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Injury and time studies of working processes in fishing

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Abstract

Epidemiological studies of occupational injury document the incidence rates of the main structures as type of workplace and the work departments. The specific work processes within the departments represent an internal structure where the injury rates have not been given much attention before.

The purpose of the present study was to relate the length of the working time to the number of injuries for the specific working processes in fishing. Time measurements were performed during participation in fishing trips with four different kinds of vessels. Risk index numbers for the specific working processes were calculated by dividing the number of injuries within a 5-year period with the total sum of minutes used for each working process as measured during one fishing trip for each type of fishing. The highest risk index numbers were found for embarking and disembarking the vessel, which only takes a minimum of time for the fishermen. Also for other working processes, especially working with the gear and nets, the index numbers were high and relevant for the prevention. This can be used as a supplemental tool of injury prevention to point out working processes that need high attention for prevention. The method can be applied for other industries.

Keywords: Time studies; Fishing; Injury; Prevention; Working process; Speed

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1. Introduction

Commercial fishing has been recognised as the most dangerous economic activity in the European Union (EU), having an injury incidence rate 2.4 times the EU occupational average (EU, 2001). As a preventive measure, the fishing industry must comply with the EU directive about risk assessment in the workplace. A workplace assessment is carried out as regards the potential risks to health and safety of workers arising in the normal course of their activities and duties (a priori analysis) (Dorval, 1984; Saari, 1986). This assessment can be compared with data from previous accidents and near accidents (a posterior analysis). Accident statistics provide an overview of the number of injuries in this industry compared with other industries, but the statistics lack details as to specific working processes and fishing methods. In a study of self-reported occupational injuries among European fishermen, 22 different working places on board and 17 different processes were described. To allow comparison of results across countries the working activities were however classified in a few main working processes (Dorval, 1984). In a Swedish study, the injuries were allocated to 18 different groups of a combination of working processes, contact forms and injury mechanisms on trawlers (Törner and Nordling, 1999). None of the above-mentioned studies offers a precise description of the working processes or their time duration.

The study populations of occupational injury studies in general are stratified according to the main domains of occupational branches, job-types and the different characteristics of the workers like gender, age, race, education and other similar characteristics. Denominator data for studies of occupational injury have been delimited to the number of person-years or person-days at sea for the fleet. While it has been recommended to perform studies of injury incidence rate related to the specific use of time compared to the specific working processes, no such studies have been published so far (The NORA Traumatic Occupational Injury Team, 1998). In two earlier studies, the specific working processes in different fishing methods were classified and a series of reported injuries were coded according to this system, allowing pointing out the working processes with the highest number of injuries (Jensen et al., 2003, 2005). The purpose of the present study was to find working processes with a high number of injuries in order to point out the processes that need attention and preventive measures.

2. Methods and materials

Two of the authors, (Stage and Noer), both trained fishery technologists, joined the fishing vessels on normal fishing tours with the aim of describing the working processes on the different types of vessels. Definitions and classifications of the working processes were developed. The method has been explained earlier in detail (Jensen et al., 2003, 2005). Fig. 1 describes the procedures of the study.

2.1. Time studies of the working processes during the fishing trips

Time studies were subsequently performed for 4 different types of fishing methods by joining the fishing vessels again: industrial trawler (The fishing method is defined as industrial fishery because fish are landed for processing purposes, e.g. for production of fish oil and fish meal.) and for three types of fishing for fresh market fish: gill-netting, Danish

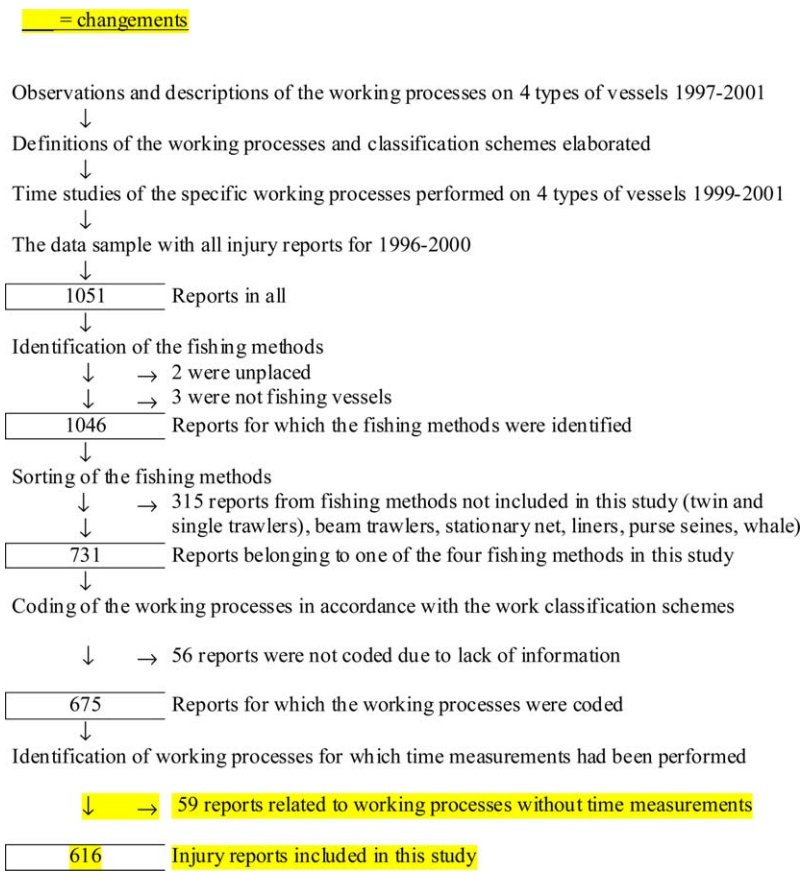

Fig. 1. Procedures of the study and data flow scheme.

seining and 2-trawling (one trawler with a double net). Drawings of the fishing methods are shown in Fig. 2. The time study was performed on a 2-trawler (one vessel with two trawls).

Time was measured by monitoring each crew member's work routines using a separate stop watch and noting the results in the classification. The experts each observed two crew members during the entire expedition. When the observer needed sleep, the crew member on duty took over and registered the used time.

The duration of each working process was calculated as the total amount of time for all fishermen spent on that particular activity during the expedition. The activities related to the specific working processes were performed in a cyclical pattern; the cycles of preparing, shooting and hauling of the gear and nets were repeated 5–10 times per day in each of the 4–9 days' duration of the fishing trips. The time measurements were performed during the whole trip and the total number of minutes for all fishermen was summed up for each of the working processes. All aspects of the working processes were included in the study, e.g. walking past the trawl drum when pulling the nets. The time spent on walking from one activity to another on the vessel was initially included in the related working activities. Later, separate studies of movement activities (traffic on board) were performed; studies of the amount of time spent on e.g. walking up/down a ladder or embarking/disembarking the

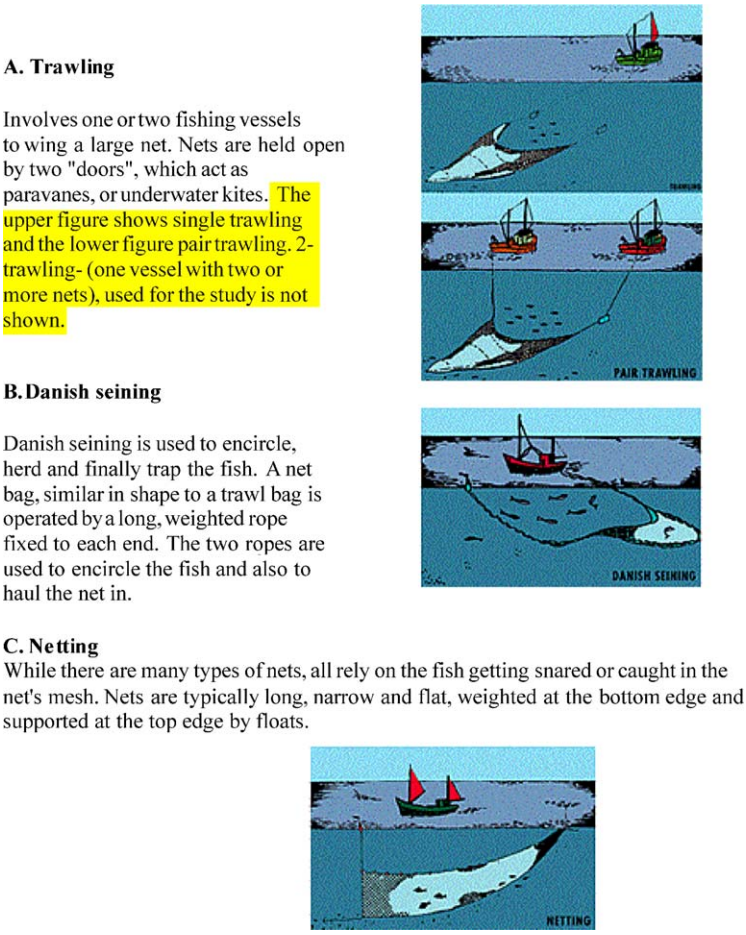

Fig. 2. Illustrations of the fishing methods for netting, trawling and Danish seining are reproduced with kind permission from the Ministry of Fisheries New Zealand, Starfish, Science Facts Sheets.

vessel, were made. The number of times each crew member performed such actions on the whole expedition was multiplied by the length of time necessary to perform each type of personal moving (the fishermen walking around) activity on board, yielding the total amount of time spent on different kinds of individual movements.

Not all of the working processes could be monitored as it was too difficult to follow all three or four crew members, and therefore, only the main activities were monitored throughout the whole fishing trip. Landing the fish was not included in the study, and time studies for activities not carried out on this particular expedition have been omitted.

2.2. Coding of reported injuries

According to Danish law, all occupational injuries resulting in more than one day's absence from work are to be reported to the Danish Maritime Authority on a special form. All injuries reported to the Danish Maritime Authority in the period 1 January 1996 to 31

December 2000 were coded by using the detailed classification system as mentioned before. Names and registration numbers of vessels appeared on the forms, making it possible to identify the vessel type. Fishing methods were identified—except in eight cases—by comparing this data with old volumes of fishing vessel catalogues (illustrated Danish fishing vessels). As regards the eight unidentified vessels, the type and the fishing method of three vessels were identified by information from local fishermen or by our knowledge of local conditions. Three other vessels were not engaged in fishery, and the last two vessels could not be identified. A few parts of the working processes that were not carried out during the expeditions were added in connection with the coding. These included part or sub-processes involved in setting the nets: blocking up, chain strapping the warps, and part or sub-processes of pulling the nets: letting go, and knocking out.

2.3. Relations of number of injuries and the time used for the working processes

The number of injuries registered during the 5-year period for each working process for each type of fishing were divided by the total numbers of minutes used for each of the working processes during the fishing trips and then multiplied by 100, giving a set of risk index numbers (*N* injuries/100 min) for the specific working processes. Only working processes for which time measurements had been performed were included in the calculations of the index numbers.

3. Results

The fishing methods were identified in 1046 of the 1051 injuries reported in the 5-year study period related to all types of fishing methods (Fig. 1). 731 of the injuries related to the four fishing methods are included in this study. The 17-item classification of the principal processes (Table 1) captured 675 (92%) of the injuries in the four fishing methods (range: 88–95% for the four fishing methods). Insufficient data made it impossible to identify the working processes in the remaining 56 injury reports. 616 injuries for which time measurements of the working processes had been performed, were included in the study.

3.1. All four fishing methods

Table 1 displays the numbers of injury reports related to the main working processes in the four fishing methods and the total number of minutes used for the specific working processes. The index numbers varied from 0 to 260 within all four fishing methods. The majority of the injuries were related to fishermen moving around on board and the main working processes 5–7, preparing, shooting and hauling of the fishing gear and nets for all fishing methods. The working processes involving fishermen moving about had the highest number of injuries compared with the short overall time spent on this activity in all four fishing methods, especially for embarkation and for climbing up and down ladders.

3.2. Fresh market fishing vessels—other working processes

The three fishing methods for fresh market fishing included: Danish seine, gill-netting and 2-trawlers. For these types of fishing methods the index numbers were especially

Table 1
Number of injuries reported in five years in four types of fishing (*N*)

Working process	Fishing methods for fresh market fishing									Fish for industrial production		
	Seiner			Gill-net			2-Trawler			Industrial trawler		
	N	Time	*N*/time	*N*	Time	*N*/time	*N*	Time	*N*/time	*N*	Time	*N*/time
1. Traffic: home and harbour	0			0			0			1		
2. Traffic on board[a] (total)	11	188	5.9	26	83	29.2	11	262	2.9	44	144	30.6
2.1. Embarkment/disembarkment	3	3	100	9	4	225	3	4	75	13	5	260.0
2.2. Traffic on deck	3	130	2.3	9	54	16.7	2	114	1.8	9	48	18.8
2.3. Traffic in cabin	0	10	0	0	17	0	2	65	3	3	37	8.1
2.7. Traffic on ladders	5	45	11.1	7	8	87.5	4	79	5.1	19	58	32.8
3. Bridge watch[b]	4	3284	0.1	0	3328	0	1	12,528	0.0	3	10,948	0.0
5. Preparing the gear	12	1463	0.8	8	541	1.5	10	632	1.6	30	724	4.1
6. Shooting the nets and gear	6	475	1.3	10	867	1.2	4	635	0.6	30	1068	2.8
7. Hauling the nets and gear	17	1461	1.2	29	3012	1	24	2184	1.1	138	1832	7.5
8. Handling deck gear (anchor)				2	53	3.8	0					
9. Gutting the catch	11	2827	0.4	8	239	3.3	6	3307	0.2			
10. Handling fish (other)	8	885	0.9	4	391	1	6	1236	0.5	36	363	9.9
12. Preparing deck gear	6	30	20	0	33	0	1	114	0.9	3	715	0.4
13. Working in the engine room	2	257	0.8	1	40	2.5	1	231	0.4	11	186	5.9
14. Mooring	1	45	2.2	0	24	0	0			2	20	10.0
15. Working in the galley	1	691	0.1	2	587	0.3	4	827	0.5	2	796	0.3
17. Other	4	798	0.5	5	447	1.1	6	1396	0.4	10	906	1.1
Total (2–17)[c]	94	12,592	0.5	120	9728	1.2	85	23,614	0.4	317	17,486	1.8
16. Sleep and rest	0	5264		1	11,733		0	28,730		2	2772	
Total time in minutes for the tour[d]		17,856			22,320			51,820			45,502	
No of fishermen on board on the tour		3			4			4			4	
Person-hours total		298			372			864			758	
Person-days on the tour		12			16			36			32	
Days at sea on the tour		4			4			9			8	

Time in minutes (time) for one fishing tour with 3 or 4 fishermen on board, for all draughts on all days for each type of fishing vessel. Risk index numbers (*N*/time = the number of injuries per 100 min).

[a] Traffic is defined as walk on deck, stairs, etc.

[b] There were no injuries in category no. 4 watch elsewhere.

[c] Only for working processes where time measurements were done. Time for sleep and rest was not included.

[d] The total time for working processes and time for sleep and rest included.

high for work with the deck gear on seiners (working process 12). High index numbers were also found for some of the subsidiary work processes (data not shown in Table 1): setting anchors and recovering buoys and anchors on gill-netters (7.5–23 per 100 min); moving guide bars on trawlers and hauling trawls aboard (2.8 and 1.6 per 100 min, respectively).

3.3. Industrial trawlers

Several working processes had relatively high index numbers on board industrial trawlers (Table 1). Especially: hauling the gear and nets, handling of the fish and mooring (processes 7, 10 and 14). Handling of the fish was related to a considerable number of injuries ($N = 36$). This working process involves handling of large amounts of ice in the fish cargo rooms, often done by one fisherman alone.

Table 2 displays the number of injuries, time measurements and index numbers for the main working processes 5–7 on industrial trawlers. These three main working processes involved 64% of all injuries on industrial trawlers—for working processes where time measurements had been performed. Especially for working process 5, repair of the deck gear involved a substantial number of injuries and the index numbers were notable. For working process 6, putting out the gear and nets, especially: 6.5. Shooting/putting on nets/floats and 6.7. Clipping up the back straps by the doors, were associated with most injuries and had notable index numbers. When pulling the nets, most injuries occurred at the guarding bars, heaving up the trawl, bagging, working with hatches and bunker lids and working with the trawl doors.

Table 2
Working processes 5–7 for industrial trawling[a], number of injuries (*N*), time in minutes and risk index numbers

Working process	*N*	Time	(*N*/time) Risk index numbers
5.3. Repairing gear at sea	30	724	4.1
6. Putting out the nets and gear			
6.1. Shooting nets	4	120	3.3
6.2. Attaching double wires	0	26	0.0
6.3. Paying the lazy decky away	2	284	0.7
6.4. Securing the eccoloop	0	32	0.0
6.5. Shooting/putting on nets/floats	12	334	3.6
6.6. Paying the bridles away	1	130	0.8
6.7. Clipping up the back straps	11	142	7.7
7. Pulling in the gear and nets			
7.4. Letting the back straps go	12	110	10.9
7.5. Heaving on the bridles	9	165	5.5
7.6. Pulling the turns out	2	22	9.1
7.7. Moving the guarding bars	16	67	23.9
7.8. Heaving up the trawl	31	292	10.6
7.9. Taking off the floats	2	72	2.8
7.10. Heaving up the lazy decky and eccoloop	9	341	2.6
7.11. Bagging (the cod end)	33	355	9.3
7.13. Working with the hatches, bunker lids and sorting the catch	24	408	5.9

[a] Working processes for which time measurements were performed.

4. Discussion

Time measurements were performed during the whole fishing trips and the sum of time used for each of the working processes was assessed as an estimate of the relative use of time for the different working processes for each type of fishing. This was based on the assumption, that the working processes may be seen as a closed cycle system, where each process is always performed as an integral and a necessary part of the sequence of the working processes (Dorval, 1984).

We propose that the time measurements and the calculated index numbers can be viewed as a third and fourth level of epidemiological injury data. Fig. 3 shows a schematic proposal for different levels of epidemiological injury data in fishing. The same type of scheme could also be applied to other industries. Most of the injury studies in fishing have been restricted to the first level, e.g. for Europe the relative risk was estimated to be 2.4 and for Norwegian fishermen the relative risk was estimated to be 14 times higher than for all other occupations (Bull et al., 2001; EU, 2001). Studies of fatal injuries in fishing based on person-years as the denominator were 28 and 52 times higher than for shore based industries in the UK and Alaska, respectively (Roberts, 2002; Thomas et al., 2001). Only few studies related to the specific types of fishing methods (level 2) have been performed. In a Danish study the rate of injury was more than twice as high for the larger vessels than for the smaller vessels and the relative risk was 1.6 greater for stern trawlers when compared with Danish seiners (Jensen et al., 1996).

Due to lack of information of the total population risk time for all involved types of fishing methods the index numbers cannot be used to estimate the epidemiological incidence rates. The calculated risk index numbers cannot therefore be compared between the different fishing methods. However, the relative risk for different working processes within each type of fishing can be estimated. It is a weakness of the method that time studies were performed on only one tour at sea, but as the working processes were repeated many times during the tour, this strengthens the generalisability of the time measurements. Information about the size of the ship and the weight of the catches compared with the total catches in the different parts of the fishing fleet could improve the strength of the external validity.

A study of the incidence rates of the specific working processes would require time measurements for all working processes for all fishermen during the whole 5-year period from which the reported injuries came; this would be impossible to perform. Studies of the injury

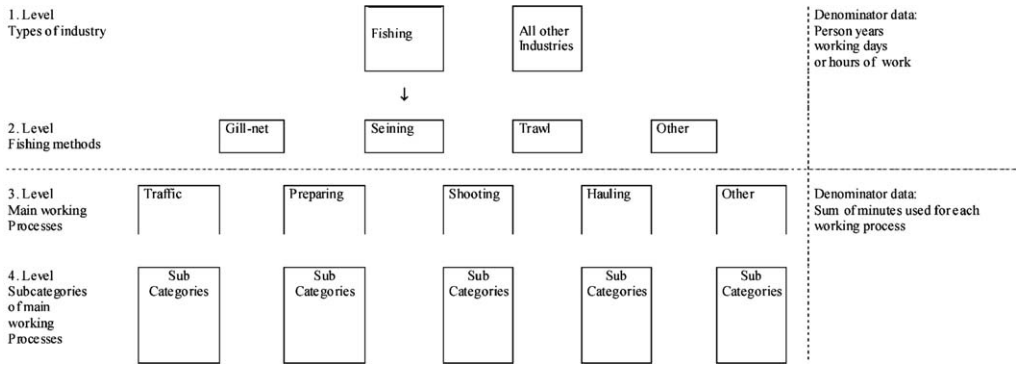

Fig. 3. Levels of epidemiological measurements in fishing.

incidence rate related to the third or fourth level of the working activity, like this study, have not been used before, except in a German study of occupational injuries in the meat industry (Selge et al., 2001). By using an automatic time monitoring system, the precise length of time each of the workers spent in the different areas of the plant, and the specific exposure time for each of the areas could be assessed. The injury rates for the working areas could be calculated and high-risk areas, e.g. areas with higher risk for falls, slips and trips, were identified.

Risk assessment should be based on the numerical values of the injuries and/or the seriousness of the injuries, independent of the time measurements. The index numbers can then be used as a supplemental indicator of the risk of different working processes. For instance, numerically more injuries happened when climbing up/down the ladder than when embarking/disembarking, but here the injuries happened within a very small proportion of the time used. Embarking/disembarking has previously been identified as a particularly hazardous activity in relation to fatal injuries (Hansen and Jensen, 1997).

During the setting of the nets, the part or sub-process of clipping up the back straps—which is part of the process of handling the chains of the heavy doors—was associated with many injuries, and this working process is one of the most dangerous working processes in fishery (Jensen et al., 1996; Törner and Nordling, 1999).

4.1. Conclusion and recommendations

Some of the working processes such as embarking and disembarking the vessels and working with the gear and nets, had a high number of injuries when compared with the relative short duration of working time spent. This was expressed by high injury index numbers. Together with preventions directed to the work environment, the personal equipment and the relationship between work and rest, this can be used as a supplemental tool for the priority of the injury prevention by pointing out working processes that need high attention for prevention.

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References

Bull, N., Riise, T., Moen, B.E., 2001. Occupational injuries to fisheries workers in Norway reported to insurance companies from 1991 to 1996. Occup. Med. (Lond) 51, 299–304.

Dorval, P., 1984. Safety and working conditions in ocean fishing through a study of occupational accidents. In: Chaumel, J.-L. (Ed.), Labor Developments in the Fishing Industry. Minister of Supply and Services Canada, Ottawa, pp. 10–22.

EU, 2001. Work-related Accidents in the EU—the Statistical Picture (1998–1999). 19. European Agency for Safety and Health at Work Facts. 14-1-2002.

Hansen, H.L., Jensen, O.C., 1997. Fiskeriet har sin pris—om dødsulykker i dansk fiskeri 1989–1996. In: Hahn-Pedersen, T. (Ed.), Sjæklen 1997—Årbog for Fiskeri-og Søfartsmuseet, Saltvandsakvariet i Esbjerg. Rosendahl, Esbjerg, pp. 57–73.

Jensen, O.C., Christensen, S., Larsen, S.E., Sørensen, L., 1996. Occupational injuries among fishermen. Bull. Inst. Maritime Trop. Med., Gdynia 47, 11–18.

Jensen, O.C., Stage, S., Noer, P., Kaerlev, L., 2003. Classification of working processes to facilitate occupational hazard coding on industrial trawlers. Am. J. Ind. Med. 44, 424–430.

Jensen, O.C., Stage, S., Noer, P., 2005. Classification and coding of commercial fishing injuries by work processes: An experience in the Danish fresh market fishing industry. Am. J. Ind. Med. 47 (6), 528–537.

Roberts, S.E., 2002. Hazardous occupations in Great Britain. Lancet 360, 543–544.

Saari, J., 1986. Accident epidemiology. In: Karvonen, M., Mikheev, M.I. (Eds.), Epidemiology of Occupational Health. World Health Organization, Regional Office for Europe, Copenhagen, pp. 299–316.

Selge, K., Kaulbars, U., Schenk, H., 2001. Trips, slips and falls in SMEs. In: Magazine of the European Agency for Safety and Health at work 4. Preventing accidents at work. Office for Official Publications of the European Communities, Luxembourg, pp. 23–24.

The NORA Traumatic Occupational Injury Team, 1998. Traumatic Occupational Injury Research Needs and Priorities. NIOSH. Report No. 98–134, p. 7.

Thomas, T.K., Lincoln, J.M., Husberg, B.J., Conway, G.A., 2001. Is it safe on deck? Fatal and non-fatal workplace injuries among Alaskan commercial fishermen. Am. J. Ind. Med. 40, 693–702.

Törner, M., Nordling, P.O., 1999. Occupational injury in Swedish fishery: 1. Analysis of injury statistics. Occup. Ergon. 2, 81–89.