saúde
EM DEBATE

ORIGINAL ARTICLE

Socio-environmental and psychosocial impacts caused by oil spills on Artisanal Fisherwomen and Fishermen

Impactos socioambientais e psicossociais causados por derramamento de petróleo em Pescadores e Pescadoras Artesanais

Luiz Rons Caúla Silva[1], Vanira Matos Pessoa[2], Antônio Jeovah de Andrade Meireles[1]

DOI: 10.1590/2358-28982024E18513I

ABSTRACT In August 2019, eleven Brazilian states were hit by an extensive oil spill. In this context: what are the main socio-environmental and psychosocial impacts caused by the oil spill on the lives of families and individuals who make their living from artisanal fishing? This is a research with mixed methods that used the following techniques: focus group and application of forms developed in a participatory manner with communities at the mouth of the Jaguaribe River, Ceará, and applied between July and August 2020. Its application was selected from a non-probabilistic sampling of the intentional type by judgment and was processed with the support of the IBM Statistical Package for Social Sciences (SPSS) software. The results indicate environmental impacts, such as: finding oil in the river and in animals; direct human exposure to oil; health symptoms after exposure; psychological effects; consumption of food resources such as fish and shellfish; and reduction in the income of Artisanal Fishermen and Fisherwomen. That way, it is understood that the lives, environment, health, and work of these populations were aggravated, especially those of socioeconomic, food and water security, and health orders.

KEYWORDS Oil pollution. Environmental health. Mental health. Occupational health. Coastal zone.

RESUMO *Em agosto de 2019, 11 estados brasileiros foram atingidos por um extenso derramamento de petróleo. Nesse contexto, quais os principais impactos socioambientais e psicossociais causados pelo derramamento de petróleo na vida de famílias e indivíduos que vivem da pesca artesanal? Trata-se de uma pesquisa com métodos mistos que utilizou como técnicas: grupo focal e aplicação de formulários desenvolvidos de forma participativa com comunidades da foz do rio Jaguaribe, Ceará, e efetuados entre julho e agosto de 2020. Sua aplicação foi selecionada a partir de uma amostragem não probabilística do tipo intencional por julgamento, cujos dados foram processados com o suporte do software IBM Statistical Package for Social Sciences (SPSS). Os resultados indicam impactos ambientais, como: presença de óleo no rio e em animais; exposição humana direta ao petróleo; sintomas na saúde após exposição; efeitos psicológicos; consumo de recursos alimentares como peixes e crustáceos; e redução da renda dos Pescadores e Pescadoras Artesanais. Assim, compreende-se que a vida, o ambiente, a saúde e o trabalho dessas populações foram agravados, principalmente aqueles de ordens socioeconômicas, de segurança alimentar e hídrica e de saúde.*

PALAVRAS-CHAVE *Poluição por óleo. Saúde ambiental. Saúde mental. Saúde do trabalhador. Zona costeira.*

[1] Universidade Federal do Ceará (UFC) – Fortaleza (CE), Brasil.
luizronscs@gmail.com

[2] Fundação Oswaldo Cruz no Ceará (Fiocruz Ceará) – Eusébio (CE), Brasil.

This article is published in Open Access under the Creative Commons Attribution license, which allows use, distribution, and reproduction in any medium, without restrictions, as long as the original work is correctly cited.

Introduction

In 1930, Brazil began to invest in the petrochemical chain, from the extraction and refining of oil to the manufacture of products and derivatives, occupying, in 2017, the seventh largest oil derivatives market worldwide, with 18 refineries currently installed in the Southeast, (56%), Northeast (23%) and South (19%) regions[1,2]. However, the intense exploitation of this fossil fuel has caused several crimes and disasters around the world, mainly due to leaks and spills of crude oil that result in environmental degradation, in situations of conflict and environmental injustice[3]. Previous disasters, such as the one that occurred in the Gulf of Mexico in 2010, had significant negative impacts on society and nature, such as damage to human health, productive activities and the contamination of several other living beings, ecosystems and environmental resources, such as air, water and soil[4].

In this context, it is essential that the oil industry seek to minimize the impacts of its activities and prevent accidents, observing the precautionary principle through an interdisciplinary dimension that encompasses the environment, health, work, safety and human rights and that integrates the Sustainable Development Goals (SDGs). Thus, it is understood that socio-environmental disasters involving oil spills need to be investigated and characterized, particularly to outline prevention, monitoring and mitigation strategies.

In August 2019, the Brazilian coast was hit by an oil spill that affected 1,009 locations[5]. When these events occur in aquatic ecosystems, such as seas and rivers, various activities, for instance, tourism, hotels, navigation and fishing, can be directly affected, as well as coastal environments, such as mangrove ecosystems, which are crucial in the provision of ecosystem goods and services; in addition to traditional communities – such as Artisanal Fishermen and Fisherwomen (AFF) and shellfish gatherers – who absorb the damage from the impacts to a greater extent. In the latter case, the violation of the human rights of these populations is recurrent, which contributes to its different consequences on health and work, making it necessary to fight the policy of hiding the impacts of the development model to reduce the vulnerability of these affected populations[6].

According to Magris and Giarrizzo[7], around 500,000 AFF may have been seriously affected by this oil spill. It is in the Northeast region where fishing prevails in the country and the activity concerns an average of 4.5% of the total population of the municipalities[8]. In the state of Ceará, in 2014, there were 38,000 registered fishermen/fisherwomen, distributed across 26 municipalities[9]. According to the Brazilian Institute for the Environment and Renewable Natural Resources (IBAMA), around 40 tons of oil were collected on the beaches of Ceará[5].

When thinking about that, it is understood that the environmental disaster that occurred on the Brazilian coast in 2019 affected the life, health, environment and work of AFF who reside in the coastal zone. In this context, the question was: 'What are the main socio-environmental and psychosocial impacts caused by the oil spill on the lives of families and individuals who make a living from artisanal fishing in the mouth of the Jaguaribe River, Ceará?'. This research analyzed the effects of the oil spill on the life, health, environment and work of this population.

Methodology

Research type and ethical aspects

The method used in this research was the mixed study. According to Johnson et al.[10(11)],

"mixed methods must include quantitative and qualitative perspectives when examining the same research question". Thus, a qualitative study can generate questions to be expanded quantitatively and vice versa[11]. Moreover, this is a descriptive research with a cross-sectional time frame. According to Mattos[12], the objective of descriptive research is to obtain more knowledge of the studied phenomenon through the interpretation of the environment and the study subjects.

It is noteworthy that this research is the result of a Master's degree dissertation, without conflict of interests, and was developed within the parameters contained in Resolution N. 510, of April 7, 2016, of the National Health Council. Furthermore, this is a study that comprises the research project 'Production of indicators for the assessment of families' living conditions and access to primary care services in the coastal and backcountry territories of Ceará and Rio Grande do Norte', approved by the Research Ethics Committee of the School of Public Health of Ceará, under Certificate of Presentation of Ethical Appreciation – CAAE number 07802419.2.0000.5037 and substantiated Opinion number 3,372,478.

Research area and participants

The study area is located in the Baixo Jaguaribe sub-basin, the east coast of the state of Ceará, northeastern Brazil (*figure 1*). Jaguaribe River is one of the main water sources in Ceará, being approximately 630 km long. Its estuary is located between the municipalities of Fortim and Aracati. It is a river-marine system that was affected by oil slicks in its lower course, and pollution control measures were installed, such as containment barriers at the mouth of this river[13].

Figure 1. Study area: Jaguaribe River estuary, 2021

Source: The authors (research data). Google Earth Image (2021).

In this context, AFF from rural fishing communities who live and work in the mouth of the Jaguaribe River participated in this research. In addition to being an area affected by the oil spills, this choice also occurred considering the demands of popular movements and entities in this region, such as the National Articulation of Fisherwomen (ANP) and the Pastoral Council of Fishermen (CPP), to carry out health and environmental studies of the rural and water populations, in addition to expanding the research about the consequences of the environmental disaster on the lives of the AFF.

Qualitative axis: collection, sampling, data analysis and ethical aspects

The qualitative stage was responsible for expanding the study topic in the context of the work of artisanal fishermen/fisherwomen. We sought to understand the subjective production of these actors regarding the consequences of the disaster. The production of qualitative data involved fieldwork through the development of the Focus Group (FG) as a collection technique, in which the researcher played the role of mediator in conducting the dialogue.

A script was adopted with the following questions: what are the consequences of the oil spill on your lives? Did the sale of fish decrease as a result of the oil spill? Have you seen oil or any other signs of contamination on the beaches? And on animals? Have your communities been affected? Are the municipal secretariats and public authorities talking to you? And what have they done to control and improve the situation? Do you think that exposure to the oil can cause damage to your health? What are you doing to face this emergency?

The FG took place in November 2019, a period in which the appearance of oil slicks on the beaches was still recurring. Nine shellfish gatherers participated in the FG; all signed the Free and Informed Consent Form (TCLE).

The information from the FG was recorded and later transcribed and submitted to computer-assisted qualitative data analysis software, the Interface de R pour les Analyses Multidimensionnelles de Textes et de Questionnaires (IRaMuTeQ). The set of information in this file is called *corpus*, which consists of several text segments, that is, sections of the *corpus* sized by the software that comprehend, in most cases, the size of three lines[14].

The *corpus* was configured by reading and reviewing the entire transcription, retextualizing and correcting typing, punctuation and vocabulary errors; standardization of acronyms; and joining of compound words using the underline character, for example, the term "*rio_jaguaribe*"[14]. The interpretative analysis of the FG data was carried out through analysis of the shellfish gatherers' speeches, which are represented by the text segments that emerged from the textual *corpus*.

Quantitative axis: collection, sampling and data analysis

Based on the results obtained with the scientific data collected in the FG and with the participation of popular movements and entities, a form called 'Quick diagnosis of exposure to oil and the relationship with the health and environment of artisanal fishermen/fisherwomen' was created, which collected primary data and identified the main impacts and implications caused by the environmental disaster on the environment, health and work of the AFF. The collection took place between June and August 2020. Moreover, as the intention of applying this form was to provide a photograph of the effects caused by the disaster, it was decided to ask some questions specifying the months from August to December 2019, the period in which the highest official records of oil presence on the beaches occurred[5].

In this research, the sample of the AFF population was selected from a non-probabilistic sampling of the intentional type by judgment, which is one whose population that will comprise the sample depends on the researcher's judgment. It should be noted that, due to the

uncertainties caused by the COVID-19 pandemic and the type of sampling chosen, the application of the forms was carried out with the help of fishing community leaders. In this sense, it is common to choose experts when it comes to judgment samples[15].

Using descriptive statistics, a discussion was carried out, as well as data analysis of the AFF responses. Mainly, absolute frequencies (*f*), relative frequencies (%) and their respective valid percentages were used, that is, the relative frequencies eliminating missing values when present; in addition to measures of central tendency and dispersion of responses. For analysis purposes, throughout the application of the forms, certain interviewees did not want to answer some questions. For these cases, there was the option 'Didn't Want to Answer (DWA)' to facilitate data analysis and avoid excluding actors and questions from the research. The selected data were processed with the aid of the IBM Statistical Package for Social Sciences (SPSS) software and represented by graphs and tables.

Results and discussion

In this section, the analysis of the results will be presented, related to a sample (n) of 89 AFF based on descriptive statistics, aiming to identify and understand the effects caused by the environmental disaster involving the oil spill on the lives of these workers and of their families. Moreover, the speeches of the shellfish gatherers who participated in the FG were also considered as a way of dialoging with the quantitative results. In this study, artisanal fishing was considered a common job for all interviewees.

Description of the participants' demographic aspects

Regarding the marital status, 45 subjects are married (50.56%), 27 are single (30.34%), 6 are divorced (6.74%), 3 are widowed (3.37%) and 8 did not want to answer (8.98%). Regarding the gender variable, of the total number of participants, only 5 were male fishermen (5.6%) and 84 were artisanal fisherwomen/female shellfish gatherers (94.4%). It can be observed that the participation of artisanal fisherwomen comprised almost all of the participants, which corroborates the study by Won et al.[16(23)] when they stated that

> [...] Women and children are more vulnerable to environmental disasters, and careful attention is required to minimize the specific impact on them in the disaster recovery process.

Regarding age, it was found that the average (n = 83) was approximately 44 years (± 12.2), with a median of 43, a minimum age of 19 and a maximum of 74 years. Moreover, it was observed that the participants' age range was concentrated on adult workers aged 30 to 55 years. Since the 1960s, there has been a reduction in the number of children of fishermen/ fisherwomen willing to remain in this activity mainly due to economic reasons[17]. According to Cardoso and Doula[18(5)], "the fragility of interconnected public policies limits income generation, the protection of natural resources and the socioeconomic development of families, factors that affect the future expectations of young resident fishermen and fisherwomen", i.e., it is observed that environmental disasters can further compromise the continuity of traditional activities, such as fishing.

Furthermore, it was possible to identify in *table 1* that the research participants reside in the following fishing communities close to the mouth of the Jaguaribe River: Guajiru, Volta, Jardim and Pontal do Maceió in Fortim; in addition to Sítio Canavieira and Quilombo do Cumbe in Aracati. It should be noted that the data in *table 1*, and the other tables in this article (*tables 2 to 5*) are available for viewing in the Open Science Framework Platform repository, under Digital Object Identifier – DOI: https://doi.org/10.17605/OSF.IO/TV8DB.

Table 1. Distribution by communities of participants, 2020

Variables	f	%
Communities (n = 89)		
Jardim	23	25.8
Volta	20	22.5
Quilombo do Cumbe	18	20.2
Guajiru	17	19.1
Sítio Canavieira	10	11.2
Pontal do Maceió	1	1.1

Source: Prepared by the authors.
n: absolute sample; f: absolute frequency; %: relative frequency.

Exposure of artisanal fishermen and fisherwomen to crude oil: a look at the environment, health and work

The question was whether the AFF saw oil traces or slicks in their municipality. Of the 89 respondents, 78 said yes (87.65%), 8 said no (9%) and 3 did not want to answer (3.37%) (*table 2*). According to a shellfish gatherer from the FG:

> *the day I saw the oil I spoke to the health department and they said we had to have sent for them and had to have other people to confirm [...].*

In March 2020, it was still possible to find oil traces/residue in some Brazilian locations, such as the Pojuca River in Bahia[5]. In other words, seven months after the start of the disaster, som e communities were still suffering from the impacts of the oil spill. Moreover, in the same month, the period of social isolation started in Brazil due to the COVID-19 pandemic, which led the FFA to suffer, disproportionately, social, economic and psychological losses on an ongoing basis, as the disasters – of a chemical and biological nature – met.

Table 2. Frequencies of the presence of oil slicks according to the month of occurrence, the environments and affected animals, 2020

Variables	f	%
Have you seen oil slicks in your municipality? (n = 89)		
Yes	78	87.6
No	8	9
Does not know	3	3.4
Month in which you saw oil slicks or residue in your community (n = 78)		
August 2019?		
Yes	28	35.9
No	48	61.5
DWA	2	2.6

Table 2. Frequencies of the presence of oil slicks according to the month of occurrence, the environments and affected animals, 2020

Variables	***f***	**%**
September 2019?		
Yes	29	37.2
No	47	60.3
DWA	2	2.6
October 2019?		
Yes	25	31.1
No	51	65.4
DWA	2	2.6
November 2019?		
Yes	10	12.8
No	66	84.6
DWA	2	2.6
December 2019?		
Yes	8	10.3
No	68	87.2
DWA	2	2.6
Where did you see oil slicks or residue? (n = 78)		
On the beach sand?		
Yes	39	50
No	39	50
In the sea?		
Yes	5	6.4
No	73	93.6
In Jaguaribe River?		
Yes	44	56.4
No	34	43.6
In the mangrove forest?		
Yes	10	12.8
No	68	87.2
On rocky shores?		
Yes	1	1.3
No	77	98.7
On sandstone reefs?		
Yes	1	1.3
No	77	98.7
Did you see any animals affected or killed by oil??		
Yes	68	76.4
No	12	13.5
DWA	9	10.1

Table 2. Frequencies of the presence of oil slicks according to the month of occurrence, the environments and affected animals, 2020

Variables	*f*	%
Animals affected or killed by the oil (n = 68)		
Only fish	30	44.1
Only turtles	8	11.8
Turtles, fish and shellfish	7	10.3
Only shellfish	2	2.9
Fish and shellfish	2	2.9
Turtles and fish	1	1.5
DWA	18	26.5

Source: The authors.
n: absolute sample; f: absolute frequency; %: relative frequency; DWA: Didn't Want to Answer.

The 87.6% who identified the presence of oil were asked which month and in which ecosystem that occurred. The months of September, August and October 2019 were the most frequent ones, being mentioned 29, 28 and 25 times respectively (*table 2*). Two shellfish gatherers claimed to have seen oil but did not want to answer in which month that occurred. Furthermore, the Jaguaribe River (56.4%), the beach sands (50%) and the mangrove (12.8%) were the environments in which the oil slicks and traces were most often verified by the AFF (*table 2*). According to the FG shellfish gatherers: "*our beach has and had found traces of oil*". It is emphasized that some interviewees observed oil in more than one of the environments and months listed in *table 2*.

In addition to the affected ecosystems, 68 participants answered they also saw animals affected or killed by the oil spill (76.4%). The most frequently mentioned fauna species were fish and turtles, in addition to shellfish used to feed the families and in local commerce (*table 2*). In Brazil, according to IBAMA, 159 oiled animals were found, of which 112 died[5]. The sea turtle was the most affected animal, with 105 occurrences, and Bahia was the state with the most records[5].

As for human exposure to oil, 63 interviewees came into direct contact with it (70.8%) (*table 3*); 58 came into contact while fishing (92.1%); 10, cleaning up the oil on the beaches (15.9%); and 4, during leisure time, for example, while bathing in the sea or river (6.3%) (*table 3*). It is observed that the main exposure situation was while working. It should be noted that there were AFF who were exposed to the oil while performing more than one activity, such as fishing and cleaning the beach.

According to Pena et al.[19], the confusing official communication characterized by the government's disorganization regarding, for example, the water quality for swimming of the beaches, the consumption of fish and precautionary and preventive behaviors led to widespread voluntarism, which mobilized thousands of unprotected people to remove the oil, aiming to defend their territories, such as AFF without knowledge of the risks. Thus, it is understood that, in the coastal zone, in environmental disasters involving oil spills, there is a high risk of chemical exposure of artisanal fishing workers and their families, such as children playing on the beach during leisure time and fishermen/fisherwomen during volunteering actions and during fishing.

Table 3. Frequencies of direct exposure to the oil among artisanal fisherwomen and fishermen, main related activities and number of times and time in hours/day, 2020

Variables	*f*	%
Did you come in direct contact with the oil? (n = 89)		
Yes	63	70.8
No	23	25.8
DWA	3	3.4
Did you come into contact with the oil while fishing? (n = 63)		
Yes	58	92.1
No	5	7.9
Did you come into contact with oil while helping to clean up the beaches? (n = 63)		
Yes	10	15.9
No	53	84.1
Did you come into contact with the oil while enjoying your leisure time at the beach or river? (n = 63)		
Yes	4	6.3
No	59	93.7
How many times did you come into contact with the oil? (n = 63)		
Only once	11	17.5
2 to 5 times	16	25.4
6 to 10 times	14	22.2
More than 10 times	9	14.3
If exposed, how long were you in direct contact with the oil? (hours/day)? (n = 63)		
1 hour	6	9.5
2 hours	22	34.9
3 hours	10	15.9
4 hours	4	6.3
More than 4 hours	5	7.9
Does not know	16	25.4

Source: The authors.
n: absolute sample; f: absolute frequency; %: relative frequency; DWA: Didn't Want to Answer.

It is evident that, of the 63 AFF that came directly into contact with the oil, 11 were exposed to contact only once (17.5%); 16, two to five times (25.4%); 14, 6 to 10 times (22.2%); 9, more than 10 times (14.3%); and 13 did not know how to answer about the number of times (20.6%) (*table 3*). The exposure time also stands out, which, for the majority of the participants, ranged between two hours a day (34.9%) and three hours a day (15.9%) (*table 3*).

In this context, attention is drawn to two fishing communities in Volta and Guajiru, since all AFF answered that they were directly exposed to the oil (100%) (*table 4*). In the community of Jardim and Cumbe, human contact with the oil was less frequent, but with significant results of AFF directly exposed to the oil (*table 4*). Moreover, according to the frequency of responses, it was observed that, in Sítio Canavieira, none of the interviewees was directly exposed. It is worth noting that only one interviewee from Pontal do Maceió community answered the form, and according to their information, they were directly exposed to the oil; however, as this is just one individual, it should be noted that these data are not representative of the community but indicate that there is at least one person from that community who was exposed to the oil.

Table 4. Frequency of the main symptoms, health effects and demand for health services by artisanal fishermen and fisherwomen exposed to the oil, 2020

Variables	*f*	%
Got in contact with the oil (n = 89)		
Guajirú (n = 17)		
Yes	17	100
No	0	0
DWA	0	0
Cumbe (n = 18)		
Yes	8	44
No	10	56
DWA	0	0
Volta (n = 20)		
Yes	20	100
No	0	0
DWA	0	0
Sítio Canavieira (n = 10)		
Yes	0	0
No	9	90
DWA	1	10
Jardim (n = 23)		
Yes	17	73.9
No	4	17.4
DWA	2	8.7
Pontal do Maceió (n = 1)		
Yes	1	100
No	0	0
DWA	0	0
Exposed individuals who felt health effects (n = 48)		
Guajirú (n = 17)		
Yes	16	94.1
No	1	5.9
Cumbe (n = 8)		
Yes	5	62.5
No	3	37.5
Volta (n = 20)		
Yes	15	75
No	5	25
Jardim (n = 17)		
Yes	12	70.5
No	5	29.5
Pontal do Maceió (n = 1)		
Yes	0	0
No	1	100

Table 4. Frequency of the main symptoms, health effects and demand for health services by artisanal fishermen and fisherwomen exposed to the oil, 2020

Variables	*f*	%
Did you feel any effect on your health after coming into contact with the oil? (n = 63)		
Yes	48	76.2
No	15	23.8
Did you seek any health services after exposure and the effects on your health? (n = 48)		
Yes	18	37.5
No	19	39.6
DWA	11	22.9
Physical symptoms after exposure (n = 48)		
Pruritus and redness		
Yes	31	64.6
No	17	35.4
Headache		
Yes	12	25
No	36	75
Nausea		
Yes	4	8.3
No	44	91.7
Dizziness		
Yes	3	6.3
No	45	93.8
Sore throat		
Yes	2	4.2
No	46	95.8
Between August and December 2019, did you experience changes in your psychological state as a result of the oil spill? (n = 89)		
Yes	60	67.4
No	16	18
DWA	13	14.6
Psychological symptoms after exposure (n = 60)		
Nervousness and stress		
Yes	19	31.7
No	41	68.3
Insomnia		
Yes	19	31.7
No	41	68.3
Sadness		
Yes	19	31.7
No	41	68.3
Not in the mood to work		
Yes	18	30
No	42	70

Table 4. Frequency of the main symptoms, health effects and demand for health services by artisanal fishermen and fisherwomen exposed to the oil, 2020

Variables	*f*	%
Crying more than usual		
Yes	15	25
No	45	75
Lack of appetite		
Yes	4	6.7
No	56	93.3
Difficulties to make decisions		
Yes	2	3.3
No	58	96.7

Source: The authors.
n: absolute sample; f: absolute frequency; %: relative frequency.

According to Laffon et al.[20], direct or indirect exposure to the oil can cause three main effects on human health: mental or psychological; physical or physiological; and genotoxicological. As it contains several substances that can be toxic to living beings, such as Benzene, Toluene, Ethylbenzene and Xylene (BTEX), Polycyclic Aromatic Hydrocarbons (PAHs) and heavy metals, physiological problems are common in individuals exposed to the oil[21,22]. These symptoms can manifest themselves in the first hours and days; and others, such as genetic changes, in the medium and long term. International studies with populations exposed to similar disasters report mental and psychological health problems[23], skin and eye lesions, nausea, headaches, potential risks to the reproductive system of men and women, endocrine problems and even cancer[24].

In South Korea, for example, in 2012, five years after the Hebei Spirit oil tanker spill, children from communities that were directly affected were diagnosed with chronic symptoms of persistent childhood asthma[21]. Therefore, it is necessary to monitor people who have been exposed to the oil to prevent chronic diseases, especially children and women. According to Laffon et al.[20], some adverse health effects may persist for a few years after exposure. For Pena et al.[19(2)], "such situations of occupational exposure require emergency health protection actions to reduce long-term damage".

> *[...] On the day of my niece's christening, when I went to be godmother there in Cumbe, I ate shrimp, then I don't know if it was because of the oil or the shrimp I ate, 'I was all swollen', my face... I was all swollen and 'hoarse' and I went to the christening just like that on Sunday. When I came, I stopped at the supermarket, because I couldn't stand the burning sensation in my body anymore, so I went to the pharmacy and asked the girl to check my blood pressure, then she said my face was really swollen, my face was all swollen and there was that burning sensation, high blood pressure, because it was after IWW ate the shrimp, but it was only once... and I've already eaten shrimp again and didn't feel like that [...].* (FG).

Table 4 also shows that 48 of the 63 AFF, after coming into direct contact with the oil, felt some effect on their health (76.2%; n = 48). The communities of Guariju, Volta and Jardim were the territories where the most AFF showed some effect on health after exposure to crude oil. When experiencing a health problem, 18 fishing workers sought the Unified Health System (SUS), 19 did not want to go to the health service and

11 did not want to answer whether or not they sought emergency services (*table 4*). The most frequent symptoms were itching (64.6%; n = 31) and headache (25%; n = 12) (*table 4*). In previous disasters, such as the one that occurred in California in 2012, the number of people who sought an emergency department with symptoms related to chemical exposure to oil increased by up to four times[25].

In addition to the physiological effects, the AFF showed changes in their psychological state due to the oil disaster (n = 60; 67.4%). Among individuals affected by large oil spills, mental disorders such as depression, suicide and generalized anxiety occur in the short, medium and/or long term[26]. In these events, the AFF are one of the categories of workers most affected by psychopathological symptoms, especially artisanal fisherwomen[16]. The most frequent psychological changes observed among the participants in this study were sadness, nervousness and insomnia, followed by discouragement when going to work, crying, lack of appetite and difficulties in making decisions (*table 4*).

> *We get very sad... when we are going to sell the merchandise, the consumers tell us to clean it, so we treat it and wash it to see if there is oil inside, but there isn't.* (FG).

> *It's been about two months since we've fished charru mussels, because of the oil... we went yesterday and I got 11 kilos of charru mussels and it's stored in the freezer, but who wants to buy it, right?* (FG).

In this research, it was observed that one of the main causes of these psychological changes occurs as a result of socioeconomic impacts, such as the reduction in fish sales and, consequently, the lack of food for families, which require adequate financial and social support. It should be noted that the AFF from the Jaguaribe River estuary reported impacts on life and health, as the fish and shellfish constitute the main source of family economics, guaranteeing family sustenance; so, with the possibility of contamination of these foods, the consumer market decreased precipitously in the first months of the disaster.

Furthermore, approximately 97% (n = 86) of those interviewed had their income reduced by the environmental disaster by between R$100.00 and R$1,000.00 (*table 5*). It can be seen that the main types of fish consumed by the families were charru mussels (90.9%), soft-shell crabs (90.9%), saltwater fish such as mullet (*Mugil brasiliensis*) (81.8%), crabs (59.1%) and shrimp (57.6%) (*table 5*). According to Struch et al.[27], fish from areas affected by the oil spill caused by the Deepwater Horizon explosion in 2010 in the Gulf of Mexico showed, between 2012 and 2015, an increase in hepatic PAH concentrations. In other words, there is an indication that bioavailable PAHs can bioaccumulate in fish tissues over time.

Table 5. Implications of the environmental disaster on income, food and food consumption and main types of fish in fishing communities at the Jaguaribe River mouth between August and December 2019, 2020

Variables	*f*	%
Loss of income for your family between August and December 2019 (n = 89)		
Yes	86	96.6
No	0	0
DWA	3	3.4

Table 5. Implications of the environmental disaster on income, food and food consumption and main types of fish in fishing communities at the Jaguaribe River mouth between August and December 2019, 2020

Variables	*f*	%
How much has your individual income decreased? (n = 89)		
Up to R$ 100.00	7	8.1
R$ 100.00 to R$ 300.00	42	48.8
R$ 301.00 to R$ 500.00	22	25.6
R$ 501.00 to R$ 1,000.00	11	12.8
DWA	4	4.7
Did you receive any emergency aid because of the oil spill? (n = 89)		
Yes	2	2.2
No	76	85.4
DWA	11	12.4
Did you worry that food would run out before you had time to buy, receive or produce more food? (n = 89)		
Yes	86	96.6
No	0	0
Does not know	3	3.4
Number of days reported with concerns about not being able to buy, receive or produce more food for their family		
Almost everyday	69	80.2
Only one or two days	14	16.3
Does not know	3	3.4
Did you consume the food fished between August and December 2019? (n = 89)		
Yes	66	74.2
No	20	22.5
DWA	3	3.3
Type of fish consumed between August and December 2019 (n = 66)		
Freshwater fish from the Jaguaribe River		
Yes	14	21.2
No	52	78.8
Saltwater fish		
Yes	54	81.8
No	12	18.2
Crab		
Yes	39	59.1
No	27	40.9
Oyster		
Yes	30	45.5
No	36	54.5
Charru mussel		
Yes	60	90.9
No	6	9.1

Table 5. Implications of the environmental disaster on income, food and food consumption and main types of fish in fishing communities at the Jaguaribe River mouth between August and December 2019, 2020

Variables	*f*	%
Shrimp		
Yes	38	57.6
No	28	42.4
Lobster		
Yes	2	3
No	64	97

Source: The authors.
n: absolute sample; f: absolute frequency; %: relative frequency; DWA: Didn't Want to Answer.

Finally, it was found that 74.2% (n = 66) of the AFF consumed what they caught between August and December 2019; 22.5% (n = 20) stated that they did not consume it; and 3.3% did not want to answer (*table 5*). There is a high consumption of fish in the months that showed the highest volumes of oil in Brazilian waters. Furthermore, when asked whether they had received any emergency aid, only 2.2% (n = 2) answered yes, and 85.4% (n = 76) said they had not received any financial aid from the federal, state or municipal governments, which made living conditions for the families even more difficult (*table 5*).

In this context, there was a concern that families would run out of food before the workers were able to buy, receive or produce more food. In *table 5*, it is observed that 96.6% (n = 86) of the interviewees were worried about lack of food for their families. For 80.2% (n = 69), this concern lasted almost every day of the week, which worsened the families' food insecurity situation (*table 5*). According to FG shellfish gatherers:

> *The AFF's concern is how they are going to live and survive to support their family, because their work, their daily bread was fishing, and people no longer want to buy fish [...] how are they going to survive... That's the concern.* (FG).

> *[...] knowing everything that is happening, of all this risk that it could be contaminated, we still have to eat it... it is a very blatant situation, because I think there is yet little disclosure.* (FG).

Final considerations

It is understood that, in this disaster scenario, the living situation of the AFF worsened even further, especially those of socioeconomic, environmental, productive, food and, consequently, health orders. It was possible to notice illnesses that tend to be related to direct exposure to the oil and that need to be monitored. Psychological changes were also recurrent and require medium and long-term monitoring, given that, in previous disasters, these effects culminated in family conflicts, resulting in some cases in the disintegration of family relationships, depression and suicides.

Moreover, it was observed that measures such as emergency aid, which aimed to provide assistance to the AFF affected by the disaster, did not reach everyone affected by the latter, especially shellfish gatherers. Therefore, the need to maintain the monitoring of the localities, families and individuals affected by the oil spill is highlighted, as several ecosystems and living beings that are fundamental to food sovereignty and the continuation of artisanal fishing work were harmed.

Acknowledgements

To the fisherwomen and fishermen who participated in the carrying out of this research, particularly, Maria de Lourdes Lima dos Santos, Luciana dos Santos de Sousa, Cleomar Ribeiro da Rocha, Maria Eliene Pereira do Vale and Socorro da Comunidade Canavieira; Francisca Diana Maia da Costa and Camila Batista Silva from the Pastoral Council of Fishermen; to the Coordination for the Improvement of Higher Education Personnel (Capes), as this work was carried out with support from Capes – Financing Code 001; and the Inova Fiocruz Program.

Collaborators

Silva LRC (0000-0002-5807-3478)*, Pessoa VM (0000-0003-3676-9607)* and Meireles AJA (0000-0003-0464-2863)* contributed equally to the preparation of the manuscript. ■

References

1. Mendes APA, Teixeira CAN, Rocio MAR, et al. Mercado de refino de petróleo no Brasil. BNDES Set. 2018;24(48):7-44.

2. Viana FLE. Indústria petroquímica. Cad Set ETENE [Internet]. 2020 [acesso em 2021 fev 22];5(139):1-11. Disponível em: https://www.bnb.gov.br/s482-dspace/bitstream/123456789/396/1/2020_CDS_139.pdf

3. Harrison JA. "Down here we rely on fishing and oil": Work identity and fishers' responses to the BO oil spill disaster. Sociol Perspect. 2019;63(2). DOI: https://doi.org/10.1177/0731121419881140

4. Fleeger JW, Riggio MR, Mendelssohn IA, et al. What promotes the recovery of salt marsh infauna after oil spills? Estuar Coast. 2019;42:204-217. DOI: https://doi.org/10.1007/s12237-018-0443-2

5. Ministério do Meio Ambiente (BR); Instituto Brasileiro de Meio Ambiente e Recursos Naturais Renováveis. Manchas de óleo: litoral brasileiro [Internet]. Brasília, DF: Ibama; 2020 [acesso em 2022 jun 30]. Disponível em: http://www.ibama.gov.br/manchas-deoleo

6. Santos RC, Gurgel AM, Silva LIM, et al. Desastres com petróleo e ações governamentais ante os impactos socioambientais e na saúde: scoping review. Saúde debate. 2022;46(esp8):201-220. DOI: https://doi.org/10.1590/0103-11042022E815

7. Magris RA, Giarrizzo T. Mysterious oil spill in the Atlantic Ocean threatens marine biodiversity and local people in Brazil. Mar Pollut Bull. 2020;153:110961. DOI: https://doi.org/10.1016/j.marpolbul.2020.110961

8. Alencar CAG. Pesca e pobreza no Brasil [tese]. Fortaleza: Universidade Federal do Ceará; 2014. 239 p.

9. Secretaria da Agricultura, Pesca e Aquicultura (CE). Parceria inédita garante registro de 36 mil pescadores e três mil embarcações no Ceará. Portal do Governo do Estado do Ceará [Internet]. 2018 dez 7 [acesso em 2021 mar 31]. Disponível em: https://www.ceara.gov.br/2018/12/07/

*Orcid (Open Researcher and Contributor ID).

parceria-inedita-garante-registro-de-36-mil-pescadores-e-tres-mil-embarcacoes-no-ceara/

10. Johnson RB, Onwuegbuzie AJ, Turner TLA. Mobile Toward a Definition of Mixed Methods Research. J Mix Methods Res. 2007;1(2). DOI: https://doi.org/10.1177/1558689806298224

11. Minayo MC, Sanches O. Quantitativo-qualitativo: oposição ou complementaridade? Cad Saúde Pública. 1993;9(3):239-262. DOI: https://doi.org/10.1590/S0102-311X1993000300002

12. Mattos JR. Um estudo sobre a segmentação dos utilizadores dos ginásios da área metropolitana de Lisboa [dissertação]. Lisboa: Universidade Nova de Lisboa; 2019. 111 p.

13. Secretaria da Agricultura, Pesca e Aquicultura (CE). Barreiras para contenção da mancha de óleo são colocadas na foz do Rio Jaguaribe. Portal do Governo do Estado do Ceará [Internet]. 2019 nov 6 [acesso em 2022 jun 30]. Disponível em: https://www.ceara.gov.br/2019/11/06/barreiras-para-contencao-da-mancha-de-oleo-sao-colocadas-na-foz-do-rio-jaguaribe/

14. Souza MAR, Wall ML, Thuler ACMC, et al. O uso do software IRAMUTEQ na análise de dados em pesquisas qualitativas. Rev Esc Enferm USP. 2018:52:e03353. DOI: https://doi.org/10.1590/S1980-220X2017015003353

15. Oliveira TMV. Amostragem não probabilística: adequação de situações para uso e limitações de amostras por conveniência, julgamento e quotas. FECAP. 2001;2(3).

16. Won YJ, Jang S, Jung N, et al. Ten years after the oil spill in taean: the recovery of the ecosystem, the life of women, and the community. Asian Women. 2019;35(4):1-22. DOI: https://doi.org/10.14431/aw.2019.12.35.4.1

17. Campallesso AJ, Cazella AA. Pesca artesanal entre crise econômica e problemas socioambientais: estudo de caso nos municípios de Garopaba e Imbituba (SC). Ambient Soc. 2011;14(2):15-33. DOI: https://doi.org/10.1590/S1414-753X2011000200003

18. Cardoso PO, Doula SM. Reservas extrativistas marinhas: perspectivas e limitações para jovens pescadores. ABC. 2018;5(2):5-19. DOI: https://doi.org/10.21726/abc.v5i2.296

19. Pena PGL, Northcross AL, Lima MAG, et al. Derramamento de óleo bruto na costa brasileira em 2019: emergência em saúde pública em questão. Cad Saúde Pública. 2020;36(2):e00231019. DOI: https://doi.org/10.1590/0102-311X00231019

20. Laffon B, Pásaro E, Valdiglesias V. Effects of exposure to oil spills on human health: Updated review. J Toxicol Environ Health B Crit Rev. 2016;19(3-4):105-128. DOI: https://doi.org/10.1080/10937404.2016.1168730

21. Noh SR, Kim JA, Cheong HK, et al. Hebei Spirit oil spill and its long-term effect on children's asthma symptoms. Environ Pollut. 2019;248:286-294. DOI: https://doi.org/10.1016/j.envpol.2019.02.034

22. Specht AJ, Dickerson AS, Kponee-Shovein KZ, et al. Toenail Metal Exposures in Fishermen from Bodo City, Nigeria. Bull Environ Contam Toxicol. 2020;104(1):90-95. DOI: https://doi.org/10.1007/s00128-019-02750-7

23. Noal DS, Braga VMR, Leal MB, et al. Desastre da Vale: o desafio do cuidado em Saúde Mental e Atenção Psicossocial no SUS. Saúde debate. 2022;44(esp2):353-363. DOI: https://doi.org/10.1590/0103-11042020E224

24. Ferguson A, Solo-Gabriele H, Mena K. Assessment for oil spill chemicals: Current knowledge, data gaps, and uncertainties addressing human physical health risk. Mar Pollut Bull. 2020;150:110746. DOI: https://doi.org/10.1016/j.marpolbul.2019.110746

25. Remy LL, Clay T, Byers V, et al. Hospital, health, and community burden after oil refinery fires, Richmond, California 2007 and 2012. Environ Health. 2019;18(1):48. DOI: https://doi.org/10.1186/s12940-019-0484-4

26. Parks V, Slack T, Ramchand R, et al. Fishing households, social support, and depression after the deepwater horizon oil spill. Rural Soc. 2019;85(2):495-518. DOI: https://doi.org/10.1111/ruso.12297

27. Struch RE, Pulster EL, Schreier AD, et al. Hepatobiliary analyses suggest chronic PAH exposure in hakes (urophycis spp.) following the deepwater horizon oil spill. Environ Toxicol Chem. 2019;38(12):2740-2749. DOI: https://doi.org/10.1002/etc.4596

Received on 06/15/2023
Approved on 01/17/2024
Conflict of interests: non-existent
Financial support: This work was carried out with support from (Capes) – Financing Code 001; and the Inova Fiocruz Program

Editors in charge: Adriana Miranda de Castro and Francco Antonio Neri de Souza e Lima