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Artigo Original

Venomous animal accidents and phytotherapeutic measures adopted by the rural population in Alagoas backlands (Brazil)

Acidentes com animais peçonhentos e medidas fitoterápicas adotadas pela população rural do interior de Alagoas (Brasil)

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ABSTRACT

Objectives: Evaluate the epidemiological aspects of accidents with venomous animals, focusing on snakebites and phytotherapic measures adopted by the rural population in municipalities in the interior of Alagoas, Brazil. **Material and methods**: This comprises a quantitative, descriptive research, carried out between 2016 and 2017 in the Alagoas backlands. The "snowball sampling" method was used to select the participants. A semi-structured questionnaire was used for data collection. The data were analyzed using the Excel 2007 software, and the relationship between variables was evaluated by Spearman's correlation. **Results**: Of the 600 reported accidents with venomous animals, the most prevalent were caused by snakes (47.00%) and scorpions (31.44%), while 21.56% were caused by other animals. A weak correlation (r = 0.33) was observed between municipality and job occupation. Of the 282 registered snakebites, the Viperidae family was predominant with 74.46% of the cases. Most accidents ocurred with members of the Bothrops/Bothrocophias (36.52%) and Crotalus (28.37%) genera. The medicinal plants used herein were barbatimão (52.00%), paratudo (21.00%), bellyache bush (15.00%) and sweet potato (12.00%), applied as leaf macerations (60.00 %), tea compresses (29.50%) and garrafada (10.50%). **Conclusion**: Medicinal plants are used in the region of Alagoas as a phytotherapic alternative to minimize the symptoms and effects of snake venom.

Keywords: Snake Bites; Poison; Phytotherapy; Public Health.

RESUMO

Objetivo: Avaliar os aspectos epidemiológicos dos acidentes com animais peçonhentos, enfocando mordidas de cobras e medidas fitoterápicas adotadas pela população rural em municípios do interior de Alagoas, Brasil. **Material e métodos**: Compreende uma pesquisa quantitativa, descritiva, realizada entre 2016 e 2017 no sertão de Alagoas. O método de snow-ball foi utilizado para selecionar os participantes. Um questionário semiestruturado foi utilizado para a coleta de dados. Os dados foram analisados no software Excel 2007, e a relação entre variáveis foi avaliada pela Correlação de Spearman. **Resultados**: Dos 600 acidentes relatados com animais peçonhentos, os mais prevalentes foram causados por cobras (47,00%)

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e escorpiões (31,44%), enquanto 21,56% foram causados por outros animais. Observou-se fraca correlação (r = 0,33) entre município e ocupação. Das 282 mordidas de cobra registradas, a família Viperidae foi predominante em 74,46% dos casos. A maioria dos acidentes ocorreu com membros dos gêneros Bothrops / Bothrocophias (36,52%) e Crotalus (28,37%). As plantas medicinais utilizadas foram barbatimão (52,00%), paratudo (21,00%), dor de barriga (15,00%) e batata-doce (12,00%), aplicadas como macerações foliares (60,00%), compressas de chá (29,50%) e garrafada (10,50%). **Conclusão**: As plantas medicinais são utilizadas na região de Alagoas como alternativa fitoterápica para minimizar os sintomas e efeitos do veneno de serpentes.

Palavras-chave: Mordidas de Cobras; Veneno; Fitoterapia; Saúde Pública.

INTRODUCTION

The state of Alagoas comprises different characteristics, including physical, economic, social and cultural. For the purpose of demographic organization, Alagoas municipalities are currently grouped into three mesoregions, namely the Backlands, Agreste and East Alagoas, which, in turn, comprise microregions composed of cities presenting similar characteristics, such as soil type, climate, vegetation, rivers and economic resources. In this study, four Alagoas backlands mesoregion municipalities were selected, three from the Santana do Ipanema microregion (Poço das Trincheiras, São José da Tapera and Santana do Ipanema) and one from the Batalha microregion (Olho D´Agua das Flores)[1].

All selected regions present the prevalence of deciduous and sub-deciduous forest and caatinga vegetation[1], which cover about 86% of Brazil's northeastern territory, and whose plant formation exhibits temporal heterogeneity due to climatic seasonality[2]. Medicinal plants containing bioactive principles displaying therapeutic properties[3] are used in this area to cure diseases and as a complementary resource to traditional serum therapy in the treatment of venomous animal accidents.

The use of these plants is part of traditional knowledge and is allied to the belief that, when affected by a certain condition, local herbs can be used to treat several different diseases[4]. Over the years, popular knowledge concerning this practice has been passed from generation to generation, subsequently followed by scientific evidence on the properties of the extracts[5].

Based on these findings, medicinal ethnobotanical and ethnopharmacological studies have emerged and have proven that about 850 plant species present anti-pathological and therapeutic potential[6,7]. Extracts obtained from these plants have appeared as alternatives to anti-ophidic treatment, due to the presence of different chemical components (alkaloids, flavonoids, lignins, tannins, tripenes) with the capacity to inhibit venom, acting directly on target macromolecules, such as enzymatic inhibitors or chemical inactivators[8].

Annually, about 115,000 cases of venomous animal accidents are reported in Brazil, leading to public health concerns. Scorpion poisoning is the most common, followed by snakes and spiders[9].

In Brazil, 86,9% of recorded snakebite cases are attributed to *Bothrops* sp.[10], leading to varied clinical conditions, presenting both local and systemic lesions[11]. However, the severity of the accident depends on several factors, such as amount of inoculated venom, bite site, patient age and time elapsed between the accident and medical care, since delays in medical attention contribute to further aggravate the clinical condition of the injured victim[12].

In this context, in order to fill the existing gap concerning venomous animal accidents, this study aimed to investigate epidemiological aspects of medically important venomous animal accidents, focusing on ophidians, and the phytotherapeutic measures adopted by the rural Alagoas backland population of northeastern Brazil.

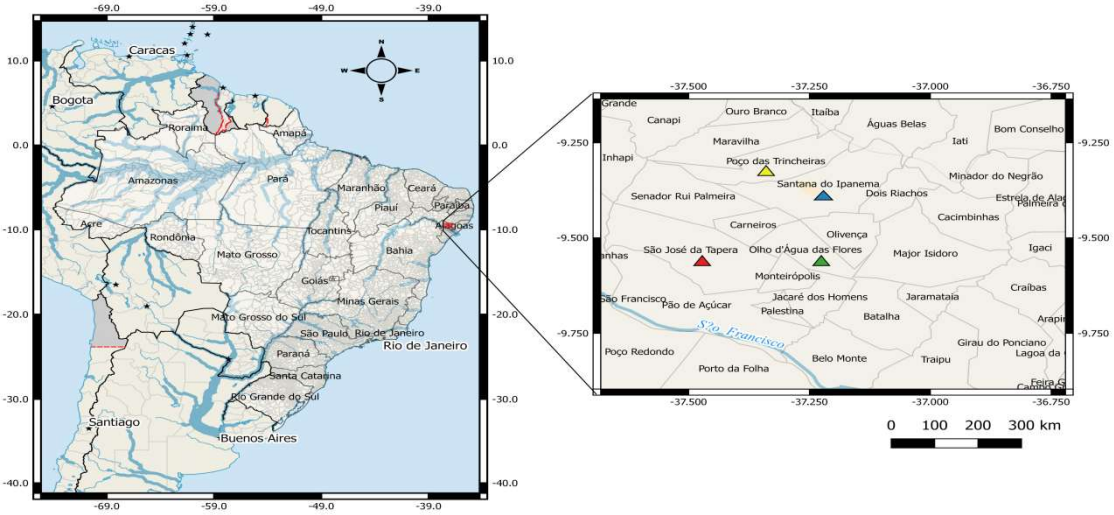
MATERIAL AND METHODS

Geographical delimitation

This study was carried out from 2016 to 2017 in four municipalities geographically located in the mesoregion of the Alagoas backlands (Figure 1) (Santana do Ipanema, Poço das Trincheiras, Olho d'Água das Flores, São José da Tapera), with similar soil, climate, rivers, vegetation and economic resource characteristics. All selected

regions present the prevalence of deciduous and sub-deciduous forest stretches, with predominant caatinga vegetation at Olho d'Água das Flores and São José da Tapera. According to IBGE data[1], this region comprises 5,271 km² corresponding to approximately 19% of the area of the state of Alagoas (27,793,343 km²).

Figure 1. Map of the state of Alagoas with the geographical location of the investigated microregions from 2015 to 2016 displayed in the inset. Source: http://qgis.osgeo.org/en/site/



Experimental design

This study comprised a descriptive quantitative research presenting an ethnobotanical character. The "snowball sampling" method was used to select study participants. This consists in obtaining an intentional sample from which the researcher investigates specific groups, based on their experience or knowledge of the investigated universe[13]. The study included individuals over 18 years old, residing in the investigated municipalities who suffered venomous animal accidents in or near their homes or in the work environment during the last ten years and used medicinal plants with anti-ophidic purpose.

After data collection obtained by applying a semi-structured questionnaire, the variables were grouped into three categories: 1) Sociodemographic victim profile (residence municipality, sex, age group (18 to 27; 28 to 37; 38 to 47; 48 to 57; 58 to 67 over 68 years old), occupation, schooling); 2) Clinical aspects of the accidents (occurrence area, seasonality, type of accident, aggressor agent, affected anatomical site, clinical manifestations); 3) Alternative treatment.

Access to the study participants was initially carried out through previous contact with the rural community leaders of the four municipalities, in order to establish trust and obtain indications of possible informants for the research development. Before applying the questionnaires, participants were informed about the research objectives and invited to sign a Free and Informed Consent Form. A total of 600 venomous animal accidents were recorded, and, among these, 282 were caused by ophidians.

Strategies for the recognition of venomous species

To facilitate the recognition of venomous snakes and medicinal plants used in the treatment of ophidian accidents by the study participants, two methodological strategies were adopted: the use of an "Illustrative Catalog" containing a photographic registry of snakes of medical importance, to assist in aggressor agent identification (family, scientific name, popular name), constructed using both the Brazilian reptiles - List of species[14] and bibliographic surveys on snake phylogeny and classification.

Considering that the classification of medically important snakes aids in species recognition and contributes to antivenom formulation strategies and injury treatment, a species list consultation was motivated by the need to understand the taxonomic changes occurred within the Elapidae and Viperidae families concerning their current nomenclature, in order to avoid doubts regarding previous publications to these standards.

The second strategy was the presentation of a "Mobile Herbarium", containing information on medicinal plants (family, scientific name, popular name) that grow in the study area. Tropicos. org[15] and the Angiosperm Phylogeny Website[16] were consulted for herbarium preparation. These materials were presented to the participants during the questionnaire application, whenever any doubts occurred regarding the identity of the aggressor agent and/or the plant used as treatment.

Statistical analysis

The collected data were tabulated and analyzed using the Microsoft Office Excel 2007 software. The quantitative variables were analyzed through descriptive statistics. Spearman's Correlation test was applied to assess correlations between the variables. Correlations were analyzed by a scale r that ranges from -1 to +1 in which, the higher the value, the greater the correlation strength. This study was approved by the Ethics Committee of the Federal University of Alagoas - UFAL (CAAE No. 68561517.4.0000.5013) and developed according to the precepts of the Brazilian National Health Council Resolution 510/2016.

RESULTS

A total of 600 cases of venomous animal accidents (snakes, scorpions, spiders, bees, others) were recorded in the rural area of the Alagoan backlands, in the municipalities of Poço das Trincheiras (21.16%, n = 127), Olho d'Água das Flores (22.34%; n= 134), Santana do Ipanema (29.00 %; n= 174) and São José da Tapera (27.50%; n= 165). The most prevalent aggressors were snakes (47.00%, n = 282) and scorpions (31.44, n = 189 cases).

According to the sociodemographic profile of the studied population, 53.16% of the victims were male and 46.84%, female. Among the different age groups, the highest percentage of victims ranged from 28 to 37 years old (25.86%), revealing that accidents occurred in the economically active population. Concerning schooling, 40.50% of the participants were semi-literate and 40.50% were literate. In relation to occupation, 72.17% were farmers and 27.83% performed domestic activities near their housings. No correlation was detected between gender or age and occupation, ($r = 0.17$ and $r = -0.20$, respectively), while a weak positive correlation between accident municipality and occupation was evidenced ($r = 0.33$). The noted accidents were possibly directly linked to environmental conditions and the non-use of personal protective equipment (PPE).

Schooling was not an expressive risk factor for venomous animal accidents, in contrast with occupation (72.17%) for rural workers, due to their direct relationship with environmental conditions and lack of personal protection equipment (PPE). Regarding the other victims, 27.83% reported that the accident occurred near their residences, while 17.72% of the participants did not report where the accident took place.

Accidents occurred during the entire year, with a small, albeit non-significant, increase in the number of cases between May and June, and no significant variations throughout occurrences. The most affected anatomical sites were feet (29.43%) and legs (21.62%). However, this does not rule out the possibility of involvement of other anatomical sites during animal aggression, similar to most other studies reporting ophidian accidents [16,17] in Brazil.

Of the 282 reported incidents, identified snake species comprised members of the Viperidae (74.46%), Colubridae (19.50%) and Elapidae (6.04%) genera. Of these, the most frequent types of accidents by aggressive snakes were by *Bothrops* sp. (36.52%) and *Crotalus* sp. (28.37%) (Table 1).

Table 1. Snakes implicated in snakebites in the rural area of the municipalities of Poço das Trincheiras, São José da Tapera, Santana do Ipanema and Olho d´Água das Flores, Alagoas, Brasil.

Family/Species	Popular Portuguese name	Type of accident	Total n	Total %
COLUBRIDAE				
Philodryas olfersii	Cobra-verde		32	11.35
Chironius sp	Cobra cipó		1	0.35
Liophis miliaris	Cobra d' Água		4	1.42
Thamnodynastes pallidus	Corre campo		18	6.38
ELAPIDAE				
Micrurus lemniscatus (Linnaeus, 1758)	Cobra coral	Elapidic	17	6.04
VIPERIDAE				
Bothropoides erytromelas (Amaral, 1923)	Jararaca-da-seca	Bothropic	103	36.52
Caudisona durissa (Linnaeus, 1758)	Cascavel	Crotalic	80	28.37
Lachesis muta (Linnaeus, 1766)	Surucucu-pico-de-jaca	Lachetic	27	9.57
TOTAL			282	100.00

Regarding local clinical manifestations, pain (75.00%) and edema (25.00%) were observed both individually and associated, common in snakebites. Concerning symptom associations, the most frequent were pain and edema (50.00%), while the most prevalent systemic manifestations, myolitic (45.00%) and neuroparalytic (10.00%), were evident in crotalic accidents. The remaining 45% comprised other manifestations.

The medicinal plants used as alternatives to traditional serum therapy were distributed in 09 families and 11 species, namely Annonaceae (*Echinodorus grandiflorus* - Cham. & Schltdl. (Chapéu-de-couro); Anacardiaceae - *Anacardium occidentale* L. (Cajuzinho); *Myracroduon urundeuva* Allemão (Aroeira); Apocynaceae - *Tabernaemontana catharinenses A.* DC. (Leiteiro); Asteraceae - *Piptocarpha rotundifolia* Less. Baker (Paratudo); Bignoniaceae - *Arrabidaea chica* Bonpl. B. Verl. (Cipó-pau); Euphorbiaceae (*Jatropha gossypiifolia* L. (Pinhão roxo); *Croton pedicellatus* Kunth. (Batata-de-teiu); Fabaceae (*Stryphnodendron adstringerns* Mart. Coville (Barbatimão), Malpighiaceae - *Byrsonima crassifólia* L. Rich. (Murici); Salicaceae - *Cesaria sylvestris* Sw. (Erva-de-bugre). Plant data and their respective pharmacological actions are displayed in Frame 1.

Frame 1. Pharmacological properties of families/species described in the literature used as phytotherapics in accidents with venomous animals, mainly snakes*.

Family/Species	Popular name	Pharmacological action	Authors
ANNONACEAE *Echinodorus grandiflorus* Cham. & Schltdl.	Chapéu-de-couro	Anti-inflammatory Astringent Analgesic Anti-ophidic*	Kobayashi et al. 2000[17] Shigemori et al. 2002[18] Coelho, 2013*[19]
ANACARDIACEAE *Anacardium occidentale* L.	Cajuzinho	Anti-inflammatory Antidiarrheal Hypoglycemic Anti-ophidic*	Olajide et al., 2004[20] Costa, 2010*[21] Ushanandini et al, 2009*[22]
ANACARDIACEAE *Myracrodruon urundeuva* Alemão	Aroeira	Antiseptic Antidiarrheal Healing properties Antimicrobial Antitumoral	Di-stasi et al., 2002[23] Lorenzi; Matos, 2002[24] Lima et al., 2006[25] Gazzaneo et al., 2005[26] Queires et al., 2006[27]
APOCYNACEAE *Tabernaemontana catarinenses* A. DC.	Leiteiro, cobrina, jasmim-cata-vento, leiteira de dois irmãos	Analgesic Healing Antitumoral Hemostatic Antihypertensive Cardiotonic Anti-herpetic Vermifuge Anti-ophidic *	Quinet; Andreata, 2005[28] Boni et al, 2011*[29]
BIGNONIACEAE *Arrabidaea chica* Bompl. B. Verl.	Cipó-pau, crajiru, carajuru, pariri, cipó cruz	Anti-inflammatory Anti-anemic Healing properties Anti-hemorrhagic Antispasmodic Antihemorrhagic Antidiarrheal Anti-ophidic*	Borrás, 2003[30] Da Silva, Bieski, 2018[31] Oliveira et al., 2009*[32]
FABACEAE *Stryphnodendron adstringerns* Mart. Coville	Barbatimão	Anti-inflammatory Antimicrobial Healing properties Antioxidant Anti-ophidic*	Costa et al., 2012[33] De Paula et al., 2010[34] De Paula et al., 2009*[5] Lucena et al., 2009*[35] Souza et al., 2007[36]
ASTERACEAE *Piptocarpha rotundifolia* (Less.) Baker	Paratudo, candeia, infalível	Anti-inflammatory (especially in cases of syphilis infection) Antidiarrheal Anti-ophidic*	Accarini, 2016[37] Vilar, 2004 e 2005*[38,39]
EUPHORBIACEAE *Croton pedicellatus* Kunth	Batata-de-teiú	Antidiarrheal Antitumoral Hypoglycemic Antithermic Antihypertensive Anti-inflammatory Anticonstipant Analgesic Healing properties Anti-ophidic*	Vilar et al., 2007*[40]
EUPHORBIACEAE *Jatropha eliptica* (Pohl) Oken	Pinhão roxo, purga -de-largato	Anti-ophidic*	Vilar et al., 2007*[40] De Paula et al., 2010*[34]
MALPIGHIACEAE *Byrsonima crassifólia* L. Rich.	Murici branco, amarelo, Vermelho	Antimicrobial, except for *Escherichia coli*. Anti-ophidic*	Gellen; Silva, 2016[41] Ferreira, 2011*[42]
SALICACEAE *Cesaria sylvestris* Sw	erva-de-bugre, guaçatonga, apiá-acanoçu, bugre-branco, café-bravo	Antitumoral Anti-inflammatory Analgesic Anti-ophidic*	Vilar, 2004*[38] Costa, 2010*[21]

These species are mostly used (75% of the participants) in the form of tea by decoction or infusion. The literature indicates that these species contain several chemical compounds characterizing them as medicinal, such as alkaloids, flavonoids, tannins, triterpenes, gallic acid, reducing sugars.

DISCUSSION

The prevalence of reports of ophidian accidents compared to other venomous animals (scorpions, spiders and bees) is worrisome, since these cases lead to higher mortality and lethality rates, mainly in northeastern Brazil[43]. The high incidence of accidents among male agricultural workers in the economically active age group corroborates previous studies [44,45,46].

The impact of these cases, especially in the Brazilian northeast, is relevant considering that the population most exposed to the risk of accidents presents favorable socioeconomic conditions leading to clinical complications due to the inoperability of Brazilian public policies. According to Saraiva et al.[47] this fact can be explained due to the fact that rural area workers, because of their work activities in the field, become more exposed to this type of accident.

In this study, schooling was not considered an expressive risk factor for venomous animal accidents, confirming the studies carried out by Santana and Suchara[48] and Oliveira et al[49].

Regarding seasonality, the data reported herein corroborate the study carried out by Brito et al.[50], that demonstrated an increased number of venomous animal accidents in the Brazilian northeast from May to September, followed by decreases from October onwards, due to regional variations.

In addition to type of occupation, lack of personal protective equipment (PPE) use, frequency of exposure and suitable planting period, Saraiva et al. [47] confirm that seasonality interferes with behavioral snake characteristics and can, therefore, influence accident distribution throughout the year. The recognition of the greater seasonal risk of occurrence periods may aid in strengthening preventive measures and actions[51].

The predominance of lower limb accidents may be related to climatic factors in the region, increased human activity in the field, and terrestrial habits of Brazilian venomous snakes, who deliver defensive lunges at close range that usually do not exceed one-third of their length[49,52,53].

According to the World Health Organization (WHO), snakebite accidents are considered a neglected tropical disease due to effective lack of intervention during accidents. It is estimated that around 2.5 million snakebite accidents occur every year worldwide, with 250,000 developing into serious complications and 85,000 resulting in death[54].

Lachesis, Micrurus and *Bothropoides* genera were the most reported by the rural population. In Brazil, nine venomous snake genera are recognized: *Bothrops, Bothropoides, Bothriopsis, Bothrocophia, Rhinocerophis, Crotalus, Lachesis, Micrurus* aand *Leptomicrurus*. Due to similar manifestations and treatment with the same serum, the first five genera were clustered into one group. *Bothrops* are responsible for 86.9% of the cases, *Crotalus* for 8.7%, *Lachesis* for 3.6% and *Micrurus* and *Leptomicrurus*, for 0.8%[55].

Sandrini et al.[56] emphasize that aggressions are due to defensive snake actions when faced with imminent threats. Depending on the species and the conditions in which the accident occurred, lesions may comprise scratches, perforations and even tearing, with or without tissue poisoning. This can be explained by disorderly urban growth and low socio-health conditions that contribute to these animals becoming synanthropic, in association with ecological imbalances and leisure activities, ecotourism, fishing and agriculture, thus contributing to the high frequency of these occurrences[51].

According to Moura et al.[57] the clinical scenario varies according to age, bite site, amount of inoculated venom and time elapsed before receiving medical care, the latter being significantly worrisome due to the distance between the accident and medical care sites.

Bothrops ophidian accidents are the most frequent. The local effects of these snakebites are very fast, potentially leading to complications, such as necrosis and amputation of the affected limb. *Crotalus* bites are more severe, as victims present a higher lethality rate due to renal impairment. *Lachesis* accidents, despite low incidence rates, are caused by large snakes, that inoculate higher amounts of venom, increasing lethality. *Elapidae* produce neurotoxins easily absorbed by blood

which act by competing or blocking acetylcholine in the neuromuscular junctions, causing pre- and post-synaptic reactions, which may lead to respiratory muscle involvement and death due to respiratory failure[57].

Accidents caused by colubrids (non-venomous snakes) are common among opisthoglyphous species, mainly *Philodryas olfersii* and *Thamnodynastes pallidus*. These species inoculate low severity venom, except in the case of children as victims. Symptoms (hemorrhagic, edematogenic and fibrinogenolitic) are similar to *Bothrops* cases, leading to pain, edema, alterations in blood coagulation, hemorrhage and ecchymosis which, in turn, result in inappropriate use of serum therapy, since the indicated treatment is symptomatic (analgesic and anti non-hormonal inflammatory) [58].

The administration of anti-ophidic serum is recommended by the Brazilian Ministry of Health in cases of snakebite accidents, according to the severity of the poisoning. However, the population assessed in the present study used alternative medicinal plant treatments.

The data obtained herein confirm previous studies[5,21,29] that scientifically report anti-ophidic properties for the investigated plant species. This data is correlated with the fact that plant extracts contain several chemical components, such as alkaloids, tannins, flavonoids and triterpenes, which are able to inhibit venom, acting as enzyme inhibitors, chemical inactivators, or immunomodulators, which interact directly with target macromolecules, characterized as promising sources of new bioactive natural compounds[3,8]. However, it is worth mentioning that, although the species *Mycobacterium urundeuva* (aroeira) was listed herein as an antiophidic plant, no scientific studies reporting antiophidic action for this species are available, only for analgesic, anti-inflammatory[59] and antimicrobian[60] effects, verified through pharmacological tests. The percentages of reported symptoms (pain 75.00% and edema 25.00%), either isolated or associated, may be due to the fact that the population associates this medicinal species to its the symptomatic effects, directly contributing to increased use. In addition, the use of medicinal plants in snakebite accidents is related to habits, customs and popular beliefs, given mentioned participant justifications for not seeking medical attention, as they consider snakebites presenting only local symptomatology as low risk, or, alternatively, believe in the power of prayers, healer guidance, or relative and friend indications.

In addition, participant responses clearly indicate unawareness of the snake species (type, ophidian or toxicological action) and difficulty in accessing treatment, due to large distances between the accident site and the medical service location, thus increasing risks of complications or deaths.

Some study limitations are noted, such as difficulty in accessing rural area residences, with the accidents reported by the participants themselves, regardless of when they occurred. This leads to possible unreliability regarding reports and individual ability to remember details about snakebite events. The incidence of snakebites may also be underestimated due to the use of traditional medicine by injured individuals[61] and the fact that they did not seek out the local health service, either due to significant distances or disregard for the severity of the accident. Thus, the present study is complementary when dealing with cases of venomous animal accidents, many not notified to local health services, and phytotherapeutic treatment.

In this context, the results demonstrate that medicinal flora has been used as an alternative in the treatment of snakebite accidents in Alagoas backlands. However, this palliative measure does not exclude the urgent need for implementation of governmental and professional strategies regarding organization and structuring health care services, professional training and continuous educational actions aimed at the population, comprising, mainly, agricultural workers, in order to promote health and quality of life.

Although primary data were used in this study, it is important to report that due to its ethnobtotanic nature, its applicability was limited by its retrospective character, which is associated with a memory bias of the accident, adequate animal species recognition and plant species employed as an alternative treatment reported by participants.

CONCLUSION

Snakebites in the Alagoan hinterland were frequent, displaying typical and relevant epidemiological aspects, with medicinal flora as

an alternative used for the treatment of these accidents. However, this palliative measure does not exclude the urgent need to implement governmental and professional strategies with regard to the organization and structuring of health care services, professional training and continuous educational actions for the population, especially agricultural workers, regarding health promotion and quality of life.

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