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Non-Standard Work Hours, Accidents and Injuries Among Seafarers. A Systematic Review

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ABSTRACT

Studies have shown that non-standard work hours are linked to an increased risk of accidents and injuries in sectors such as healthcare, transportation, and manufacturing. Nevertheless, findings related to seafarers in the maritime work environment are limited and inconsistent. To date, synthesised information or overview has not been published on this topic. Against that backdrop, this systematic review examined whether there is a relationship between non-standard work hours, such as night shifts, extended work hours, and rotating shifts, and accidents and injuries among seafarers. The study was registered in PROSPERO (2024 CRD42024543444). The review included 941 relevant primary studies from peer-reviewed electronic databases, including Ovid MEDLINE, PsycINFO, EMBASE, and the Web of Science core collection, using a predefined search strategy following PRISMA guidelines. Three studies met the inclusion criteria. These studies, primarily registry-based and cross-sectional, reported accidents and injury rates as key outcomes. The studies spanned multiple countries. Higher accident frequencies occurred during night shifts (00:00-04:00) compared to normal day hours. Overall injury rate reported by one of the studies was 9.1% in a multi-country survey. This systematic review shows a high rate of accidents and injuries among seafarers globally, and incidents seemed to be more frequent during non-standard work hours. However, empirical studies on the association between non-standard work hours and the occurrence of accidents and injuries among seafarers are scarce, warranting further research on this topic.

Keywords: Non-standard work hours, Seafarers, Shift work, Injury, Accident, Systematic review, Observational

INTRODUCTION

Maritime industry is an important part of the supply chain for transportation of raw materials and finished products globally. Around 80 percent of volume of goods are transported internationally and it is estimated to be higher in

most of developing countries (United Nations Trade and development, 2024). The volume of seaborne trade has more than doubled from 1990 to 2021 from four to eleven billion tons of goods respectively (United Nations Trade and development, 2024). Figures related to number of people employed in the shipping industry are scarce, but the European Union stated that their shipping industry employed 555 000 people in 2018 (Statista, 2024).

Maritime work includes some of the most hazardous occupations in the world. The International Labor Organization (ILO) and the International Maritime Organization (IMO) have characterized fishing and seafaring as the most dangerous and hazardous occupations (Jensen et al., 2006; McGuinness et al., 2013; Shan, 2020; Zhang et al., 2019). Work at sea comprises multiple and complex tasks that demands presence of 24/7 operations, thus non-standard work hours are common (Kim, 2021). Non-standard work hours (i.e., shift work) include all types of working hours that take place outside normal daytime hours (evenings, nights, and early mornings), Monday and Friday and outside normal working days (weekends), which refers to work during conventional daytime hours on weekdays. However, the definition of non-standard working hours varies and changes over time (George & Chattopadhyay, 2015). Typically, non-standard work hours includes extended work hours/long shifts, night shifts, irregular and unpredictable hours, and rotating two or three watch systems (Hesselink & Goudswaard, 2024). Non-standard work hours are generally associated with increased risk of accidents and personal injuries among onshore workers (Kecklund & Axelsson, 2016; Fischer et al., 2017). However, the knowledge in this area in terms of seafarers is limited. A comprehensive understanding of how non-standard work hours relate to the occurrence of incidents and injuries at sea is of major importance for seafarers' health and safety, as well as for decision makers, regulators and society at large.

In this review, the term maritime work encompasses work on vessels in the sea or ocean, including merchant transport and fishing. Likewise, the term seafarers in this study refers to individuals employed onboard any type of marine vessel, regardless of their specific roles and responsibilities, and includes a wide range of professions such as Captain, Chief mate, Deck Officers, Engineers, electro-technical officers, Chief Steward (Seafarers, 2024). Seafarers work tasks are diverse and vary depending on the type of vessel, such as oil and gas tankers, bulk carriers, chemical tankers, fishing vessels, car carriers, cruise ships, and military vessels as well as on the specific role allocated to the seafarer. Maritime work bears inherent risks from changing weather conditions, the volatile nature of the sea to complexity of logistics involving navigation across international waters (Shahbakhsh et al., 2022; & Wu, et al., 2022). These facts indicate an increased likelihood for adverse health and safety outcomes of workers at sea, including accidents and injuries (Zhang & Zhao, 2017). By prioritizing health and safety of seafarers, governments and companies can potentially reduce costs associated with accidents and injuries meanwhile improving overall well-being and productivity.

Work during non-standard work hours is common in our society. A survey based on the European Working Conditions Survey (EWCS) conducted in

29 European countries found that approximately 39 percent were employed in non-standard work schedules (Gracia et al., 2021). Several non-standard work schedules exist in maritime industry including various watch keeping systems. Common categories are two-watch systems (2- teams share the 24-h period) and three-watch systems (3- teams share the 24-h period). Examples of these work schedules are 6h on – 6h off, 12h on – 12h off, 8h on – 8h off, and 4h on – 8h off (van Leeuwen et al., 2021).

Despite the existence of published primary studies, there exists to date no synthesized information or overviews on the association between non-standard work hours and accidents and injuries in the maritime sector. Therefore, this systematic review aimed to examine whether there is a relationship between non-standard work hours, accidents and injuries among seafarers.

METHODS

A systematic review was carried out to investigate the relationship between non-standard work hours and the occurrence of accidents and injuries among seafarers. This review adhered to the updated PRISMA-2020 (The preferred Reporting Items for Systematic Reviews and Meta-Analyses) statement 2020 (Page et al., 2021) and was pre-registered in PROSPERO (2024 CRD42024543444).

Eligibility Criteria

This review included primary full-text empirical studies concerning seafarers available up to April 2025, that reported on the relationships or the associations between non-standard work schedules and accidents or injuries at sea among adult seafarers. Peer reviewed articles were screened based on the following inclusion criteria: (i) primary research articles published in peer-reviewed journals, (ii) full text available in English language; (iii) quantitative studies employing prospective or retrospective designs, such as observational studies (cohort, cross sectional, case- control) or experimental or interventional studies, (iv) studies reporting workers exposed to non-standard work schedules, and (v) studies reporting accidents and or injuries among seafarers as the outcome. In addition, studies that determine how different types of non-standard work schedules used at sea vessels relate to accidents and injuries in seafarers were included. Qualitative studies, conference proceedings, case reports, editorials, unpublished literature, grey literature, dissertations/theses, case reports and book chapters were excluded. Taken together, this review included original studies adhering to the PICO framework for systematic reviews, i.e., **P**articipant (maritime workers, seafarers, seamen), **I**ntervention/Exposure (non-standard work hours, shift work, night shift, rotating shift), **C**omparator (day work, standard work hours) and **O**utcome (accidents, injuries) (Amir-Behghadami & Janati, 2020; Eriksen & Frandsen, 2018).

Information Sources and Search Strategy

A comprehensive literature search was carried out to include all available studies up to July 2024 and supplementary search was done in April 2025

in four electronic databases: Ovid MEDLINE, PsycINFO, EMBASE and Web of Science core collection. Additional searches were conducted using Google Scholar and through backward citation tracking from the reference lists of key articles. Relevant synonyms and subject headings for non-standard work hours in seafarers were combined using Boolean operators. The search strategy was designed and conducted in collaboration with an academic librarian and peer-reviewed by another researcher. An example of the search terms and strings used in the Ovid MEDLINE electronic database are presented in Table 1. Seach strings used *(((Work Schedule Tolerance/ or Shift Work Schedule/) OR ((work schedule* or work table or non-standard work* or non-standard work* or nonstandard work* or night work* or night shift* or evening shift* or shift work* or shiftwork* or work shift* or rotat* shift* or work rest cycle* or work load or work stress).ti,ab,kf.)) AND ((Naval Medicine/ or Ships/) OR (Seafarer* or seafarer* or seaman or seamen or sailor* or deck officer* or crew or marine* or maritime or sea or ocean or nautical or naval or navy or ship* or boat* or submarine* or yacht*).ti,ab,kf.)))*.

Table 1: Search strategy in Ovid MEDLINE with supplementary upgrade April 2025.

Database(s): Ovid MEDLINE(R) and Epub Ahead of Print, in-Process, in-Data-Review & Other Non-Indexed Citations, Daily and Versions <1946 to April 20, 2025>.

#	Searches	Results
1	Work Schedule Tolerance/ or Shift Work Schedule/	8675
2	(work schedul* or work table or non-standard work* or non-standard work* or nonstandard work* or night work* or night shift* or evening shift* or shift work* or shiftwork* or work shift* or rotat* shift* or work rest cycle* or workload or work stress).ti,ab,kf.	22230
3	1 or 2	26405
4	Naval Medicine/ or Ships/	15476
5	(Seafarer* or seafarer* or seaman or seamen or sailor* or deck officer* or crew or marine* or maritime or sea or ocean or nautical or naval or navy or ship* or boat* or submarine* or yacht*).ti,ab,kf.	289552
6	4 or 5	293052
7	3 and 6	384
8	limit 7 to (case reports or meta-analysis or "review" or "systematic review")	36
9	**7 not 8**	348

Study Selection and Data Collection Process

Duplicates were removed using the bibliographic software EndNote. The principal investigator oversaw the searches until it was complete. The resulting records were imported into the web-based Covidence platform for screening (Covidence)-*https://app.covidence.org/reviews/452404*. Two independent authors screened all articles against the pre-defined inclusion

criteria, starting with title and abstract screening, then performed full-text screening to assess whether the study contained required information. Both authors independently assessed the full texts of potentially eligible studies. Any disagreements were resolved by consensus through discussions. Briefly, the electronic search in all four databases yielded a total of 1464 studies. A total of 523 duplicates were then removed. Following removal of duplicates, 941 studies were retained and screened for title and abstract. Of these, 14 studies were selected for full-text review. Since only a few studies exists and most seafarers work outside normal workday, all studies on seafarers and the specified outcomes i.e., non-standard work hours vs. occurrence of accidents and injuries were included. Finally, a total of three studies were included in the final review (Figure 1). The screening and selection process was documented in accordance with the PRISMA–2020 guideline for reporting systematic reviews (Page et al., 2021).

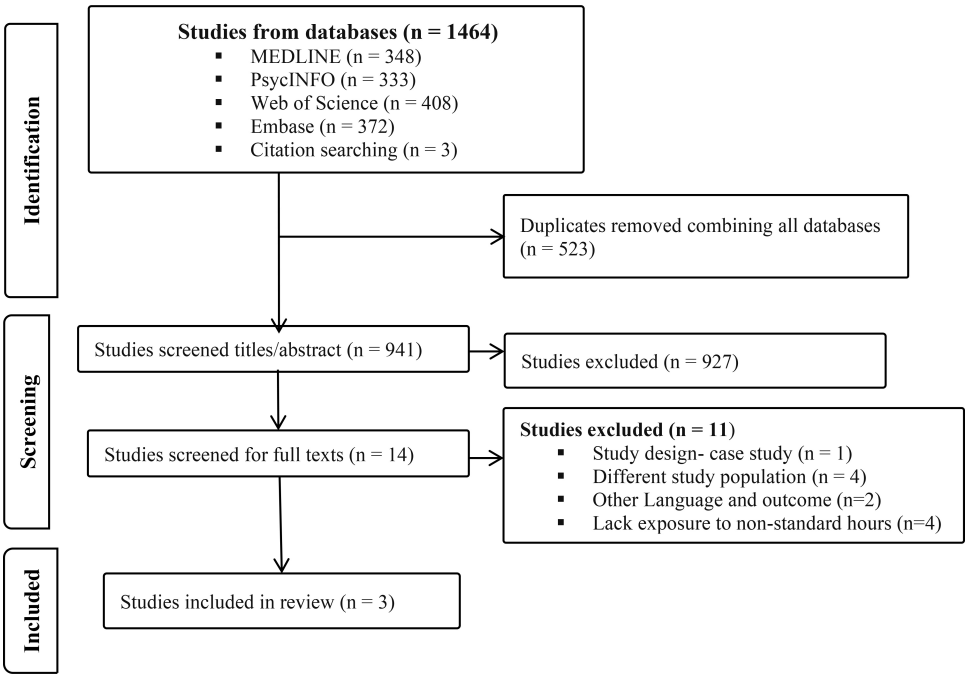

Figure 1: PRISMA–Flowchart of included and excluded primary studies.

Data Extraction

A pre-determined and piloted data extraction form embedded in the Covidence web-based software was used for data extraction. Inter-rater reliability was assessed using percentage agreement and Cohen's Kappa to ensure consistency and transparency of the review process (Belur et al., 2021). For the title and abstract screening, the reviewers showed a proportionate agreement of 0.98, and a Cohen's Kappa of 0.53 indicating moderate agreement beyond chance. Likewise, the Cohen's Kappa for risk of bias evaluation was 0.50.

Data extraction was conducted independently by two authors [I.P.N and E.V.T]. To promote consistency in data extraction, the two authors participated in training and discussion sessions to harmonize their understanding of the data extraction tool. Information to be extracted from primary studies included: author(s), year of publication, study design, sample size, characteristics of the study population, types of non-standard working hours including watch systems, definition and measurement of accidents and injuries, statistical methods used, and effect estimates with corresponding measures of uncertainty (e.g., incidence ratio [IR]), quantification of the association between non-standard working hours and accidents or injuries (Table 2). Any difference in extracted information between the two authors were resolved by discussions to reach consensus.

Methodological Quality Assessment of Primary Studies

The methodological quality of the included studies was assessed independently by two authors using an adapted and customized 14-items checklist (Table 3). This tool was originally developed and used for assessing risk of bias in systematic review and meta-analysis of workplace bullying and sickness absence as well as an ongoing meta-analysis on the association between shift work and sickness absence (Nielsen et al., 2016; Sunde et al., 2022). The risk of bias instrument evaluates each article on 14-items, with a total score ranging from 0 (highest risk of bias) to 14 (lowest risk of bias). These scores were then categorized as follows: high risk (0–5), moderate risk (6–10) and low risk (11–14), respectively (Nielsen et al., 2016). The methodological quality assessment was conducted with the three studies reporting both exposure (non-standard work hours) and outcomes (incidence of accidents and injuries) (Table 3).

Data Synthesis

A narrative synthesis of information from the final studies was conducted. This included description of basic study characteristics (author, year of publication, country), study design, data source, population description, sample size and outcome measures. Three studies that reported a relationship between non-standard work hours and occurrence of accidents and injuries among seafarers were analysed summarised in Table 2.

RESULTS

Characteristics of Included Studies

A total of three primary studies involving seafarers were finally included in this review (Table 2). All studies were observational (two cross-sectional, and one retrospective) studies. The studies included data from more than one country, so the studies covered a wide range of countries, including the UK, Norway, Denmark, Poland, Philippines, Indonesia, Croatia, Spain, South Africa, Ukraine, Russia, China (including Hong Kong), Germany, Sweden, and Ireland. Of the three studies, two were registry-based and one utilized

survey data. The key outcome measure reported was the injury incidence rate.

A multicounty study analysed registry data of 1163 vessel accidents involving seafarers regarding 4h-on-8h-off watch system and frequency of accidents (Vinagre-Ríos et al., 2021). Another study analysed registry data from six countries that compared incidence of accident between day and night shifts (Akhtar & Utne, 2015) whereas, one study analysed long working hours (one of non-standard work hours) and injury rates among seafarers (Table 2).

Methodological Quality Assessment Results

The three studies varied considerably in term of methodological quality. Two studies had moderate methodological quality (Akhtar & Utne, 2015; Jensen et al., 2004); whereas one study had high risk of bias (Vinagre-Ríos et al., 2021) as shown in Table 3. Studies were mainly cross sectional in design, making them vulnerable to biases. All studies, except one, lacked detailed information on the type of non-standard work hours which, was among the key attribute of the current review.

Outcomes

The studies in Table 2 provides valuable information on non-standard work hours and the occurrence of injury and accident rates among seafarers. A survey conducted among seafarers in eleven countries (the UK, Denmark, Poland, Philippines, Indonesia, Croatia, Spain, South Africa, Ukraine, Russia, China) reported an overall injury rate of 9.1% injury rate during the most recent tour of duty, suggesting that seafaring is a high-risk occupation; however, detailed information on work schedules, including shift patterns, was not captured or analysed.

A multicounty study examined the 4h-on-8h-off watch system in relation to occurrence of accidents across several vessels (collisions and groundings). This study found that accidents were more frequent during night shifts, particularly between 00:00h and 04:00h - shifts (Vinagre-Ríos et al., 2021). Similar findings were documented in a study that analysed occurrence of accidents in several countries such as Norway, the UK, China, Germany, Sweden, and Ireland. The authors pointed out that accidents were more frequent during non-standard work hours, particularly between 22:00 and 07:00, than during day shifts (Akhtar & Utne, 2015).

DISCUSSION

The purpose of this systematic review was to investigate the association between exposure to non-standard work hours and the risk of accidents and injuries among seafarers. Overall, a high incidence rate of accidents, fatal accidents and injuries was observed among seafarers. Furthermore, accidents were reported to occur more frequently during night shifts compared to during day shifts. This suggests a likely association between non-standard work schedules and the occurrence of accidents and injuries among seafarers. However, the lack of detailed non-standard work exposure data in most

Table 2. Characteristics of included studies and reported exposure to non-standard hours and occurrence of accidents and or injuries among seafarers.

Author, Year, Country	Study Design	Data Source	Population Description	Sample Size	Non-Standard Work Hours	Outcome Metrics	Estimates
Vinagre-Rios J. et al. (2021)- *Multicounty*	Cross sectional study	Registry- IMO accident investigation registry	Seafarers merchant vessels	1163 vessel accidents	Watch systems vs. accident (4-on/8-off, 6/6 system)	Frequency /Numbers	Accidents occur more frequent and serious during night shifts (00.00 hrs – 04.00 hrs)
Akhtar, MJ. et al. (2015) - *(Norway; UK; China, German, Hongkong, Sweden, Ireland)*	Retrospective study	Registry - *Accident investigation reports from MAIB*	Seafarers	33 fatigue-related accidents	Time of incidents (night vs. day shifts)		Fatigue factors contribute to accidents (***collision and groundings)- circadian effects i.e., most groundings happened between 22:00 – 07:00 hours.
Jensen O.C et al. (2004) - *(UK; Denmark; Poland; Philippines; Indonesia; Croatia; Spain; South Africa; Ukraine; Russia; China)*	Cross sectional study	Survey	Seafarers from 11 countries	6461	Three category of working hours per week (<57, 57-70, 71+)	*IR	**Overall injury rate was 9.1% during their latest tour of duty. • IRR (57-70 hrs) = 1.17 (0.81-1.69) • IRR (70+hrs) = 0.90 (0.61 – 1.32)

*IR = incidence Ratio, **IRR** = Incidence rate ratio. **MAIB** = Marine Accident Investigation Bureau (British); **IMO** = International Maritime Organization; **HSE** = Health and Safety Executive (United Kingdom - **UK**).

***Collision** is defined as two vessels unintentionally being in physical contact with each other; **Grounding** is defined as the vessels impact on the seabed causing damage to the hull.

Table 3. Evaluation of methodological quality of primary studies.

			Vinagre-Rios, J. et al., 2021	Akhtar, MJ. et al., 2015	Jensen O.C et al., 2004
	Sampling and representativeness	**Criterion**			
1	Sampling method:				
	▪ Nonprobability sampling (including purposive, quota, convenience and snowball sampling)	0			
	▪ Probability sampling (including simple random, systematic, stratified g, cluster, two-stage and multi-stage sampling) or registry (i.e., full sample/all workers)	1	1	1	1
2	Was the response rate reported?				
	▪ Not reported, response rate below 44%	0	0	0	
	▪ Response rate at 44% or above	1			1
3	Are the individuals selected to participate in the study likely to be representative of the target population?				
	▪ No	0			
	▪ Yes	1	0	1	1
4	Selection bias: Is there a risk of selection bias caused by the inadequate selection of participants?				
	▪ High risk	0			
	▪ Low risk	1	0	1	1
5	Is the sample size adequate for establishing relationships (assumption of statistical power)?				
	▪ No	0			
	▪ Yes	1	0	1	1
	Measurement and confounders				
6	How was non-standard work hours/shift work assessed?				
	▪ Self-report	0			0
	▪ Objective data (including registries and payroll records)	1	1	1	
7	How were accidents and or injury assessed?				
	▪ Self-report	0			0
	▪ Objective data (including registries and payroll records)	1	1	1	
8	Performance bias: Is there a risk of bias caused by the inadequate measurement of exposure?				
	▪ High risk	0	0	0	
	▪ Low risk	1			1
9	Are the statistical methods appropriate for the study design?				
	▪ No/ I cannot tell	0	0		
	▪ Yes	1		1	1
10	Were meaningful demographic covariates included?				
	▪ No	0	0	0	
	▪ Yes	1			1
11	Were other work factors adjusted for?				
	▪ No	0	0	0	
	▪ Yes	1			1
12	Is the study design cross-sectional or observational/experimental/interventional (with time-lag)?				
	▪ Cross sectional	0	0	0	0
	▪ Case control, Cohort, Experimental/interventional	1			
13	Was accident and or injury adjusted for in analyses?				
	▪ No	0	0	0	
	▪ Yes	1			1
14	Confounder bias: Is there a risk of bias caused by the inadequate confirmation and consideration of confounding variable?				
	▪ High risk	0	0	0	0
	▪ Low risk	1			
	Overall scores: Score (risk of bias level) *		**3 (high)**	**7 (moderate)**	**10 (moderate)**

**Total risk level score categories: high risk (0-5), moderate risk (6-10), low risk (11-14)*

studies limits the ability to establish definitive conclusions on associations between work hours and the occurrence of incidents among seafarers. Seafaring comprises a significant population in maritime operations that demands 24-hour continuous work. Our synthesis of three observational studies shows that seafaring remains a high-risk occupation, with injury rates and fatal accident rates that far exceed those reported for many land-based industries (Roberts & Hansen, 2002; Wagstaff & Sigstad Lie, 2011). The persistently elevated rates likely reflect the combined hazards of a physically demanding environment, long periods at sea, and organizational factors such as small crew sizes and the tight turnaround schedules, as well as other factors specifically relevant for seafarers (Wagstaff & Sigstad Lie, 2011; Wu et al., 2022).

The review noted that, accidents were more frequent during night shifts than standard day shifts. These results are biologically and operationally plausible. Humans follow a natural 24-hour cycle of physiological and behavioral changes aligned with the daily light-dark cycle (Blume et al., 2019; Vitaterna et al., 2001). This suggests that seafarers working between 22:00hrs and 07:00hrs operate at the circadian low, when alertness, reaction time and executive function are naturally impaired, and these deficits are likely to be amplified by cumulative sleep restriction, motion exposure and monotony on the bridge or in the engine room. (Schwartz & Klerman, 2019). Furthermore, this natural sleep-wake cycle is highly disrupted when individuals work at non-standard work hours such as shift work (Boivin et al., 2022; Schwartz & Klerman, 2019). In continuous and demanding operations, such as those of seafarers, this disruption can limit human capabilities which in turn can increase the risk of accidents and personal injuries. Furthermore, night shifts are typically staffed by relatively few crews, reducing opportunities for cross-checking and error recovery, while the simultaneous performance of safety-critical manoeuvres, e.g. entering ports in the early morning, may add task complexity. However, studies included in the current review lacked detailed information on specific shift schedules, and methodological quality varied considerably, thus limiting the strength of conclusions regarding a direct association between non-standard work schedules and accidents or injuries among seafarers.

With the limited number of studies identified in the present review, there might be unique research challenges in the maritime sector. Future studies are clearly needed, and it is possible to design and conduct empirical studies in sea vessels without jeopardizing their routine operations (Yan et al., 2021). Research among seafarers in the maritime sector presents unique challenges for obtaining information that can have major importance for prevention of injuries at work. The continuous work at sea exacerbates the risks of injuries, together with other risk factors, such as the isolated and demanding nature of seafaring work. The non-standard work hours can intensify fatigue and mental stress already inherent in the work at sea, demanding further knowledge on how to effectively manage such work situation (Brooks & Greenberg, 2022; Suleiman et al., 2021).

One of the primary strengths of this review is its systematic and comprehensive synthesis of studies that met eligibility criteria following a

predefined registered protocol. This approach provided the current and robust understanding of what is available in literature regarding the non-standard work hours and accidents and injuries among seafarers minimizing bias and ensuring transparency and reproducibility. However, this review had several limitations that should be noted: The main weakness concerns the lack of detailed exposure to non-standard work hours. The diversity in study attributes (exposure to non-standard hours vs. outcome- occurrence of accidents, and injuries) made the material and studies identified unsuitable for inclusion in a meta-analysis. Most studies included in the current review were registry-based and thus less prone to recall bias, their mainly cross-sectional design limits causal inference, and few provided granular exposure data on specific tasks or vessel types. Nevertheless, the consistency of high absolute rates across diverse national settings underlines the need for preventive measures. This might include fatigue-risk management systems that account for maritime operational realities (Wadsworth et al., 2008). There is also a need for longitudinal research that links precise work-hour metrics, vessel characteristics and safety culture indicators to injury outcomes.

CONCLUSION

This systematic review highlights the existence of a high rate of accidents and injuries among seafarers across several countries globally. Accidents and injuries were more frequent during non-standard work hours, particularly during night shifts. However, our results were based on a scarce number of studies which puts limits on the empirical evidence on the association between non-standard work hours and the occurrence of accidents and injuries among seafarers. Further research in this area is thus clearly warranted.

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