perfil clínico e epidemiológico de acidentes por escorpião em Rorainópolis.

A pesquisa envolve apenas resposta ao questionário online, o qual foi elaborado com o intuito de que o tempo gasto para o seu preenchimento seja mínimo, em torno de 10 a 15 minutos. A pesquisa apresenta risco mínimo, que pode estar associado ao desconforto quanto ao tema, ou a experiências pessoais envolvendo acidentes escorpionicos. É possível que às perguntas possam causar algum constrangimento ao participante e à população envolvida. Neste caso, o(a) Senhor(a) terá a liberdade de recusar ou retirar seu consentimento em qualquer fase da pesquisa, sem qualquer tipo de penalização, de acordo com a Resolução 466/12 do CONEP. Além disso, o(a) senhor(a) tem o direito de: 1) ser mantido atualizado sobre os resultados parciais das pesquisas, caso seja solicitado, terá acesso a todas as informações; 2) receber resposta a qualquer pergunta e esclarecimento sobre os procedimentos, riscos, benefícios e outros relacionados à pesquisa; e poderá procurar esclarecimentos com a professora Cléria Mendonça de Moraes, via e-mail cleria.moraes@ufrr.br, telefone (95) 991431391 ou com o

pesquisador Joel Ramanan da Cruz, joel.academicorr@gmail.com, telefone (95) 98409-6294 ou na Universidade Federal de Roraima, Centro das Ciências da Saúde, Av. Cap. Ene Garcês, 2413 - Aeroporto, Boa Vista - RR, 69310-000, em caso de dúvidas ou notificação de acontecimentos não previstos. A sua participação nesta pesquisa é voluntária e não haverá despesas, nem compensações pessoais ou financeiras pela participação em qualquer fase do estudo.

Informamos que o(a) Senhor(a) tem a garantia de acesso, em qualquer etapa do estudo, sobre qualquer esclarecimento de eventuais dúvidas; e caso sinta necessidade, poderá entrar em contato com o Comitê de Ética em Pesquisa (COEP) no endereço Bloco da PRPPG-UFRR, última sala do corredor em forma de T à esquerda (o prédio da PRPPG fica localizado atrás da Reitoria e ao lado da Diretoria de Administração e Recursos Humanos - DARH), e-mail: coep@ufr.br, telefone (95) 3621-3112 Ramal 26. O comitê entrará em contato com a pesquisadora responsável, Prof^a Dr^a Cléria Mendonça de Moraes, e-mail cleria.moraes@ufr.br e o discente Joel Ramanan da Cruz, e-mail joel.academicorr@gmail.com.

Declaro que entendi os objetivos, riscos e benefícios de minha participação na pesquisa e concordo em participar e submeter um e-mail válido e/ou telefone para contato, para podermos enviar para você uma cópia deste termo.

Você declara estar ciente do anteriormente exposto e concorda em participar desta pesquisa?

- a) Sim, declaro e concordo em participar voluntariamente desta pesquisa, e submeter um e-mail válido.
- b) Não, não gostaria de participar desta pesquisa.

APPENDIX D – INFORMED AND FREE CONSENT FORM (IN-PERSON)**TERMO DE CONSENTIMENTO LIVRE E ESCLARECIDO PARA O
QUESTIONÁRIO IMPRESSO:**

Pesquisadores responsáveis: a: Prof^a Cléria Mendonça de Moraes, Prof^a Kristiane Alves de Araujo, o discente Joel Ramanan Cruz do curso stricto sensu do Programa de Pós-Graduação em Saúde e Biodiversidade da Universidade Federal de Roraima, e professor Bruno Rafael Ribeiro de Almeida da Universidade Estadual do Pará.

O(a) senhor(a) está sendo convidado(a) a participar da pesquisa intitulada “Caracterização clínico-epidemiológica dos acidentes escorpiônicos em Rorainópolis”. Para participar desta pesquisa o(a) senhor(a) deve ser morador(a) do município de Rorainópolis e ter entre 18 e 59 anos, não ser indígena, não ser gestante, se estrangeiro ser fluente no português e não apresentar doença hepática ou renal prévia. A pesquisa tem como objetivo: Descrever o quadro dos acidentes envolvendo escorpiões no município de Rorainópolis entre 2015 e 2022 e identificar as espécies de escorpião da região relacionadas aos acidentes. É necessário que o(a) senhor(a) leia este documento com atenção (caso tenha dificuldade de ler, peça para um parente ler para o(a) senhor(a), pois pode conter palavras que o(a) senhor(a) não entenda. Caso isso aconteça se o(a) senhor(a) aos pesquisadores que estarão disponíveis para explicar-lhe qualquer palavra ou procedimento que o(a) senhor(a) não entenda claramente. O propósito deste documento é dar o(a) senhor(a) informações sobre a pesquisa e, se assinando, o(a) senhor(a) estará permitindo a sua participação no estudo. Esta pesquisa tem como uma das finalidades produzir conhecimento científico para população e poder ajudar os profissionais da área de saúde a ter um conhecimento mais claro e amplo sobre as manifestações epidemiológicas, clínicas dos envenenamentos por escorpiões em Rorainópolis, cujos dados servirão para futuras ações de saúde tanto no município quanto no Estado de Roraima. Todos os dados obtidos serão utilizados exclusivamente com finalidades científicas conforme previsto no consentimento do participante. Os pesquisadores se comprometem a utilizar os dados coletados somente para a pesquisa que, depois de finalizada, terá seus resultados veiculados no meio acadêmico e científico. Não serão divulgados dados que permitam a sua identificação. Os dados serão analisados em conjunto, guardando sob absoluto sigilo das informações pessoais. Não existe benefício ou vantagem direta em participar deste estudo. Os benefícios e vantagens em participar são indiretos, proporcionando retorno social e promoção da saúde através de melhorias na caracterização do perfil clínico e epidemiológico de acidentes por escorpião em Rorainópolis.

A pesquisa envolve apenas resposta a um questionário, o qual foi elaborado com o intuito de que o tempo gasto para o seu preenchimento seja mínimo, em torno de 10 a 15 minutos. A pesquisa apresenta risco mínimo, que pode estar associado ao desconforto quanto ao tema, ou a experiências pessoais envolvendo acidentes escorpiônicos. É possível que às perguntas possam causar algum constrangimento ao participante e à população envolvida. Neste caso, o(a) Senhor(a) terá a liberdade de recusar ou retirar seu consentimento em qualquer fase da pesquisa, sem qualquer tipo de penalização, de acordo com a Resolução 466/12 do CONEP. Além disso, o(a) senhor(a) tem o direito de: 1) ser mantido atualizado sobre os resultados parciais das pesquisas, caso seja solicitado, terá acesso a todas as informações; 2) receber resposta a qualquer pergunta e esclarecimento sobre os procedimentos, riscos, benefícios e outros relacionados à pesquisa; e poderá procurar esclarecimentos com a professora Cléria Mendonça de Moraes, via e-mail cleria.moraes@ufrr.br, telefone (95) 991431391 ou com o pesquisador Joel Ramanan da Cruz, joel.academicorr@gmail.com, telefone (95) 98409-

6294 ou na Universidade Federal de Roraima, Centro das Ciências da Saúde, Av. Cap. Ene Garcês, 2413 - Aeroporto, Boa Vista - RR, 69310-000, em caso de dúvidas ou notificação de acontecimentos não previstos. A sua participação nesta pesquisa é voluntária e não haverá despesas, nem compensações pessoais ou financeiras pela participação em qualquer fase do estudo.

Informamos que o(a) Senhor(a) tem a garantia de acesso, em qualquer etapa do estudo, sobre qualquer esclarecimento de eventuais dúvidas; e caso sinta necessidade, poderá entrar em contato com o Comitê de Ética em Pesquisa (COEP) no endereço Bloco da PRPPG-UFRR, última sala do corredor em forma de T à esquerda (o prédio da PRPPG fica localizado atrás da Reitoria e ao lado da Diretoria de Administração e Recursos Humanos - DARH), e-mail: coep@ufr.br, telefone (95) 3621-3112 Ramal 26. O comitê entrará em contato com a pesquisadora responsável, Profª Drª Cléria Mendonça de Moraes, e-mail cleria.moraes@ufr.br e o discente Joel Ramanan da Cruz, e-mail joel.academicorr@gmail.com.

Declaro que entendi os objetivos, riscos e benefícios de minha participação na pesquisa e concordo em participar

Este termo está sendo elaborado em duas vias, sendo que uma via ficará com o(a) senhor(a), e outra arquivada com os pesquisadores responsáveis.

Abaixo está o consentimento livre e esclarecido para ser assinado caso não tenha ficado qualquer dúvida.

Assinatura do participante

Nome: _____

CPF: _____

impressão digital

Assinatura da testemunha

Nome: _____

CPF: _____

Pesquisador responsável, telefone

APPENDIX E – REQUEST FOR WAIVER OF INFORMED AND FREE CONSENT FORM

SOLICITAÇÃO DE DISPENSA DO TERMO DE CONSENTIMENTO LIVRE E ESCLARECIDO

PARA O PERÍODO DE JANEIRO DE 2015 À DE DEZEMBRO DE 2022.

Solicitamos ao Comitê de Ética em Pesquisa desta instituição, para o período de janeiro de 2015 à dezembro de 2022 a isenção do Termo de Consentimento Livre e Esclarecido (TCLE) deste projeto encaminhado para vossa apreciação e intitulado “Caracterização clínico-epidemiológica dos acidentes escorpiónicos em Rorainópolis”, pelo mestrando Joel Ramanan da Cruz, e pelos professores Cléria Mendonça de Moraes, com a colaboração Kristiane Alves Araújo do curso de Pós-graduação em Saúde e Biodiversidade da Universidade Federal de Roraima, e orientação do Prof. Bruno Rafael Almeida e por se tratar de estudo não intervencionista e que dispensa a coleta de informação direta com o sujeito de pesquisa. Além disso, ao ser facultado o acesso às informações sobre exames, observações de dados pessoais de indivíduo oriundos de documentos relativos a prontuários, julgamentos expressos em questionários, resultados de exames clínicos e laboratoriais e demais instrumentos de natureza documental, pertencentes aos arquivos do Hospital Regional Sul Governador Ottomar de Souza Pinto e via SINAN-web, terá com a finalidade específica de coleta de informações para o desenvolvimento do protocolo e será preservada a privacidade e a confidencialidade de tais documentos e dos seus sujeitos.

As razões para solicitação da isenção do TCLE são enumeradas a seguir: 1. Levantamento de dados em prontuários, o que não interfere no cuidado recebido pelo paciente; 2. Não há riscos físicos e/ou biológicos para o paciente uma vez que o estudo é meramente observacional; 3. População de estudo eventualmente sem seguimento na instituição no presente (pacientes de outras localidades ou falecidos); 4. A confidencialidade da identificação pessoal dos pacientes é garantida pelo pesquisador principal e pelas técnicas de levantamento e guarda dos dados: os pacientes serão identificados apenas através de iniciais e números de registro que servem apenas para validar a individualidade da informação. Esses dados não serão objetos de análise. Por esses motivos e como o uso e destinação dos dados coletados durante este projeto de pesquisa estão descritos no mesmo, solicitamos a dispensa do referido documento, conforme a Resolução 466/12 IV. 8- "Nos casos em que seja inviável a obtenção do Termo de Consentimento Livre e Esclarecido ou que esta obtenção signifique riscos substanciais à privacidade e confidencialidade dos dados do participante ou aos vínculos de confiança entre pesquisador e pesquisado, a dispensa do TCLE deve ser justificadamente solicitada pelo pesquisador responsável ao Sistema CEP/CONEP, para apreciação, sem prejuízo do posterior processo de esclarecimento". Por fim, assumimos a responsabilidade pela fidedignidade das informações e aguardamos deferimento.

Atenciosamente,

Boa Vista, 03 de novembro de 2021.

Pesquisadora Responsável

APPENDIX F – REQUEST FOR ACTIVE SCORPION SEARCH

Título da Pesquisa: “Caracterização clínico-epidemiológica dos acidentes escorpiônicos em Rorainópolis”

Nome do(a) Pesquisador(a) Responsável: Prof.^a Cléria Mendonça de Moraes

Nome dos demais participantes da equipe: Prof.^a Kristiane Alves de Araujo, o discente Joel Ramanan Cruz do curso stricto sensu do Programa de Pós-Graduação em Saúde e Biodiversidade da Universidade Federal de Roraima, e professor Bruno Rafael Ribeiro de Almeida da Universidade Estadual do Pará.

O Sr.(Sra.) está sendo convidado(a) a autorizar a coleta de escorpiões em sua propriedade para a realização desta pesquisa que tem como finalidade identificar se o escorpião causa acidentes graves ou não. Os pesquisadores coletarão apenas escorpiões que estiverem peridomiciliar.

Ao participar deste estudo o Sr. (Sra.) permitirá que o (a) pesquisador(a) entre em sua propriedade, vasculhe o ambiente e capture os escorpiões, usando pinças, luvas e frascos com tampa. Também serão tiradas imagens dos escorpiões e do ambiente. O Sr. (Sra.) tem liberdade de se recusar a participar e ainda se recusar a continuar participando em qualquer fase da pesquisa, sem qualquer prejuízo. Sempre que quiser poderá pedir mais informações sobre a pesquisa diretamente com a professora Cléria Mendonça de Moraes, via e-mail cleria.moraes@ufrr.br, ou telefone (95) 991431391 e com o pesquisador Joel Ramanan da Cruz, joel.academicorr@gmail.com, ou telefone (95) 98409-6294. Se necessário, poderá entrar em contato com Comissão de Ética no Uso de Animais (CEUA) da UFRR. Além disso, serão realizadas imagens do local da coleta, caso o (a) senhor (a) permita.

A pesquisa apresenta risco mínimo, que pode estar associado as perguntas e a imagem que podem causar algum constrangimento ao participante e à população envolvida. Neste caso o(a) participante(a) terá a liberdade de se recusar ou retirar seu consentimento em qualquer fase da pesquisa, sem penalização ao(a) mesmo. Os procedimentos adotados nesta pesquisa obedecem aos princípios éticos no uso de animais, elaborados pelo Conselho Nacional de Controle de Experimentação Animal (CONCEA), sobre a utilização de animais em atividades educacionais e em experimentos que envolvam espécies definidas na Lei 11.794/2008, e a coleta está amparada pela Licença nº 67767-1, conforme Instrução Normativa ICMBio nº 03 de 01/09/2014.

Não existirão despesas ou compensações pessoais para o participante em qualquer fase do estudo.

Após estes esclarecimentos, solicitamos o seu consentimento de forma livre para a coleta de escorpiões em sua propriedade para esta pesquisa. Preencher, por favor, os itens que se seguem:

Nome do Proprietário: _____

CPF/RG: _____

Assinatura do Proprietário

Assinatura do Pesquisador

Data: ____/____/____

TELEFONES

Pesquisador: Joel Raman Cruz, telefone (095) 98409-6294

Orientador: Prof.^a Cléria Mendonça de Moraes, telefone (095) 991431391

CEUA/UFRR: Comissão de Ética no Uso de Animais (CEUA) no endereço Bloco da PRPPG-UFRR, última sala do corredor em forma de T à esquerda (o prédio da PRPPG fica localizado atrás da Reitoria e ao lado da Diretoria de Administração e Recursos Humanos - DARH), e-mail: ceua@ufrr.br, telefone (95) 3621-3112 Ramal 26.

ANNEX A – NOTIFICATION FORM

República Federativa do Brasil Ministério da Saúde		SINAN SISTEMA DE INFORMAÇÃO DE AGRAVOS DE NOTIFICAÇÃO FICHA DE INVESTIGAÇÃO		Nº
ACIDENTES POR ANIMAIS PEÇONHENTOS				
CASO CONFIRMADO: Paciente com evidências clínicas de envenenamento, específicas para cada tipo de animal, independentemente do animal causador do acidente ter sido identificado ou não. Não há necessidade de preenchimento da ficha para casos suspeitos.				
Dados Gerais	1 Tipo de Notificação	2 - Individual		
	2 Agravado/doença	ACIDENTES POR ANIMAIS PEÇONHENTOS		Código (CID10)
	4 UF	5 Município de Notificação	3 Data de Notificação	
Dados de Identificação	6 Unidade de Saúde (ou outra fonte notificadora)	Código	7 Data dos Primeiros Sinais	Código (BCE)
	8 Nome do Paciente	9 Data de Nascimento		
	10 (ou idade)	11 Sexo M - Masculino F - Feminino I - Ignorado	12 Gestante 1 - Não 2 - Sim 3 - Não sabe 4 - Não sabe 5 - Não 6 - Não sabe 7 - Não sabe	13 Raça/Cor 1 - Branco 2 - Preto 3 - Amarelo 4 - Pardo 5 - Indígena 6 - Não sabe
Dados de Residência	14 Escolaridade	15 Número do Cartão SUS		16 Nome de mãe
	17 UF	18 Município de Residência	Código (IBGE)	19 Distrito
	20 Bairro	21 Logradouro (rua, avenida, ...)	Código	22 Número
Dados Complementares do Caso	23 Complemento (apto., casa, ...)	24 Geo campo 1	25 Geo campo 2	26 Ponto de Referência
	27 CEP	28 (DDD) Telefone	29 Zona 1 - Urbana 2 - Rural 3 - Pântano 4 - Ignorado	30 País (se residente fora do Brasil)
	31 Data da Investigação	32 Ocupação	33 Data do Acidente	34 UF
Atendimento Epidemiológico	35 Município de Ocorrência do Acidente	Código (BCE)	36 Localidade da Ocorrência do Acidente	37 Zona de Ocorrência 1 - Urbana 2 - Rural 3 - Pântano 4 - Ignorado
	38 Local da Picada	39 Tempo Decorrido Picada/Atendimento 1) 0-1h 2) 1-3h 3) 3-6h 4) 6-12h 5) 12-24h 6) 24-48h 7) Ignorado	40 Manifestações Locais 1 - Sem 2 - Não 3 - Ignorado	41 Se Manifestações Locais Sim, especificar: 1 - Sem 2 - Não 3 - Ignorado
	42 Manifestações Sistêmicas 1 - Sem 2 - Não 3 - Ignorado	43 Se Manifestações Sistêmicas Sim, especificar: 1 - Sem 2 - Não 3 - Ignorado	44 Tipo de Acidente 1 - Serpente 2 - Aranha 3 - Escorpião 4 - Lagarta 5 - Ateia 6 - Outros 7 - Ignorado	45 Tipo de Acidente 1 - Bororé 2 - Condeco 3 - Elástico 4 - Lacerante 5 - Serpente Não Peçonhenta 6 - Ignorado
Dados Clínicos	46 Manifestações Sistêmicas 1 - Sem 2 - Não 3 - Ignorado	47 Se Manifestações Sistêmicas Sim, especificar: 1 - Sem 2 - Não 3 - Ignorado	48 Tipo de Acidente 1 - Bororé 2 - Condeco 3 - Elástico 4 - Lacerante 5 - Serpente Não Peçonhenta 6 - Ignorado	49 Tipo de Acidente 1 - Bororé 2 - Condeco 3 - Elástico 4 - Lacerante 5 - Serpente Não Peçonhenta 6 - Ignorado
	50 Manifestações Sistêmicas 1 - Sem 2 - Não 3 - Ignorado	51 Se Manifestações Sistêmicas Sim, especificar: 1 - Sem 2 - Não 3 - Ignorado	52 Tipo de Acidente 1 - Bororé 2 - Condeco 3 - Elástico 4 - Lacerante 5 - Serpente Não Peçonhenta 6 - Ignorado	53 Tipo de Acidente 1 - Bororé 2 - Condeco 3 - Elástico 4 - Lacerante 5 - Serpente Não Peçonhenta 6 - Ignorado
	54 Manifestações Sistêmicas 1 - Sem 2 - Não 3 - Ignorado	55 Se Manifestações Sistêmicas Sim, especificar: 1 - Sem 2 - Não 3 - Ignorado	56 Tipo de Acidente 1 - Bororé 2 - Condeco 3 - Elástico 4 - Lacerante 5 - Serpente Não Peçonhenta 6 - Ignorado	57 Tipo de Acidente 1 - Bororé 2 - Condeco 3 - Elástico 4 - Lacerante 5 - Serpente Não Peçonhenta 6 - Ignorado
Dados do Acidente	58 Tipo de Acidente 1 - Bororé 2 - Condeco 3 - Elástico 4 - Lacerante 5 - Serpente Não Peçonhenta 6 - Ignorado	59 Tipo de Acidente 1 - Bororé 2 - Condeco 3 - Elástico 4 - Lacerante 5 - Serpente Não Peçonhenta 6 - Ignorado	60 Tipo de Acidente 1 - Bororé 2 - Condeco 3 - Elástico 4 - Lacerante 5 - Serpente Não Peçonhenta 6 - Ignorado	61 Tipo de Acidente 1 - Bororé 2 - Condeco 3 - Elástico 4 - Lacerante 5 - Serpente Não Peçonhenta 6 - Ignorado
	62 Tipo de Acidente 1 - Bororé 2 - Condeco 3 - Elástico 4 - Lacerante 5 - Serpente Não Peçonhenta 6 - Ignorado	63 Tipo de Acidente 1 - Bororé 2 - Condeco 3 - Elástico 4 - Lacerante 5 - Serpente Não Peçonhenta 6 - Ignorado	64 Tipo de Acidente 1 - Bororé 2 - Condeco 3 - Elástico 4 - Lacerante 5 - Serpente Não Peçonhenta 6 - Ignorado	65 Tipo de Acidente 1 - Bororé 2 - Condeco 3 - Elástico 4 - Lacerante 5 - Serpente Não Peçonhenta 6 - Ignorado
	66 Tipo de Acidente 1 - Bororé 2 - Condeco 3 - Elástico 4 - Lacerante 5 - Serpente Não Peçonhenta 6 - Ignorado	67 Tipo de Acidente 1 - Bororé 2 - Condeco 3 - Elástico 4 - Lacerante 5 - Serpente Não Peçonhenta 6 - Ignorado	68 Tipo de Acidente 1 - Bororé 2 - Condeco 3 - Elástico 4 - Lacerante 5 - Serpente Não Peçonhenta 6 - Ignorado	69 Tipo de Acidente 1 - Bororé 2 - Condeco 3 - Elástico 4 - Lacerante 5 - Serpente Não Peçonhenta 6 - Ignorado

Animais Peçonhentos

Sinus Net

SVS

19/01/2006

Tratamento	49 Classificação do Caso 1 - Leve 2 - Moderado 3 - Grave 9 - Ignorado	50 Soroterapia 1 - Sim 2 - Não 9 - Ignorado
	51 Se Soroterapia Sim, especificar número de ampolas de soro: Antibotrópico (SAB) Antibotrópico (SAC) Antibotrópico (SAAr) Antibotrópico-laqueético (SABL) Antibotrópico (SAE) Antibotrópico (SALex) Antibotrópico-crotálico (SADC) Antibotrópico (SAEs) Antibotrópico (SAtori)	
	52 Complicações Locais 1 - Sim 2 - Não 9 - Ignorado	53 Se Complicações Locais Sim, especificar: 1 - Sim 2 - Não 9 - Ignorado Infecção Secundária Necrose Extensa Síndrome Compartimental Déficit Funcional Amputação
	54 Complicações Sistêmicas 1 - Sim 2 - Não 9 - Ignorado	55 Se Complicações Sistêmicas Sim, especificar: 1 - Sim 2 - Não 9 - Ignorado Insuficiência Renal Insuficiência Respiratória / Edema Pulmonar Agudo Septicemia Choque
Condições	56 Acidente Relacionado ao Trabalho 1 - Sim 2 - Não 9 - Ignorado	57 Evolução do Caso 1 - Cura 2 - Óbito por acidente por animais peçonhentos 3 - Óbito por outras causas 9 - Ignorado
	58 Data do Óbito	59 Data do Encaminhamento

Acidentes com animais peçonhentos: manifestações clínicas, classificação e soroterapia			
Tipo	Manifestações Clínicas	Tipo Soro	Nº ampolas
OFIDISMO	Botrópico javaca javacaça aratu cagaca		2 - 4
	Leve: dor, edema local e equimose discreta		
	Moderado: dor, edema e equimose evidentes, manifestações hemorrágicas discretas	SAB	4 - 8
	Grave: dor e edema intenso e edema, bolhas, hemorragia intensa, oligúria, hipotensão		12
	Crotálico cascavel bororonga		5
	Leve: prurido papular, turvação visual discretos de aparecimento tardio, sem alteração da cor da urina, miopia discreta ou ausente		
OFIDISMO	Moderado: prurido papular, turvação visual discretos de início precoce, miopia discreta, urina escura	SAC	10
	Grave: prurido papular, turvação visual evidentes e intensos, miopia intensa e generalizada, urina escura, oligúria ou anúria		20
	Laqueético surucuru prato-de-jaca		10
	Moderado: dor, edema, bolhas e hemorragia discreta	SABL	
	Grave: dor, edema, bolhas, hemorragia, cólicas abdominais, diarreia, bradicardia, hipotensão arterial		20
	Elaeético coral verde-limão		10
OFIDISMO	Grave: dor ou parestesia discreta, prurido papular, turvação visual	SABL	10
	Escorpiônico escorpião		—
	Leve: dor, eritema e parestesia local		
ARACNISMO	Moderado: sudorese, náuseas, vômitos ocasionais, taquicardia, agitação e hipertensão arterial leve	SAEs ou SAA	2 - 3
	Grave: vômitos profusos e incoercíveis, sudorese profusa, prostração, bradicardia, edema pulmonar agudo e choque		4 - 5
	Loxoscelico aranta-marrom		—
	Leve: lesão incatarralística sem aranha identificada		
	Moderado: lesão sugestiva com equimose, palidez, eritema e edema endurecido local, celulite, febre, exantema	SAA ou SALex	5
	Grave: lesão característica, hemólise intravascular		10
ARACNISMO	Foneurísico aranta- amarela aranta-da- barroca		—
	Leve: dor local		
	Moderado: sudorese ocasional, vômitos ocasionais, agitação, hipertensão arterial	SAA	2 - 4
LOMBRÍCIA	Grave: sudorese profusa, vômitos frequentes, priapismo, edema pulmonar agudo, hipotensão arterial		5 - 10
	Latruncular latruncula		—
	Leve: dor, eritema, edematozidade regional, coagulação normal, sem hemorragia		
LOMBRÍCIA	Moderado: alteração na coagulação, hemorragia em pele e/ou mucosas	SALex	5
	Grave: alteração na coagulação, hemorragia em viscerais, insuficiência renal		10

Informações complementares e observações

Anotar todas as informações consideradas importantes e que não estão na ficha (ex: outros dados clínicos, dados laboratoriais, laudos de outros exames e necropsia, etc.)

Investigador	Município/Unidade de Saúde	Cód. da Unit. de Saúde
	Nome	Função
	Assinatura	
Animais Peçonhentos		Sinan Net
		SVS 19/01/0006

ANNEX B - LETTER OF APPROVAL FOR CONDUCTING THE RESEARCH AT THE HOSPITAL



UNIVERSIDADE FEDERAL DE RORAIMA
PRÓ-REITORIA DE PESQUISA E PÓS-GRADUAÇÃO
PROGRAMA DE PÓS-GRADUAÇÃO EM SAÚDE E BIODIVERSIDADE
Criado através da Resolução CEPE/UFRR Nº 026, de 08 de dezembro de 2020



CARTA DE ANUÊNCIA PARA AUTORIZAÇÃO DE PESQUISA

Ao Senhor **Elson Alves da Silva**,

À Direção do Hospital Regional Sul Governador Ottomar de Souza Pinto

O discente, **Joel Ramanan Cruz**, do Programa de Pós-graduação em Saúde e Biodiversidade da UFRR (PPGSBio-UFRR), vem pelo presente, solicitar, à Direção desta unidade, autorização para realizar levantamento de dados dos pacientes acidentados por escorpiões no período 2015-2022, e entrevista a acidentados, para o projeto de pesquisa intitulado "**Caracterização clínico-epidemiológica dos acidentes escorpiônicos em Rorainópolis**", sob a orientação da professora Prof. Dra. Cléria Mendonça de Moraes (PPGSBio-UFRR), co-orientação do Prof Bruno Rafael Ribeiro de Almeida (UEPA) e colaboração da Profª Kristiane Alves Araujo (PPGSBio-UFRR). O projeto completo está anexo a esta carta.

Após a aprovação do Comitê de Ética em Pesquisa, a coleta de dados deste projeto será iniciada, atendendo todas as solicitações e recomendações da direção do hospital.

Contando com a autorização desta instituição, colocamo-nos à disposição para qualquer esclarecimento.

Pesquisador principal: Profª Dra. Cléria Mendonça de Moraes

Contato: (95) 99143-1391, e-mail: cleria.moraes@ufr.br

Pesquisador assistente: Joel Ramanan Cruz

Contato: (95) 98409-6294, e-mail: joel.academicom@gmail.com

Pesquisador assistente: Prof. Bruno Rafael Ribeiro de Almeida

Contato: (92) 98711-4088, e-mail: brunorafat8@gmail.com

Pesquisador assistente: Profª Drª Kristiane Alves Araujo

Contato: (95) 99117-5117 e-mail: kristiane.araujo@ufr.br

Boa Vista, 22 de setembro de 2021.

CLERIA MENDONÇA: Assinado de forma digital
DE por CLERIA MENDONÇA
MORAES:138812498 DE:MORAES:138812498
00 Data: 2021.09.22
20:49:46 -04'00'

Prof. Drª Cléria Mendonça de Moraes
Professora Efetiva do curso de Medicina da UFRR
SIAPE 3068242

☒ Concordamos com a solicitação

☐ Não concordamos com a solicitação

Direção do Hospital Regional Sul Governador Ottomar de Souza Pinto

Elson Alves da Silva
Diretor Geral
CPF: 146.112.111
11/09/2021

ANNEX C - LETTER OF APPROVAL FOR ACCESSING SINAN (GRANTED BY THE MUNICIPAL HEALTH SURVEILLANCE SUPERINTENDENT)



UNIVERSIDADE FEDERAL DE RORAIMA
PRÓ-REITORIA DE PESQUISA E PÓS-GRADUAÇÃO
PROGRAMA DE PÓS-GRADUAÇÃO EM SAÚDE E BIODIVERSIDADE
Criado através da Resolução CEPE/UFRR N° 026, de 08 de dezembro de 2020



CARTA DE ANUÊNCIA PARA AUTORIZAÇÃO DE PESQUISA

À Secretaria Municipal de Saúde - Prefeitura Municipal de Rorainópolis
Superintendência da Vigilância em Saúde
Sr. CLAYSON BATISTA OLIVEIRA

O discente, **Joel Ramanan Cruz**, do Programa de Pós-graduação em Saúde e Biodiversidade da UFRR, vem pelo presente, solicitar, à Coordenadoria desta unidade, autorização para realizar coleta de dados do Sistema de Informação de Agravos de Notificação – SINAN dos pacientes acidentados por escorpiões no período 2015-2022 para o projeto de pesquisa intitulado **"Caracterização clínica-epidemiológica dos acidentes escorpiônicos em Rorainópolis"**, sob a orientação da professora Profa. Dra. Cléria Mendonça de Moraes (PPGSBio-UFRR), co-orientação do Prof. Bruno Rafael Ribeiro de Almeida (UEPA) e colaboração da Prof.^a Kristiane Alves Araujo (PPGSBio-UFRR). O projeto completo está anexo a esta carta.

Após a aprovação do Comitê de Ética em Pesquisa, a coleta de dados deste projeto será iniciada, atendendo todas as solicitações e recomendações da coordenação desta Vigilância.

Contando com a autorização desta instituição, colocamo-nos à disposição para qualquer esclarecimento.

Pesquisador principal: Prof.^a Dra. Cléria Mendonça de Moraes

Contato: (95) 99143-1391, e-mail: cleria.moraes@ufr.br

Pesquisador assistente: Joel Ramanan Cruz

Contato: (95) 98409-6294, e-mail: joel.academicorr@gmail.com

Pesquisador assistente: Prof. Bruno Rafael Ribeiro de Almeida

Contato: (92) 98711-4088, e-mail: brunoraf18@gmail.com

Pesquisador assistente: Prof.^a Dr.^a Kristiane Alves Araujo

Contato: (95) 99117-5117 e-mail: kristiane.araujo@ufr.br

Boa Vista, 27 de setembro de 2021.

CLERIA MENDONÇA
DE
MORAES:138812498
00

Assinado de forma digital
por CLERIA MENDONÇA
DE MORAES:13881249800
Data: 2021.09.27
22:16:29 -0400

Prof. Dr.^a Cléria Mendonça de Moraes
Professora Efetiva do curso de Medicina da UFRR
SIAPE 3068242

☒ Concordamos com a solicitação

☐ Não concordamos com a solicitação

Clayson Batista Oliveira
Coord. Mnt. da Vigilância em Saúde

Clayson Batista Oliveira
Coordenador de Vigilância em Saúde
Clayson Batista Oliveira

ANNEX D - LETTER OF APPROVAL FOR ACCESSING SINAN (GRANTED BY THE MUNICIPAL HEALTH SECRETARY)



UNIVERSIDADE FEDERAL DE RORAIMA
PRÓ-REITORIA DE PESQUISA E PÓS-GRADUAÇÃO
PROGRAMA DE PÓS-GRADUAÇÃO EM SAÚDE E BIODIVERSIDADE
Criado através da Resolução CEPE/UFRR N° 026, de 08 de dezembro de 2020



CARTA DE ANUÊNCIA PARA AUTORIZAÇÃO DE PESQUISA

À Secretaria Municipal de Saúde - Prefeitura Municipal de Rorainópolis
Sra. ADNA ALVES PINTO

O discente, Joel Ramanan Cruz, do Programa de Pós-graduação em Saúde e Biodiversidade da UFRR, vem pelo presente solicitar à Secretaria Municipal de Saúde de Rorainópolis autorização para realizar coleta de dados do Sistema de Informação de Agravos de Notificação – SINAN dos pacientes acidentados por escorpiões e atendidos nas Unidades Básicas de Saúde de Rorainópolis no período 2015-2022 para o projeto de pesquisa intitulado “Caracterização clínica-epidemiológica dos acidentes escorpiônicos em Rorainópolis”, sob a orientação da professora Profa. Dra. Cléria Mendonça de Moraes (PPGSBio-UFRR), co-orientação do Prof. Bruno Rafael Ribeiro de Almeida (UEPA) e colaboração da Prof.ª Kristiane Alves Araujo (PPGSBio-UFRR). O projeto completo está anexo a esta carta.

Após a aprovação do Comitê de Ética em Pesquisa, a coleta de dados deste projeto será iniciada, atendendo todas as solicitações e recomendações da coordenação desta Vigilância.

Contando com a autorização desta instituição, colocamo-nos à disposição para qualquer esclarecimento.

Pesquisador principal: Prof.ª Dra. Cléria Mendonça de Moraes

Contato: (95) 99143-1391, e-mail: cleria.moraes@ufr.br

Pesquisador assistente: Joel Ramanan Cruz

Contato: (95) 98409-6294, e-mail: joel.academicorr@gmail.com

Pesquisador assistente: Prof. Bruno Rafael Ribeiro de Almeida

Contato: (92) 98711-4088, e-mail: brunorafa18@gmail.com

Pesquisador assistente: Prof.ª Dr.ª Kristiane Alves Araujo

Contato: (95) 99117-5117 e-mail: kristiane.araujo@ufr.br

Boa Vista, 13 de outubro de 2021.

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Prof. Dr.ª Cléria Mendonça de Moraes
Professora Eletiva do curso de Medicina da UFRR
SIAPE 3068242

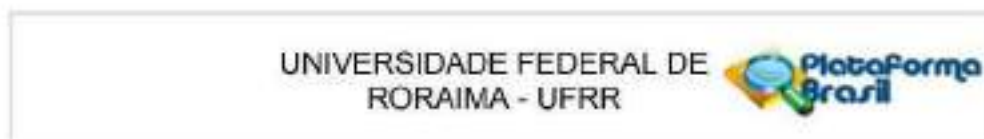
☒ Concordamos com a solicitação

☐ Não concordamos com a solicitação

Adna Alves Pinto
Secretária Municipal de Saúde
Rorainópolis

ADNA ALVES PINTO
Secretária Municipal de Saúde de Rorainópolis

ANNEX E – APPROVAL BY THE ETHICS COMMITTEE



PARECER CONSUBSTANCIADO DO CEP

DADOS DO PROJETO DE PESQUISA

Título da Pesquisa: CARACTERIZAÇÃO CLÍNICO-EPIDEMIOLÓGICA DOS ACIDENTES ESCORPIÔNICOS EM RORAINÓPOLIS

Pesquisador: CLERIA MENDONÇA DE MORAES

Área Temática:

Versão: 2

CAAE: 54090221.8.0000.5302

Instituição Proponente: Universidade Federal de Roraima - UFR

Patrocinador Principal: Financiamento Próprio

DADOS DO PARECER

Número do Parecer: 5.251.710

Apresentação do Projeto:

CARACTERIZAÇÃO CLÍNICO-EPIDEMIOLÓGICA DOS ACIDENTES ESCORPIÔNICOS EM RORAINÓPOLIS

O escorpionismo é um importante problema de saúde pública em muitos países, inclusive no Brasil. Algumas políticas já foram desenvolvidas, como notificações compulsórias imediatas, vigilância epidemiológica e a produção de soros. Porém, ainda se observa escassez de estudos epidemiológicos e de biodiversidade, com destaque para a região Norte, onde se encontra o município de Rorainópolis, sul de Roraima. Assim, pesquisas sobre acidentes são relevantes. Nesse sentido, o projeto pretende descrever o escorpionismo em Rorainópolis, abordando seus aspectos clínicos e epidemiológicos. Para isso, far-se-á um levantamento de dados dos acidentes, sintomatologia, tratamento e outros relevantes por consulta a prontuários do Hospital Regional Ottomar de Sousa Pinto e acesso aos sistemas da Secretaria Municipal de Saúde, considerando o período de 2015 a 2022. Também serão realizadas entrevistas aos acidentados que forem admitidos, buscando informações sobre o acidente, indígenas, pessoas com reduzida capacidade de tomar decisões, pacientes com idade maior ou igual a 60 anos, gestantes e crianças), estrangeiros não fluentes em português e pessoas com doenças hepáticas e renais prévias não serão considerados no estudo. Trezentos e noventa e dois questionários on-line e impressos serão aplicados à população do município, buscando dados sobre acidentes e localização de escorpiões. Em todos esses casos, os participantes assinarão o Termo de Consentimento Livre e Esclarecido.

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 UF: RR Município: BOA VISTA
 Telefone: (65)3621-3112 Fax: (65)3621-3112 E-mail: cosp@ufrr.br

UNIVERSIDADE FEDERAL DE RORAIMA - UFRR



Continuação do Parecer: 5.251.710

Far-se-á coletas de escorpiões em Rorainópolis em áreas prioritariamente ocupadas por seres humanos. Os espécimes serão identificados, confirmados, descritos com auxílio de especialistas e depositados nas coleções da Universidade Federal de Roraima. Os dados serão analisados com programas aplicativos de computador através de estatística descritiva. Espera-se obter um perfil dos casos de acidentes com escorpiões em Rorainópolis, com descrição da clínica dos acidentes, distribuição geográfica e descrição das espécies causadoras, comparando também com o perfil dos casos de acidentes por outros animais peçonhentos e de outras regiões do Brasil.

Objetivo da Pesquisa:

Objetivos da Pesquisa:

Objetivo Primário

Caracterizar os aspectos clínico-epidemiológicos do escorpionismo no município de Rorainópolis – RR

Objetivo Secundário

- Descrever o quadro dos acidentes envolvendo escorpiões no município de Rorainópolis entre 2015 e 2021;
- Comparar os dados dos acidentes causados por escorpiões, disponibilizados pelo SINAN para a cidade de Rorainópolis, com os registrados pela Secretaria Municipal de Saúde de Rorainópolis de 2015 a 2022;
- Identificar as espécies da escorpiofauna da região relacionadas aos acidentes.

Avaliação dos Riscos e Benefícios:

Avaliação dos Riscos:

A pesquisa apresenta um risco mínimo de quebra de sigilo e de constrangimento para o participante da pesquisa, pois serão coletadas informações verbais e fotográficas que demonstrarem a clínica do participante. Os pesquisadores reforçarão ao entrevistado que sua identidade será preservada, e que a imagem será restrita ao local da picada em ângulo fechado. A confidencialidade do participante será mantida pelos pesquisadores.

Avaliação dos Benefícios:

A pesquisa permitirá a descrição mais detalhada, a conduta prévia e consequentemente um esclarecimento das condições epidemiológicas e os aspectos clínicos dos acidentes escorpiônicos no município de Rorainópolis. Além disso, proporcionará uma fonte de informações para os

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UNIVERSIDADE FEDERAL DE RORAIMA - UFRR



Continuação do Parecer: 5.251.710

gestores do hospital e do município e consequentemente para o entendimento do escorpionismo na região, assim como na promoção de saúde.

Comentários e Considerações sobre a Pesquisa:

Projeto de pesquisa do Mestrado do Programa de Pós-graduação em Saúde e Biodiversidade.

Considerações sobre os Termos de apresentação obrigatória:

Todos os termos de apresentação obrigatória constam no projeto de pesquisa

Conclusões ou Pendências e Lista de Inadequações:

Recomenda-se a aprovação do protocolo de pesquisa, pois a Pesquisadora solucionou as pendências, bem como não foram observados óbices éticos.

Considerações Finais a critério do CEP:

Este parecer foi elaborado baseado nos documentos abaixo relacionados:

Tipo Documento	Arquivo	Postagem	Autor	Situação
Informações Básicas do Projeto	PB_INFORMACOES_BASICAS_DO_PROJETO_1820534.pdf	15/01/2022 20:29:56		Aceito
Outros	RESPOSTA_AO_PARECER_DE_PENDENCIA.pdf	15/01/2022 20:16:34	JOEL RAMANAN DA CRUZ	Aceito
TCLE / Termos de Assentimento / Justificativa de Ausência	TCLEs.pdf	15/01/2022 20:14:10	JOEL RAMANAN DA CRUZ	Aceito
TCLE / Termos de Assentimento / Justificativa de Ausência	TCLEs_ALTERACOES_DESTACADAS_EM_VERMELHO.pdf	15/01/2022 20:13:33	JOEL RAMANAN DA CRUZ	Aceito
Cronograma	CRONOGRAMA_ALTERACOES_DESTACADAS_EM_VERMELHO.pdf	15/01/2022 20:13:13	JOEL RAMANAN DA CRUZ	Aceito
Projeto Detalhado / Brochura Investigador	PROJETO_FINAL_COMPLETO_191121_ALTERACOES_DESTACADAS_EM_VERMELHO.pdf	15/01/2022 20:12:47	JOEL RAMANAN DA CRUZ	Aceito
Outros	SOLICITACAO_DISPENSA_TCLE.pdf	19/11/2021 22:07:12	JOEL RAMANAN DA CRUZ	Aceito
Outros	TCLEs_completo_191121.pdf	19/11/2021 22:06:47	JOEL RAMANAN DA CRUZ	Aceito
Projeto Detalhado / Brochura Investigador	PROJETO_FINAL_COMPLETO_191121.pdf	19/11/2021 22:04:08	JOEL RAMANAN DA CRUZ	Aceito
Outros	CARTAS_DE_ANUENCIA_COMPILADAS.pdf	16/11/2021 13:53:27	JOEL RAMANAN DA CRUZ	Aceito

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**UNIVERSIDADE FEDERAL DE
RORAIMA - UFRR**



Continuação do Parecer: 5.251.710

Declaração de Pesquisadores	DECLARACAO_PESQUISADORA.pdf	11/11/2021 11:54:16	JOEL RAMANAN DA CRUZ	Aceito
Orçamento	orcamento.pdf	11/11/2021 11:33:40	JOEL RAMANAN DA CRUZ	Aceito
Cronograma	cronograma.pdf	11/11/2021 11:33:24	JOEL RAMANAN DA CRUZ	Aceito
Folha de Rosto	FOLHA_DE_ROSTO_ASSINADA.pdf	10/11/2021 22:19:22	JOEL RAMANAN DA CRUZ	Aceito

Situação do Parecer:

Aprovado

Necessita Apreciação da CONEP:

Não

BOA VISTA, 19 de Fevereiro de 2022

**Assinado por:
Bianca Jorge Sequeira Costa
(Coordenador(a))**

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UF: RR **Município:** BOA VISTA
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ANNEX F – AUTHORIZATION FOR SCORPION COLLECTION



Ministério do Meio Ambiente - MMA

Instituto Chico Mendes de Conservação da Biodiversidade - ICMBio

Sistema de Autorização e Informação em Biodiversidade - SISBIO

Autorização para atividades com finalidade científica

Número: 80432-1	Data da Emissão: 17/02/2022 08:35:36	Data da Revalidação: 17/02/2023
De acordo com o art. 28 da IN 03/2014, esta autorização tem prazo de validade equivalente ao previsto no cronograma de atividades do projeto, mas deverá ser revalidada anualmente mediante a apresentação do relatório de atividades a ser enviado por meio do Sisbio no prazo de até 30 dias a contar da data do aniversário de sua emissão.		

Dados do titular

Nome: Joel Ramanon da Cruz	CPF: 031.040.062-07
Título do Projeto: Caracterização Clínico-Epidemiológica dos Acidentes Escorpínicos em Roraima	
Nome da Instituição: UNIVERSIDADE FEDERAL DE RORAIMA	CNPJ: 34.792.077/0001-83

Cronograma de atividades

#	Descrição da atividade	Início (mês/ano)	Fim (mês/ano)
1	Relatório	01/2023	03/2023
2	Identificação dos escorpiões	02/2022	12/2022
3	Coleta dos escorpiões	02/2022	03/2023

Equipe

#	Nome	Função	CPF	Nacionalidade
1	Bruno Rafael Ribeiro de Almeida	Colaborador	004.626.882-08	Brasileira
2	Cléia Mendonça de Moraes	Orientadora e colaboradora	138.812.498-00	Brasileira

Observações e ressalvas

1	Deve observar as especificidades de preservação corria a COVAD-TR das atividades sanitárias locais e das Unidades de Conservação e seus ecossistemas.
2	Esta autorização NÃO libera o uso da subestância com potencial agrotóxico e/ou matricida a NÃO anexo o pesquisador titular e os membros de sua equipe da necessidade de atender às exigências e obter as autorizações previstas em outros instrumentos legais relativos ao registro de agrotóxicos (Lei nº 7.802, de 11 de julho de 1989, Decreto nº 4.374, de 4 de janeiro de 2002, entre outros).
3	Esta autorização NÃO libera o uso da subestância com potencial agrotóxico e/ou matricida a NÃO anexo o pesquisador titular e os membros de sua equipe da necessidade de atender às exigências e obter as autorizações previstas em outros instrumentos legais relativos ao registro de agrotóxicos (Lei nº 7.802, de 11 de julho de 1989, Decreto nº 4.374, de 4 de janeiro de 2002, entre outros).
4	O titular da autorização ou de licença permanente, assim como os membros de sua equipe, quando da violação da legislação vigente, ou quando da inadequação, omissão ou falta de descrição de informações relevantes que subsidiaram a expedição do ato, poderá, mediante decisão motivada, ter a autorização ou licença suspensa ou revogada pelo CIBIO, nos termos da legislação brasileira em vigor.
5	Este documento somente poderá ser utilizado por os três projetos na Instigação Biológica CBIO nº 032010 ou na Instigação Biológica CBIO nº 100510, no que se refere esta Autorização, não podendo ser utilizado para fins comerciais, industriais ou exportivos. O material biológico coletado deverá ser utilizado para atividades científicas ou educacionais no âmbito do ensino superior.
6	As atividades de campo exercidas por pessoa natural ou jurídica estrangeira, em todo o território nacional, que impliquem o deslocamento de recursos humanos e materiais, terão por objeto estudos, pesquisas, experimentos, biológicos e minerais, papéis integrantes da cultura natural e cultura popular, presentes e passadas, visando, por meio da interação e interação que os resultem ao estudo, a difusão da pesquisa, a valorização e a valorização do Ministério de Ciência e Tecnologia.
7	Este documento não dispensa o cumprimento da legislação que dispõe sobre acesso a patrimônio genético existente no território nacional, na plataforma continental e na zona econômica exclusiva, ou ao conhecimento tradicional associado ao patrimônio genético, para fins de pesquisa científica, bioprospecção e desenvolvimento tecnológico. Veja maiores informações em www.mma.gov.br/gen .
8	O titular da licença ou autorização e os membros de sua equipe deverão optar por métodos de coleta e instrumentos de captura desconhecidos, sempre que possível, ao grupo taxonômico de interesse, evitando a morte ou dano significativo a todos os grupos, e empregar esforço de coleta ou captura que não comprometa a viabilidade de populações de grupo taxonômico de interesse em condições de vida.

Este documento foi expedido com base na Instrução Normativa nº 03/2014. Através do código de autenticação abaixo, qualquer cidadão poderá verificar a autenticidade ou regularidade deste documento, por meio da página do Sicojor/CAIRB na Internet www.jcmbr.com.br/sicojor

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Autorização para atividades com finalidade científica

Número: 80432-1	Data da Emissão: 17/02/2022 08:35:36	Data da Revalidação*: 17/02/2023
De acordo com o art. 28 da IN 03/2014, esta autorização tem prazo de validade equivalente ao previsto no cronograma de atividades do projeto, mas deverá ser revalidada anualmente mediante a apresentação do relatório de atividades a ser enviado por meio do Sisbio no prazo de até 30 dias a contar da data do aniversário de sua emissão.		

Dados do titular

Nome: Joel Ramanan da Cruz	CPF: 031.540.062-57
Título do Projeto: Caracterização Clínico-Epidemiológica dos Acidentes Escorpiônicos em Rorainópolis	
Nome da Instituição: UNIVERSIDADE FEDERAL DE RORAIMA	CNPJ: 34.792.077/0001-63

Observações e ressalvas

8	Esta autorização NÃO exonera o pesquisador titular e os membros de sua equipe da necessidade de obter as anuências previstas em outros instrumentos legais, bem como do consentimento do responsável pela área, pública ou privada, onde será realizada a atividade, inclusive do órgão gestor do sistema indígena (FUNAI), da unidade de conservação onde será realizada a atividade, se for o caso, e, se necessário, passar o ou os membros do time dentro dos limites da unidade de conservação, tendo o caso processo de regularização fundiária em curso.
10	Em caso de pesquisa em UNIDADE DE CONSERVAÇÃO, o pesquisador titular desta autorização deverá contactar a administração da unidade a fim de CONFIRMAR AS DATAS das expedições, as condições para realização das mesmas e de uso da infraestrutura da unidade.

Outras ressalvas

1	Não teremos de cada coleta providenciar a retirada de todos os itens utilizados para a coleta das espécies nos pontos de amostragem. É importante e extremamente recomendável a citação do nº da licença Sisbio nos artigos que visem a serem publicados pelo pesquisador e por membros de sua equipe de pesquisa.	CEICAV/UFRRJ/UFPA
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Locais onde as atividades de campo serão executadas

#	Descrição do local	Município-UF	Bioma	Caverna?	Tipo
1	Sede e zona rural	Rorainópolis-RR	Amazônia	Não	Fora de UC Federal

Atividades

#	Atividade	Grupo de Atividade
1	Coleta/transporte de espécimes da fauna silvestre in situ	Fora de UC Federal

Atividades X Táxons

#	Atividade	Táxon	Qtd.
1	Coleta/transporte de espécimes da fauna silvestre in situ	Scorpiones	100

A quantidade prevista só é obrigatória para atividades do tipo "Coleta/transporte de espécimes da fauna silvestre in situ". Essa quantidade abrange uma porção territorial mínima, que pode ser uma Unidade de Conservação Federal ou um Município.

A quantidade significa: por espécie X localidade X ano.

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Autorização para atividades com finalidade científica

Número: 80432-1	Data da Emissão: 17/02/2022 09:35:08	Data da Revalidação*: 17/02/2023
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Dados do titular

Nome: Joel Ramanan da Cruz	CPF: 031.540.062-07
Título do Projeto: Caracterização Clínico-Epidemiológica dos Acidentes Escapilóricos em Rorainópolis	
Nome da Instituição: UNIVERSIDADE FEDERAL DE RORAIMA	CNPJ: 34.792.077/0001-63

Materiais e Métodos

#	Tipo de Método (Grupo taxonômico)	Materiais
1	Método de captura/coleta (Invertebrados Terrestres)	Coleta manual, Captura manual, Outros métodos de captura/coleta (Armadilha de interceptação e queda (pitfalls))

Destino do material biológico coletado

#	Nome local destino	Tipo destino
1	UNIVERSIDADE FEDERAL DE RORAIMA	Laboratório

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Autorização para atividades com finalidade científica

Número: 40432-1	Data da Emissão: 17/02/2022 09:39:38	Data da Revalidação: 17/02/2023
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Dados do titular		
Nome: Joel Raman da Cruz	CPF: 031.540.062-07	
Título do Projeto: Caracterização Clínico-Epidemiológica dos Acidentes Escopificos em Rorainópolis		
Nome da Instituição: UNIVERSIDADE FEDERAL DE RORAIMA	CNPJ: 34.792.077/0001-83	

Registro de coleta imprevista de material biológico

De acordo com a Instrução Normativa nº 001/2014, a coleta imprevista de material biológico ou de substrato não contemplado na autorização ou na licença permanente deverá ser anotada na mesma, em tempo específico, por ocasião da coleta, devendo esta coleta imprevista ser comunicada por meio do relatório de atividades. O transporte do material biológico ou do substrato deverá ser acompanhado da autorização ou da licença permanente com a devida anotação. O material biológico coletado de forma imprevista, deverá ser destinado à instituição científica e, depositado, preferencialmente, em coleção biológica científica registrada no Cadastro Nacional de Coleções Biológicas (CCBIO).

[illegible]

* Identificar o aspecto do nível taxonômico possível

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