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Safety and Accidents in Fishing: A Study of Causes and Risk Factors in the Norwegian Fishing Fleet

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ABSTRACT

Objectives: The Norwegian government declared Vision Zero for serious injuries and fatalities for everyone working at sea in 2022. Occupational accident rates in the Norwegian fishing fleet are higher than those for other maritime industries, and measures must be based on a thorough knowledge of causes. This article aims to provide updated knowledge on causes and risk factors for occupational accidents in the Norwegian fishing fleet.

Methods: Three sources of data were used: 1) A database of fatal accidents updated by the research institute SINTEF Ocean and a registry of occupational injuries kept by the Norwegian Maritime Authority, 2) 40 accident investigation reports published by the Norwegian Safety Investigation Authority, and 3) interviews with 12 active fishers and representatives for key stakeholders involved in fishers' safety.

Results: Analyses of occupational accidents indicated more than half of fatalities in the period 2000–2022 were due to vessel disasters and fisher overboard events. Most of those involved worked on vessels that were 6–10.99 m in length. Accident investigation reports published in the period 2013–2023 indicate many overboard accidents happened to fishers working alone and were caused by fishers being dragged overboard with equipment, fishers falling overboard, or ropes under tension suddenly snapping. The interviews revealed the fishers and key stakeholders were concerned about accidents. The underlying causes and risk factors they described were technological (vessel, fishing gear, and equipment), organizational (planning and decision-making, competence and training, working hours, and rest), and regulatory (control and inspections, requirements for safety management, and fisheries management and safety). Furthermore, the interviews indicated fisheries management may have a negative influence on safety and working conditions and need be considered to improve fishing safety.

Conclusion: Coastal fishers are overrepresented in fatal accidents, while most occupational accidents are reported from sea-going trawlers. Measures should target technological, organizational, and regulatory factors, as well as framework conditions.

KEYWORDS

Fishers; fishing vessel; occupational accidents; occupational health and safety; safety

Introduction

It is time to move away from the old mindset through hundreds of years – that people die at sea. The sea gives and the sea takes. We must move on; six deaths per year in fishing is way too high. Perhaps it is time to aim for zero injured and dead in fishing.¹

This statement from Olve Grotle, a Norwegian politician whose father worked as a fisher, led to a historic decision. In 2022, the Norwegian government declared “Vision Zero” for serious injuries and fatalities for everyone working at sea. A national action plan to achieve this vision is planned to be launched in 2024.

The Norwegian fishing fleet has had higher accident rates than other maritime industries for decades, and fishers are concerned their work may adversely affect their health.^{2–5} Global accident

rates among fishers demonstrate that efforts to improve fishers' working conditions are greatly needed.^{6–8} Fishing has long traditions in Norway, and fishers today are key actors in value chains that not only provide food to the global society but also have ripple effects and considerable export value to the Norwegian society.⁹

At the end of 2022, there were 9,597 people registered as full-time fishers, and 1,233 were registered with fishing as a secondary occupation.¹⁰ The active fishing fleet consisted of 4,713 vessels, of which 4,465 were coastal vessels under 28 m in length.¹¹ A total of 3,670 vessels were below 11 m in length and were likely operated by one fisher on board. Common types of fishing gear in the coastal fleet are gillnets, longlines, Danish seine and jigging for fishing cod, haddock, and saithe. Deep-sea

vessels use longlines, gillnets, Danish seine, purse seine, or trawls.

Since the 1980s a cohesive regulatory regime aimed at sustainable resource management has been in place for fishers,¹² but regulation of occupational health and safety came late compared to other industries. Today, fishers must document their safety work in safety management systems, first introduced for vessels above 500 gross tonnage in 2010 and for all fishing vessels since 2017. While the Directorate of Fisheries are responsible for fisheries management, it is the Norwegian Maritime Authority (NMA) who are responsible for safety at sea for all vessel types.^{12,13}

NMA keeps an official register of reported occupational fatalities and injuries on board Norwegian vessels, including commercial fishing vessels. In addition, the Norwegian Safety Investigation Authority (NSIA) examines fatalities for occupational fishers. However, thorough analyses of characteristics and causes of fatalities and reported accidents in occupational fishing have not been updated since 2012.^{4,5,14}

Achieving Vision Zero means putting safety first. Arguing that preventive and mitigating measures must be based on a solid knowledge of causes, the objective of this article is *to provide updated knowledge of causal chains and risk factors for occupational accidents in the Norwegian fishing fleet*. Three research questions, drawing on three data sources, guided the study:

- (1) What are the key characteristics of registered fatalities and reported injuries in commercial fishing?
- (2) What contributing or underlying causes for severe accidents are described in official investigation reports?
- (3) What do active fishers and key stakeholders involved in fishing safety identify as key causes and risk factors for accidents in the coastal fishing fleet?

Methods

This article presents analyses of registered fatalities and injuries in the Norwegian fishing fleet, accident investigation reports, and an interview study.

While some argue against the term accidents when referring to preventable events, this study uses the definition of “accident” used by Rausand and Haugen¹⁵: “An accident may be defined as a sudden, unwanted, and unplanned event or event sequence that has led to harm people, the environment, or other tangible assets.”^(p. 35) This is in line with the definition applied by Leveson.¹⁶

Analyses of occupational accidents: registered fatalities and injuries

Two sources of occupational accidents for the period from 2000 to 2022 were used for this study. The first source is a database of fatalities in the Norwegian fishing fleet maintained by the Norwegian research institute SINTEF Ocean. It is based on official sources, such as media articles and public accident investigation reports, in addition to personal communication. The database has been updated over several years and is described in detail by McGuinness et.al.⁵ The second is the reported occupational nonfatal and fatal injuries on board Norwegian commercial vessels registered by the NMA, to which the authors were granted access for the study. The analyses are an update and continue the time series published by McGuinness et. al.⁴

Both data sources contain fatalities and thus overlap. The SINTEF Ocean database has criteria other than NMA for inclusion of fatal events, and it contains information about drownings at port, assumed suicides, and occupational accidents related to maintenance of fishing vessels and gear storage/handling on the quay, which is not included in the NMA registry. Furthermore, NMA also register personal accidents on board foreign fishing vessels in Norwegian waters, as well as vessel disasters in foreign waters when a Norwegian ship has been involved in the accident (e.g., collisions between Norwegian cargo ship and a local fishing vessel).

Based on these data sources, a systematic analysis of registered personal injuries and fatalities on board fishing vessels was conducted. Frequency counts, the number of accidents per year, vessel category, event types, injury modes, fishing gears used, and work operations were identified.

Fatality rates were calculated as the number of injured fishers per 10,000 person-years (fatalities

registered by SINTEF Ocean). Incident rates were calculated as the total number of nonfatal and fatal injuries registered by the NMA per 1,000 person-years. In this context, “incident” is used for both nonfatal and fatal accidents. The person-years are derived from yearly registrations of the number of occupational fishers in Norway in the official registry “Fiskermanntallet”,¹⁰ according to an equation that takes both part-time and full-time fishers into account.^{4,5} The calculation of person-years is thus a way to standardize the effective working time for all registered fishers in Norway to express the time at risk.

Microsoft Excel was used for storage and categorization of occupational injury data, as well as conducting analyses and making charts.

Accident investigation reports

While registrations of occupational accidents give valuable information about direct causes and the injuries, they usually provide scarce information about contributing and underlying causes. According to the legislation, the NSIA are required to investigate all accidents where lives are lost at sea. The reports provide information about the course of events and causal chains, based on witness accounts (if any) and other materials. For this study, 40 accidents involving Norwegian fishing vessels that happened in the period 2012 to January 2023 were analyzed systematically to identify contributing or underlying causes. Data were abstracted from relevant NSIA reports published in the period 2013 to January 2023, and two researchers categorized the data according to accident type (e.g., vessel disaster), direct causes and underlying causes (organizational, operational/human, and technical factors).

Interview study

The interview study targeted the coastal fleet, where fishers historically have been more prone to fatalities than other parts of the fleet. Based on an interview guide designed for the study, semi-structured qualitative interviews with 12 people were conducted in September to December 2023 to study underlying causes and risk factors. The questions were open-ended and aimed to elaborate

on topics the informants were particularly concerned about based on personal experiences. Informants were asked about their work responsibilities and background, and what they see as common unwanted events, risk factors, and direct and underlying causes of personal injuries and fatalities in fishing. They were also asked about suggestions for measures that can improve fishers’ safety. Interviews were conducted as digital meetings (Microsoft Teams) or by telephone. The informants were chosen to include both active fishers (of different ages, gender, and geographical location) and key stakeholders to safety in the fishing fleet. They were recruited through direct inquiries to fishers’ organizations, via media coverage, and by the snowball method (tips from informants about other relevant informants).

Two researchers participated in each interview, and detailed notes were taken. Analysis was done by inductive coding aimed to find relevant causes and risk factors, and the interview data were categorized into three main categories: technological, organizational, and regulatory.

The material was handled according to the principles established by the Norwegian Centre for Research Data (SIKT reference number 305,769). Rights to use accident data and informed consent from all participants were obtained. The interview participants were all informed about the purpose of the study, and their participation was voluntary and anonymous.

Results

Fatal and nonfatal injuries in the Norwegian fishing fleet (2000–2022)

Fishing fatality database

According to the SINTEF Ocean database for fishing fatalities, 149 occupational fishers lost their lives at work in the Norwegian fishing fleet during 2000–2022. **Figure 1** indicates the number of fatalities each year from 2000 to 2022, as well as the fatality modes and rates.

Regarding the fatality modes, analyses revealed that 92 (61.7%) of the 149 fatal accidents were caused by vessel disasters and overboard events (**Figure 2**). Furthermore, there were several drownings at port (16.8%). The fourth most

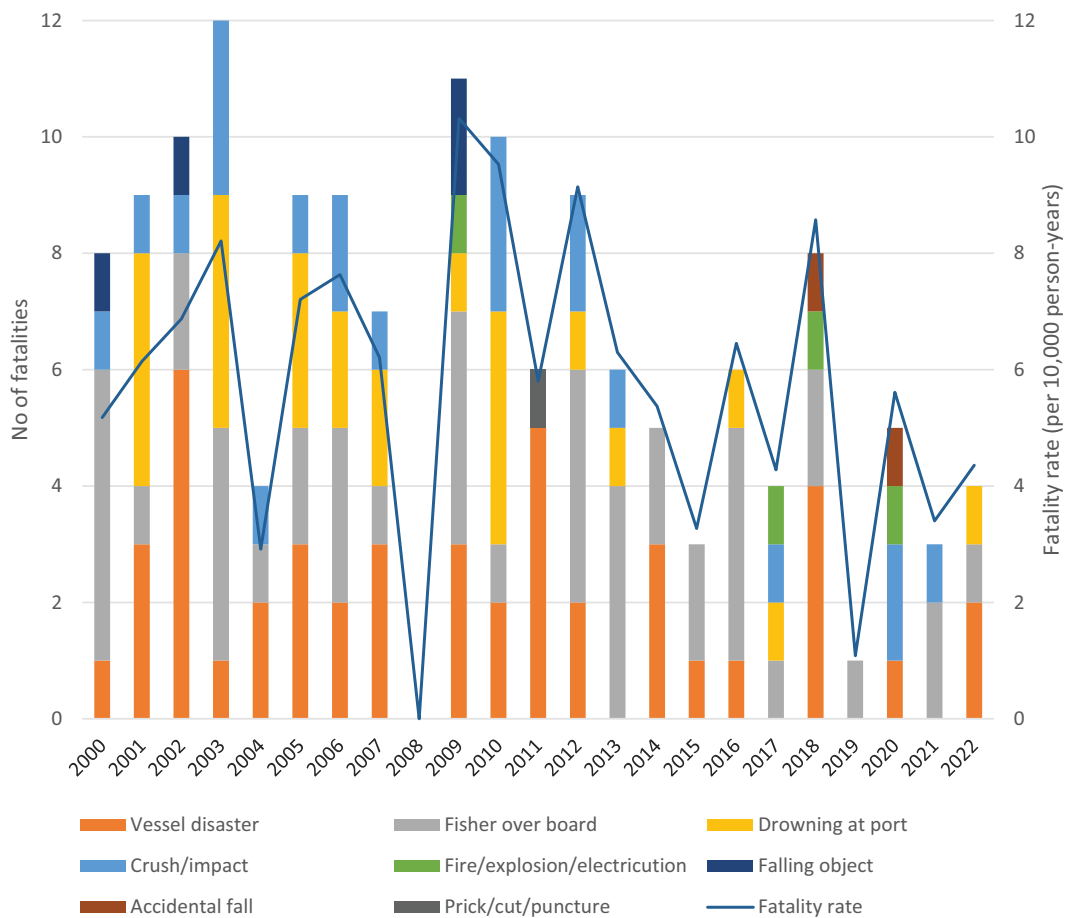


Figure 1. Fishing fleet fatalities for 2000–2022 (149 in total), fatality modes, and fatality rates (per 10,000 person-years). Source: SINTEF Ocean database.

frequent incident type was blows or crushes from objects (14.1%). In total, 93% of all occupational fatalities in commercial fishing during 2000–2022 can be traced back to these four fatality modes.

Figure 2 also indicates which fleet groups (sorted by length) within which the fatalities occurred. The highest fatality rate was found for the vessel group 6–10.99 m. As many as 79 (53.0%) of the 149 fishers who lost their lives worked alone on smacks, and among these, vessel disasters and overboard accidents were the most frequent types of events (63 fatalities). Small coastal fishing vessels (11–14.99 m) were the second most accident-prone (11.4% of the 149 fatalities), while 9.4% of the fatal accidents occurred on trawlers over 28 m in length.

Drowning at port (16.8% of the accidents) has occurred in all vessel groups, except the very smallest (“open fjord boat” < 6 m). Drowning at port was the dominant event for the vessel group

“medium coastal fishing boat” (7 out of 11 fatalities in this group) and purse seine vessels (3 out of 4 fatalities). However, Figure 1 indicates a positive trend in that the relative share of drowning-in-port accidents has decreased since 2015, and in the latest 5-year period (2018–2022), one fisher drowned in a fatal incident at port.

On longliners/gillnetters and trawlers, overboard accidents were the most common accidents during the years included in the analyses (Figure 2). These are often incidents caused by entangling in the fishing gear, ropes, or lines, leading to fishers being pulled overboard. Crush/impact from objects or equipment was also a frequent fatality mode (14.1%) and caused fatalities in all vessel groups, except on the open boats and purse seiners. During the study period, this was the most common fatality mode on large coastal fishing vessels (4 out of 12 fatalities).

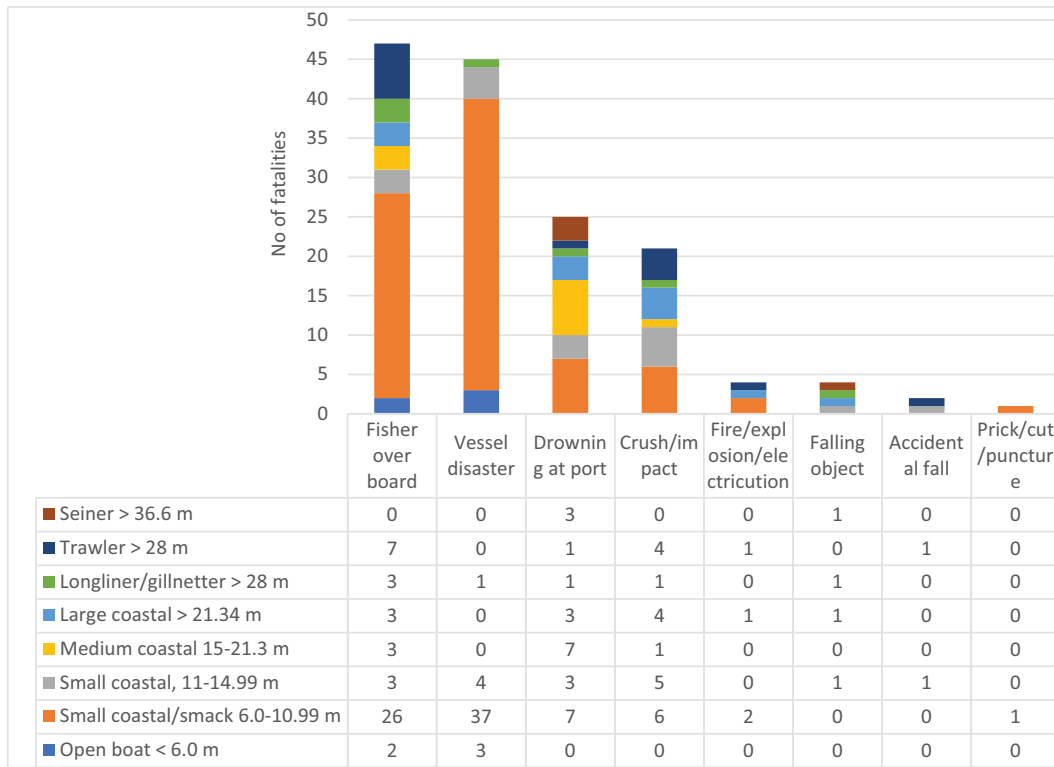


Figure 2. The 149 fatalities for 2000–2022 categorized according to event type and fishing vessel groups.

Occupational accidents registered by the NMA

A total of 3,815 fatal and nonfatal incidents, which included 3,673 occupational injuries and 142 fatalities, were registered by the NMA in the study period. Figure 3 presents the total number of registered injuries per year. In this section, the

incident rate is calculated as the number of injured fishers per 1,000 person-years.

The NMA categorizes occupational accidents into 13 modes of injury, with all categories analyzed in this study. Table 1 presents the event or exposure types, number of registered injured

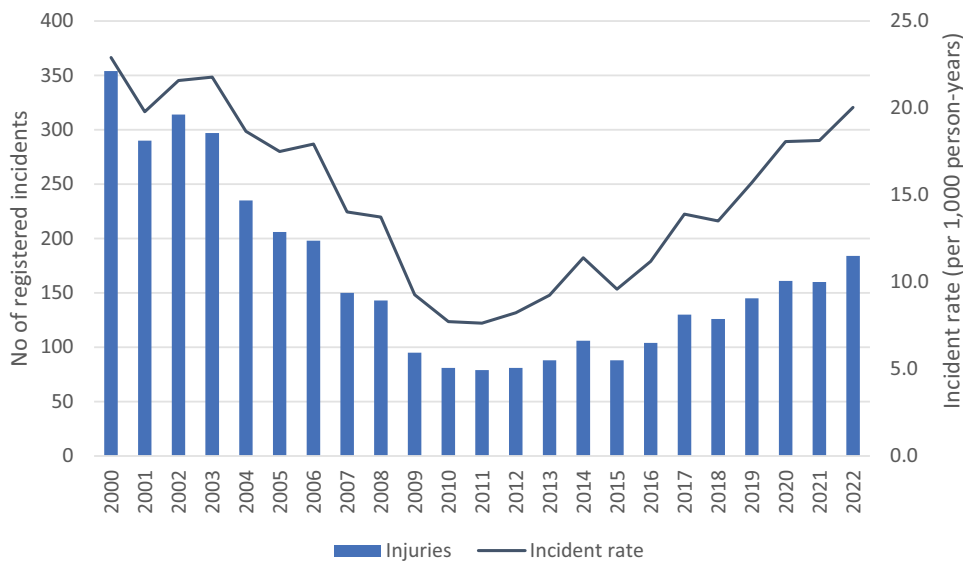


Figure 3. Number and rate of occupational injuries (n = 3,815) registered by the Norwegian maritime authority (2000–2022). The incident rate is calculated as the number of injured fishers per 1,000 person-years.

Table 1. The number of occupational accidents categorized according to event/exposure type, registered by the Norwegian maritime authority for 2000–2022 (in total 3,815 incidents).

Event/exposure type	No. of injured fishers (2000–2022)	Percentage of total
Entanglement or crush	837	21.9%
Blow by an object	799	20.9%
Fall to the same level	597	15.6%
Prick/cut/puncture	349	9.1%
Fall to a lower level	370	9.7%
Lifting, carrying	264	6.9%
Use of tools/equipment	115	3.0%
Exposure to toxic chemicals	108	2.8%
Fall into sea	105	2.8%
Vessel disaster	72	1.9%
Exposure to high/low temperature	42	1.1%
Explosion, fire, gas, or exposure to electricity	37	1.0%
Other accidents	120	3.1%
Total	3,815	100.0%

persons, and the number of incidents in each category as a percentage of the total number (3,815).

“Entanglement or crush” was the most frequent cause of all injuries (837 or 21.9% of all 3,815 incidents). “Blow by an object” was approximately at the same level (799 or 20.9%). There were also many injuries due to falls. The NMA has categories for both “fall to the same level” and “fall to a lower level.” If the two categories are combined, they result in a quarter of all occupational accidents.

Figure 4 presents a graph showing the number and incident rate of occupational injuries for seven

vessel groups. The trawler fleet was registered with the highest number of reported occupational accidents (1,499: 39.3% of 3,815 registered incidents), while the fewest were reported from the coastal fishing fleet under 21 m in length (a total of 19.5%).

Further analyses of which work operations were ongoing when the incidents occurred demonstrated the work operation with the highest frequency of injuries was “setting and hauling gear, other work on deck” (Table 2). There were 1,992 injuries or 52.2% of the total registrations that occurred during such operations on deck. The second most injury-prone work operation

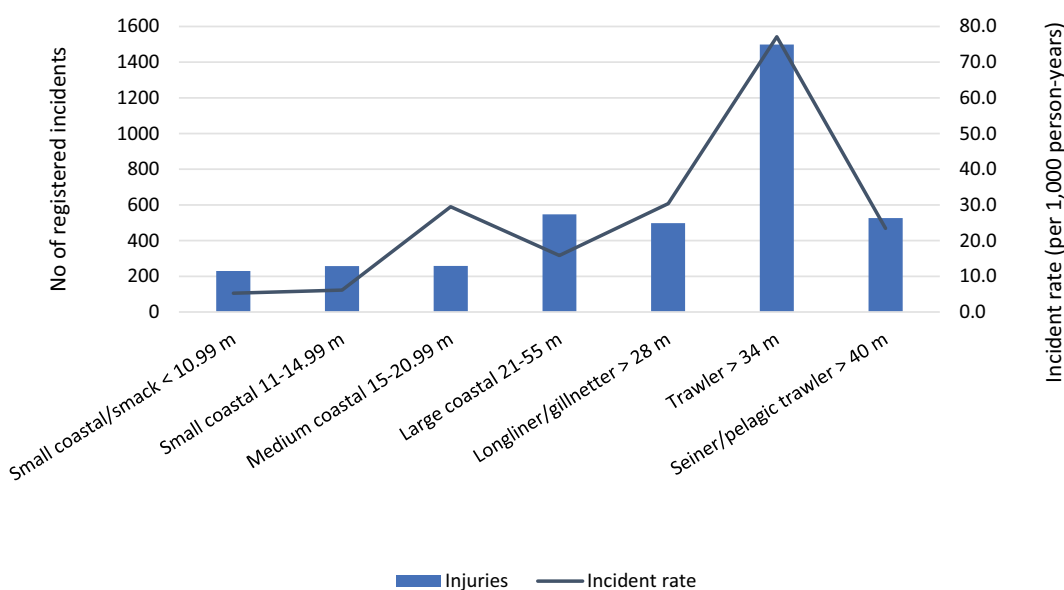


Figure 4. Occupational injuries per vessel group for 2000–2022 (3,815 in total). The incident rate is calculated as the number of injured fishers per 1,000 person-years. Data source: Norwegian maritime authority.

Table 2. The main work operations ongoing when the incidents occurred. Based on occupational accidents registered by the Norwegian maritime authority for 2000–2022 (in total 3,815 incidents).

Work operation	No. of injured fishers (2000–2022)	Percentage of total
Setting and hauling gear, other work on deck	1,992	52.2%
Catch handling, work in the hold, cleaning, working with loads	941	24.7%
Passage onboard, to and from vessel, mooring/anchoring and port work	332	8.7%
Repairs, maintenance, on deck or in engine room	273	7.2%
Work in galley, mess, accommodation	134	3.5%
Work in the wheelhouse, vessel preparation, use of lifeboat	59	1.5%
Vessel disaster	84	2.2%
Total	3,815	100.0%

was “catch handling, work in the hold, cleaning, working with loads.” This kind of work is performed partly on deck but mainly below deck. A total of 941 accidents (24.7%) occurred during such work, which is a quarter of the registered personal accidents during 2000–2022. “Passage onboard, to and from vessel, mooring/anchoring and port work” is the third category on the list of work operations with the highest likelihood of occupational injuries – a total of 332 accidents (8.7% of 3,815). In total, these three work operations are linked to 85.6% of all occupational accidents analyzed in this study.

Underlying causes and risk factors according to investigation reports

Reports from the NSIA provided insights into contributing and underlying causes of fatal accidents in the fishing fleet. For fishing vessels there is a difference in the regulations between vessels above and below 15 meters. For fishing vessels below 15 meters, only fatal accidents require investigation, but for vessels above 15 meters, vessel disasters and accidents resulting in considerable damage to the environment are also investigated according to the regulations. Nonfatal occupational injuries are not investigated by the NSIA.

In 2013–2023, the NSIA published 40 investigation reports on accidents involving fishing vessels that were within the scope of the study. Of the accidents, 17 were due to vessel capsizing (13 fatalities), and two involved collisions (no fatalities). There were 21 reports categorized as “occupational accidents.” These were incidents with fatal outcomes due to overboard accidents (14), entanglement/crush (6), and fire/gas and explosions (1). In total, the 40 investigated accidents resulted in 34

fatalities, and 14 of them involved fishers working alone on board.

Overboard accidents were either caused by the fisher being dragged overboard with the equipment, the fisher accidentally falling overboard, and in one case the fisher fell due to a rope under tension that accidentally tore. Of the 14 overboard accidents, 10 involved fishers working alone.

Heavy equipment caused five of six entanglement/crush injuries. The underlying and contributing causes of these accidents were described as a lack of training or safety understanding, a lack of risk assessments, and a lack of physical barriers. Vessel stability was stated as a contributing cause for 12 of the 17 vessel disasters. Here, missing control of stability calculations, errors in stability calculations, and marginal rest stability were mentioned, often in combination with the design of scuppers and heavy loads on deck.

Technological factors were mentioned in 8 of 40 reports, underlining the importance of evaluating operational risk in the design phase, and building physical safety barriers into the equipment or the vessel itself (i.e., fishing gear, winches, and deck layout). In 10 of the total 40 reports, different aspects related to the regulatory authorities were mentioned, including a lack of regulatory requirements or inspections.

Causes and risk factors according to fishers and key stakeholders

The interview informants were six active fishers (coastal fishers, aged 17–60 years old, male and female) and six representatives for key stakeholders involved in fishers’ safety (three authority

representatives, an insurance agent, a Coast Guard staff member, and a high school teacher who teaches students who study for a certificate of apprenticeship in fishing).

Overall, the interviews conducted revealed that coastal fishers, as well as the stakeholders involved, are anxious to reduce the number of accidents: “One accident is one too many” (Fisher 4). Avoiding falling overboard is a key concern, especially for fishers alone on board, as echoed by an informant from the authorities, “Falling overboard at sea is the most dangerous” (Authority Representative 1). The fishers also related this opinion: “I am conscious of avoiding situations that may lead to me falling into the sea” (Fisher 3).

Findings from the interviews were categorized according to the underlying causes, risk factors, or concerns the informants highlighted. The main categories (and subcategories) were:

- (1) Technological (vessel, fishing gear, and equipment);
- (2) Organizational (planning and decision-making, competence and training, and working hours and rest);
- (3) Regulatory (control and inspections, requirements for safety management, fisheries management and safety).

These categories are described in more detail in the following sections.

Technological

Regarding technological aspects, the design of the vessel, fishing gear, and equipment is considered important for safety. This is reflected in avoiding overboard accidents and ensuring optimal stability and maintenance of vessels. It was noted that technological development contributes to improved safety, both in new vessels and if changes to the vessels are made.

Fishing gear was also discussed as a risk factor. For instance, risk sources on board should be removed or reduced by shielding gear and ropes from people. Emergency stops and less manual handling of gear were mentioned by some informants as beneficial. In addition to acute accidents, there was also concern about strain injuries and

a greater awareness of this: “When I started, [the work] was supposed to be heavy. Now, we have aids”. (Fisher 3)

The benefits of different types of safety equipment were discussed in the interviews, including knives to cut ropes, personal floating vests, and helmets. Some also pointed out the need for suitable workwear for female fishers. An automatic identification system (not mandatory for all fishing vessels) was considered an important safety measure and tool for search and rescue operations.

Not all equipment received positive reviews. Safety lines designed to hinder fishers falling overboard were considered impractical by some fishers: “The safety line does not work for me; it would be dangerous. It is perfect if one stands in one place all the time” (Fisher 1).

Organizational

Planning and decision-making

The interviews indicated fishers are aware of many hazards and planning and decision-making are important for handling hazards and risks. The informants highlighting the need for taking precautions – as one fisher said, “You have to be alert and rested and stand inside as much as possible between operations to not get stuck and dragged out (Fisher 2)”.

Bad weather was considered a contributing factor to accidents – as unforeseen “things can happen, especially in bad weather” (Fisher 3). Bad weather affects vessels’ movements and can complicate fishing operations. One fisher stated “currents and wind are particularly important to consider when fishing for crayfish and crab, and despite being careful, it was often in good weather that things happened” (Fisher 5). Fisher 3 noted despite not being “an exact science, the weather forecast is crucial for planning and making decisions as fishers”.

Regarding decision-making, economic assessments are important for coastal fishers: “The money can only be spent once” (Fisher 1). Moreover, Authority Representative 3 underlined some of the small vessels are sometimes in poorer conditions due to the small quotas: “One often starts with a poorer boat than those who have been in the industry for a long time.

Some have boats that are in relatively poor condition.” Even with planning the work, unforeseen events or what are referred to as “just need to” events are considered a risk factor: “As long as things are going routinely, things go well. But when unforeseen things happen, the focus on one’s own safety can decrease. This often happens in connection with *just need to*” (Authority Representative 1).

Competence and training

A lack of knowledge or competence was perceived as an underlying cause for accidents:

Many accidents are due to a lack of basic knowledge.
(Fisher 2)

Most capsizes are due to poor seamanship.
(Fisher 3)

This, in turn, can be linked to poor training. For new fishers, onboard training introduces them to knowledge through practice. Working in a safe way was described by one fisher as the small things one learns through practice: where to hold when walking, where to get a grip when the sea is rough, where to tread, and where it is slippery. The fisher noted one makes a mental assessment before performing tasks so one can be confident in where to place one’s feet because “falling overboard is forbidden” (Fisher 1).

Who is responsible for training on board can be of great importance. A young fisher who had been deployed on several boats throughout high school highlighted there are different routines on different vessels and some fishers are more careful than others. The formal safety training for fishers is a 40-hour course (the STCW-F), and fishers consider it vital to reduce risk. Still, some noted the course is too focused on rescue and less on prevention and performing the work safely: “The safety training does not involve work practices” (Fisher 2).

Competence also relates to feeling safe: “I feel relatively safe and would claim I am in control” (Fisher 6). However, some informants believed fishers feeling they are in control may also be a challenge to safety: “The biggest challenge is the culture of ensuring their own safety. They work alone and do not have to take responsibility

for others. They feel that they are in control” (Authority Representative 3).

Working hours and rest

A lack of rest was highlighted as a risk factor, but several informants noted it can be difficult to follow the requirements for rest: “One works until one is finished, especially when there is a lot of fish. But one probably takes it too far” (Authority Representative 3).

Regulatory

Control and inspections

A lack of control and inspections by the authorities or that fishers do not address errors and deficiencies was considered an underlying cause of accidents. Both active fishers and other stakeholders were concerned with supervision as a crucial factor for safety at sea and stated supervisory inspections activity should be increased: “If the NMA had had more outreach activities, it would have had an effect” (Authority Representative 3). More cooperation between the Directorate of Fisheries and the NMA was also highlighted, as the visibility and inspection rate by the directorate through inspections at ports and at sea was described as higher than that of the NMA.

Requirements for safety management

Requirements for safety management apply to all fishing vessels and are often emphasized by authorities as highly important for safety. A lack of safety management was, therefore, explored through interviews as a potential risk factor. However, the interviews revealed fishers do not actively practice safety management to prevent accidents. While assessing the hazards on board as part of the work, many coastal fishers are not used to conducting and documenting systematic risk assessments required by the authorities. Fisher 3 noted, “It is made for larger vessels and difficult for smaller vessels to follow.”

Fisheries management and safety

Fisheries management was described as an underlying cause for accidents through different examples. Even though 80% of the catch value is

subject to access and/or catch regulations, there are still some fisheries that are not access or quota regulated. These fisheries are regulated through maximum quotas or group quotas – which often provide incentives for intensive fishing to ensure the largest possible share of the group quota, also known as race fishing or Olympic fishing. In open-access coastal fishing and Greenland halibut fishing, participants fish on a group quota. One fisherman believed these regulations could cause fishers to “push the limits” by, for example, pushing the boat and engine more than they should (Fisher 1). Another informant said, “Olympic fishing has a safety aspect because the fishers push the boundaries and work long hours. This affects safety in a negative sense, without a doubt” (Authority Representative 3).

Many informants were concerned about lone fishing, highlight it as a significant cause of fatal accidents:

Being alone on board . . . when it goes wrong, it goes very wrong.” (Authority Representative 2)

We will not have total safety until everyone understands that being a sole fisherman is dangerous. (Insurance representative)

For parts of the coastal fishing fleet, the discussion about being able to have more people on board was also related to the so-called co-fishing scheme. In practice, the co-fishing scheme means two fishers can be together on board and fish both quotas on one of the two vessels. However, the scheme does not apply to small boats that fish on group quotas (as seen in open-access coastal fisheries). Sole fishers do not necessarily have the finances to be more on board: “Would like to be more people on board, but it is an economic problem” (Fisher 2).

Furthermore, some consider reporting requirements a safety hazard because it requires attention that is needed to conduct the fishing operations: “What stands out in fisheries is the total workload with reporting. The regime is too overwhelming with everything that should be reported. The sum is too big” (Authority Representative 1).

Discussion

To put safety first, the knowledge about contributory causes to accidents as well as perceived risk-influencing factors provided here are important to consider. Considering Vision Zero for serious injuries and fatalities, the study findings indicate more than half of the 149 fatalities were due to vessel disasters and overboard accidents. Furthermore, 79 of the 149 fatalities worked alone on-board smacks (vessel length: 6–10.99 m). Gillnetting is the vessel activity causing most fatalities (31 of 79 smack fishers).

According to the registrations by the NMA, the number of occupational injuries decreased from 354 incidents in 2000 to 79 in 2011, after which it seems to increase again. The decreasing trend in number of incidents from 2000 to 2010 was probably partly due to a decreasing number of active vessels and occupational fishers. However, if this was the only explanation, the injury rate would have remained stable, which also decreases in the same period. From 2000 to 2022, the number of Norwegian fishers decreased by 33%. Another explanation is that the NMA changed its registration routine from using a copy of a form submitted to the Norwegian Labour and Welfare Organisation to asking the fishers to report on an additional form to the NMA. This extra reporting work might have caused fishers not to report to the NMA, as the social security benefits are considered more important. Occupational accidents with no or minor injuries may then have been neither reported nor registered. After 2013, the number of reported incidents increased. This increase is partly because the NMA now focuses on preventive work and learning from incidents and encourages all injuries to be reported. It is reasonable to believe that relatively more accidents are being reported, as the number of fatalities has decreased during the same period.

While the small fishing fleet is overrepresented regarding fatal injuries, the highest number of reported nonfatal occupational injuries comes from the trawler fleet, where accidents often happen during fishing operations on deck and catch work. However, the nonfatal occupational injuries are not investigated by the NSIA, but previous studies have described ship motion, failure to

adequately maintain equipment, a lack of safety procedures, a lack of safety awareness, pressure, stress, fatigue, and long work hours as underlying causes.^{4,17,18}

Previous studies have argued that the operational orientation of fishers should be considered when safety management is implemented to avoid conflict with safety practices.^{12,19} Understanding fishers' perceptions of risk and practices to stay safe is, therefore, important.^{12,20–25} Concerns raised about economy influencing boat standard, maintenance, and fishing alone were discussed in the interviews conducted for this study and have also been documented in other studies and countries.^{17,18}

In this study, interviews targeting the risk-exposed coastal fleet add experience-based knowledge that both overlaps with and expands the findings from previous research as well as the occupational accident and investigation reports analysis. Overall, results from analyzing injury incidents, investigation reports, and interviews show several overlaps. Fishers are very concerned with overboard accidents and prevention of risk through design and seakeeping abilities of the vessels, considering the weather, using safety equipment and shielding themselves physically from ropes and equipment. The NSIA encourages fishers to use safety equipment, such as safety lines, personal floating devices, emergency stops, and rescue ladders to reduce the consequences of falls overboard. Interviews also point out lack of training and lack of inspections from the authorities as risk factors for accidents – findings that overlap with the NSIA investigation reports.

Findings from the interviews not described in accident and investigation reports are the potentially negative impacts of the fisheries management regulations on fishers' working conditions. Interviews show regulations that restrict co-fishing (to avoid fishing alone), feeling pressured to go to sea due to Olympic fishing regulations, or being distracted because of overwhelming reporting requirements are seen as concerning for safety. While fishers also call for more safety inspections from the authorities, the concerns described here relate to the fisheries management regime, rather than the safety regulations. This calls for a holistic

approach to fishers working conditions and measures for safety.

Historically, the regulation of fishers' activities has targeted the conservation of fish stocks and profitability of the fleet, while safety regulations came late compared to other sectors. The occupational health and safety regulation has been related to the International Maritime Organization and the EU.^{26,27} There has been little overlap in the design of regulations in the two domains of fisheries management and occupational health and safety regulations, which are tied to two separate authorities.¹³ Similar descriptions of compartmentalized administrative responsibilities, little attention paid to the relationship between management and fishing safety despite management negatively impacting safety, have been previously described in other countries.^{28–32}

Study limitations

This study used multiple data sources, but some study limitations may influence the results presented. For the fatal accidents the SINTEF Ocean database and NSIA investigation reports provide additional information that is valuable to understand the contributing causes. For the accidents reported to the NMA there is little or no information about underlying causes. Furthermore, even though the NMA encourages all injuries to be reported, the lack of incentives to report and the lack of an administration are expected to cause underreporting, especially from the coastal fishing vessels and fishers who work alone.

The fatality rates are quite unstable due to the small numbers analyzed per year (Figure 1). This could have been solved by a multiple year grouping to compare fatality rates. However, the number of full-time fishers in the national registry was reduced by 40% from 2000 to 2010, which greatly influence the number of person-years and hence the fatality rate. In this context it is valuable to follow the fatality rates year by year.

Qualitative interviews provide valuable insight into people's perceptions and experiences. For this study, both active fishers and stakeholders for fishing safety participated. Informants from different age groups, gender, and geographical location were included. It is important to note

the study may still hold limitations regarding the selection and number of participants, the interview design, as well as the analysis of data performed by the researchers.

Conclusions

To achieve the Norwegian government's Vision Zero for fatalities and serious injuries at sea, measures that target commercial fishers are paramount. Coastal fishers are particularly vulnerable to fatal accidents, including overboard events, while the highest number of occupational injuries is reported from the sea-going trawlers, with most of these accidents happening during work operations on deck.

While it is individual fishers who are most exposed to the risk at sea, a range of stakeholders may hold the key to measures that can interact and help put safety first. Some key stakeholders are regulators and ship owners, as well as boat designers, fishing gear suppliers, insurance companies, organizations and institutions providing training for fishers. As this study has demonstrated, measures should target technological, organizational, and regulatory factors. Instead of limiting the scope to the safety regulations, measures aimed at framework conditions related to economy and fisheries management are important to consider moving forward.

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Editorial disclaimer

The scientific discipline of injury prevention describes fatal and nonfatal injuries as predictable and preventable. In the English language, the term "accident" implies a random, unavoidable event or "act of God" and, thus, in the United States, where the *Journal of Agromedicine* is housed and edited, the philosophy is to replace these terms with event and incident, or detail such as crash, fall or suffocation. However, this is not a universal philosophy; therefore, this article from a Scandinavian country, uses the word "accident."

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