

Assessment of health management performance in the oil spill disaster crime on the coast of the state of Pernambuco

Avaliação da atuação da gestão em saúde no desastre-crime de derramamento de petróleo na costa do estado do Pernambuco

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ABSTRACT This study aimed to analyze the actions taken by health management to deal with the criminal disaster of an oil spill off the coast of Pernambuco in 2019. It is a case study investigating the health sector's actions in four municipalities in Pernambuco. Data was collected through interviews with 16 health department managers (municipal and state), using a semi-structured script with questions about performance, impacts, actions taken, difficulties, challenges, and lessons learned. The Collective Subject Discourse analysis revealed four thematic axes: a) managers' perception of the impacts of the crime disaster; b) actions taken in the process of risk management of the disaster crime by the health sector; c) difficulties faced in the process of mitigating the disaster; d) evaluation of management actions during the disaster crime and future preparation. Weaknesses in health management were identified in disaster mitigation actions due to the need for more preparation of health services and professionals. The lack of instruments and coordination between the federated entities intensified the difficulties, generating calamity in the territory. This points to the need to build instruments and protocols to guide such actions in these situations so that activities can be carried out more efficiently and effectively.

KEYWORDS Oil spill. Disaster. Disaster response. Health sector. Risk management.

RESUMO Este estudo objetivou analisar as ações desenvolvidas pela gestão de saúde no enfrentamento do desastre-crime de derramamento de petróleo na costa pernambucana em 2019. Trata-se de estudo de caso que investigou a atuação do setor saúde em quatro municípios de Pernambuco. A coleta de dados foi mediante entrevistas com 16 gestores de secretarias de saúde (municipal e estadual), utilizando roteiro semiestruturado com perguntas sobre atuação, impactos, ações desenvolvidas, dificuldades, desafios e lições aprendidas. A análise do Discurso do Sujeito Coletivo evidenciou quatro eixos temáticos: a) percepção dos gestores sobre os impactos do desastre-crime; b) ações desenvolvidas no processo de gestão de risco do desastre-crime pelo setor saúde; c) dificuldades enfrentadas no processo de mitigação do desastre; d) avaliação das ações da gestão durante o desastre-crime e preparação futura. Identificaram-se fragilidades da gestão em saúde nas ações de mitigação do desastre, resultado da falta de preparo dos serviços e dos profissionais de saúde. A falta de instrumentos e a desarticulação entre os entes federados intensificaram as dificuldades, gerando situações de calamidade no território. Isso aponta para a necessidade de construção de instrumentos e protocolos que guiem tais ações nessas situações, para que as atividades sejam desenvolvidas com mais eficiência e eficácia.

PALAVRAS-CHAVE Derramamento de petróleo. Desastre. Respostas em desastres. Setor saúde. Gestão de risco.

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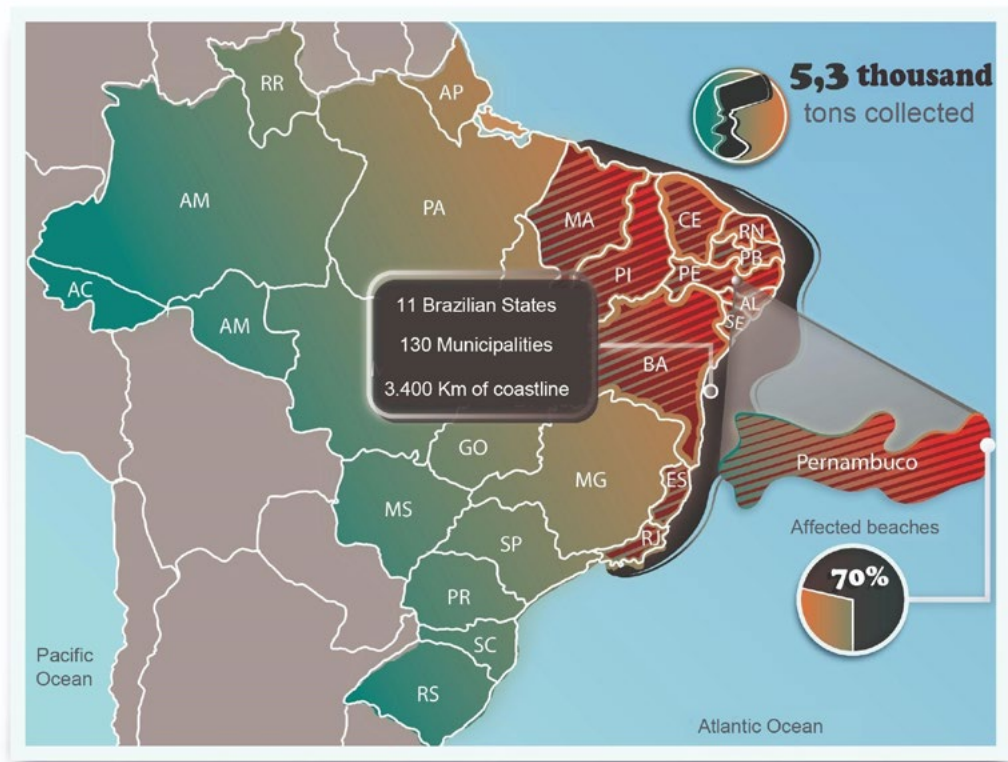
Introduction

The risk of oil spills at sea has significantly increased with the growth in the exploration, production, sale, and maritime transportation of petroleum. In 2022 alone, seven spills were recorded, with 15,000 tons of oil being released into international waters¹. In Brazil, the record of oil spills at sea began in 1975, under the responsibility of state-owned oil company

PETROBRAS, when 6,000 tons of oil were discharged into Guanabara Bay².

In 2019, the Brazilian coast was hit by more than 5,3 thousand tons of crude oil, first appearing in the State of Paraíba, then in Pernambuco, later spreading to the nine northeastern and two southeastern states^{3,4}. In this context, the spill seriously affected Pernambuco, where more than 1,6 tons of crude oil reached 70% of the beaches, polluting eight estuaries in 13 municipalities^{3,5,6}.

Figure 1. Map of the area affected by the oil leak



Source: Own elaboration based on survey data.

This oil release has caused a severe ecological disturbance to coral reefs and mangroves⁶, interrupting fishing and tourism, damaging the economic livelihood of fishermen⁷, and the population's health because exposure to oil through breathing and skin contact is associated with signs/symptoms of headache, nausea,

dizziness, skin irritation, and shortness of breath. Additionally, there are possible long-term effects, such as cancer, damage to the nervous system, and heart disease – and in cases of intense exposure, it may lead to coma and death⁸.

Due to its magnitude and negative impact on the lives of communities and the environment,

the uncertainty of responsibility, and the weakness of the response, this event can be characterized as a disaster crime^{9,10}, considering the damage caused and the conditions of vulnerability produced by a series of actions or omissions.

With the increasing frequency of disasters, especially those of technological origin, which are often more severe and widespread, it is crucial to prepare response strategies across all levels of government. In this context, risk management emerges as a key approach not only for disaster reduction through prevention and promotion but also for managing the aftermath through alert and response actions and for the recovery and rehabilitation of affected areas^{8,11}. These efforts should be carried out collaboratively, involving multiple sectors, communities, and non-governmental organizations. This can be achieved by disseminating scientific and technological knowledge to inform and train the population, enabling them to participate effectively in these efforts, mitigate damage, and assist in the recovery of affected territories¹².

The ability to manage a disaster is closely tied to the level of development of the affected municipality, state, or country. These events expose the socio-environmental vulnerabilities of impoverished populations and reveal limitations in risk management, mitigation, and the restoration and reconstruction of living conditions and health for those impacted^{11,13}.

Disasters are complex and require health managers to develop comprehensive strategies to mitigate health risks. This involves a spectrum of services, from primary health care to surveillance and both intermediate and advanced levels of care, to address the full scope of damage and its underlying causes¹⁴.

In addition, ongoing actions are required after a disaster, integrating health efforts with socio-environmental and economic initiatives to support the population in rebuilding and recovering their living and health conditions. Moreover, public institutions, organized civil society, and even private entities must provide

the conditions for the reconstruction of 'normality' to occur more sustainably and reduce the risks of a new disaster^{11,13,15}.

The fragility and scarcity of research on health management in the context of oil-related disasters highlight the need for studies from a public health perspective¹⁶.

This article examines the actions undertaken by health management in response to the 2019 oil disaster in Pernambuco, highlighting the key challenges encountered and the lessons learned to enhance public health management practices.

Material and methods

Between 2021 and 2023, an exploratory qualitative case study was conducted in four coastal municipalities of Pernambuco that had over 70% of their coastline affected by the oil spill and accounted for 75.27% of the total oil collected across the state: Ipojuca, Cabo de Santo Agostinho, São José da Coroa Grande, and Jaboatão dos Guararapes.

The study targeted managers from the health departments of the affected municipalities and the state of Pernambuco who were involved in the response to the oil spill and consented to participate in the research. Participants were identified through the minutes of situation room meetings held during the disaster, which included health sector representatives (managers and/or coordinators) from the impacted municipalities. Additionally, the snowball sampling technique was used to identify interviewees, with a minimum of two participants from each department. At the end of each interview, participants were asked to recommend a coordinator or manager involved in the disaster mitigation efforts. Managers who had left their positions before the interview were excluded from the study.

The interviews were conducted using a semi-structured questionnaire with 28 questions, organized into five thematic blocks: a) the interviewee's professional profile to gain

insights into their background, training, and experience as a manager; b) perceptions of the disaster's impacts, to assess the effects on the population's socioeconomic conditions and health; c) actions taken by the health sector in managing the disaster crime, to explore the processes of disaster preparedness and response; d) challenges faced in disaster mitigation, such as difficulties accessing guiding documents and coordinating efforts among federal entities for crisis management; e) the management's interaction with the population, to evaluate the level of social participation in the implemented actions; and f) an assessment of the actions taken during the disaster crime and preparedness for future events, focusing on the effectiveness of management and readiness for potential future incidents.

The interviews were digitally recorded, with an average duration of 50 minutes, and were conducted individually, except on two occasions when the interviewed managers invited their team to contribute. The recordings were then transcribed and organized into Excel® 2010 spreadsheets, using the Collective Subject Discourse (CSD) analysis technique to identify key expressions and central ideas. This process led to the definition of four categories of analysis: 1) Managers' perceptions of the impacts of the disaster crime; 2) Actions taken by the health sector in managing the disaster crime; 3) Challenges faced during disaster mitigation; and 4) Evaluation of management's actions during the disaster-crime and preparation for future disasters.

The study was approved by the Research Ethics Committee of the Aggeu Magalhães Institute, part of the Oswaldo Cruz Foundation (IAM/FIOCRUZ Pernambuco), under the Certificate of Ethical Appreciation Presentation (CAAE) No. 25398119.9.0000.5190 and opinion No. 5.037.340. It was conducted under Resolutions No. 466 of December 12, 2012, and No. 510 of April 7, 2016, issued by the National Health Council.

Results and discussion

Sixteen of the eighteen invited participants were interviewed, including ten municipal and six state workers. The group consisted of coordinators from various sectors: health surveillance (encompassing sanitary, epidemiological, and environmental surveillance, the Environmental Health Surveillance Center for Risks Associated with Disasters – VIGIDESASTRES, and Health Surveillance of Populations Exposed to Chemical Contaminants – VIGIPEQ), Primary Health Care (PHC), Occupational Health Surveillance, and the Toxicological Information and Assistance Center (CIATOX), as well as municipal managers. The participants had diverse educational backgrounds and varying levels of experience.

Of the sixteen participants, ten were female, and six were male. All had higher education degrees: six were nurses, two psychologists, one doctor, three veterinarians, one nutritionist, one biologist, one physiotherapist, and one pharmacist. The average experience in public health was 11.25 years, ranging from two to thirty-six years. Only four participants reported having experience with a major health event:

I had already taken part in an investigation into clay contamination. I had also visited the Porto de Suape to investigate soil contaminants, contaminants from oil derivatives, a very specific thing, but nothing compared to the magnitude of the oil spill on the beach. (Municipal Manager 09).

Professional experience and technical knowledge are crucial elements in conducting health actions, enabling faster and more effective responses¹².

The following presents the disaster management actions health managers took to mitigate damage, both in the affected municipalities and across the state of Pernambuco.

Managers' perception of the impacts of disaster crime

The study sought to identify the impacts by examining how the disaster affected the socio-economic conditions and health of the affected population. The findings highlighted multiple

repercussions, notably in tourism, health, the economy, food and nutrition security, and local lifestyles. Socioeconomic and health problems were particularly significant (*table 1*), creating additional challenges for families who rely directly on the coastal and estuarine areas for their livelihoods.

Table 1. Managers' comments on the impacts of disaster crime in Pernambuco

Managers' perception of the impacts of disaster crime	
Socio-economic Impacts (tourism, fishing, loss of income sources, etc.)	<p><i>It was a huge social issue because they couldn't go to sea for a while. The only reason they didn't starve was thanks to the food baskets we could provide, but many of them were left with nothing to eat and nothing to feed their children. Since they weren't selling anything, nobody wanted to buy it, so they had to eat what they had. So, they said: 'If we don't sell, we have to eat. How am I going to feed my children?' (Municipal Manager 06).</i></p> <p><i>There was a drop in sales, even for the vendors along the coast who also sell seafood and fish at their stalls. They also reported a significant reduction in the public's consumption of these products at the time (Municipal Manager 07).</i></p>
Health Impacts	<p><i>I remember patients coming in with skin rashes, in some cases with a history of vomiting, itching, and some gastrointestinal symptoms (Municipal Manager 08).</i></p> <p><i>These impacts and the possibilities of becoming ill are manifold. Petroleum contains several extremely harmful substances in the short and long term. The exposure we consider for people is the same as the exposure we consider for occupational health. For example, routine exposure to benzene is extremely harmful, carcinogenic, and harms people's bodies badly (State Manager 11).</i></p>
Impacts on the mental health of the affected population	<p><i>Some people supported their families and the community with a certain level of autonomy through the sea. And you suddenly cut off that source of production, and while those of us who enjoyed seafood simply stopped eating it out of fear of chemical contamination, they lost their source of income. This situation led to depression for those people—both men and women who were the breadwinners for their households. It also increases issues like domestic violence and alcoholism (State Manager 15).</i></p>

Source: Own elaboration.

The ban on fishing due to the potential contamination led to a loss of income for fishermen. This impacted the availability of one of the primary sources of food for these families and made it difficult for them to purchase other necessities. Other workers, such as merchants, were also affected by the closure of the beaches.

In Pernambuco, the commercial sale of shellfish and crustaceans fell by 80% to 100%, alongside a decline in the sales of other products¹⁰. In some communities, fishermen were advised not to fish during the initial months of the COVID-19 pandemic as a biosafety measure, exacerbating the vulnerability caused by the disaster crime⁴.

The repercussions on health encompassed both physical health, due to the effects associated with exposure to oil, and mental health, as a result of changes in the lifestyles of this population¹⁰. As an atypical event, many municipalities were unprepared for such a situation, thus increasing risks and damage. The lack of readiness increased the population's exposure to the risks, with several cases of people suffering from exogenous intoxication symptoms, such as dizziness, headaches, fever, and dermatitis, among others reported.

Despite complaining, many did not seek health services, making it difficult to notify and provide care. Some adopted homemade

solutions to alleviate the symptoms, with reports of using toxic substances (such as kerosene) to remove oil residues from the body.

This population continued to be exposed to the substance through their work, as they could not afford to stop subsistence fishing due to the challenges of receiving emergency aid provided by the government to some affected families²⁰.

Another identified situation was the denial of the problems resulting from exposure to oil, considering the symptoms simple or an exaggeration of the population, or dismissing the possibility of people becoming ill due to exposure.

News reports have emerged about the disaster crime, many of them without highlighting the health issue or the seriousness of the impact on the region²¹. The lack of adequate and timely information may have left the population confused as to what to do about the situation. As a result of the poor communication about the problem²², many were unable to identify whether the symptoms they were experiencing were related to the oil exposure.

Exposure to oil components can cause acute and chronic intoxication with damage appearing months or years after the event, regardless of the level and time of exposure, such as cancer, hematological diseases, disorders of the circulatory, pulmonary, renal, immune and neurological systems, emotional disorders, and hormonal imbalances^{23,24}.

These disasters impact mental health and provoke a catharsis of emotions among residents and those who depend on the sea for their livelihood. These communities have a symbiotic relationship with nature, which goes beyond economic aspects, encompassing cultural and spiritual dimensions that resonate in every aspect of their lives^{25,26}.

In this context, it is important to train healthcare professionals within the Unified

Health System (SUS) not only to address intoxication cases but also to provide proper support and management of the mental health effects, ensuring ongoing care for the affected population¹¹.

Actions taken in the disaster crime risk management process by the health sector

To characterize the actions carried out by the health sector in the disaster crime risk management process, the questions focused on preparing for and responding to the disaster. This involved forming a crisis committee, training health professionals, monitoring and notifying the exposed population, and health education actions.

The literature shows that oil-related disasters in Brazil, the United States, South Korea, and other countries have resulted in numerous consequences, necessitating a reorientation of their social protection systems to address the impacts generated²⁷⁻²⁹. However, the response actions to the oil spill were poorly coordinated, lacking integration among government agencies or coherent intersectoral strategies, diverging from the necessary recommendations that this situation required^{27,29}.

In the case examined here, only one municipality managed to organize itself before the oil arrived, preventing disastrous situations such as population exposure to the substance. The other municipalities had to respond after the event occurred (*table 2*). Planned actions included establishing crisis committees, training healthcare professionals for support and treatment, and implementing measures for monitoring and reporting exposed individuals.

Table 2. Managers' comments on actions taken in the health sector's disaster crime risk management process

Actions taken in the disaster crime risk management process in the health sector	
Organization of actions before the arrival of petroleum	<i>We had already prepared everyone a week before. We were already training the network to prevent the impact that other municipalities have had. We already had all the PPE. Then, several health professionals took part in a disaster course. Even before the oil arrived, we trained the team and the entire health network (Municipal Manager 06).</i>
Actions taken during the oil's arrival	<p><i>Surveillance and primary care made a lot of effort to be with the fishermen and provide guidance on contact issues. We also distributed pamphlets on the beach because, at that time, there were still small oil patches on the beach, and people had started to visit. So, we carried out this pamphlet distribution with the dengue prevention team (Municipal Manager 03).</i></p> <p><i>A crisis management committee was set up long before the oil arrived. It stayed until the end of the actions (Municipal Manager 06).</i></p> <p><i>Multiple departments united their efforts and devised a comprehensive emergency action plan to address the oil influx. On the first day, our collective focus was on oil cleanup at the beach. We also coordinated with all urgent and emergency services to ensure they were vigilant for signs of poisoning and ready to contact us (Municipal Manager 09).</i></p> <p><i>Health officials weren't the only ones involved. The mayor, the Civil Defense staff, and the Environment Department were also involved (Municipal Manager 01).</i></p>
Setting up a crisis committee	
Providing training for professionals	<p><i>Guidance was provided because we needed it, including for emergency professionals. We needed to recognize the signs of exogenous intoxication and suspect whether they were related to the oil or not (Municipal Manager 01).</i></p> <p><i>All PSF units underwent comprehensive training to effectively receive and treat these patients. Samu's readiness and the hospital's mixed unit further ensured our preparedness (Municipal Manager 02).</i></p>
Monitoring and surveillance of the exposed population	<p><i>We began to structure our actions more based on this higher volume and these notifications. We started sending teams to identify the situation, the volume, the people who were involved in cleaning up, and who was managing it. We began to make this diagnosis informally. We released a technical note for the population and one for health professionals to notify anyone with exogenous intoxication. We instituted immediate notification. As notifications came in, we also started to make weekly reports. We assessed how the notification was going and the main symptoms every week to create a database. We asked the Ministry of Health's EPISUS for support. We had weekly meetings with the Ministry of Health (State Manager 11).</i></p> <p><i>The health actions were primarily focused on symptomatic treatment for those with exogenous intoxication and monitoring these individuals. We coordinated our efforts with the nearest populations, the riverside communities, through the family health teams and health surveillance teams. This collaborative approach ensured that these individuals did not venture into the mangroves, the river, or the beach (Municipal Manager 01).</i></p> <p><i>SAMU (Federal Emergency Ambulance Service) and other emergency services were on standby when teams went out to collect affected individuals. The basic health units were also on standby, with the emergency staff not just waiting for the teams to return but actively providing guidance and support (Municipal Manager 01).</i></p> <p><i>We identified a specific group to work specifically on this and directed the professionals there to the decentralized SAMU base. We sent a team of health professionals to the beach area, where we even set up a health base with several professionals involved to identify these cases to be notified (Municipal Manager 04).</i></p> <p><i>As this was unprecedented, there were no acceptable levels of oil components in fish for consumption. ANVISA (National Sanitary Surveillance Agency) issued a technical note showing the levels that could be consumed. We didn't think suspending consumption at any time would be necessary. ANVISA's actions have to be backed up by research and science, and not simply because oil has appeared there, and we would suspend the fish consumed in the state or the town. So, with the difficulties of fish traceability, which we needed to have more clearly, there was no need to suspend the fish consumption for two reasons: the first is that there were no levels of contaminants that could be condemned. The second is that there was no certainty that the fish on sale were contaminated (State Manager 12).</i></p>

Table 2. Managers' comments on actions taken in the health sector's disaster crime risk management process

Actions taken in the disaster crime risk management process in the health sector	
Health Education Activities	<p><i>So, for the riverside populations, we went to do on-site advice. There were days when we went through the streets and did house-to-house advice in areas where we knew there were shellfish gatherers and fishermen who lived there. People who went to the mangroves to catch Aratu crabs to eat that same day. We checked to see who had had contact and who hadn't and monitored who had had contact, and we did this through the primary care teams (Municipal Manager 01).</i></p> <p><i>We invited the representatives of the fishermen's and shellfish gatherers' associations to participate in this specific group. We held meetings practically every week because we listened to the demands, desires, and difficulties to try to intervene together (Municipal Manager 04).</i></p>

Source: Own elaboration.

Due to the situation's urgency, public authorities, fishermen, street vendors, local residents, and others mobilized to remove the oil from the beaches. These actions were carried out without adequate preparation, as most of those involved worked without Personal Protective Equipment (PPE) and without understanding the health risks, thereby exposing themselves to hazardous situations¹⁰. Without prior preparation to minimize damage, the efforts were made in an unplanned, fragmented, and uncoordinated manner^{11,13,15,30,31}.

FORMING THE CRISIS COMMITTEE

All interviewees reported the formation of crisis committees to manage the disaster, composed of multiple sectors and professionals. Various departments were involved, including health coordination, fishermen, merchants, the tourism sector, non-governmental organizations, and other governmental agencies.

Crisis committees should be among the first measures taken in public health emergencies, as involving stakeholders from various backgrounds enables the planning and execution of strategic and effective actions¹¹. It is crucial that, in addition to governmental bodies, these committees include representatives from affected communities, experts, and researchers with knowledge of the involved agents and related damages to combine community, technical, and scientific knowledge^{14,30}.

TRAINING PROCESSES FOR HEALTH PROFESSIONALS

Since there was no history of such events in the municipalities or the state, health managers and professionals lacked prior knowledge about the substance and its potential harm. This made it necessary to conduct training on the clinical management of poisoning, reporting procedures, organizing health services, establishing protocols, and defining workflows within the care network. Ongoing and continuous training is essential for improving health services and professional development¹⁵, contributing to enhancing service delivery¹³.

Preparing the health sector requires effective actions, such as creating and structuring strategic teams ready to respond to such situations¹³, like VIGIDESASTRES and the Strategic Information Center in Health Surveillance. Strengthening health surveillance helps prevent inadequate actions from becoming a new disaster, exacerbating a situation that could have been avoided with preventive measures^{11,32}.

Some municipalities recognized the need to deploy health teams to the affected areas by setting up health bases to monitor the population, provide guidance, offer support, and handle the necessary reporting. However, only one municipality prepared its professionals and health network to respond to this disaster crisis. The shortcomings in the preparedness of the municipalities and the state,

which delayed responses in certain situations, led to increased exposure and escalated risk scenarios.

Disasters of significant magnitude call for a joint effort from federal entities to mitigate damage, coordinated through intersectoral collaboration. The Health Emergency Operations Center (COE-SAÚDE) serves as the hub for this coordination, connecting all stakeholders responsible for disaster response with the General Emergency Operations Committee (COE-GERAL). The COE-Geral's role is to ensure a unified and effective response to the disaster)^{11,16}.

The main actions carried out by the federal entities were monitoring, case notification, and health education. As soon as the oil hit the beaches, the municipalities began to manage the situation. Each entity developed actions at different levels, depending on their level of preparedness. According to the state managers, when the oil reached the coast, they didn't know how to act, making it difficult to monitor and support the actions of the municipalities. As a result, the state's actions were carried out in response to emerging demands.

Based on the notifications, the state sent teams to the affected areas to conduct a situational assessment. Technical notes were issued to the population and healthcare professionals regarding reports of intoxications, which, due to the severity of the issue, became mandatory for immediate reporting. Additionally, weekly bulletins were produced. The state of Pernambuco was considered the link between the Ministry of Health (MS) and the municipalities, with contact established through situation room meetings.

HEALTH MONITORING AND SURVEILLANCE OF THE EXPOSED POPULATION

Local managers prioritized monitoring the cases of people who had come into contact with the substance and showed signs of exogenous intoxication and preventing further exposure. They organized support for the

volunteers who were removing the substance from the beach, providing PPE to minimize direct contact. At first, there was no specific instrument for notifying those exposed, which led to the use of exogenous intoxication forms from the Notifiable Diseases Information System (SINAN), even in the absence of clinical manifestations indicating a case.

A reported challenge was the lack of knowledge about the substance and its impact on the fish. Laboratory analyses were conducted to determine if the fish were contaminated, but the absence of reference standards for acceptable levels of toxic compounds meant that neither the municipalities nor the state issued guidelines on the suspension, restriction, or special recommendations for fish consumption.

This led to difficulties between the state and municipalities because the media influenced the suspension of fish consumption. Additionally, research institutions recommended the same action after identifying petroleum in the digestive and respiratory systems of fish, shellfish, mollusks, and crustaceans, ultimately leading to advisories against consuming food from these areas^{33,34}.

Ideally, in areas affected by a spill, the levels of toxicologically/ecotoxicologically relevant contaminants in economically relevant species consumed by the population, the capacity to adopt mitigation measures, the response capacity of local health systems, the relationship between socio-economic impacts and impacts on food and nutritional sovereignty and security resulting from the suspension or restriction of consumption, among others, should be assessed so that decisions can be made as to whether to continue trading in and consuming potentially contaminated food³⁵. Unfortunately, this was not observed in the studied state and its municipalities.

HEALTH EDUCATION ACTIONS

Health education efforts aimed to help the population avoid contact with the oil spill.

These efforts included distributing informational pamphlets, training community health workers and disease control agents on preventive actions, and providing guidance on properly using PPE for professionals and volunteers involved in the oil cleanup. In one municipality, health education initiatives were also carried out in schools, encouraging children and adolescents to share this information with their families, neighbors, and friends.

Community leaders were invited to join the crisis committee to identify their needs and demands, thus creating a bridge between the authorities and the community. This also highlighted the importance of building a grassroots surveillance system. In addition, meetings were held with leaders of the fishing colonies to talk about the symptoms and what to do in the event of exposure. Additionally, there were training and discussion groups with waterfront workers, shopkeepers, hoteliers, and beachgoers at the fishermen's colony and association, all aimed at preventing contact with the substance.

Social participation is fundamental in the disaster management process. Given their knowledge of the territory and their links with community members, social workers help to map the most vulnerable areas and groups, health facilities, alternatives, and other elements that technicians are unaware of^{11,13,30,36}.

Recognizing the importance of teamwork in disaster situations is essential. It supports the identification and triage of victims, health education for communities, and the need for diagnosis and treatment. However, it's the effective access to healthcare, including psychological support, that truly makes a difference in disaster response and recovery efforts³⁷.

Even though exposure to oil components is associated with severe health outcomes, the managers' statements did not reveal the adoption of adequate measures to increase the sensitivity of reporting suspected cases of poisoning. Furthermore, there was no evidence of health professionals being trained to diagnose these cases, establishing population

cohorts for longitudinal monitoring of signs and symptoms potentially related to exposure, or other necessary actions.

Difficulties faced in the disaster mitigation process

The challenges encountered in the disaster mitigation process stemmed from a need for knowledge about guiding documents and difficulties in coordination among federal entities. Several factors hindered the development of practical actions: the absence of a guiding framework for organizing responses to technological disasters, which led to improvised efforts; a lack of understanding of the municipality's epidemiological profile, which made it difficult to implement more effective and targeted actions to address potential health impacts associated with the disaster; and poor coordination among federal entities, which delayed the response of some managers as they awaited guidance on how to address the problem, given the need for a tripartite approach.

LACK OF KNOWLEDGE ABOUT GUIDING DOCUMENTS

Without official guiding documents and due to a lack of coordination, communication, and planning among federal entities, each entity sought any available data source for guidance. One municipality used the actions taken in Brazil's Southeast region for oil spill situations as a model, focusing on reducing public contact with the substance to prevent potential health damage. Another municipality drew on examples from other countries that had faced similar situations to guide their actions. A third municipality developed an action plan during the process, which further slowed the response, and utilized the VIGIDESASTRES' Emergency Response Preparedness (ERP) plan, adapting it to the situation despite its general nature. The state adapted the ERP for floods in

Pernambuco³⁸ to address the context of the oil spill. Additionally, another municipality used available resources from the SUS, such as the exogenous notification form, which had to be adapted for the case.

At the time of the disaster, the National Contingency Plan for Oil Pollution Incidents was in force and could have been adopted to guide the actions of local managers. This plan provides broad guidelines with a focus on coordinating disaster response³⁹. During and after this disaster, additional documents with more specific response actions were published^{40,41}.

Technical notes were issued to provide guidance to the public. However, it's important to consider that these documents use formal language and may not be accessible to everyone. They were distributed via the Internet, yet the majority of those directly affected are socio-economically vulnerable, with low levels of education and limited access to technology. Thus, it is crucial to consider the target audience and develop more accessible communication methods.

Insufficient measures were taken to mitigate the disaster, primarily due to a lack of planning, leading to a delayed response that failed to protect the population exposed to the oil in the affected areas.

DIFFICULTIES IN COORDINATION BETWEEN FEDERATED ENTITIES

Difficulties were identified in articulating and organizing responses between the federal entities. State management attempted to provide standardized information by issuing technical information notes and holding meetings to avoid response deficiencies.

Some municipalities received minimal and delayed support from the Ministry of Health and the State Health Department. This was mentioned as the main reason for the difficulty in determining what actions to take and how to implement them, based

on the organizational principle of the SUS of tripartite management. It was also due to the great magnitude of the event, in which, in theory, the federal level should have assumed leadership and guided the other federal entities in decision-making.

Soares⁶ reports that the federal government's inaction or late action intensified the disaster's harmful effects on the environment and the lives and health of communities. In this context, there was a delay in implementing the contingency plan, which should have been improved according to the situation, with more specific guidelines for local administrations and a delay in providing support to the other federal entities.

Tripartite management points out that when the municipality is unable to meet the demands of its territory, it can request support from other cities in its health region that have a greater capacity for physical and financial resources through the Regional Health Management, the state, and the federal government.

In the event of an oil spill, the MS is responsible for mobilizing the SUS and supporting prevention, preparedness, and response actions. This includes supporting the Executive Committee and the Monitoring and Evaluation Group in proposing guidelines for implementing the National Contingency Plan and guiding and supporting the SUS management spheres in the definition, execution, evaluation, and monitoring of such actions³⁹.

Political limitations also emerged in the statements of local managers, leading to difficulties in carrying out mitigation actions. Managers had to temper their language and decision-making to avoid conflicting with the economic interests of the local power holders.

Most municipalities in Pernambuco are small, which means they have access to fewer resources. This limitation affected disaster management, resulting in limited resources for acquiring materials, hiring professionals to address the crisis, and implementing other necessary measures.

Evaluation of management actions during the disaster crime and preparation for future disasters

At this stage, an effort was made to identify the managers' perceptions regarding the management's performance, strengths, challenges, and lessons learned. Some managers believed they could respond quickly to the population, even considering the unusual

nature of the event. Only one municipality managed to prevent significant health impacts by organizing before the oil arrived, avoiding or reducing direct exposure. The support provided by the state government in some municipalities was highlighted as a facilitator. Another point raised was the technical competence of the teams, despite their lack of preparation for dealing with such a situation (*table 3*).

Table 3. Difficulties and lessons learned according to managers' comments in the disaster-related crime mitigation process in Pernambuco

Difficulties faced in mitigating disaster-related crime	Lack of knowledge about guiding documents	<p><i>Literally, health had no protocol to follow (Municipal Manager 02).</i></p> <p><i>We used the SINAN's notification form and a form that EPISUS left for us. We weren't guided by a contingency plan; we were guided by our feelings about what to do at the time (Municipal Manager 09).</i></p> <p><i>We used the state contingency plan for the rains, even though it's another event. It talks about preparedness and response actions. We tried to adapt it to the oil issue. We have the Ministry handbook that talks about disasters. I think it's the QBNR handbook, which is a disaster of chemical and biological origin, and there are several records (State Manager 11).</i></p>
	Coordination difficulties between states	<p><i>Our plight was exacerbated by the lack of the right instruments, state support, and the involvement of the Ministry of Health. The delay in their response left us in a desperate situation, as we were unsure how to proceed. By the time we received a response from the state, we had already endured 15 days of oil (Municipal Manager 03).</i></p> <p><i>The federal government's National Surveillance program included a more technical discussion; it called in toxicologists and oil specialists. However, it was a very disorganized federal government, the Presidency of the Republic, and other related institutions that didn't involve PETROBRAS. Because it's PETROBRAS that knows how to reverse the damage caused by oil. There was a clumsy decision to bring in the Brazilian Navy, which came as if it were the only one involved, but it was just part of a circus. Although it also provided some help, but without any scientific basis (State Manager 15).</i></p>
Lessons learned in mitigating the crime disaster	Knowledge accumulation	<p><i>Everything that was built, the lessons learned, and the mistakes and successes made back then make a difference in new occurrences (State Manager 11).</i></p> <p><i>We always have to think that this could happen again and that we should be prepared. Municipal schools should address this through education. However, we should mainly prepare people who spend time at sea daily; they are our most excellent watchdogs (Municipal Manager 02).</i></p> <p><i>We need to return to oil planning, specifically chemicals. But really, if we hadn't had the COVID-19 pandemic, the preparedness and response plan would have been well advanced (State Manager 15).</i></p>
	Experience with disaster-related crime	<p><i>Reports remind the municipality of how it acted during that period. I think this will make it much easier in the future because, at the time, we even picked up examples from places with very different realities (Municipal Manager 07).</i></p> <p><i>We are not fully prepared. If we used a plan today, we would use what we did in 2019 (Municipal Manager 01).</i></p> <p><i>If we've already been through it, we more or less know what to expect. I think that after COVID-19, which was another disaster, it prepared us a lot (Municipal Manager 03).</i></p>

Source: Own elaboration.

Faced with the possibility of a disaster, efficient and timely communication between health services and the population is essential. Local media outlets have been identified as quick strategies for reaching the population and disseminating warning messages about the dangers of a disaster and its consequences, especially for at-risk communities. This communication is used as a technological tool to control risk situations and protect and promote health, both environmental and occupational⁴².

Managers' experiences, whether positive or negative, have resulted in an accumulation of knowledge. Moreover, they can guide best practices in the event of a future disaster, raising awareness of the importance of drawing up and implementing action plans early on, led by a qualified technical team.

It is crucial to consider the need for ongoing education and training for professionals, especially given the context of public health in Brazil, where a significant portion of management positions are filled through political appointments. This can lead to high turnover and low technical qualifications among professionals. Additionally, the demands of daily service dynamics and the various health situations faced regularly, along with the complex overlap of health and socio-environmental issues, limit the ability to address other priorities.

Freitas¹¹ emphasizes promoting continuing education for health professionals by conducting periodic training with simulated exercises for disaster situations to test and update the established plan.

Technical reports detailing the actions taken, methods used, challenges, and successes achieved are valuable for current and future management. They provide insights to the manager so as not to repeat mistakes and allow successful experiences to be replicated¹⁴.

It was observed that services, professionals, and management lack preparation to respond to such situations. There is no prior planning or mobilization for implementing disaster risk

management, leaving the region vulnerable to these events.

Health management should maintain a process of monitoring, evaluation, and actions focused on disaster risk management. To achieve this, it is recommended that disaster management indicators be integrated with health indicators⁴⁰. This would allow for identifying, assessing, and monitoring potential disaster occurrences to implement preventive measures and early warning systems^{13,36}.

Maintaining a process of reviewing and updating the ERPs for disasters, taking into account the dynamics of the territory, the organization of health services, and the training of professionals, among other elements, is fundamental to dealing with the occurrence of disasters⁴².

Final considerations

The disaster crime demanded significant efforts from authorities and relevant agencies to mitigate the environmental and public health impacts on the affected population. The results highlighted significant weaknesses in health management, including the lack of prior organization and planning and the absence of teams equipped to handle such situations in most management agencies across all three levels of government, resulting in an inability to prevent further harm.

Another issue identified was the weakness of social protection measures, particularly the implementation of socio-economic policies. Given that the most affected population (artisanal fishers) lost their means of livelihood and that many did not receive the financial assistance provided by the federal government, some municipalities offered basic food baskets. However, these were insufficient to meet the needs of these families.

Actions aimed at preventing, mitigating, and managing damage resulting from these events do not depend solely on health management but must be joint actions with other

sectors/segments and services, such as environmental agencies, civil defense, social action secretariats, and organized civil society itself. Local communication services are essential in disasters, as they enable the dissemination of information to the population and issue early warnings, which can prevent risky situations.

Given the scarcity of such documents, each federated entity needs to draw up an ERP for oil-related disasters. These plans should cover all phases of disaster management to help manage and prevent this type of disaster, from the risk management phase — to prevent the occurrence of the adverse event — to the recovery and resilience phase of the affected areas.

Collaborators

Alves MJCF (0000-0002-6704-6623)* contributed to the conception, collection, analysis, and interpretation of data, writing and critical review, and final approval of the manuscript. Machado LOR (0000-0002-3364-7930)* and Santos MOS (0000-0002-2129-2335)* contributed to the conception, data collection, critical revision, and final approval of the manuscript. Freitas CM (0000-0001-6626-9908), Costa RCL (0000-0003-4913-4846)*, Gurgel AM (0000-0002-5981-3597)* and Gurgel IGD (0000-0002-2958-683X)* contributed to data analysis and interpretation, critical revision, and final approval of the manuscript. ■

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