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Systematic review: Psychomental reactions of survivors after fatal maritime disasters at sea

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REVIEW ARTICLE

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ABSTRACT

Background: *Several studies have shown that accidents and disasters at sea account for a significant share of seafarers' deaths. Additionally, the experience of a disaster often has a crucial impact on the mental health of survivors. The objective of this systematic review is to analyze the psychomental symptoms and their development over time after a maritime disaster, as well as the scores used to measure the severity of the symptoms.*

Materials and methods: *A comprehensive literature search was conducted in the scientific databases PubMed, PubPsych, PsycArticles, and Scopus to identify studies related to fatal maritime disasters. This systematic search yielded 239 studies and twelve were ultimately included in the review after the application of specific exclusion criteria.*

Results: *The included studies described the psychomental symptoms of 40 seafarers, 422 navy and US Coast Guard crew members, and 300 passengers who experienced maritime disasters. Survivors of fatal maritime disasters exhibit significant symptoms of posttraumatic stress and depression. The diagnostic screening cut-offs for post-traumatic stress disorder (PTSD) based on the Total Impact of Event Scale (IES-Total) score were exceeded in a*

significant number of the survivors. Although symptoms diminish over time, survivors' mental health often remains significantly affected for several years after the disaster.
Discussion: *The symptoms and the severity of PTSD and depression after a maritime disaster and their development over time show parallels with findings from land-based disaster research. Overall, the number of identified studies and their actuality in the field of maritime research are unsatisfactory. This highlights the necessity for additional research in the field of maritime disaster medicine.*

Keywords: maritime disaster, seafaring, post-traumatic stress disorder (PTSD), depression, anxiety, Impact of Event Scale (IES), Beck Depression Inventory (BDI), General Health Questionnaire (GHQ)

INTRODUCTION

The voyages of professional seafarers frequently last several months, with around 40% of the travel time spent on sea passage and around 20% on river passage [1]. Especially during these voyage episodes of sea and river passage, ship crews are largely left to their own devices. Frequent voyages to secluded areas, possible poor weather conditions and the generally limited medical resources on board are problems for seafarers' access to health care in case of emergencies and disasters [2]. Although a considerable amount of literature has been published in the field of disaster studies, there is no universally adopted definition of disaster [3]. For the purpose of this review, the definition of a "very serious marine accident" as defined in German law in § 1a Maritime Safety Investigation Law (SUG, *Seesicherheits–Untersuchungs–Gesetz*) is adapted and maritime incidents are considered disasters if they result in at least one fatality [5].

Despite rapidly declining fatality rates [5, 6] disasters and accidents on vessels remain a major and serious threat to seafarers' health and wellbeing; between 40% and 50% of seafarer deaths observed in a review of European studies were attributed to accidents and disastrous events at sea [7]. Additionally, a Danish study found that 59% of active seafarers’ deaths occurred during sea passage and estimated that shipboard crews are six times more likely to die from occupational accidents than shore-based workers [5]. As there are usually no doctors on board and professional medical assistance is sometimes only available several days after the shipwreck, shipping disasters and medical emergencies are potentially critical and poignant experiences that may severely affect the mental health of seafarers. Following a fatal

incident on board, the crew is often unable to depart the ship for several days, which may affect their ability to distance themselves from the incident and to process the associated trauma. The situation is further complicated by the possibility of dysfunctional responses by other affected survivors of the disaster.

The damage caused by a maritime disaster goes beyond the initial loss of life, as it has a profound impact on the survivors as well. In disaster research, the impact of a disaster on the psychomental well-being of survivors can be assessed, for instance, through the use of symptom measurement instruments such as the Impact of Event Scale (IES), General Health Questionnaire (GHQ) and the Beck Depression Inventory (BDI) [8, 9] which can provide standardized quantitative assessments of the manifestation of symptoms and may contribute to the scientific knowledge of the mental health consequences of disasters [10–12].

The findings of research on most land-based disasters have linked the experience of a disaster to the manifestation of mental disorders such as post-traumatic stress disorder (PTSD), depression, and anxiety [8, 13]. With this in mind, there appears to be a significant risk to the mental health of survivors of maritime disasters that needs to be understood by healthcare professionals and other organizations involved in the care of seafarers, such as the Seafarers' Mission, in order to best mitigate potential negative mental health outcomes.

While merchant seafarers are particularly vulnerable to maritime disasters in their line of work [7], this review also includes other populations, such as passengers and other occupational groups that spend significant time at sea, e.g. members of the navy or other public organizations such as the U.S. Coast Guard. Despite the significant differences between these groups (for instance in terms of average age, the role on board or the professional training), there are similar fundamental aspects of the disaster experience for all those involved in maritime incidents. For example, exposure to the same life-threatening hazards during a disaster (such as drowning, hypothermia, exhaustion) or to the death of strangers or even colleagues and friends, and the risk of negative psychomental consequences that may affect daily life after a disaster, remain constant regardless of group affiliation.

Because survivors of maritime disasters are exposed to relatively unique scenarios as described above, findings of general disaster research may not always be applicable and require further confirmation in maritime settings. Therefore, the objective of this review is to evaluate the type and severity of psychomental symptoms and their development over time in survivors after a fatal maritime disaster.

MATERIALS AND METHODS

In order to analyze the psychomental symptoms after fatal maritime disasters, this systematic literature review was carried out through a search of several scientific databases. The databases PubMed, PubPsych, PsycArticles and Scopus were searched in May 2024 to identify relevant studies between 1984 and 2024. The databases were selected based on their extensive catalogs of scientific literature and their well-established relevance and credibility in medical and mental health research. Apart from the publication year, no further restrictions, such as the type of publication, were applied to the search in the databases. The following search string was used to identify studies relevant to this systematic review: *[(death at sea) OR (maritime disaster) OR (disasters at sea) OR (shipping disaster)] AND [(mental health) OR (psychosomatic symptoms) OR (psychological symptoms) OR (PTSD)]*.

Several exclusion criteria were established in advance to narrow down the literature hits and to achieve the objective of this review. The exclusion criteria were applied sequentially at both title/abstract level and full-text level to identify the final results for this systematic review. Research hits without available abstracts and/or full texts in German or English language were excluded, as were hits that had no relation to seafaring, seafaring disasters with fatal outcomes or in which the focused study population was not directly involved in the fatal disaster (e.g. rescue workers). In addition, research that did not provide a sufficient quantitative description of the study population or mental health outcomes, and research that focused primarily on basic maritime scientific research (without reporting on symptom manifestation) was excluded.

To achieve a higher degree of comparability between merchant seafarers, navy crew/US Coast Guard members and passengers the final exclusion criteria was introduced; studies were only included in this review if the disaster scenarios and mechanisms were conceivable in a merchant seafaring setting (e.g. no war experiences or studies that focused on the effects of the disaster on children). The identification and screening process is visualized in Figure 1. The study identification, selection and evaluation processes were conducted independently by three researchers to minimize potential sources of bias and to improve the reliability of this review.

The database search with the aforementioned string identified 238 search results, of which 54 were duplicates across the databases. Another 18 results were excluded because the abstracts and/or full texts were not available in German or English. With the inclusion of one hand-selected study, a total of 167 abstracts/titles were screened on abstract level.

A significant proportion of the studies had no relation to seafaring, fatal maritime disasters or the examined study population was not directly involved, and thus 134 records were excluded. In addition, seven studies lacked a quantitative symptom description or focused on basic maritime scientific research without reporting on the manifestation of symptoms. Finally, eleven military or civilian passenger studies were omitted from full-text review because a conceivable transferability of the disaster scenario to the maritime seafaring was not given.

This process resulted in 15 remaining studies for eligibility screening on full-text level. Of these, one paper was excluded as it did not provide a sufficient quantitative description of the mental health consequences of the disaster. Two further papers were excluded based on the final criterion since one disaster occurred during a military training exercise and was thus not applicable to merchant seafaring, and the other study investigated a population which was solely underage during the time of the disaster.

In their study Líndal and Stefánsson (2011) [15] examined fishermen, who are classified as seafarers in this review. Upon completion of the search and screening process, twelve studies were selected for inclusion in the subsequent review and analyzed. A particular emphasis was placed on the evaluation of psychological questionnaires because of their ability to serve as standardized and quantitative measures of psychomental symptoms. The time course of symptoms was taken into account when multiple observation periods were available.

RESULTS

The twelve studies included in this systematic review were published between 1984 and 2011, five of which were published after the turn of the millennium. As shown in Table 1, two out of the twelve publications focused on merchant seafarers [15, 16] and two studies dealt with navy crew and US Coast Guard members [17, 18] — with the circumstances of one seafaring disaster allowing one additional publication to study both groups [19]. The remaining seven studies focused on passengers.

The study designs varied considerably. Cross-sectional and cohort studies were the most common, with four studies each. Case reports were also a frequent design and were used three times. Finally, Dalgleish et al. (2000) [20] presented a review summarizing a decade's worth of research on the survivors of the Herald of Free Enterprise disaster. The quality of the included studies was rated according to the Scottish Intercollegiate Guidelines Network (SIGN) [21] grading system and SIGN grades ranged from 2+ to 3. According to the SIGN

grading system, two studies achieved a grade of 2+, followed by three studies with a grade of 2– and six studies with a grade of 3. As Dalgleish et al. (2000) [20] constitutes a review, it could not be rated on the basis of the SIGN system.

Overall, the aims of the studies as described by their authors (Table 1), the chosen intervals of observation after disaster and the contents of the investigation (Table 3) are heterogenous. To distinguish between short-term and long-term symptoms, this review follows the approach of Newnham et al. (2022) [8], who defined long-term symptoms as those lasting more than twelve months. The following common trends seem to emerge from their combined analysis:

- to study the short-term and early effects of the disaster (9 of 12 studies) [16, 18–20, 22–26]
- to study the long-term and late effects of the disaster (6 of 12 studies) [15, 17, 20, 22, 24, 27]
- to examine possible influences (e.g. social support, prior health problems and feelings of guilt) on the development and/or severity of symptoms (6 of 12 studies) [17, 18, 20, 22–24]
- to study the impact of disaster characteristics (e.g. immersion in disaster, relatives perishing in disaster) on the severity of symptoms (6 of 12 studies) [15, 20, 22–24, 27]

Three of the included studies, Dalgleish et al. (2000) [20], Dyregrov and Gjestad (2003) [22] and Joseph et al. (1991) [24], contain aspects of all the trends, although it should be noted that the first mentioned paper is a review summarizing a decade of research on the Herald of Free Enterprise disaster. On the other hand, four papers are largely limited and/or have a dominant emphasis on the analysis of a single trend, with all of them focusing on the study of short-term and early effects of the disaster [16, 19, 25, 26].

In total eight different, unique maritime disasters were the basis for this review with an additional 20 small-scale disasters being reviewed by Líndal and Stefánsson (2011) [15].Two disasters were examined in multiple studies; the Herald of Free Enterprise disaster in 1987 was the basis for the analyses by Dalgleish et al. (2000) [20], Dooley and Gunn (1995) [27] and Joseph et al. (1991) [24], while the sinking of the MS Estonia in 1994 was the subject for Eriksson and Lundin (1996) [23] as well as Taiminen and Tuominen (1996) [25].

The maritime disasters that formed the basis for the included studies exhibit considerable variations in terms of the magnitude of the disaster (Table 2). At the time of disaster, the ships carried between 29 and 1038 people on board, with reported fatality rates ranging from 1

person (~1%) to over 900 persons (~87%). The median of total fatalities was 51 (39%). The disasters examined in the studies by Líndal and Stefánsson (2011) [15] and Tekin et al. (2005) [16] are not included in these ranges due to insufficiently precise descriptions.

Overall, the included studies collected information on 40 merchant seafarers (with an additional 88 seafarers in control group), 422 navy crew/US Coast Guard members (with an additional 387 navy crew members in control group) and approximately 300 passengers (Table 2). The mean age of all investigated survivors is approximately 35 years; however some uncertainty remains due to lacking, unclear or unspecific age descriptions.

The 88 seafarers included in the control group of Líndal and Stefánsson (2011) [15] were involved in potentially life-threatening disasters, which remained without deaths, while the 387 navy crew members in the control group of Hoiberg and McCaughey (1984) [17] were recruited from the crew of a comparable vessel that was not involved in any disaster. The last control group was employed by Dalgleish et al. (2000) [20], who, in some aspects of their analysis, utilized a control group of matched participants.

SYMPTOMS OF SURVIVORS AFTER MARITIME DISASTER

In the study by Líndal and Stefánsson (2011) [15], simple phobias, nightmares, sleeping difficulties and symptoms of hyperarousal were significantly more common in seafarers affected by fatal maritime disasters than in survivors of non-fatal disasters. Nightmares, sleeping difficulties, irritability, intrusive symptoms, exaggerated startle responses and symptoms of stress disorders were also reported by Tekin et al. (2005) [16] in survivors of a fatal maritime disaster. All but one survivor saw substantial reductions in symptoms eight weeks after the traumatic event.

Most of the survivors of the maritime disaster in the study by Taiminen and Tuominen (1996) [25] showed symptoms of the anxiety cluster, followed by the denial cluster (16.7%), acute specific phobias (15.8%), feelings of guilt, dissociative and depressive reactions (10.5% each). Similarly, diagnostic labels for anxiety disorders were also frequently applied to survivors in the maritime disaster study by Dooley and Gunn (1995) [27].

McCaughey (1985) [19] reported on the symptoms of seafarers and military officer candidates after a maritime disaster. The most common symptoms and reactions were fatigue, sadness, crying spells, irritability, vulnerability, shock, anger and guilt. Furthermore, officer candidates were much more likely to report decreased concentration than seafarers.

SYMPTOM SCORES FOR SURVIVORS AFTER MARITIME DISASTER

A considerable number of standardized instruments were used in the included studies. However, only variants of IES, GHQ, Posttraumatic Symptom Scale (PTSS-10), BDI, State-Trait Anxiety Inventory (STAI) and instruments referencing diagnostic criteria of Diagnostic and Statistical Manual of Mental Disorders (DSM-III/DSM-IV) are used in at least two studies and are therefore displayed in Table 3. Impact of Event Scale (7/12), GHQ (5/12) and PTSS-10 (3/12) are the most used instruments. Both BDI and STAI are used twice — each in the same two studies. Instruments based on DSM-III or DSM-IV are also applied in two studies. In addition, four studies didn't apply any of these instruments. Lastly, ten instruments were used in only one study each (and are therefore not displayed in Table 3), so that in total 16 different standardized instruments were used.

A sufficient analysis of the PTSS-10 was not possible due to a lack of clear information and uncertainty about the versions of the score used, the ranges employed and the cut-off values. Consequently, this score is not evaluated and further taken into account in the present review. Furthermore, a comparison of STAI scores was not a meaningful addition to this review and was also omitted from the analysis because Dalgleish et al. (2000) [20] did not provide separate values for the subscales (State and Trait Anxiety).

Other prominent methods used to collect information on symptoms included the use of non-standardized or open questions (8/12), the extraction of information from documents (5/12), the gathering of information through interviews (4/12), and the observation of subjects and diagnosis of mental disorders during care (3/12), as shown in Table 3. The earliest observations were made immediately after the disaster and the latest observations were made an average of eight years after the disaster. Three studies employed single observations, five studies collected observations over continuous periods of varying intervals and four studies conducted multiple observations at specific times. A brief narrative summary and description of the observation intervals after the maritime disaster can be found in Table 3.

While post-disaster interventions, either by external parties (e.g. social services, government agencies) or by health professionals, were mentioned in seven studies [16, 18, 19, 22, 23, 25, 27], only three [16, 22, 25] provided detailed descriptions. Among these, merely Dyregrov and Gjestad (2003) [22] analyzed possible effects of the intervention; they found no significant difference in IES-Total or GHQ values between participants and non-participants of applied debriefing sessions.

Table 4 presents data from the IES-Total, BDI and GHQ instruments, as only these scores provided sufficient analyzable data in at least two studies. The IES-Total is used as a measure

of posttraumatic stress symptoms, the BDI as an assessment of depressive symptoms and the GHQ as a screening tool for psychiatric illness [10–12].

In almost all of the included studies, regardless of group affiliation (merchant seafarers, navy crew/US Coast Guard members or passengers) or observation period, the mean values of IES-Total are well above 10 (as reference value of a normal population sample) [12, 26, 28]. Furthermore, the disaster studies on passenger vessels [20, 27, 26] report mean IES-Total values that considerably surpass the 35-point cut-off level proposed by Neal et al. (1994) [29] at the initial observation. While IES-Total values generally significantly decrease over time in the studies with multiple observation periods (except for Joseph et al. (1991) [24]), significant long-term posttraumatic stress symptoms can be observed, as the mean IES-Total values of all included studies remained above the normal population reference value of 10. In fact, the passenger studies by Dalgleish et al. (2000) [20], Joseph et al. (1991) [24] and Thompson et al. (1994) [26] show that even after three years, 19 months and ten months respectively, the mean values of IES-Total score are still above the cut-off value of 35.

Different levels of depression severity can be distinguished based on the version of the BDI used in the studies (a value between ten and 20 is suggested to be associated with mild depression, while values between 20 and 30 are indicative of moderate depression and values above 30 are reflective of severe depression) [30]: At the earliest observation period measured, the mean BDI values in the study by Joseph et al. (1991) [24] are in the range for moderate depression at eight months after disaster, while the mean values reported by Dalgleish et al. (2000) [20] fall within the threshold for mild depression at twelve months after disaster. Over time, both passenger studies show a reduction in depressive symptoms, yet both remain at moderate and mild depression levels, respectively, even at several years after the disaster.

While the included studies use different versions of the questionnaire, namely GHQ-28 and GHQ-30, the proposed cut-off levels for the screening of psychiatric conditions by the original authors are similar at 4/5 and 3/4, respectively [11, 31]. At the initial assessment, the mean GHQ values are distinctly above the cut-off score and thereafter show a decrease in values over time. Two notable exceptions are observed, as Joseph et al. (1991) [24] reported an increase in mean GHQ scores between eight and 19 months, and Dyregrov and Gjestad (2003) [22] reported a mean GHQ value below the cut-off of 4/5 (GHQ-28) at 18 months.

DISCUSSION

Survivors of a maritime disaster are potentially exposed to an exceptionally high level of psychomental distress. It is therefore of great importance to gain an understanding of the manifestation of post-disaster symptoms. Post-traumatic stress disorder, depression and anxiety are common psychopathological manifestations in the aftermath of disasters [8, 13]. The aims of the included studies focused primarily on the assessment of the short-term effects of the disaster on survivors, although long-term effects were also frequently investigated. Some of the studies were also intended to examine the impact of certain disaster characteristics or other possible influences on symptom severity, although these factors are not the subject of this review. The most frequently identified instruments in the review to investigate the short- and long-term mental health effects of a maritime disaster include the IES, BDI and GHQ.

The IES was developed as an instrument to evaluate posttraumatic stress symptoms following a traumatic or stressful event and consists of a series of 15 items from the symptom clusters intrusion and avoidance [12, 28]. The IES-Total score has been established as one of the most widely used instruments for measuring PTSD symptoms in disaster research, exhibits high sensitivity and specificity (89% and 88% at a cut-off value of 35), and has been substantiated and psychometrically validated as a screening instrument for PTSD in further research [8, 29, 32, 33]. In addition, Dyregrov and Gjestad (2003) [22] reported a Cronbach's alpha coefficient for IES-Total of 0.89 and Eid et al. (1999, 2001) [28, 18] reported a Cronbach’s alpha of 0.85 for IES-Total, reflecting a high degree of internal consistency.

The analysis of the IES-Total values of the investigated populations indicates that individuals, regardless of their group affiliation, manifest pronounced intrusion and avoidance symptoms after a maritime disaster. The reduction in posttraumatic stress symptoms over time in survivors of maritime disasters is largely consistent with the observation of the review by Newnham et al. (2022) [8], who evaluated the prevalence and time course of PTSD symptoms across diverse land-based disaster types. The mean IES-Total value in some of investigated populations even exceeds the cut-off score of 35 after several months and years, indicating the likely occurrence of a PTSD diagnosis [22, 29]. This suggests that maritime disasters have the potential to cause considerable long-term posttraumatic stress symptoms.

The findings of the seafarer study by Líndal and Stefánsson (2011) [15] support the assumption that the above findings also apply to merchant seafarers. Although the first assessment of posttraumatic stress symptoms using the IES-Total did not take place until eight years after the disaster, the relatively high symptom burden and the observed general decrease

in symptoms indicate a substantial initial manifestation of posttraumatic stress symptoms. This assumption is partly supported by the authors of the study, who also hypothesized a significant burden of posttraumatic stress symptoms after the seafaring disaster [15].

The BDI is a 21-item inventory that rates the intensity of attitudes and symptoms commonly seen in depressed patients on a scale from 0 to 3 [10]. The small decline in mean BDI values between 8–12 months and several years after the disaster suggests that depressive symptoms among survivors of maritime disasters remain elevated and decline only slowly, at least for the period beyond one year. This is consistent with the findings of the aforementioned review of land-based disasters, which also found an elevated prevalence of depressive symptoms following disaster exposure that remained relatively stable over time, particularly within the first two years [8].

The GHQ differs from the previously discussed instruments as it is not designed to measure specific psychological symptoms, but rather as a screening instrument to identify individuals who exhibit symptoms of psychiatric conditions [11]. The questionnaire includes a wide spectrum of items which are rated according to their severity; for example, the GHQ-28 version includes somatic, social, psychological, and psychiatric symptoms [11]. The cut-off values used to screen for psychiatric disorders of 4/5 for the GHQ-28 (sensitivity 88% and specificity 84%) and 3/4 for the GHQ-30 (sensitivity 85% and specificity 80%) demonstrate satisfactory diagnostic performance [11, 31]. One study [22] has demonstrated a high degree of internal consistency of the GHQ based on a Cronbach's alpha coefficient of 0.93. The mean GHQ values of the passenger populations were almost exclusively distinctly above the cut-off level, suggesting a high burden of various somatic, psychological and psychiatric symptoms after maritime disaster. The time course of symptoms as measured by the GHQ demonstrates a more heterogeneous pattern than those observed for the IES and BDI scores discussed previously. Nevertheless, the results support the conclusion that significant symptoms may persist for an extended period of time.

Finally, it's worth noting that the items of the GHQ correspond to some of the symptoms of the standardized scores discussed earlier, as well as to some of the symptoms that were summarized in the section “Symptoms of survivors after maritime disaster”. For instance, anxiety-related symptoms are prominently featured in the GHQ items [11], and Taiminen and Tuominen (1996) [25] and Dooley and Gunn (1995) [27] have observed symptoms of the anxiety cluster in the majority of survivors or have frequently diagnosed anxiety disorders among their survivor populations. These exploratory findings suggest that anxiety may have a

substantial impact on the mental health and well-being of survivors in the aftermath of a maritime disaster.

METHODS AND OBJECTIVES FOR FUTURE MARITIME RESEARCH

Future researchers have to select appropriate instruments to assess the mental health of survivors of maritime disasters. Depending on whether the chosen focus of the study is to assess posttraumatic stress or depressive symptoms or to screen for psychiatric disorders, the IES, BDI and GHQ scores appear to be interesting instruments for future maritime disaster research. They exhibit promising psychometric properties for use as screening instruments [11, 12, 31–33] and because of their previous use in maritime disaster studies, future researchers can draw on reference populations when evaluating and comparing results. This is particularly important because, as this review demonstrates, studies of maritime disasters are relatively rare and many aspects of maritime disasters remain insufficiently understood.

While this systematic review provides information on post-disaster mental health reactions, it does not provide much insight into how best to support survivors of maritime disasters. Only Dyregrov and Gjestad (2003) [22] have investigated the effects of an intervention on mental health after the experience of a maritime disaster. However, they found no evidence that the debriefing of survivors after a maritime disaster results in a significant reduction in posttraumatic symptoms [22]. Further research into the effectiveness of interventions for survivors of maritime disasters is urgently needed to improve the psychological care of disaster victims and to establish evidence-based interventions.

LIMITATIONS

There are some limitations to this review that should be considered. A main limitation is that there are relatively few studies of merchant seafarers in this review, as only three of the twelve studies (comprising 40 seafarers) focused on them. While the original intention of this review was to evaluate the post-disaster psychomental reactions of merchant seafarers, maritime disaster studies involving navy crew/US Coast Guard members and passengers were also included due to the small number of studies that addressed merchant seafarers. Although the last exclusion criterion applied (conceivable scenarios in merchant shipping) was introduced explicitly to make comparisons between populations as meaningful as possible, and indeed many parallels in symptom presentation were found particularly between passengers and merchant seafarers, it remains a significant limitation.

The included studies also varied considerably in terms of the investigated populations, methods, study aims and the magnitude of the disaster. There were also uncertainties and discrepancies in the reported figures, such as the number of individuals on board and the number of fatalities in the same disaster (Table 2), or imprecise information on the observation intervals (Table 3). Finally, it should be noted that it is not possible to fully and comprehensively capture the circumstances or trauma potential of the disaster and other influencing factors from the review of studies. As a result, potential influences on the mental health of survivors after a disaster may have gone unrecognized.

CONCLUSIONS

The findings from the review affirm some of the results of general, land-based disaster research; this suggests that the review was able to validate certain aspects in the context of maritime disasters. The summarized evidence supports that even many years after a maritime disaster, a significant burden of psychological symptoms, particularly posttraumatic stress symptoms and depressive symptoms, can be present and affect the mental health of survivors. This systematic review provides a descriptive overview of reported psychomental symptoms after fatal maritime disasters. The consideration of the results and findings of the review could provide an important basis for the identification of survivors' mental health needs and the development of more effective interventions for seafarers and other victims of maritime disasters.

ARTICLE INFORMATION AND DECLARATIONS

Author contributions: Author — conception and execution of review, literature search, interpretation of results, discussion, writing. Co-authors — conception of review design, supervision, assistance in writing and interpretation / discussion.

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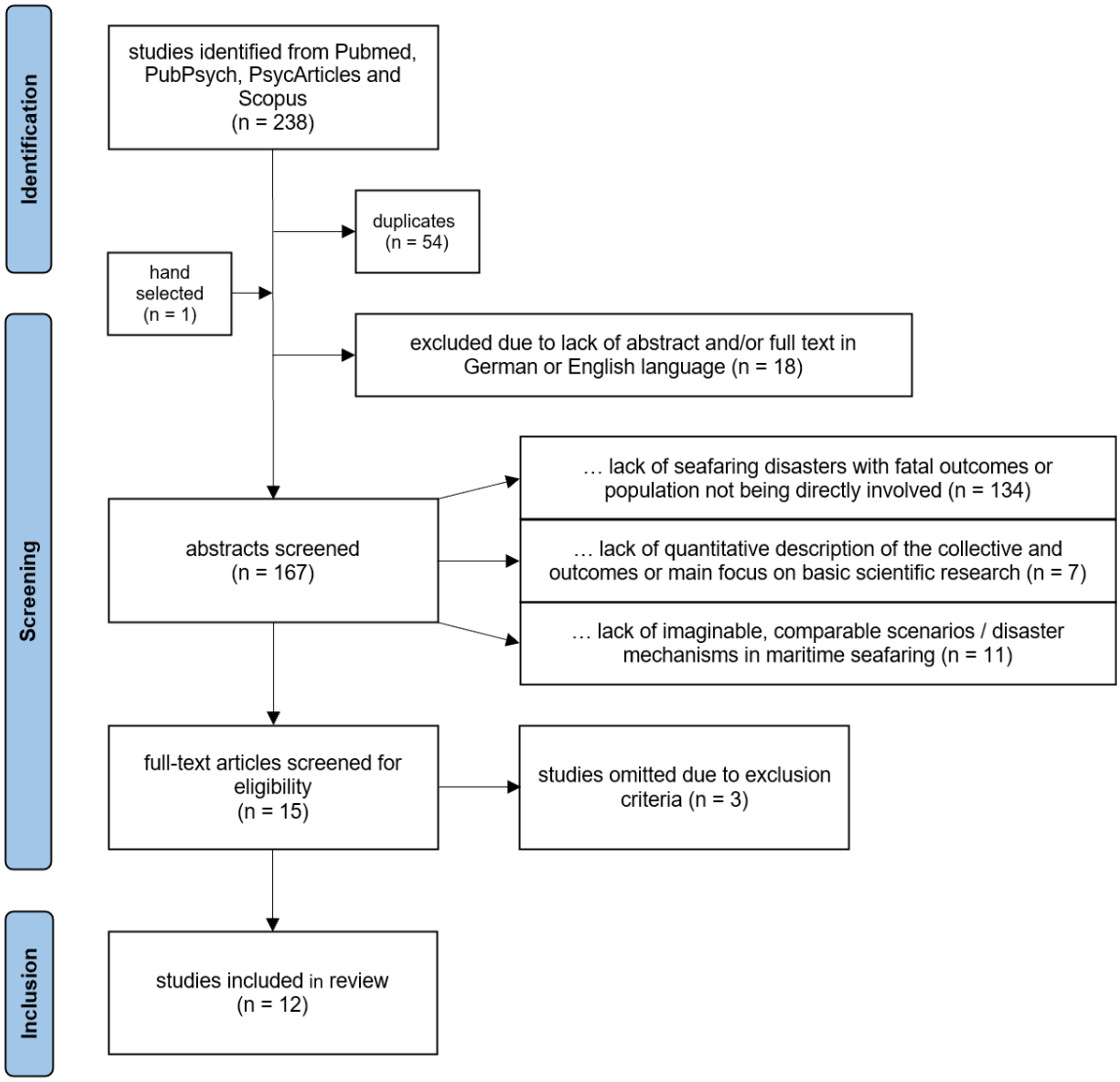

Figure 1. Identification, screening and inclusion process of research hits visualized in PRISMA diagram [14]

author	title	study group	pub. year	vessel	study design	review-relevant aims of study	SIGN grade
Líndal & Stefánsson	The long-term psychological effect of fatal accidents at sea on survivors: (…)	seafarers	2011	smaller fishing boats	cross-sectional study	The goal is to determine whether survivors of small maritime disasters experience long-term symptoms of PTSD and whether the frequency or severity of symptoms correlates positively with the severity of the disaster.	3
Tekin et al.	A burn mass casualty event due to boiler room explosion on a cruise ship: (…)	seafarers	2005	cruise ship	case report	To review the experience and psychological sequelae of a boiler room steam explosion.	3
McCaughey	US Coast Guard collision at sea	seafarers & navy crew	1985	US Coast Guard ship	case report	To describe the emotional, psychological and physical symptoms of the survivors.	3
Eid et al.	Post-traumatic stress symptoms following shipwreck of a Norwegian Navy frigate - (…)	navy crew	2001	frigate	prospective cohort study	To conduct a short-term follow-up of post-traumatic stress reactions and to investigate whether contextual and individual factors are related.	2+
Hoiberg & McCaughey	The traumatic aftereffects of collision at sea	navy crew	1984	missile cruiser	prospective cohort study	To examine the psychological effects of an maritime collision by comparing the performance and psychiatric hospitalizations during a 3-year follow-up of the disaster Navy crew.	2-
Dalgleish et al. *	The Herald of Free Enterprise disaster. Lessons from the first 6 years	passengers	2000	ferry	review	To address questions about the time course of symptoms, mediating and moderating factors of posttraumatic stress reactions and possible predictor variables of distress and psychological problems at later time points.	n.a.
Dooley & Gunn *	The psychological effects of disaster at sea	passengers	1995	ferry	cross-sectional study	To determine whether crude measures of the nature and/or severity of psychological stress or threat (such as immersion and bereavement) are related to severity of symptoms.	3
Joseph et al. *	Causal attributions and psychiatric symptoms in survivors of the Herald of Free Enterprise disaster	passengers	1991	ferry	prospective cohort study	To investigate the relationship between causal attributions and psychiatric symptoms and whether guilt is a possible predictor of more severe and prolonged reactions.	2-
Dyregrov & Gjestad	A maritime disaster: reactions and follow-up	passengers	2003	catamaran	prospective cohort study	To report on the disaster survivor's reactions and their received psychosocial help.	2+
Eriksson & Lundin **	Early traumatic stress reactions among Swedish survivors of the m/s Estonia disaster	passengers	1996	ferry	cross-sectional study	To assess the short-term impact on disaster survivors.	2-
Taiminen & Tuominen **	Psychological responses to a marine disaster during a recoil phase: experiences from the Estonia shipwreck	passengers	1996	ferry	case report	To describe the psychological reactions and corresponding behavioral patterns among disaster survivors during the first three days.	3
Thompson et al.	The Marchioness disaster: preliminary report on psychological effects	passengers	1994	riverboat	cross-sectional study	To describe the psychological after-effects on disaster survivors.	3

* = Herald of Free Enterprise disaster; ** = MS Estonia disaster

Table 1: *Overview and general information about included studies. Publications sorted by main population group investigated in study (study group).*

	disaster			characteristics of investigated survivors		
author	study group	total number of persons aboard ship	total fatalities (%)	description / recruitment of population	n	age
Líndal & Stefánsson	seafarers	not specified	not specified	- case group: 5 fishermen crews which were involved in fatal disasters - control group: 15 fishermen crews which were involved in non-fatal disasters	- case group: 24 - control group: 88	mean 39.4 ± 9.1 years
Tekin et al.	seafarers	not specified	6	burn patients after boiler room steam explosion	9	mean 27 years (range 23-53)
McCaughey	seafarers & navy crew	29	11 (38%)	all survivors	- 7 seafarers - 11 navy crew members	- seafarers: mean 25.3 years - navy crew: mean 26.7 years
Eid et al.	navy crew	114	1 (0.9%)	survivors of disaster who were available on ship 3 weeks after disaster	- first questionnaire: 82 - second questionnaire: 74 - third questionnaire: 64	- officers: mean 29.8 years (SD 5.5) - crew: mean 21.6 years (SD 1.7)
Hoiberg & McCaughey	navy crew	336	7 (2%)	- cohort group: surviving crew of disaster group - control group: crew of comparable ship	- cohort group: 329 - control group: 387	not available
Dalgleish et al. *	passengers	<580	193 (≥33%)	- first observation: survivors referred to psychology department, often in regard to compensation claims - second & third observation: survivors known to social services - control group: matched subjects	- first observation: 37 - second observation: 73 - third observation: 37 - control group	- first observation: mean 33 years (range 16-63) - second observation: mean 35 years (range 17-55) - third observation: mean 39.8 years
Dooley & Gunn *	passengers	459	193 (42%)	survivors referred for psychiatric evaluation and assessment of psychological injuries in regard to compensation claims	47	15/75 (20%) <20 years
Joseph et al. *	passengers	600	193 (32%)	survivors of disaster who were assessed by psychology department, provided a written statement about their experiences and sought out financial compensation	20	mean 34 years (range 19-54)
Dyregrov & Gjestad	passengers	85	16 (19%)	contactable survivors	- first questionnaire: 53 - second questionnaire: 29	mean 27.9 years (SD 12.0, range 14-62)
Eriksson & Lundin **	passengers	>900	~765 (~85%)	Swedish survivors of disaster	42	mean 40.5 years (range 19-65)
Taiminen & Tuominen **	passengers	>1,038	>900 (~87%)	survivors taken to Turku University Central Hospital	38	mean 34.8 years (range 12-77)
Thompson et al.	passengers	131	51 (39%)	survivors referred by solicitors	27	mean 27.9 years (SD 4.9)

* = Herald of Free Enterprise disaster; ** = MS Estonia disaster

Table 2: *Victims of disaster and investigated survivor populations. Publications sorted by main population group investigated in study (study group).*

Table 3. Observation intervals, methods and contents of studies, and use of standardized instruments. Publications sorted by main population group investigated in study and by descending frequency of the standardized instruments used. Only instruments that have been used in at least two publications are shown

			most frequently used standardized instruments					
author	intervals of observation after disaster	methods (contents)	IES	GHQ	PTSS-10	BDI	STAI	DSM
Lindal & Stefánsson	single observation within an average of 8 years	semi-structured interviews and open-ended questions	✓	✓	✓			
Tekin et al.	regular observations during hospital admission and at least one psychological follow-up after discharge	reviewal of patient's written and electronic records, observation and diagnosis by burn center psychology team						
McCaughey	observations for 12 days, possibly up to one year for a few seafarers	examination of psychiatric records and observations by disaster intervention group, non-standardized questions (reactions to accident)						
Eid et al.	first observation at 3 weeks, second observation at 4 months and third observation at 12 months	non-standardized questions (contextual factors such as time in navy crew and individual factors such as coping style)	✓		✓			
Hoiberg & McCaughey	3 years before and after disaster	data extracted from patient health and career history files covering time before and after disaster						
Dalgleish et al. *	first observation within 1 year, second observation at 3 years and third observation at 6 years	open-ended questions and non-standardized questions (guilt, substance abuse) either by self-report data, postal questionnaires or personal visit	✓	✓		✓	✓	
Dooley & Gunn *	at least one, sometimes multiple observations of patients assessed over >18 months	interviews, clinical notes, legal reports, special investigations and non-standardized questions (immersion, bereavement, psychiatric history and symptoms after disaster)						✓
Joseph et al. *	written statements within ~3.5 months, first observation at ~7.5 months and second observation at ~19 months	psychological interviews, non-standardized self-report measures, extraction of information from documents (perceived internality and controllability of disaster and intensity of impact)	✓	✓		✓	✓	
Dyregrov & Gjestad	first observation at 6 weeks and second observation at 18 months	non-standardized questions (disaster exposure, helpfulness of intervention meetings, perception of functioning before disaster, peritraumatic reactions and perception of help received)	✓	✓				
Eriksson & Lundin **	single observation at 3 months	open-ended questions, non-standardized questions (personal loss, coping abilities, exposure to dead passengers) and standardized instrument on basis of DSM-IV (especially measuring dissociative symptoms of acute stress disorder)	✓		✓			✓
Taiminen & Tuominen **	daily observations for the first three days	observations by crisis intervention group						
Thompson et al.	single observation at 10 months	interview	✓	✓				

IES = Impact of Event Scale; GHQ = General Health Questionnaire (28 or 30 item version); PTSS-10 = Posttraumatic Symptom Scale; BDI = Beck Depression Inventory; STAI = State-Trait Anxiety Inventory; DSM = Diagnostic and Statistical Manual of Mental Disorders (DSM-3 or DSM-4)
* = Herald of Free Enterprise disaster; ** = MS Estonia disaster

BDI — Beck Depression Inventory; DSM— Diagnostic and Statistical Manual of Mental Disorders; GHQ — General Health Questionnaire; IES-Total — Total Impact of Event Scale, PTSS-10 — Posttraumatic Symptom Scale; STAI — State-Trait Anxiety Inventory

Table 4. Scores of the most frequently used standardized instruments with at least one inter-study comparison. Publications sorted by main population group

		mean values of the most frequently used standardized instruments		
author	**time after disaster**	**IES-Total**	**BDI**	**GHQ**
Líndal & Stefánsson	avg. of 8 years	18.4		
Eid et al.	3 weeks	22.5		
	4 months	13.8		
	12 months	14.2		
Dalgleish et al. *	within 1 year	44.2	17.9	21.9
	3 years	35.1		10.0
	6 years	27.0	13.1	
Joseph et al. *	~7.5 months	46.9	29.4	22.4
	~19 months	44.8	24.4	25.7
Dyregrov & Gjestad	6 weeks	26.6		7.0
	18 months	19.1		4.0
Eriksson & Lundin **	3 months	28.3		
Thompson et al.	10 months	46.4		15.4
* = Herald of Free Enterprise disaster; ** = MS Estonia disaster				

BDI — Beck Depression Inventory; GHQ — General Health Questionnaire; IES-Total — Total Impact of Event Scale