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Follow-up of citations of maritime epidemiological injury studies

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ABSTRACT

Background: *The article is based on a review and follow-up of the citations of 13 epidemiological studies that aimed to improve maritime health and safety. While it's well-recognised that epidemiology is needed in occupational health and safety, the main research question: "How can epidemiology help workers to return healthy from the sea" was unanswered.*

Materials and methods: *The 13 articles were selected as a representative sample of different epidemiological design studies intended to contribute to improving safety management in fishing, merchant shipping and offshore industry. The PubMed, Research Gate, Cochrane-Library and Google Scholar were searched for authors that had cited our articles by using full bibliographic information and the results analysed.*

Results: *In all, 213 citation records were identified. After duplicates and records with insufficient information were removed, 123 full-text articles were eligible for evaluation with answers to the research questions: how did other authors use the studies, how has the injury epidemiology been developed, which recommendations are given for new policies and new studies and how can epidemiology help workers return safe and healthy from the sea?*

Conclusions: *The answer to the main research question is yes, epidemiological studies are not only useful but a necessary component by providing the needed evidence for successful prevention programmes.*

(Int Marit Health 2020; 71, 1: 62–70)

Key words: epidemiology, injury, fishing, seafaring, citations, maritime

INTRODUCTION

The review is based on 13 published articles that aim to improve the safety in the maritime sector and a follow-up of the citations by other authors in published studies.

While epidemiological studies in the maritime health and safety domains were rare until the 1990s, these studies can be seen as pioneering in the maritime injury epidemiology. The method of follow-up of the citing articles is a new method that is supposed to improve the methods and to find new results.

Each of the selected collection of 13 studies highlights some specific design studies in injury epidemiology (Table 1). The articles represent different types of study-design like register-based cohorts, cross-sectional questionnaire studies, case-referent study based on registers of injuries in seafaring, fishing and offshore workers in the oil and gas industry. The studies are for the main part based on the Danish fishermen and seafarers and some of them are from international collaborations.

Concerning the study populations, there are about 1.6 million merchant seafarers and 35 million fishermen and they together with the offshore workers contribute to a significant part of the European and the global economy [1]. Important common characteristic for merchant seafarers, fishermen and offshore workers is that they are away from home, staying on the ships and oil platforms at sea for weeks, months and even half of years. This poses some specific living and working conditions that is supposed to have some significant health impact in a short- and longer-time perspective.

While epidemiology of diseases has been developed over more than 100 years, the practice of occupational

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Table 1. Summary of the selected studies for review

	Materials	Methods	Main results
1. Mortality and injury			
1. Jensen (1996) Mortality in fishing	Danish commercial fishermen 1970–1985 compared to all economically active men (60974 fisherperson-years (375 deaths)	Cohort study. Standardised mortality ratio was calculated from the death register and population housing data	High mortality due to accidents, and increased risk from cancer, respiratory and cardiovascular diseases
2. Jensen et al. (2014) Fatal accidents in fishing review study	Scientific articles and reports from the maritime authorities in 8 Northern countries 1990–2014	The original incidence rates were recalculated as per 1000 person -years for international comparison of the trends	Fatal injury rates decreased by around 50% due to implemented safety programmes
3. Jensen et al. (2014) Fatal and non-fatal injuries in the offshore oil and gas production	A literature review was performed by literature search and by examining national databases	Search and examining PubMed, Embase, Google Scholar and Web of Science	Non-fatal injuries offshore decreased. The few epidemiological studies does not allow for firm conclusions
2. Injuries in fishing			
4. Jensen et al. (2005) Classification of working processes	The work processes were described and classified in 17 main and up to 13 subsidiary work tasks (n = 550)	The injuries were coded according to the developed classification system	Preparing, shooting and hauling of the gear constitute about 50% of all injuries
5. Jensen et al. (2006) Injury and time studies	Time measurements for the 17 main and 13 subsidiary working processes analysed during fishing trips in 4 vessel types	Injury reports in a 5-year period were allocated to the specific working processes and risk index numbers calculated	Especially high risk for embarking and disembarking but also for other work processes
6. Jensen (2006) Injury risk at work processes	The reported injuries (n = 550) to the National Maritime Authorities for 5-years defined the cases	A case-referent design with samples of person-time as denominator and the reported injuries as the nominators	The variations in the odds ratios of the fishermen continuously shift between low and high-risk work processes
3. Injuries in seafaring			
7. Jensen et al. (2004) Self-reported injuries — evaluation of data validity	A pilot study was conducted (n = 1068) in Finland, Denmark, the Philippines, Croatia and Spain using self-completed questionnaires	Self-reporting duty period was compared with information from the crew register of the Maritime Authority	Self-report of the duration of the latest tour of duty is useful for seafarers from merchant ships but not for ferries
8. Jensen et al. (2005) Subjective assessment of safety	A questionnaire study was carried out in 11 countries (n = 6461) seafarers who attended a regular health examination	Multivariate analyses were used to analyse the occupational safety on board, hazardous exposures and the use of personal protection equipment	Occupational safety was the lowest among ratings, seafarers < 30 years of age, in the engine rooms and dry cargo ships
4. Slips, trips and falls (STF)			
9. Jensen et al. (2000) Slips, trips and falls in fishing	Fishing injuries (n = 582) treated at the emergency ward and registered in the Nordic Medic Statistical Committee (NOMESCO) system	The proportion of fall injuries in different age groups, injury types (body lesions) and the injury mechanisms were analysed	The proportion of fall injuries in different age groups was U-shaped. STF injuries was 25% of all
10. Jensen et al. (2000) Slips, trips and falls in seafaring	A questionnaire study was carried out in 11 countries (n = 6461)	The seafarers gave information on whether they were injured during their latest tour of duty, and whether STF preceded the injury	43% were STF related. The high proportion of STF injuries came by use of a specific question, was it a STF?
11. Jensen et al. (2010) Reduction of slips trips in fishing by intervention	Fishermen tested new boots with anti-sleeping soles and tried them out under active fishing for half a year (n = 161)	Questionnaires at baseline and after half a year to determine the comfort and possible reduction of STF	The new boot had significant better comfort and feeling of firm grip when standing and walking
5. Working conditions at sea			
12. Jensen et al. (2006) Working conditions in seafaring	Seafarers in 11 countries (n = 6461) responded a questionnaire at the health examinations in the seafarers' clinics	The questions concerning the most recent tour of duty self-rated health status and the main characteristics of working conditions	Most seafarers worked every day of the week, and on average for 67–70 hours a week during periods of 2.5–8.5 months
13. Jensen et al. (2014) Social security for seafarers	Seafarers from 5 countries (n = 127) completed a questionnaire at the health examinations in the seafarers clinics	The questions concerning their knowledge about their social security status on coverage for disease and retirement	A significant part of the seafarers comes from the poorer countries without good social security systems

epidemiology was nearly non-existent until 1990 and the development of injury epidemiology and especially in the maritime setting has been a challenge. One of the main challenges is how to get valid nominator and denominator data to yield unbiased epidemiological rates-ratios. Over the latest decennia we have introduced the term "injury" for the body damage and "accident" for the preceding incident [2]. An injury can be defined as a sudden event (caused by an accident) in which an external noxious agent hurts or injures a person. The epidemiological studies of occupational injuries were sparse until the nineteen eighties and injury studies had low interest among the epidemiologists.

THE RESEARCH QUESTIONS

How did other researchers use the studies?
Which recommendations for preventive policy and prevention are there?
Which recommendations are given for new studies?
How was the maritime occupational injury epidemiology further developed?
How can epidemiology help workers to return healthy from the sea?

MATERIALS AND METHODS

The methods used in the 13 articles involved a transition from epidemiological descriptive design to more advanced statistical methods in the studies. The studies are divided in five sections: 1. Mortality and fatal injuries; 2. Injuries in fishing; 3. Injuries in seafaring; 4. Slips, trips and falls; 5. Working conditions at sea.

The 13 articles were selected as a good representative sample of studies contributing to an epidemiological analysis of the occupational risks to improve the safety management in fishing, merchant shipping and offshore industry. Since the aim of this study was to analyse descriptive studies in health and safety in fishing, the criteria were set to achieve this aim. The whole process of search and selection of the citing articles is shown in Table 2.

SEARCH FOR THE CITING ARTICLES

One by one, the 13 articles in the collection were searched in PubMed Google Scholar by using the full bibliographic information e.g. "**Jensen OC. Injury risk at the work processes in fishing: a case-referent study. European Journal of Epidemiology. 2006; 21(7): 521.** The searches were repeated in PubMed, Cochrane and Research Gate to see if more citing articles come up. The citing articles were searched from 1st October 2017 to 31th October 2018. The follow-up time for the sample of the citations varies from the first publication in 1996 to the latest included in 2014.

INCLUSION CRITERIA OF THE CITING ARTICLES

The first step was to systematise and analyse the citing articles and to define the eligibility criteria for the citation articles to be included. All types of epidemiological design, in English or Spanish were included: literature reviews, cross-sectional, cohort and case-control studies. Only peer reviewed scientific articles were included.

EXCLUSION CRITERIA OF THE CITING ARTICLES

Articles or thesis in languages not understood by the author, like Indonesian, Chinese, Finnish or other languages are excluded. Administrative reports are excluded.

ETHICAL ISSUES

The review work does not involve any personal participant and company information, and so the study does not involve ethical problems. All data is processed according to the medical duties act, as well as the guidelines for good epidemiological practice is followed.

RESULTS

In all 213 citation records were identified through database searching and additional free records were identified through other articles. After removal of 17 duplicates and 22 records with insufficient information, a total of 199 records remained for screening. Of those 76 were excluded due to either lack of full text or other problems. The final 123 full-text articles were eligible for evaluation (Fig. 1). Twenty-five were included in the quantitative synthesis and 90 studies in the qualitative synthesis the articles are distributed in the five main sections: mortality and fatal accidents, injuries in fishing, injuries in seafaring, slips, trips and falls and working conditions in seafaring. The citing articles that used this study as background with no further comments are kept out of this review.

Study 1: Mortality in Danish Fishermen [3]. The study aimed to investigate the mortality patterns in Danish commercial fishermen (1970–1985), compared to all economically active men by the use of standardised mortality ratio with 95% confidence intervals for all causes among crewmembers was increased for accidents, ischaemic heart diseases, bronchitis and emphysema compared to all economic active men. Of the 13 citations, 3 studies for comparison: [4, 5].

Study 2: A review of fatal accident incidence rate trends in fishing international [6]. The review is based on scientific journal articles and some few technical reports from the maritime authorities in Poland, United Kingdom, Norway, Iceland, Denmark, United States and Alaska and Canada. The risk of fatal injuries was reduced by around 50% to an average of about 1 per 1000 person-years. The safety programmes seem to have good effects, still the risk is

Table 2. Search and selection procedure of the citing articles

1. Search each of the 13 articles in the databases mentioned by using the full bibliographic information in Vancouver style to identify articles that have cited one or more of the 13 articles
2. Search each of the citing articles one by one in PubMed and/or Google Scholar, and to be registered in 13 separate Zotero bibliographic databases
3. The full-text of citing each article are then searched in PubMed and/or Google Scholar or Research Gate and included in the Zotero database
4. Revise the citing articles one by one, delete duplicates and mark those with and without full-text
5. Exclude citations of no relevance (based on abstract or full-text) foreign languages and not maritime health
6. Evaluate one by one the full text of the citation articles, search for "Jensen" and copy the cited texts articles
7. Copy the citations with "snapshot" and paste them in the "Citation Archives" for evaluation
8. Classify the copied information according to the 5 classification points in PRISMA: doublet, exclusion of other reason, quantitative/ /qualitative useful, full-text/non-full text in (Liberati et al. 2009)
9. Construct a "selection tree" scheme for each of the 13 articles
10. Transfer the results to a sum scheme for all the 13 articles (Fig. 1)
11. Analysis, systematise and sum up the relevance of the citations in the Results section
12. Answers the research questions based on the 13 selected articles and the citing articles
13. Sum up in the conclusions on the gained new knowledge on methods and evidence for new prevention policies
14. Sum up the recommendations from the 13 articles and the citing articles about the needed prevention, policies for prevention and for new research

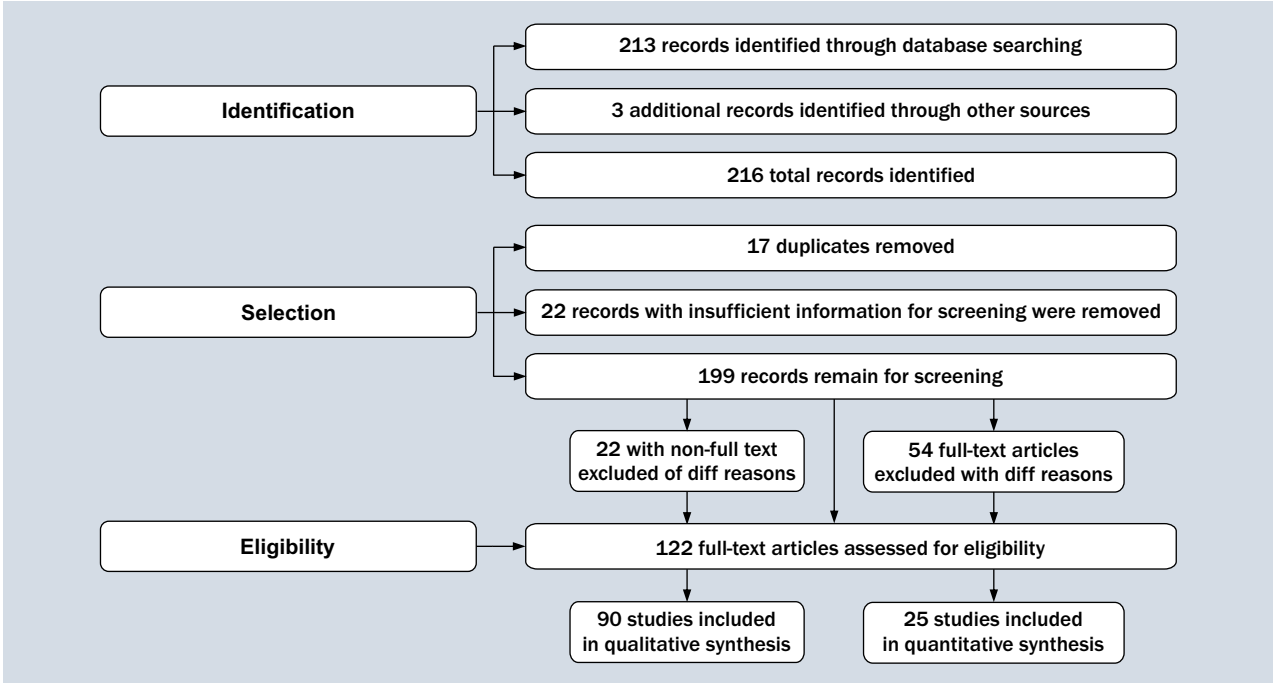

Figure 1. Selection tree of the "citing articles" included in the review

about 25 to 50 times higher than for onshore workers. Of the 13 citations, 5 were excluded, 2 doublets, 2 were used as background references and 3 for comparison of the quantitative results.

Study 3: A review of epidemiological injury studies in the oil and gas offshore industry with the objectives to evaluate the preventive programmes effect [7]. The fatal injuries in the oil and gas production in the US are seven times higher than for other workers in the US and the rate increased.

Study 4: Classification and coding of commercial fishing injuries by work processes: an experience in the Danish fresh market fishing industry [8]. This study was an answer

to the lack of a detailed classification system for fishing accidents and relates closely to Study 3. The objective was to describe all main work processes to create a new classification system to be used for injury prevention. The working processes were described and a classification catalogue with 17 main categories and up to 13 associated subsidiary categories for each of the fishing methods were prepared. All fishing injury reports to the Danish Maritime authorities for 5 years were coded according to the specific type of vessel and the specific working process where the injuries happened. The study was cited by 15 authors in the introduction of their studies and discussed in other studies.

Study 5: Injury and time studies of the working processes in fishing. The objective was to solve the methodical problem that the use of a common overall denominator, e.g. days at sea related to different working processes on board is not useful to estimate the incidence rates for the specific working processes. To solve the problem there was a need to estimate the more precise use of working time for specific working processes in typical types of professional fishing. The working time for the specific working processes in fishing was related to the number of injuries related to the same working processes [9]. The study was cited by 15 authors in the introduction of their studies but also in the discussion of some of the studies.

Study 6: Injury risk at the work processes in fishing: a case-referent study [10]. The aim of the study was to estimate the injury rate-ratios for the main work processes in commercial fishing. The problem is that epidemiological studies describe the incidence ratios only related to the main strata in the industries, while the injury incidence ratios for the specific work processes within the workplaces have not yet been studied. The study was cited by 12 authors in the introduction of their studies but also in the discussion of some of the studies.

Study 7: Self-reported injuries among seafarers. Questionnaire validity and results from an international study [11]. The aim was to test the method of self-report of injuries and length of time at risk during the latest duty period and second to study the injury incidence rate among seafarers by use of the method. 32 authors cited the study.

Study 8: Subjective assessments of safety, exposure to chemicals and use of personal protection equipment in seafaring. The objective was to describe the seafarers' assessments of the occupational safety on board, their exposure to chemicals and the use of personal protection equipment and to identify the areas for further risk assessment and preventive measures [12]. A questionnaire study was carried out in 11 countries among seafarers who attended a regular health examination. The study was cited by 11 authors, some in the introduction and others in the discussion of their studies as commented in the discussion.

Study 9: Non-fatal occupational fall and slip injuries among commercial fishermen analysed by use of the Nordic Medic Statistical Committee (NOMESCO) injury registration system [13] in order to add more detailed information about slips, trips, and falls on board fishing vessels. Data on fishing injuries treated at the emergency ward at Esbjerg Central Hospital was registered in the NOMESCO injury registration system [14] and 38 authors cited the study.

Study 10: Non-fatal occupational injuries related to slips, trips and falls in seafaring [15]. Merchant seafaring often involves hazardous occupational operations and several studies have shown increased fatal injury incidence often related to slips, trips and falls on board and falls overboard [16, 17]. In all 27 authors cited the study.

Study 11: Reduction of slips, trips and falls and better comfort using new anti-slipping boots in fishing [18]. One hundred and fifty fishermen participated in the study with a baseline questionnaire and repeated the questionnaire after they had used the new boots for half a year. The result was that the new boots were considered as much better or somewhat better by 90% of the fishermen reporting they had a good grip on the deck and a feeling of standing firmly. In all 6 authors cited the study

Study 12: Working conditions in international seafaring [19]. The objective was to describe the self-rated health and the main characteristics of the seafarers working conditions. A total of 6461 seafarers in 11 countries responded to a questionnaire concerning the most recent tour of duty. In general, the seafarers' self-rated health was good, but it declined significantly with age. 20 authors cited the study,

Study 13: Social security for seafarers globally [20]. The seafarers completed a short questionnaire concerning their knowledge about their social security status. The significant disparities in the social security coverage were pointed out among the nationalities. The solutions suggested are to implement the minimum requirements as recommended by the International Labour Organisation 2006 Convention, to survey the implementation and in the long term to struggle for a global social equality. The only one citation was from one of the co-authors.

DISCUSSION

This is to our knowledge the first study to follow-up on how other authors have cited and used a sample of studies. Contributions from the citing articles to the main research questions are identified and discussed.

HOW DID OTHER RESEARCHERS USE THE STUDIES FOR COMPARISONS?

In contrast to our Danish Study 1, the Swedish fishermen had lower mortality rates from: all causes, malignancies, respiratory and cardiovascular diseases compared to

other men [4]. The similar pattern was found for Finnish fishermen with lower mortality from: all causes, ischemic heart diseases, cerebrovascular diseases and malignant neoplasms than the general population [5]. Study 4 and 6 on classification and coding of injuries by the work processes was followed by several other authors: Syron et al. [21] utilised our system to code non-fatal injury cases to point out the most frequent work processes associated with non-fatal injuries. Krenz et al. [22] also found the "Jensen" System useful for activity classification for claims. Lucas et al. [23] applied a framework based on our system to code processes specifically related to long-liners and trawlers. McGuiness and Piniella et al. [24] points out the need for specific classification of the working processes for more effective prevention [25].

Study 7 on self-reported injuries among seafarers was used by among others Shan [26]. Study 9, on the occupational fall and slip injuries in fishermen coded according to the Nordic Medico Statistical Injury Registration System was used by Bull et al. [27] who found similar high percentages of slips, trips and falls in fishing. Study 10 on slips, trips and falls (STF) in merchant seafaring was followed by several authors confirming that STF related injuries especially in the engine rooms need to be taken in attention for better prevention [28, 29]. Study 11 on the fishermen's test of new boots with anti-slipping soles was commented by Lucas et al. [30] who mention the resistance to introduce new type of footwear and that good footwear can hinder falls overboard and save life's [30–32].

HOW WAS THE MARITIME OCCUPATIONAL INJURY EPIDEMIOLOGY FURTHER DEVELOPED?

Study 1: The methods used in epidemiology have changed radically from using paper forms to pure digitalised data over the latest half century. This great development in the epidemiology permits to handle big amount of data with advanced statistical methods, especially the multiple regression analysis [33]. Study 2: The review of fatal injuries in fishing [6], shows an overall decrease of the fatal incidence rates over the last decades. The study showed that trends can be compared for the first time with meaning for the planning of the prevention activities. In Study 5 and 6, the injury and time studies of the working processes in fishing was new and opens up for a more specific and effective prevention of the injuries in fishing. The aim was to estimate the relative risks for specific working processes in order to focus the prevention on the specific work processes. The use of the case-control study design in occupational injury studies is rare and the new method by using the samples of time for the work processes as the denominators is new. The injury epidemiology in merchant seafaring was further developed in Study 7 by asking for the precise number of days at sea in order to obtain precise denominator data for calculation of the **Incidence risks** and **relative risks** the first time. The subjective assessment of safety, exposure to chemicals and use of personal protection equipment in seafaring in an international setting was documented for the first time in Study 8. A solution to the methodological problems by using proportionate risk estimates in Study 9 was proposed by multiplication the proportions with the estimates of the incidence rates of all injuries [34]. Based on the learning from the NOMESCO Study 9, the seafarers were asked specifically whether slips trips and falls preceded the occurrence of the injury in Study 10. The method was new and not surprising that injuries related to STF on merchant ships were more frequent than the previous estimates. The experiment of the use of good footwear for fishermen in Study 11 was new and commented by various authors. In the development of epidemiology, we have moved from Haddon's Matrix to the modern epidemiological sociological model of the ethology to be used for prevention. We have also moved excellently forward since the era where "accident" epidemiology was not recognised as scientific discipline e.g. that injury epidemiology is nearly absent [35].

WHICH RECOMMENDATIONS FOR PREVENTIVE POLICY AND PREVENTION ARE THERE?

Based on the trend's analyses of fatalities in fishing in Study 2, the preventive programs seem to have good effects. Still, the authors call for continued effort to improve safety in fishing in all the studies [23, 30, 36].

According to the authors comments on Study 4, 5 and 6 the analysis of the specific risk at the different work processes is recommended to identify hazardous tasks [21]. Future prevention efforts should target work processes associated with the most frequent and most severe injuries by using time estimates for work processes in order to determine risk estimates.

Our proposal of the need for better trauma prevention on board in Study 7 was supported by several authors [37–39]. The main recommendation from Study 11 is to encourage fishermen to replace their boots as soon as they are worn out and that risk assessments of fishing vessels should include assessment of footwear. The recommendations in study 12 include that further studies are necessary to describe more closely the influence of work schedules on the health and social life of seafarers. Patella et al. [40] cite us because we supply the documentation that the engine crew suffer the highest overall levels of stress followed by the deck and engine officers. Österman and Hult [41] cite us because we say that the seafarers work and live between 2 to 8 months on board continuously exposed small possibilities for recreation together with people of various backgrounds and nationalities.

Oldenburg et al. [42] again refer to our study to find out the very long stay on board after 10 months on the conditions with permanent physical factors noise and vibration post on the working and leisure time has a physical and mental effect on the quality of life. Rydstedt et al. [43] again refer to our study concerning the engine room personnel with the highest mental health problems. Oldenburg and Jensen [44] 2012 support and cite our study about the extreme work press also mention that we found nearly 70 work all hours per week for both officers and none officers per week. In Study 8, the use of personal protective equipment was assessed to be too low among some parts of the crew and in some working areas and types and sizes of ships. Several authors cited our article and agreed there is a need to improve the safety and the prevention of the risks on board [45–47].

WHICH RECOMMENDATIONS ARE GIVEN FOR NEW STUDIES?

Several studies underscore the lack of international requirements to harmonise the registration of injuries in fishing for prevention [24, 48]. In Study 7 it was concluded that subjective data about the length of the tour for calculating the incidence rates is useful for merchant ships but not for ferries and other type or permanent employment. When the seafarers have permanent contracts specifying the number of hours or days per year, this can be used for denominator data for calculation of the injury incidence rates. Study 9: By using the NOMESCO system for occupational injuries from falls and slips (STF) some important new issues in the injury epidemiology was realised. The estimated proportion of STF-injuries was more precise and higher than seen before. An analysis based on the free text in the NOMESCO register files, revealed that one fourth of the injuries are related to falls/and slips and thus preventable and constituted 60% of all injuries to the chest. And then it was realised that giving specific attention to STF-related injuries will give the most precise estimate of STF-injuries for the prevention. To avoid a possible misclassification and underestimation of STF-injuries it was recommended to include an extra specific variable: whether falling or slipping preceded the crash phase of the injury or not. This was utilised later in the international questionnaire study among seafarers [15]. Based on the Danish and the Norwegian studies, the NOMESCO system was found useful for analysis of fishing injuries by data from the emergency rooms. Still, there is no information recorded about the working process, which hinders for effective use in the practical prevention, and this was the subject for the other studies. Study 12 on the social security for seafarers was not followed by other studies. The gap of knowledge remains and calls for more studies. It is also worth mentioning that qualitative studies should be used for further investigation in this area.

HOW CAN EPIDEMIOLOGY HELP WORKERS TO RETURN HEALTHY FROM THE SEA?

The study examples illustrate how the evidence from epidemiology contributes to identify the relative risk of fatal and non-fatal injuries and diseases.

In this way the studies are necessary as contributing components to successful prevention.

This is consistent with the definition of epidemiology as being “the study of the distribution and determinants of health-related states or events (including disease), and the application of this study to the control of diseases and other health problems” [48, 49]. The five steps to risk assessment are carried out by using knowledge from research about the risk in general and knowledge about what is the best prevention. The risk assessment comes from observations and from epidemiological knowledge about the risk in number and severity. Proposals for effective prevention measures also come from epidemiological research.

If the evaluations show there is no or too little effect of the prevention measure we need to amend the prevention type and repeat the evaluation process once more. Seen from a global perspective there is an urgent need to help with epidemiology for fishing and aquaculture in the developing countries, e.g. Latin American and African countries [50].

CONCLUSIONS

The studies have been useful and contributed to obtain better safety in fishing and seafaring and contributed with new methods in injury epidemiology. The main research question whether epidemiology can help the workers to get home safely from work is answered with a “yes”. The studies are needed to establish an optimal prevention planning like architectural plans are needed for successful building construction. To avoid biased results the epidemiological studies, need to be conducted under the highest scientific standards.

The developing countries pose a specific challenge for the epidemiology in fishing and aquaculture with millions of workers in the poorest countries. A supposed high incidence on fatal and non-fatal injuries needs urgently to be documented for political attention and effective prevention.

In a global perspective new emerging risks continue to occur, and surveillance programmes of health and safety are needed and should be developed based on the documented risks from the studies.

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