

ORIGINAL ARTICLE

Accidents with fish during artisanal fishing in forest communities in the Western Amazon

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Abstract

Introduction: Amazonian fish have great socioeconomic importance due to their potential for sport fishing, commercial and subsistence uses. However, accidents caused by fish (ichthyism) are very common and are considered a public health problem that receives little attention by public health managers, and epidemiological data is considered underestimated due to the low demand for hospital care.

Objective: this research aimed to quantify and evaluate injuries related to fish during subsistence fishing activities in rivers, lakes and streams in forests in the state of Acre in the Western Brazilian Amazon.

Methods: 233 residents who practiced artisanal fishing in three protected areas were interviewed.

Results: among the fishermen interviewed, 155 (66.5%) reported having suffered at least one accident during this activity, 60.1% of whom were men. The majority of injuries were related to the ethnospecies known as “mandim” (*Pimelodus* spp.), with the fingers being the most affected region due to handling the fish while removing it from nets and hooks, resulting in pain, bleeding and hotness in the affected area in most cases.

Conclusion: the need to produce relevant information on injury prevention and care was observed, which are essential measures to promote the health and treatment of injured fishers.

Keywords: venomous fish, envenoming, fish injuries.

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Authors summary

Why was this study done?

A study previously carried out with a fishing colony located in the city of Cruzeiro do Sul, which has a history of accidents with fish, prompted us to study this morbidity in forest dwellers who live in communities further away from urban centers.

What did the researchers do and find?

We interviewed fishermen who carry out fishing activities in communities located in forests in the state of Acre and recorded that they have a high rate of injuries caused by fish and little demand for health services.

What do these findings mean?

Primary and secondary care are essential in order to promote the health and treatment of injured fishers. There must be guidance on prevention, first aid measures and the importance of medical care for the treatment of injuries.

Highlights

Accidents with fish are a common cause of morbidity in populations living in forests in conservation units in Acre during subsistence fishing activities. The main fish involved in accidents are mandis (*Pimelodus* spp.), stingrays (*Potamotrygon* spp. and *Paratrygon* spp.) and traíra (*Hoplias* cf. *malabaricus*), and most victims do not seek hospital medical care, contributing to the underreporting of this health problem.

INTRODUCTION

Brazil has the largest volume of fresh water in the world, most of which is concentrated in its Amazon region, which has many riverine communities along the riverbanks^{1,2}. These riverine inhabitants have a direct relationship with this environment and part of their sustenance comes from artisanal fishing in lakes, rivers and streams¹⁻³. Due to this close link between man and the environment, injuries caused by venomous and traumatogenic fish are important causes of morbidity and the temporary or permanent inability to perform daily activities, especially among fishers^{4,6}.

Envenomations in humans that are caused by venomous fish (either freshwater or marine) are frequently reported. However, these are mostly related to stingrays and catfish that use their stingers or spines to inoculate their toxins, which can cause tissue rupture and envenomations in humans^{4,6}. There are also traumatic injuries, which include bites from fish such as piranhas and traíras (*Hoplias* cf. *malabaricus*), or even electric eels that give off shocks^{4,6}. Other problems can occur such as the ingestion of poisonous fish or even those contaminated by bacteria, toxic plants or dangerous chemicals such as mercury^{4,6}.

Generally, people injured by fish usually seek health services only when the clinical condition is critical. In the case of the northern region of Brazil, this can be less likely since many of these cases usually occur in places far from urban centers, further reducing the possibility of victims seeking hospital medical care⁴⁻⁷. Thus, these limitations can contribute to the emergence of complications and sequelae in the victims^{8,9}. Moreover, the lack of information regarding the correct treatment of the injury tends to encourage the injured person to use alternative treatments, such as medicinal plants, in order to alleviate the symptoms of the injury and often inadequate first aid is performed^{6,10,11}. Considering the importance of this cause of morbidity, we present here the cases of injuries caused by fish during artisanal fishing and the first aid used by fishers in three conservation units located in the state of Acre.

METHODS

The research was developed in three conservation units in the state of Acre; these being the Chico Mendes Extractive Reserve (RESEX Chico Mendes), the Cazumbá Iracema Extractive Reserve (RESEX Cazumbá Iracema) and the Rio Gregório State Forest (FE Gregório) (figure 1).

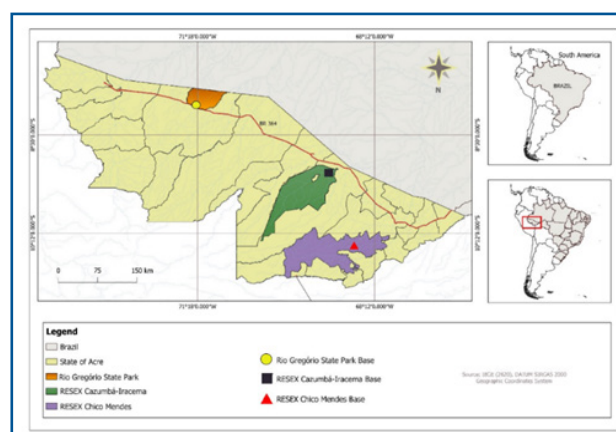


Figure 1: Location of study areas in three regions of the state

Study area I was the Seringal Dois Irmãos, which is part of the RESEX Chico Mendes. It was created by Decree N^o. 99,144, of March 12, 1990, and its lands, which have an area of 996,757 ha are distributed in seven municipalities of the state of Acre (Brasiléia, Epitaciolândia, Assis Brasil, Sena Madureira, Rio Branco, Capixaba and Xapuri)¹². The community where the research was carried out is part of the municipality of Xapuri, in the alto Acre region and has an area of approximately 8,500 ha. About 140 residents live in the community and their daily activities include extractivism, hunting and fishing for sustenance, along with agriculture and animal husbandry.

Study area II was the Cazumbá community, which is part of the RESEX Cazumbá-Iracema. RESEX Cazumbá-Iracema has an area of 750,794.70 ha and was created by decree on September 19, 2002. Its lands are distributed in two municipalities of the state of Acre, namely Sena Madureira (with 94% of the area) and Manoel Urbano (with 6% of the area). The community where the research was carried out is located in the municipality of Sena

Madureira, in the Caeté River basin, and has an area of 6,017.77 ha¹³. It has approximately 165 residents divided into 57 families, and the economy of the families is based on extractivism and family farming or a combination of the two, in addition to rearing small animals^{12,13}.

Study area III, on the other hand, was in FE Gregório, which is part of the Rio Gregório State Forest Complex (CFERG). CFERG has an area of approximately 216,062 ha and was created by Decree N°. 9718 of March 9, 2004. It is located in the municipality of Tarauacá, in the state of Acre¹⁴. According to Acre (2018)¹⁴, at FE Gregório, about 1,000 people live in houses that are on the banks of rivers and streams, in addition to near the BR-364 highway, where they carry out extractivism in the form of hunting, fishing, collecting wild fruits, removing wood for use within the community, in addition to farming and animal husbandry. The study was conducted however with the residents that live near to the BR-364 highway, which has a smaller number of residents.

The data collection period was between the months of August and October 2021. The study population comprised individuals older than 12 years of age who had been exposed to the risks of accidents with venomous or traumatogenic fish, due to subsistence fishing in the communities where they live.

The participants were randomly selected, observing only the inclusion criteria: being over 12 years old and being involved in fishing. The snowball sampling technique¹⁵ was applied during the research, whereby the interviewee provided information about other possible participants who performed the same activity in their community. The participants were subjected to a questionnaire about sociodemographic data, accidents caused by fish during fishing and the first aid performed at the time of the accident, in order to quantify and evaluate the injuries caused during this activity in the communities studied.

The concept of “ethnospecies”, according to Medeiros *et al.* (2016)¹⁶, was used in this research and corresponds to a living being framed at a terminal or subterminal level of a popular taxonomy, considering it as a synonym for “popular name”. For the taxonomic identification and correlation of popular fish names, Silvano *et al.* (2001)¹⁷, Queiroz *et al.* (2013)¹⁸, Jacó *et al.* (2020)¹⁹ were used as guides. The standard maximum measurements of the species (figure 2) followed Froese and Pauly (2023)²⁰.

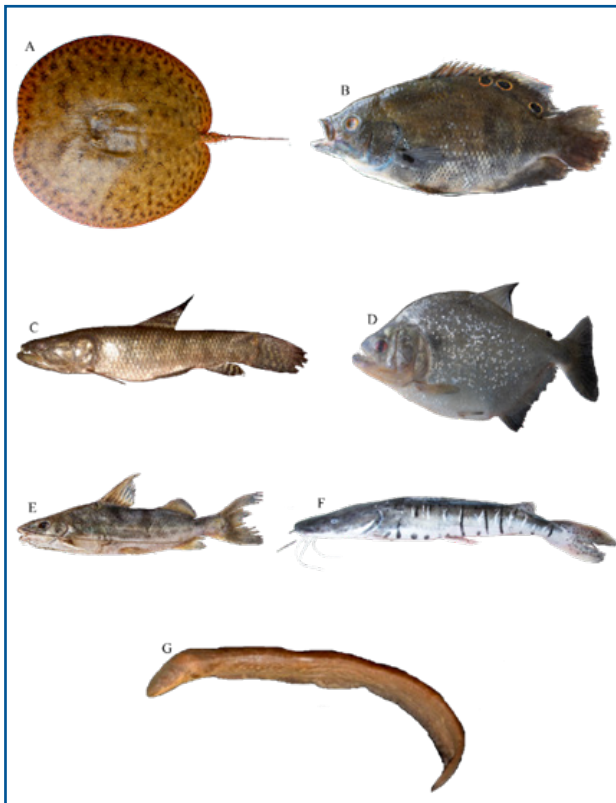
All ethical aspects were respected according to the recommendations of resolution 466/12 of the National Health Council. The project was approved by the Research Ethics Committee (CEP) of the Federal University of Acre (UFAC) under number 4,335,390. All the interviewees signed the informed consent form and, for those under 18, an informed assent form was supplied.

RESULTS

A total of 233 artisanal fishers were interviewed, which were distributed into 138 men (59.2%) and 95 women (40.8%), with 60 (25.8%) people between 23 and 33 years of age and an average of 36.7 years of age. Most of the participants were literate, making up 178 (76.8%) of the total; however, 109 (61.2%) participants reported having only been to elementary school. Of the 233 subsistence fishers interviewed, 155 (66.5%) reported having suffered at least one accident while fishing, with a total of 223 injuries being reported. Most cases were recorded in men (60.1% of accidents) with a mean age of 37 years. The artisanal fishers reported 10 ethnospecies of fish with the potential to cause injury (figure 2), which were classified according to their popular names in the region. Most of the lesions (57.8% of the reports) were caused by mandim (*Pimelodus* spp.), followed by stingrays (16.1%), traíras (10.8%) and other fish (15.3%) (table 1).

Table 1: Number of injuries per type of fish during artisanal fishing in three conservation units in the state of Acre

Fish (popular name)	Possible species	Total	%
Mandim	<i>Pimelodus</i> spp.	129	57.8
Surubim	<i>Pseudoplatytoma</i> spp.	6	2.7
Bico de pato	<i>Sorubim</i> lima	4	1.8
Barba chata	<i>Pinirampus</i> pinirampu	1	0.4
Capararí	<i>Pseudoplatytoma</i> tigrinum	1	0.4
Poraquê	<i>Electrophorus</i> spp.	10	4.5
Cará	<i>Astronotus</i> spp./ <i>Cichlasoma</i> amazonarum/ <i>Satanoperca</i> spp	1	0.4
Traíra	<i>Hoplias</i> cf <i>malabaricus</i>	24	10.8
Piranha	<i>Serrasalmus</i> spp. / <i>Pygocentron</i> nattereri	11	4.9
Arraia	<i>Potamotrygon</i> spp. / <i>Paratrygon</i> spp.	36	16.1
Total		223	100



The majority of respondents (72.2%) reported that injuries occurred when handling fish while removing them from nets and hooks etc. Other circumstances of the accidents occurred when stepping on the fish (21.8%), during diving to catch fish (4.2%) or while in the water (1.8%). In relation to the period of the day, 36.8% occurred in the morning, 45.7% in the afternoon and 17.7% at night.

The upper limbs corresponded to the principal anatomical region affected, with 73.5% of the lesions recorded. These were caused by almost all the fish species recorded in this research, with the exception of caparari (*Pseudoplatytoma tigrinum*) and stingrays (*Potamotrigon* spp. and *Paratrygon* spp.) (table 2). The rest of the injuries occurred in the lower limbs, and most of these (62.7%) were caused by stingrays, mandim, surubim and bico-de-pato, affecting anatomical regions such as the foot, ankle and heel (table 2).

Figure 2: Photos of some of the main fish species responsible for accidents during artisanal fishing
 A) *Paratrygon aiereba*, 800 mm TL; B) *Astronotus* sp., 457 mm TL; C) *Hoplias* cf. *malabaricus*, 650 TL; D) *Serrasalmus rhombeus*, 415 mm TL; E) *Pimelodus blochii*, 350 mm TL; F) *Pseudoplatystoma fasciatum*, 1,050 mm TL; G) *Electrophorus* sp. 2,500 mm TL.
 Photographs: A = Aerison Nogueira Freire; B – G = Tiago Ricardo Fernandes Jacó.

Table 2: Anatomical region of the body affected in accidents caused by fish during artisanal fishing in three conservation units in the state of Acre

Fish (popular name)	Anatomical region	Total	%
	Fingers	104	46.6
Mandim	Hand	13	5.8
	Foot	11	4.9
	Calf	1	0.4
	Foot	29	13.0
Arraia	Calf	3	1.3
	Ankle	3	1.3
	Heel	1	0.4
Traíra	Fingers	18	8.1
	Hand	6	2.7
Piranha	Hand	9	4.0
	Fingers	2	0.9
	Thigh	4	1.8
Poraquê	Arm	2	0.9
	Shin	2	0.9
	Hand	2	0.9
	Hand	3	1.3
Surubim	Arm	1	0.4
	Foot	1	0.4
	Thigh	1	0.4
Bico de pato	Hand	2	0.9
	Foot	2	0.9
Cara	Hand	1	0.4
Barba chata	Hand	1	0.4
Caparari	Thigh	1	0.4
Total		223	100

The fishers reported signs and symptoms such as local pain (92.8%), hemorrhage (35.4%), heat in the affected area (20.2%), edema (17.5%), erythema (12.5%), fever (9.0%), local paresthesia (3.6%), necrosis (2.7%) and electric shock (1.35%) as a result of the accident. Among the injured, only 8 (5.2%) sought a hospital for medical treatment after injuries caused by stingrays (7 cases; 87.5%) and surubim (1 case; 12.5%).

According to what was reported, 56.1% of the fishers interviewed used alternative treatments to alleviate the signs and symptoms, as well as to treat complications resulting from the accident. Of those that

used drugs, 15.2% used dipyron and 8.8% paracetamol. The application of the mucus from the fish's eye at the site of the injury to relieve pain was used by 4% of those injured by mandim (*Pimelodus spp.*). On the other hand, the smoke from a burning termite mound was used to treat the injured region by 8% and the application of condensed milk was used by 3.2% of those involved in accidents with stingrays (*Potamotrigon spp.* and *Paratrygon spp.*). In addition, 3.2% of respondents used thiomersal to treat injuries caused by traíra (*Hoplias cf. malabaricus*) (table 3).

Table 3: Alternative treatments used and type of fish that caused the accident during artisanal fishing in three conservation units in the state of Acre

Fish (popular name)	Treatment used	Total	%
Arraia	Smoke from a burning termite mound	10	8
	Ground coffee	3	2.4
	Condensed milk	4	3.2
	Grated avocado stones	1	0.8
	Warm iron (at the site)	1	0.8
	Brazil nut porridge (<i>Bertholletia excelsa</i>) (at the site)	2	1.6
	Bitter coffee	1	0.8
	Balsam (<i>Sedum dendroideum</i>)	1	0.8
	Copaiba (<i>Copaifera langsdorffii</i>) oil	2	1.6
	Paracetamol	6	4.8
	Metamizole	6	4.8
	Benzathine benzylpenicillin	2	1.6
	Penicillin	1	0.8
	Oxytetracycline	1	0.8
	Rifamycin	1	0.8
	Barba chata	Dipyron	1
Bico de pato	Paracetamol	2	1.6
	Metamizole	1	0.8
Mandim	Cooking salt	2	1.6
	Lard (fat) from a manatee (<i>Trichechus inunguis</i> Natt.)	1	0.8
	Mucus from the eye of the mandim	5	4.0
	Brazil nut milk (<i>Bertholletia excelsa</i>)	2	1.6
	Juice (sap) of the leaf of the purple cotton plant	2	1.6
	Grated cassava root	1	0.8
	Armadillo fat	1	0.8
	Armadillo fat	1	0.8
	Paracetamol	11	8.8
	Dipyron	19	15.2
	Metamizole	9	7.2
	Meloxicam	10	8
Piranha	Oxytetracycline	1	0.8
Surubim	Paracetamol	1	0.8
	Benzathine benzylpenicillin	1	0.8
Traíra	Lard (fat) from a manatee (<i>Trichechus inunguis</i> Natt.)	1	0.8
	Alcohol (for cleaning)	7	5.6
	Thiomersal	4	3.2
	Meloxicam + Metamizole	1	0.8
Total		125	100

DISCUSSION

Accidents involving fish were routine at the study site and were reported by 66.5% of the interviewees. This indicates to what extent accidents with fish are a cause of morbidity for populations that carry out subsistence or artisanal fishing^{2,6,10,21}. The predominance of injuries in men reflects how artisanal fishing is a predominantly male activity, as it requires physical strength and, as was observed in this study, women are employed on a smaller scale in this activity, exercising for the most part, activities related to the repair of materials used during fishing or in the preparation of fish for family meals^{5,6,21-23}. However, in the northeastern region of the country, when it comes to professional fishers, there is a considerable number of women working in this activity²⁴. The fishers of the communities studied have a low level of education, since most have incomplete primary education (56.8%) and 35.5% are illiterate, which is corroborated by other studies^{6,21,22}.

The cases of accidents with injuries involved species of mandis (57.8%), stingrays (16.1%), traíras (10.8%) and piranhas (4.9%) These results are similar to the reports of artisanal fishers from the middle Araguaia River region in Tocantins state²⁵ and in the Alto Juruá region in Acre⁶. Lesions resulting from mandis (*Pimelodus* spp.) were the most frequent, corresponding to more than 50% of cases, and some interviewees reported having been injured on several occasions by this fish. This was followed by stingrays (*Potamotrygon* spp. and *Paratrygon* spp.), and this is similar to what was observed by Costa *et al.* (2020)⁶ for the Vale do Alto Juruá region, also in Acre.

Mandis can cause envenomations through the spines located on the lateral and dorsal fins that, like the stinger of stingrays, contain tissues that produces toxins that are responsible for an intense inflammatory reaction, which mainly causes pain and edema^{4,6}. Sarmiento *et al.* (2015)²⁶ identified that, in addition to these symptoms, the venom of some mandis, such as *Pimelodus maculatus*, can induce muscle fiber injury due to increased serum creatine kinase (CK) concentrations.

Stingrays, the second most cited fish for being responsible for injuries in this study, can cause envenomations through their stingers, which have venom-secreting glands. These injuries generally present greater severity and are reported to cause severe pain and can evolve to necrosis⁴. The proteolytic activity of stingray envenomations was investigated by Lameiras *et al.* (2014)²⁷ in animal models, and the venom of *Potamotrygonidae* such as *Potamotrygon motoro* induced rhabdomyolysis and, consequently, necrosis in mice. Pain and bleeding have been reported in most cases and may result from severe injuries, as evidenced in other studies^{6,11}. The appearance of ulcers can occur in the subsequent stages of envenomation². In the study by Costa *et al.* (2021)²³, some cases with ulcers, involving the species *P. motoro*, required a recovery time of up to six months. Depending on the clinical evolution, anatomical region or organ affected, some accidents can be considered serious; there are reports of hemopneumothorax caused by a sting to the thorax²⁸ and vascular lesions in the great saphenous vein²⁹, and in both cases they may progress to death.

The third and fourth species most cited in the study were the traíra (*Hoplias cf. malabaricus*) and the piranhas (*Pygocentron nattereri* and *Serrasalmus* spp.), which can cause major injuries through their bites^{4,6}. These fish species are considered traumatogenic since they have teeth that are adapted to capture their prey, but they can be used for defense and cause crater-shaped lesions and heavy bleeding^{4,10}. Moreira and Haddad Jr. (2021)²⁴ reported a case of an accident with a piranha in which the victim presented a crater-like lesion in the calcaneal region. Health care was performed; however, the wound was covered with an inadequate bandage, evidencing that many health professionals are inadequately trained to take care of these types of cases.

Also noteworthy in this study is the report of seven people who had accidents with electric eels (*Electrophorus* spp.), which, depending on the species, can measure over 2m in length and emit electrical discharges of up to more than 500 volts, and is capable of killing human beings through paralysis and subsequent drowning⁴. Catânia (2017)³⁰ described an experiment in humans with shocks caused by a small *Electrophorus electricus* and it was found that the electrical discharges delivered reached a peak of up to 50 mA, exceeding the activation limits of nociceptors reported for humans and horses.

Most of the accidents occurred during the afternoon (45.7%), which is the main period of fishing activity according to the interviewees. These results were also observed by Costa *et al.* (2020)⁶ in work carried out with fishers from the Vale do Juruá region in the state of Acre.

Fishers suffered most of the injuries to the upper limbs (73.5%), with more injuries to the fingers (55.6%). This converges with the findings of Freitas and Rodrigues (2015)²¹ in their study with artisanal fishers, in which they observed that more than 65% of the injuries occurred in the upper limbs. However, this observation differs from other studies involving traumatogenic and venomous fish^{6,7,11}, in which the anatomical region most affected was the lower limbs.

Pain was the most reported symptom in both traumatogenic accidents and envenomations. In envenomations, it can have mild, moderate or severe intensity, the latter being reported as unbearable³¹.

It was observed that the majority (94.8%) of the interviewees did not seek hospital medical care, thus contributing to the existence of a high rate of underreporting of these cases in the Information System of Notifiable Diseases (SINAN) of the Brazilian Unified Health System, a situation also reported in other studies^{6,23,32}. It is essential that the victim is referred to a health unit to perform wound cleaning and surgical extraction of possible fragments of spines and parts of stingers that are lodged in the wound. There is a need for the use of preventive antibiotic therapy against secondary infection, analgesia in cases of severe pain, and the evaluation of the vaccination situation in regard to immunization against tetanus^{4,24,33}.

In the present study, the use of several types of treatment for lesions was reported, and the smoke from a burning termite mound was the most used, which was also observed by other authors in the Amazon^{6,34}. It is important to highlight the high use of medicines by the

victims; however, Silva *et al.* (2020)³², in another region of the state, observed the predominance of the use of medicinal plants. Among the measures adopted, the use of the mucus of the mandim's eye in the affected region was reported to relieve the pain after perforation by the fish. A similar finding was reported by Prado (2017)³⁵ in a study conducted in the state of São Paulo. In the state of Mato Grosso do Sul, there are also reports of the use of herbal medicines by fishers, in addition to harmful practices such as the application of urine on the site of the wound, a procedure that can aggravate the injury³⁶. Silva *et al.* (2010)³⁷ reported the use of fish parts (eyes and viscera) or other substances (mud, leaves, sand, urine and termite pupae) in an attempt to relieve symptoms. Costa *et al.* (2021)²³ report the use of other methods in stingray envenomations, ranging from the use of breast milk to human feces. Such behavior represents a risk and increasing the chances of secondary infections and even contribute to the victim not seeking hospital care. There were no reports of the use of warm water in accidents with stingrays, which is the correct emergency treatment procedure, as it is proven that immersion of the injured site in warm water (approximately 50°C) for 30 to 90 minutes decreases pain²⁴.

Performing first aid in a wrong manner and the lack of hospital care can favor the emergence of more serious complications or sequelae^{6,34}. Nonetheless, these popular remedies are used as a way to alleviate the symptoms at the time of the injuries, and evidence the lack of knowledge of the victims about the possible harmful effects of some of the substances used³⁷. However, the use of natural medicinal resources has great relevance in populations with limited access to health care services³⁴.

It is important to emphasize that these populations do not have access to information regarding the prevention of accidents with aquatic animals. There are few studies in the literature that focus on this subject, and there are no studies on this subject in relation to the region studied. One of the few studies published in the literature was carried out by Edilson *et al.* (2015)³⁶, in which the level of knowledge of fishers from the state of Mato Grosso do Sul regarding this topic was evaluated. Their results indicate that only 10% of respondents said they knew some type of preventive measure for these accidents. This is a worrying fact that highlights the neglect in health education for this sector of the public.

CONCLUSION

The results found in our research indicate that there is a high morbidity rate caused by fish. In the envenomations by venomous fish, mandis and stingrays predominate and, when it comes to traumatogenic injuries, most are caused by traíras.

Seeking health care services after an accident with a fish is a conduct that occurs rarely, and there is a preference for self-medication or the use of alternative home-made

treatments, most without scientific proof and which can be sometimes harmful to the victim. This can lead to serious damage and bring about a poor prognosis in some cases.

Primary and secondary care are essential in order to promote the health and treatment of injured fishers. There must be guidance on prevention, first aid measures and the importance of medical care for the treatment of injuries. Therefore, measures should be taken such as the development of more research on this topic and the creation of public health policies by the government that improve the notification of cases and access to information for the population so as to reduce the risks of these cases.

Author Contributions

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Conflicts of Interest

the authors report on conflict of interest.

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Resumo

Introdução: os peixes da Amazônia possuem grande importância socioeconômica devido ao seu potencial para pesca esportiva, usos comerciais e de subsistência. Contudo, os acidentes com peixes são bem comuns e considerados um problema de saúde pública pouco observado pelos gestores públicos, sendo os dados epidemiológicos considerados subestimados devido à pouca procura do atendimento hospitalar.

Objetivo: essa pesquisa teve por objetivo quantificar e avaliar as injúrias relacionadas aos peixes durante a atividade de pesca de subsistência em rios, lagos e igarapés em florestas do estado do Acre no oeste da Amazônia brasileira.

Método: foram entrevistados 233 moradores que praticam a pesca artesanal em três unidades de conservação.

Resultados: Entre os pescadores entrevistados, 155 (66.5%) relataram ter sofrido pelo menos um acidente durante essa atividade, sendo 60.1% destes homens. A maioria das lesões estava relacionada à etnoespécie mandim (*Pimelodus spp.*), tendo os dedos da mão como a região mais acometida devido ao manuseio do peixe enquanto o removiam do equipamento de pesca, resultando em dor, sangramento e queimadura local na maioria dos casos.

Conclusão: foi observado a necessidade de produção de informações relevantes sobre a prevenção e cuidados de lesões, que são medidas essenciais para promover a saúde e o tratamento dos pescadores feridos.

Palavras-chave: peixes peçonhentos, envenenamentos, peixes traumatogênicos, injúrias com peixes, pesca artesanal.

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