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ORIGINAL ARTICLE

Working environment and fatigue among fishers in the north Atlantic: a field study

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ABSTRACT

Background: *This study investigates how Faroese deep-sea fishers' exposure to work-related stressors affects their sleep, sleepiness, and levels of fatigue. Being constantly exposed to the unpredictable and harsh North Atlantic Ocean, having long work hours and split sleep for up to 40 days consecutively, they will arguably suffer from fatigue.*

Materials and methods: *One hundred and fifty seven fishers participated in this study, and data was gathered throughout 202 days at sea. Subjective data was collected at the start and end of trips via questionnaires, sleep and sleepiness diaries and supplemented by objective sleep data through actigraphs. Ship movements were logged with a gyroscope connected to a laptop. A noise metre measured each work station and resting area, and noise exposure profiles were calculated based on each participant's activity and location. Linear mixed-effect models investigated the effects of work exposure variables on sleep efficiency, and cumulative link mixed models measured effects on the Karolinska Sleepiness Scale and physical fatigue scale.*

Results: *Time of day followed by ship movement were the exposure variables with the highest impact on the outcome variables of sleep efficiency, sleepiness and physical fatigue. The number of days at sea revealed correlations to outcome variables either by itself or interacting with the sleep periods per day. Crew size, shift system or noise did not impact outcome variables when in the model with other variables. Larger catches improved sleep efficiency but did not affect sleepiness and physical fatigue ratings.*

Conclusions: *The findings indicate a chronically fatigued fisher population, and recommends urgent attention being paid to improving the structure of vessels and installing stabilators for greater stability at sea; work schedules being evaluated for protection of health; and work environments being designed that fulfill human physiological requirements in order to ensure the wellbeing and safety of those at sea.*

(Int Marit Health 2023; 74, 1: 1–14)

Key words: fishers, work environment, roll, noise, fatigue, Multidimensional Fatigue Inventory-20 (MFI-20), Pittsburgh Sleep Quality Index (PSQI), Karolinska Sleepiness Scale (KSS), sleep, sleepiness, shiftwork

INTRODUCTION

The Faroe Islands is an archipelago situated in the North Atlantic Ocean with a population of around 54,000 people. The fishing and salmon farming industry are the backbone of the country's economy, with fish products making up 95% of total exports. Faroese fishers who participated in this

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study work in deep waters where challenging and unpredictable weather patterns often call for constant alertness in the areas of safety and balance. Despite declining accident rates in Scandinavian countries over the past decade [1–3], the accident rate amongst Faroese fishing crews is four times higher than that of land workers [1]. Studies have shown that fatigue is a problem amongst this group; and according to Wadsworth et al. [4], cognitive fatigue is the largest single factor contributing to the accidents (14%).

Occupational fatigue is proving to be a major problem in workplaces, with studies revealing its consequences as being especially damaging in the sectors of economy. Fatigue-induced work-related accidents in the United Kingdom alone are estimated to cost around £240 million a year [5] and costing 136.4 billion USD in lost productivity and healthcare costs [6]. The causes of fisher fatigue are the same as those observed amongst land-based workers, particularly when it comes to shift work. The most significant difference observed, however, is that those in the maritime sector are exposed to extra fatigue-inducing variables that are exclusive to sea-based operations in that their work takes place on constantly moving surfaces and in isolation from family, friends and familiar social activities. Furthermore, while usual work periods are limited to a single shift per day for work on land, split sleep (owing to multiple shifts per day) most often occurs at sea.

Within the realm of maritime operations too there are differences that impact the wellbeing of crews. During our data collection period, Faroese fishers were less protected against excessive working hours than workers on merchant fleets. Crews on merchant fleets were covered by the Maritime Labour Convention (MLC) legal obligations to get at least ten hours of rest per day divided into no more than two sleep periods, with a minimum of 77 hours of rest per week and a maximum of 14 hours of work per day. Crews on Faroese fishing vessel were not protected by the legal obligations of MCL, and were only entitled to 8 hours of rest per day. The usual working week of the fishers in this study was 84 hours or more, which often involved multiple shifts and sleep allocations that were usually broken into two or more periods a day. In a way, fishers might be better off than the maritime industry where it concerns the time being away from land [7], while factors, like the amount of fish defining working hours make the fishers worse off than the maritime industry, regarding this matter. It is important to note, however, that subsequent to our data collection, the laws pertaining to the rest hours for Faroese fishers changed as of 2021, bringing them under the protection of the MLC.

Crews on fishing vessels are more controlled by the catch than the clock, i.e., if the catch is good and they cannot load and store it within their stipulated work hours, they continue working until those on the next shift take over. This usually happened without fishers being granted compensatory rest periods. Thus, the fishers' work week gets longer and their rest periods more fragmented than that of their counterparts on merchant fleets. Additionally, the workload is typically high in ports and lower while at sea for crews on merchant ships [8], whereas the fishers' workload is more or less constant from the beginning to the end of trips with occasional extended hours expected of them if situations like vessel and equipment repairs or good catches call for it. Despite the decrease in working hours over the decades, the fishers' working day and week are still longer than for workers onshore. Additionally, manual handling of the fish, fishing methods and the quantity of the catch further influence the workload they carry [9].

The International Maritime Organization (IMO) defines fatigue as "a reduction in physical and/or mental capability as the result of physical, mental or emotional exertion which may impair nearly all physical abilities including strength; speed; reaction time; coordination; decision making; or balance." Work at sea might cause more fatigue than many other sectors ashore since working hours take place around the clock [10, 11].

Harsh weather conditions have adverse effects on the work environment at sea. Studies have shown that working on a moving vessel causes higher energy expenditure [12, 13]. Nevertheless, when studying the percentage of scores of seven or more on the Karolinska Sleepiness Scale (KSS) and the similar scale of physical fatigue (where ship movement was grouped into the three approximately same-sized groups of low, medium and high), roll and pitch seemed to have an instant preventive effect on the subjective feeling of sleepiness and physical fatigue. Fishers reported the lowest percentages of scores higher than seven — which is the marker for the risk of dozing off [14] — with middle roll and pitch, and often scored highest with low roll and pitch [15]. This in no way implies that roll and pitch do not cause fatigue but rather that higher ship movement forces fishers to be alert, and lower movement enables them to lapse into a state of relaxation. Åkerstedt et al. [16] support this explanation and point to the importance of the context, with participants reporting lower scores after activity and higher scores following rest periods.

Sleep disturbance due to noise has been rated as the major causal factor among 6-hour shift workers operating in the North Sea [17]. The World Health Organization (WHO) [18] states that disturbed sleep is the most frequently expressed complaint by noise-exposed populations, resulting in daytime sleepiness and lower functioning levels.

Shift work has been defined as work completed outside the usual 9:00 to 17:00 schedule from Monday to Friday [19]. Shift work disrupts the circadian rhythm, thereby causing sleep problems for many workers [20, 21]. A high

Table 1. Details of the vessel groups in this study

Vessel details	Longliner fresh fish	Longliner freezer	Netting vessels	Trawler	All
	Mean (SD)	Mean (SD)	Mean (SD)	Mean (SD)	Mean (SD)
Number of vessels*	6	1	3	5	15
Number of trips per vessel group*	8	1	3	5	17
Mean age of vessels	55.38 (5.18)	29	44.67 (8.96)	18.5 (9.65)	40.71 (18.4)
Building material	Steel	Steel	Steel	Steel	Steel
Gross tonnage	391.38 (32.98)	703	347.33 (58.18)	125.38 (6.04)	323 (158.1)
Breadth [m]	7.47 (0.06)	9	7.66 (0.82)	6.31 (0.46)	7.2 (0.9)
Depth [m]	6.17 (0.11)	4.4	5.26 (1.11)	3.3 (0.83)	5.1 (1.3)
Length overall	39.91 (2.90)	42	37.41 (1.47)	21.4 (1.68)	43.2 (8.8)
Engine power [kW]	487 (112.93)	745	618 (302.58)	344 (24.10)	484 (174.7)
Crew size	14 (1.30)	14	10 (0)	4 (0)	10.1 (4.3)

*The number of vessels and the number of trips do not add up because three trips were done onboard the same vessel, under different conditions. The first trip took place in summer when the fishing was good and the recommended work hours were exceeded. The second was conducted in another fishing area where the routines were different and the workload was lower; and the third happened closer to land with a small catch and many inexperienced deckhands, which required the implementation of another shift system (8 on, 8 off, 8 on, 4 off), leaving less time for rest; SD — standard deviation

work-to-rest ratio tends to cause poor circadian alignment and shorter sleep [15, 22]. The impact of shift work on sleep, sleepiness and performance seems to be mediated by: (i) circadian effect or time-of-day; (ii) hours at work (as against the opportunity for sleep); and (iii) the consistency of start and finish time [23]. Moreover, 81% of fishers claim that their sleep problems are limited to times at sea [17]. Given the choice, most would opt out of shiftwork [24].

The aim of this study is to investigate whether ship movement, noise, workload, work and rest schedules, ship variables and the number of days at sea over the preceding 12 months could be associated with fisher fatigue.

We hypothesised "sleep efficiency," measured by the ActiGraph, as being positively impacted by: 1a) ship variables such as vessel size and engine power; 2a) crew size; 3a) size of catch per day; and 4a) number of days at sea; and being negatively impacted by 5a) the weather (causing ship movement, pitch and roll); and 6a) noise during work and rest time. We also surmised that 7a) that different shift systems have different effects on sleep efficiency. Similarly, we hypothesised that sleepiness as measured by the KSS and fatigue measured by a Physical Fatigue Scale (PFS) will be positively impacted by: 1b) ship variables such as vessel size and engine power; and 2b) crew size, which will have a protective effect on the KSS and physical effect, with ratings decreasing as vessel and crew size grew larger. We surmised KSS and PFS scores being adversely impacted by: 3b) the weather (causing ship movement, pitch and roll); 4b) noise during work and rest time; 5b) number of days at sea; 6b) size of catch per day; and 7b) different shift systems will have different effect on KSS and PFS.

MATERIALS AND METHODS

DESCRIPTIVE STATISTICS

Data were collected onboard four vessel groups in the Faroese deep sea fishing fleet from May 2017 to July 2018 off fresh fish longliners, freezer longliners, small trawlers and netting vessels. The details of these vessels are given in Table 1.

Of the 176 fishers who were invited to participate in the study, 89.2% (comprising 156 men and one woman) agreed to do so. When responding to the question about overall health, 91.8% stated that they were in excellent, very good or good health, thus implying that they were generally healthy. Their mean age was 42.2 (standard deviation [SD] 16.3) years. Data collection took place mainly onboard the vessels from the time they left harbour to the last day of fishing before they returned. The fishers also completed sleep and sleepiness registrations in diaries throughout the entire trip. Data and observations onboard the vessels were collected by the first author. A questionnaire collecting demographic data about their work, work history and various psychometric questionnaires were used.

SHIP MOVEMENT

Ship movements were logged throughout the entire trip using a gyroscope (30 × 30 × 20 cm) with two inbuilt sonar sensors (Taeko scl-30a1, Foruna Industries, Esbjerg). It was positioned in the wheelhouses near the centre of the ship. The gyroscope was connected to a laptop and registered ship movement on two planes: rolls from side to side and pitch from fore to aft. PicoLog, Pico Technology, provided the computer software (PicoLog data acquisition software/data logging software, n.d.).

NOISE LEVELS

Noise levels were typically measured during a whole shift per working station while the periods of measurement were sometimes shorter for resting areas. We used a Casella SEL-633 Environmental and Occupational Noise Meter for measurement (www.casellameasurement.com). Noise exposure profiles in decibel level dB(A) were calculated per person based on knowledge about their individual duties, rotational systems and the decibel levels measured in each station. Details of noise per vessel are listed in Table 2 together with environmental exposures.

SLEEP MEASURES BY ACTIGRAPHY

Wrist-worn actigraphs (ActiGraph GT9X link; Pensacola, FL, USA) were used as an objective measure of sleep and activity. Various sleep variables were obtained from the ActiGraphs: total number of sleep periods, mean number of sleep periods per day, mean sleep durations per day and sleep efficiency (defined as the percentage of time spent sleeping in bed). The Cole-Kripke algorithm was used to estimate the sleep parameters [25]. Further information on the results concerning sleep is referred to in our earlier work [15].

SLEEPINESS MEASURES AND PHYSICAL FATIGUE SCALE

The KSS [26], ranging from 1 (very alert) to 9 (extremely sleepy) was used to measure sleepiness during the trip. A similar physical fatigue scale, also ranging from 1 to 9, with 1 (very rested) and 9 (extremely physically fatigued) was also present in the diary. Fishers were instructed to register their sleepiness and physical fatigue in diaries provided to them at least every two hours while at work.

SLEEP QUALITY

The Pittsburgh Sleep Quality Index (PSQI) is a questionnaire which measures long-term sleep quality [27]. The PSQI score was used as a subjective measure of a more general level of sleep quality; and the Multidimensional Fatigue Inventory-20 (MFI-20) exploring five factors: general fatigue, physical fatigue, mental fatigue, reduced activity and reduced motivation with a 5-point Likert scale (1–5) was used to measure the fishers' level of fatigue at the beginning of the trip [28].

WORK EXPOSURE VARIABLES

Variables regarding the fishers' work exposure included the catch in tons per person per day, shift system, crew size, length of the trip and days at sea per year. The fishers were identified by ID numbers, and variables measured were subjective ratings of sleepiness, physical fatigue, objective sleep variables measured by the actigraphy, time of day of sleep, length of sleep and sleep efficiency.

VESSEL VARIABLES

Variables concerning the ship were: vessel type, age of vessel, building material, size in gross tons, length, breadth and engine power in kilowatts (kW).

ANALYTICAL METHODS

Analyses were conducted using RStudio 4.2.1 (RStudio Team, 2020). RStudio: Integrated Development for R. RStudio, PBC, Boston, MA (URL http://www.rstudio.com/), with the packages tidyverse [29], readxl [30], hms [31], lme4 [32], lmerTest [33], clmm [34], nlme [35] for data manipulation and analysis, and colourspace [36] and gridextra [37] for creating figures.

Mean and standard deviation from the PSQI and MFI-20 were explored using SPSS 25, after which a linear mixed model analysis was run on sleep efficiency against ship movement variables, noise, work exposures and various ship variables.

The linear mixed effects model was defined using crew ID nested within vessel type as random intercepts to investigate sleep efficiency and how it was affected by environmental variables. Sleep efficiency was the outcome variable in the model. Additive predictor variables were pitch, roll, catch per person per day in tonnes, engine power, as well as a dummy variable designating a time of day when the crew went to bed which was constructed using the following time points: morning (06:30 to 12:30), day (12:30 to 18:30), evening (18:30 to 00:30) and night (00:30 to 06:30). An interaction term with the number of days at sea crossed with the mean number of periods of sleep per day prior to the observation was also included.

Cumulative link mixed models were used to investigate the effects on the ordinal variables KSS and physical fatigue. Models were constructed in a similar way to the investigation on sleep efficiency.

The KSS and the PFS were reported every second hour during the trip. The frequent recordings made them an excellent measure of the fishers' subjective fatigue level per day (acute fatigue), and suitable for uncovering the relationship between environmental variables (that vary daily) and fatigue. Because KSS and the PFS are ordinal variables, cumulative link mixed models were used to investigate how these measures were affected by the same predictor variables tested in the linear mixed effects model.

Several measured variables were excluded as they did not affect sleep efficiency, KSS and PFS, or were too related to other terms, thus making them difficult to interpret. Therefore, the models in Tables 5 and 6 are the smallest adequate models to describe the effects on the outcome variables.

The impact of noise on the three outcome variables, sleep efficiency, KSS, and PFS was investigated separately

Table 2. Descriptive statistics of the crews divided into vessel groups

	Longliner fresh fish	Longliner freezer	Netting vessel	Trawler	Overall
	Mean (SD)	**Mean (SD)**	**Mean (SD)**	**Mean (SD)**	**Mean (SD)**
Number of participants	90	14	29	19	152
Captain	7	1	3	5	16
Mate	9	1	3	5	17
Engineman	8	1	3	4	16
Cook	8	1	3	2	14
Deckhand	51	8	17	3	79
Holdman*	7	2			9
Minutes slept per sleep	149.3 (48.1)	220.6 (56.2)	198.9 (63.7)	117.7 (50.0)	161.9 (60.4)
Minutes slept per day	278.8 (76.3)	332.5 (40.8)	250.3 (94.9)	233.4 (80.2)	272.3 (81.8)
Body mass index	26.3 (5.6)	27.9 (6.1)	25.7 (4.8)	29.0 (4.4)	26.7 (5.3)
Age	42.4 (1.7)	36.3 (15.4)	41.5 (15.4)	46.4 (15.2)	42.1 (16.1)
Work years as a fisher	25.1 (14.1)	17.7 (18.2)	17.6 (16.2)	27.8 (15.2)	19.5 (16.3)
Mean workdays a year:	199	189	187	204	196
Minimum days	15	39	50	100	15
Maximum days	320	340	300	340	340

*On netting vessels, the mate takes care of getting the fish down to the hold, while on trawlers it is a deckhand who undertakes the task; SD — standard deviation

with a linear mixed model for sleep efficiency and by using a cumulative link mixed model for the analysis of the other two outcome variables: KSS and PFS.

We defined a linear mixed effects model using vessel as random intercept. Noise during work, time off, and all day (24-hours) in interaction with the use of earmuffs were included as fixed effect variables on sleep efficiency. This process was repeated with the KSS and the PFS run separately but using a cumulative link mixed model ANOVA to examine the differences between the vessel types on the time-of-day variable.

RESULTS

DESCRIPTIVE STATISTICS

Table 2 gives an overview of the composition of the crews in the four vessel types. Furthermore, age, body mass index, years in fishing occupation and days at sea during the last year are reported groupwise.

Table 3 summarises the recorded results regarding noise exposure, ship movements, weather conditions and catches in the four vessel categories together and separately.

FATIGUE MEASURED AT THE BEGINNING OF THE TRIP

The MFI-20 revealed that the fishers experienced high fatigue on all five MFI-20 factors. The overall means were: 12 (SD 2.3) for general fatigue, 9.5 (SD 2.1) for physical fatigue, 9.2 (SD 2.1) for mental fatigue, 9.2 (SD 3.1) for reduced activity, and 7.7 (SD 2.6) on reduced motivation. See Table 4 for scores of the specific vessel groups.

LONG-TERM SLEEP QUALITY

Long-term sleep quality explored with the PSQI revealed that the current fishers have poor sleep quality, with an overall score of 9.36 (SD 3.48), where a score > 5 indicates poor sleep. This score varied between the vessel groups, with fishers on netting vessels (n = 29) being the only crews that slept only at night and who also worked the longest consecutive hours having the lowest mean score, 8.01 (SD 3.43). The fishers on the freezer longliner (n = 14), who rotated 8-on, 8-off, working every second night from 20:30 to 04:30 had the highest mean of 10.37 (SD. 3.15). The other two groups scored 9.88 (3.70) and 8.51 (1.55) for longliner fresh fish and trawler boats respectively.

WORKING ENVIRONMENTAL IMPACT ON SLEEP EFFICIENCY

The preliminary analysis showed that after dealing with collinearity and lack of variance and adding all factors into the same model, engine power was the only ship variable to add explanatory value to the model.

Table 3. The environmental exposures of the fishers in mean and standard deviation (SD)

Environmental variables	Longliner fresh fish	Longliner freezer	Netting vessel	Trawler boat	Overall
	Mean (SD)	Mean (SD)	Mean (SD)	Mean (SD)	Mean (SD)
dB(A) work	87.70 (9.52)	85.5 (7.80)	83.64 (6.90)	85.79 (8.80)	86.79 (6.62)
dB(A) time-off	66.47 (5.05)	71.07 (2.46)	73.03 (3.30)	69.26 (4.68)	67.37 (6.29)
dB(A) for 24 h day	84.84 (8.77)	83.3 (6.92)	82.06 (6.46)	83.16 (8.03)	82.65 (8.66)
dB (A) differences between work and time off	21.23 (11.47)	14.43 (7.41)	10.61 (6.78)	16.53 (10.73)	16.79 (10.8)
Mean roll	3.9 (0.59)	3.9 (0.0)	3.3 (1.19)	3.3 (0.87)	3.8 (0.87)
Max roll	59.10 (8.6)	33.6 (0.0)	39.8 (9.8)	59.1 (9.8)	59.1 (11.2)
Mean pitch	2.6 (1.54)	1.8 (0.0)	4.2 (1.99)	4.1 (3.31)	3.1 (2.0)
Max pitch	43.6 (9.8)	29.8 (0.0)	39.0 (10.2)	56.2 (10.7)	56.2 (9.8)
Mean wind [m/s]	10.11 (2.31)	11.47 (3.75)	10.34 (4.04)	9.31 (0.54)	10.23 (2.66)
Frequency (%) of days with winds ≥ 15 m/s	23.45 (16.03)	25 (0.00)	15.18 (14.42)	19.43 (10.24)	21.39 (14.84)
Mean catch in kilos per man per day	340.0 (305.4)	540.0 (182.6)	277.86 (135.4)	989.6 (503.8)	430.3 (339.8)

dB(A) work — decibel during work; dB(A) time off — decibel during time off; dB(A) for 24h day — mean decibel throughout the day; roll — ship movement from side to side, pitch — ship movement from fore to aft

Table 4. The fishers' scores in mean and standard deviation (SD) on the Multidimensional Fatigue Inventory-20 (MFI-20)

MFI-20 factors	Longliner fresh fish	Longliner freezer	Netting vessel	Trawler	Overall
	Mean (SD)	Mean (SD)	Mean (SD)	Mean (SD)	Mean (SD)
General fatigue	12.1 (2.4)	13.0 (2.2)	11.8 (2.3)	11.2 (2.1)	12 (2.3)
Physical fatigue	9.9 (2.0)	9.4 (2.7)	9.1 (1.9)	8.7 (2.1)	9.5 (2.1)
Mental fatigue	9.4 (2.1)	8.6 (2.1)	9.4 (1.9)	8.8 (2.6)	9.2 (2.1)
Reduced activity	9.4 (3.2)	8.2 (2.7)	8.9 (3.3)	10.4 (3.1)	9.2 (3.1)
Reduced motivation	8.1 (2.7)	6.6 (2.3)	7.6 (2.5)	6.8 (2.1)	7.7 (2.6)

After taking out non-significant and highly correlated variables, the results from the linear mixed model displayed in Table 5 for sleep efficiency is the minimal model to describe which variables have the highest influence on the fishers' sleep.

From this model, we see that roll, catch per person per day and the time of day the person sleeps having the highest impacts on sleep efficiency, with sleep during the day shift and night shift offering higher sleep efficiency than sleeping during the morning (06:30 to 12:30). The interaction between the number of sleep periods and the length of the trip shows a negative effect. Figure 1 demonstrates just how these two variables interact.

When not controlling for other confounding variables, the mean sleep efficiency throughout the trip is highest among freezer longliners (M = 71.7, SD = 15.8) and lowest for fresh fish longliners (M = 62.8, SD = 23.3). For trawlers and netting vessels, the sleep efficiency was 67.1 (SD = 23.8), and 68.7 (SD = 20), respectively. When examining sleep efficiency, we see a more complex picture when simultaneously controlling for the length of trip and the number of sleep periods per day. Periods of sleep in a day and number of days at sea interacted such that crew with many periods of sleep within a day had a decreasing sleep efficiency over time compared to workers who had fewer sleep periods in a day ($F_{1,2205.8} = 7.449$, $p = 0.006$, Fig. 1).

WORKING ENVIRONMENTAL IMPACT ON SLEEPINESS

As for the cumulative link mixed models, the first one reveals that the KSS has only one significant relation-

Table 5. Effect of environmental variables on sleep efficiency

Effect	Estimate	SE	P-value
Intercept*	62.31	45.65	< 0.001
Roll	–3.45	0.006	< 0.001
Pitch	–0.82	–0.26	< 0.001
Engine power of ship [kW]	0.026	0.006	< 0.001
Catch-per-person-per-day [T]	3.65	1.43	0.01
Time of day (06:30–12:30 functioned as the reference variable			
12:30–18:30	3.48	1.31	0.007
18:30–00:30	0.10	1.1	0.93
00:30–06:30	4.16	1.27	0.001
Sleep periods per day	1.41	1.48	0.34
Days at sea	0.69	0.30	0.02
Interaction: Sleep periods per day and days at sea	–0.46	0.19	0.02

[a]Intercept — baseline of sleep efficiency; Sleep efficiency — outcome variable. Exposure variables are: Roll, pitch, catch per person per day in tonnes, engine power, and the dummy variable designating a time of day when the crew went to bed, using the time points: morning (06:30 to 12:30, day (1230 to 18:30, evening (18:30 to 00:30 and night (00:30 to 06:30 as additive predictor variables. The interaction consists of the number of days at sea crossed with the mean number of periods of sleep per day prior to the observation. The estimate shows the effect of the exposure variables on the output variable (sleep efficiency. The standard deviation of an estimate is called the standard error (SE. The standard error of the coefficient measures how precisely the model estimates the coefficient's unknown value.

ship to the independent variables — the length of the trip (p = 0.045), with an increase on the KSS scale of 0.007 for every additional day at sea.

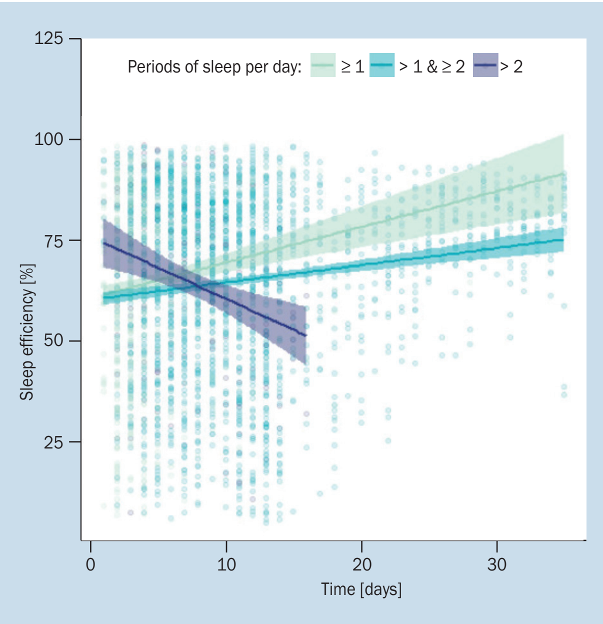

Figure 1. Sleep efficiency over days at sea. Colours signify mean periods of sleep per day: few — up to and including one sleep period per day, middle — more than one, up to and including two sleep periods per day, many — more than two sleep periods per day. Dots indicate observations, lines are lines of best fit with 95% confidence interval shaded

WORKING ENVIRONMENTAL IMPACT ON PHYSICAL FATIGUE

Physical Fatigue Scale, on the contrary, demonstrated a few more relationships to the predictor variables with the time of day and, in particular, the morning and day shift displaying significantly lower fatigue ratings than night shifts (Table 6, Fig. 2).

TIME OF DAY AND SLEEPINESS

Since the time of day showed the strongest effect on sleep efficiency and physical fatigue (Tables 5 and 6), a cumulative link mixed model was run between KSS and time of day, with ID nested within vessel type to view the relationship between these two variables when not controlling for other factors. It was found that sleepiness was highly associated with the time of day, with lower registrations of sleepiness between 06:30 and 12:30, z = –8.27, p < 0.001, 12:30 to 18:30, z = –9.21, p < 0.001, and 18:30 to 00:30, z = –2.81, p = 0.005 respectively, in comparison to the hours between 00:30 to 06:30.

VESSEL TYPE DIFFERENCES REGARDING PHYSICAL FATIGUE AND SLEEPINESS

Lastly, the mean score on the KSS and the PFS also varied across vessel types, ANOVA = (F(3,29.5) = 102.89, p < 0.001) and (F(3, 50.43) = 152.21, p < 0.001), respectively. For the difference between the vessel groups measured with the Bonferroni post hoc test (Table 7).

Table 6. Impact of environmental variables on ratings on the Physical Fatigue Scale (PFS, 1–9) from the cumulative link mixed model

Effect	Estimate	SE	P-value
Mean roll	0.05	0.02	0.02
Mean pitch	0.05	0.02	0.007
Time of day (00:30–06:30 functioned as the reference variable)			
06:30–12:30	–0.44	0.07	< 0.001
12:30–18:30	–0.042	0.07	< 0.001
18:30–00:30	0.06	0.07	0.42
Days at sea	–0.02	0.004	< 0.001

Physical Fatigue Scale (PFS) — outcome variable. Exposure variables with significant effects on outcome variable are: roll, pitch, the dummy variable designating a time of day using the time points: morning (06:30 to 12:30), day (12:30 to 18:30) and evening (18:30 to 00:30) as additive predictor variables, as against night (00:30 to 06:30) used as reference variable and the number of days at sea. The estimate shows the effect of the exposure variables on the output variable (sleep efficiency). The standard deviation of an estimate is called the standard error (SE). The standard error of the coefficient measures how precisely the model estimates the coefficient's unknown value.

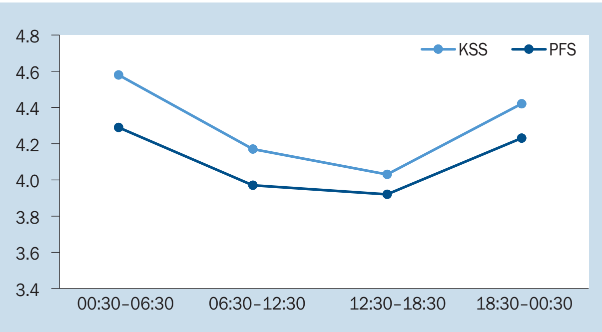

Figure 2. Mean level of sleepiness (Karolinska Sleepiness Scale [KSS]) and physical fatigue (Physical Fatigue Scale [PFS]) registered over the day, divided into four time points: night (00:30 to 06:30), morning (06:30 to 12:30), day (12:30 to 18:30) and evening (18:30 to 00:30)

NOISE AND SLEEP EFFICIENCY

Noise during time off had a positive relationship to sleep efficiency (F1, 145.5 = 12.30, p < 0.001, confidence interval [CI] = 0.33 to 1.21), with efficiency increasing by 0.78 points per increase in dB(A). No relationship was found between sleepiness and noise during time off, although a trend was observed that showed that dB(A) had a negative relationship to sleepiness (estimate = 0.04, standard error [SE] = 0.22, df = 80.09, t = 1.495, p = 0.055, CI = –0.09 to 0.01). Similarly, physical fatigue did not show any relationships to noise during work although the trend between noise and physical fatigue were close (estimate = 0.02, SE = 0.013, df = 108.87, t = 1.90, p = 0.06, CI = –0.002 to 0.050).

DISCUSSION

Data regarding the fishers' working environment were collected for this study from four types of fishing vessels to elucidate how the work environment influenced their fatigue while at sea by investigating their sleep (quantity and quality), sleepiness, physical fatigue, ship movement and noise levels; as well as by examining the effect of crew size, weight of catch in tons, vessel type, shift system, hours worked per day, time of day and length of trip.

For the 15 months of data collection, the catch was generally poor. Only one trip during this entire period had frequent, extended shifts for fishers. Insufficient catches created stress owing to the low income that would be generated from them, and overshadowed entire trips especially in the case of longliners. In one instance, the trip was called off halfway because the amount of fish caught did not cover the expenses incurred. The catch on trawlers was moderate, leaving more time for rest than work although rest was split into multiple rest periods. However, there was one particular season when the catch on trawlers was so good that workers filled up their vessels in 24 to 36 hours. During this period, a loaded trawler ran aground on the way back to land. It was not possible for the first author to personally observe these trips because there was no room on the vessels owing to the load. Overall, the data collection period saw relatively low workloads, thus the results reflected are realistic or milder than most periods.

Hypothesis 1 about ship variables showed that only the ship's engine power — seen as a good overall representation of the ship size (length, breadth, depth) — correlated positively with sleep efficiency thus accepted the hypothesis 1a, but did not reveal any effect on KSS or physical fatigue scores, thereby rejecting this hypothesis 1b. Hypothesis 2 was also confirmed with higher ship movement increasing physical fatigue and decreasing sleep efficiency. Hypothesis 3 regarding the effect of noise was rejected as noise during time off correlated positively with sleep efficiency. Contrary to expectation, hypothesis 4, which was about the effect of shift systems, was also rejected since no significant impact was revealed between shift systems and the outcome variables, sleep efficiency, sleepiness

Table 7. Scorings on the Karolinska Sleepiness Scale (KSS) and Physical Fatigue Scale (PFS) as a function of vessel type analysed by ANOVA and Bonferroni post hoc test

Scores on KSS and PFS vs vessels	Measurements (N)	Mean	SD	P-value
KSS score across vessel types				
Netting vessel vs.	558	5.00	2.12	
Longliner fresh fish	3639	4.27	1.92	< 0.001
Trawler	439	4.22	2.03	< 0.001
Longliner freezer	1998	4.17	1.63	< 0.001
All vessels	6634	4.30	1.88	< 0.001
PFS across vessel types				
Netting vessel vs.	558	4.92	2.03	
Longliner fresh fish	2839	4.03	1.79	< 0.001
Trawler	439	3.74	2.07	< 0.001
Freezer longliner	1999	4.05	1.47	0.96
Longliner fresh fish vs.	2839	4.03	1.79	
Trawler	439	3.74	2.07	0.006
Freezer longliner	1999	4.05	1.47	0.96
Trawler vs.	439	3.74	2.07	
Freezer longliner	1999	4.05	1.47	0.003
All vessels	5833	4.10	1.76	< 0.001

or physical fatigue. Hypothesis 5 was rejected with no relationship observed between crew size and the outcome variables. Hypothesis 6a and 6b were also dismissed as it revealed a pattern opposite to what was predicted, with catch-per-person-per-day showing a strong positive relationship with sleep efficiency, and no relationship to KSS and PFS. Lastly, the hypotheses 7a and 7b about the number of days at sea revealed a positive impact on sleep efficiency but a negative impact on PFS, thus rejecting hypothesis 7a regarding sleep efficiency but confirming hypothesis 7b about physical fatigue.

Fatigue and low sleep quality were problems for fishers as observed by the scores of the MFI-20 and the PSQI. This was expected as the fishers either had split sleep with up to 3 to 4 sleep periods a day, or long working hours of up to 18 hours a day. When comparing the current fishers' scores on the MFI-20 to a study of Danish fishers [38], the Faroese fishers scored significantly higher on all scales of the MFI-20 as well as when compared to the Danish population in two cross-sectional studies [39, 40]. There are a few factors that could explain these differences, the most apparent one being that the trip lengths of Danish fishers are lower overall, with 48.1% of the trips lasting only a day, 34.9% lasting between 1 and 7 days, and only 17.1% spending more than 7 days at sea in comparison to the Faroese fishers with a mean of 10.7 (SD 8.8) days. Since the largest category of Danish fishing trips last only a day, sailors most probably fish in calmer seas closer to land unlike Faroese fishers who sail into the North Atlantic Ocean for extended periods of time.

The results from the PSQI further reveal that the fishers generally had poor sleep quality, with a mean score of 9.4, which is significantly higher than the cut-off for poor sleep (> 5). In comparison, when considering a study conducted on 147 healthy participants, the mean score of the group with insomnia (46.3%) was 10.65 ± 2.79 when compared with 2.63 ± 1.29 for the non-insomnia group [41]. Although the crews of the freezer longliners reported the worst sleep quality according to the PSQI, they reported the lowest level of sleepiness on KSS during trips, and had the highest sleep efficiency. Possibly the low score on the PSQI is because the rhythm is longer than the approximate 24 hours of the biological clock, which is in line with the findings of Short et al. [23], who point to the mediating effect of the time of day and the consistency of start and finish times. However, this rhythm ensured that they got a long night's sleep every second night, making the connection between the fishers and their shifts less dependent on chronotype.

In the larger model used for testing the effect on sleep efficiency (Table 5), the time of day the fishers slept had the highest impact. Fishers slept worst in the morning (06:30 to 12:30) and best during the night (00:30 to 06:30). Roll and pitch had the second largest influence on the decrease in fishers' sleep efficiency, with substantial reductions observed with increased ship movement.

Of the individual ship variables, the size of the ship's engine showed a positive relationship to sleep efficiency. We see the engine as a usable proxy for the overall size of the ship rather than separate measures of length, depth and breadth. This finding is consistent with studies confirming that weather influences smaller vessels more than larger vessels [9].

Catch in tons per person per day showed a substantial impact on improving sleep. A larger catch meant more work for the fishers which required more use of energy thereby enhancing sleep, presumably by increased sleep pressure. Furthermore, substantial harvests of fish generally resulted in mental satisfaction since fishers know that they bring in better wages, thus relieving them of stress and uncertainty and consequently increasing sleep efficiency. These too are possible reasons for greater sleep efficiency in workers at sea.

Lastly, several studies have pointed to the adverse effects of splitting sleep into smaller amounts of time [15, 42, 43]. Our study confirms this through an interaction effect, with the number of sleep periods per day and the trip length showing a negative relationship with sleep efficiency. Getting more extended uninterrupted periods of sleep per day seemed to enhance sleep efficiency which increased with every additional day at sea. This interaction demonstrates the level of complexity to be considered in order to comprehend the potential factors from work environments that contribute to the build-up of fatigue among these fishers. On the other hand, the increase in sleep efficiency could also indicate increasing levels of fatigue as the trip progressed, which also results in higher sleep efficiency. Most likely, the answer is a combination of the two. Netting vessel crews are the only ones who get one continuous sleep period, who sleep only during the night and also have a higher work-rest ratio of 16-hours/8-hours respectively when compared with the other vessel groups. Thus, the steep increase in sleep efficiency may partly be due to excessive fatigue since this vessel group has the highest work-rest ratio. Taking all these factors into consideration, caution should be exercised in interpretations of the difference between the groupings when it comes to "sleeping once a day or less," and "sleeping more than once a day but no more than twice a day."

In the model with sleepiness as the outcome variable, the only relationship was with the number of days at sea, with sleepiness increasing as the trip grew longer. Our study supports the findings of the diurnal pattern of sleepiness being U-shaped, with higher KSS values in the early morning and late evening [44].

When considering physical fatigue scale as an outcome variable but otherwise including the same exposure variables, the cumulative link mixed model results supported the finding of Short et al. [23], with fisher's reporting highest on fatigue during the circadian nadir. A strong circadian variation has been found in sleepiness, with sleepiness peaking at night [22, 45, 46]. Our study confirmed these findings as well. The time of day was the strongest indicator of self-reported sleepiness and physical fatigue, with the highest number being reported during the evening and night shifts. This confirms many other research studies found in circadian literature about shift workers [23, 47, 48].

Roll and pitch also impacted physical fatigue ratings with more ship movement leading to higher ratings, confirming studies which indicate that ship movement leads to higher metabolic rate and exhaustion; thus, likely having a secondary effect on sleep efficiency as well [12, 13].

Findings from studies about noise frequency conclude that noise has a negative effect on sleep [17, 49, 50]. However, only a few studies have used objective measures of noise onboard vessels [51, 52]. In the current study, noise exposure was not found to impact the fishers' sleep, sleepiness or fatigue levels when analysed together with the other main variables that added significant explanations to the model. When analysed as single variables, the relationship between sleep efficiency and noise was positive. Most fishers in the current study used earmuffs for hearing protection during work which reduced the noise level by at least 20 dB(A), but did not use them during their time off. Therefore, the noise level during work cannot be expected to reflect their actual exposure as fishers were more likely to use earmuffs in locations with the highest noise. Our questionnaires only required them to indicate whether they had used them during the trip or not. Furthermore, the finding that sleep efficiency increased as the noise increased could be explained by their cumulated fatigue — partly due to noise exposure during the day — which made them sleep better. We only used average noise levels in dB(A) in our analysis and did not include peak exposures and frequencies of the sound. Although the levels recorded in the current study are high, they are relatively constant. Atkinson and Hilgard (1983) [53] claim that "people are much more able to 'tune out' chronic background noise, even if it is quite loud, than to work under circumstances with unexpected intrusions of noise." The reason why we only found significant relationships during time off but not during work may be because the range from the lowest score to the highest score was higher during time off than at work. Thus, the variance is too limited in the noise levels at work to produce significant results. Despite their insignificance, the trends between physical fatigue and noise at work, and between sleepiness and noise during time off went in predicted directions when analysed as single variables.

It was somewhat surprising that of all the ship's variables (i.e., ship age, length, breadth, depth, gross tonnage, and engine power), only engine power was associated with sleep efficiency in the combined model (Fig. 5). The variance in the engine power of the ships was higher than the variance in the other ship variables, and could be one reason for the findings.

The Cardiff Research Programme of Seafarers' Fatigue [43] states that it is the combination of risk factors that exposes the greatest fatigue, and that the effect of additional risk factors increases fatigue in a cumulative manner. The fishers in the current study were repeatedly exposed to adverse risk factors such as disturbed sleep, low sleep quality, split sleep, unfavourable and long working hours/shift schedules, ship movement and varying weather conditions, high noise and vibrations, constant need for alertness, health related behaviours such as smoking, exercise below prescribed levels for maintenance of healthy hearts and bodies (although the physical work is demanding), adverse health outcomes from somatic and muscular pain, and varying lengths of trips. According to Smith et al. [43] if the combination of the risk factors was six or higher, the odds ratio for fatigue was 8.85 at work and 9.07 during the rest period. Most participants in the study were exposed to 6+ risk factors throughout the trip, making us conclude that the risk of accidents constantly overshadows these workers, suggesting a significantly greater negative effect of fatigue than any of these factors taken in isolation. Furthermore, recent work conducted with workers in the offshore oil industry also reveals similar findings regarding health outcomes, showing the combined effects of fatigue indicators having a cumulative negative impact on the health and wellbeing of workers more than any other factor [54].

CONCLUSIONS

In this study, sleep efficiency scores from actigraphy ratings on the KSS and PFS were used as outcome variables to examine the association with the work environment. Hypothesis 1 was confirmed in that engine power correlated positively with sleep efficiency, but was rejected regarding sleepiness and physical fatigue as no relationship was found between the two. Hypothesis 2 was rejected, with no relationship between crew size and the outcome variables. Hypothesis 3 was confirmed, with more ship movement increasing physical fatigue and decreasing sleep efficiency but showing no relationship with KSS. Hypothesis 4 regarding the effect of noise was rejected as noise during time off positively correlated with sleep efficiency and shared no relationship to sleepiness or physical fatigue. Hypothesis 5 about the effect of shift systems was also rejected as no significant impact was revealed between the shift system and any of the outcome variables. Hypothesis 6a was confirmed, with catch-per-person-per-day showing a strong positive relationship with sleep efficiency, while hypothesis 6b was rejected, with no relationship between catch-per-person-per-day and KSS or PFS. Hypotheses 7a and 7b were confirmed, with days at sea having a positive impact on sleep efficiency and an adverse impact on KSS and PFS, thereby confirming our hypotheses.

We found that the time of day followed by ship movement were the most consistent exposure variables with the highest impact on the outcome variables. It is also noteworthy that the trip length was the only variable that revealed a relationship with all the outcome variables, either as a stand-alone or interacting with the number of sleep periods per day.

Ship variables were found to play a smaller role than expected in the current study. Nevertheless, we will not conclude that these variables don't matter as the variance between the size of fishing vessels within the same group was rather small, which could account for our findings. Only engine power was strong enough to show a relationship to sleep efficiency and seems to function as a reasonable estimate of the ship's size. Crew size did not reveal a significant effect. Again, possibly the same applies since there was minimal variation in crew size within the vessel groups and this could be the reason for it.

The trip length in days was a better measure of fatigue than days at sea per year most likely because the number of days per year variable is influenced by more external variables such as the variance in social and work obligations between trips. Neither the shift system nor the number of hours worked per day seemed to have a significant impact on the outcome variables. This finding was unexpected but we believe that it should be included in future studies. Possibly these findings were due 1) to having too small a sample and, 2) the different shift systems most often appearing together (with changes from one vessel type to the other) which, in reality, produce a lot of confounders. When comparing the mean scores on the KSS and physical fatigue, however, we found that the netting vessel crew that worked the longest hours were the ones who scored the highest on the KSS, followed by longliner fresh fish crews who worked the 6-6 system, which has been rated as the worst. The crews on netting vessels also scored highest on the physical fatigue scale; thus, it cannot be rejected that work hours and shift system do contribute to these scores. The time of day had the greatest impact on both their physical fatigue ratings and sleep efficiency, with the highest sleep efficiency being between 00:30 and 06:30.

The catch in tons per day was revealed to have a positive effect on sleep efficiency while large hauls did not impact the participants' sleepiness scores or physical fatigue. We expect the reason behind this to be the psychological processes because their paychecks depend on the catch. Thus, the more there was to do, the happier the fishers were; and their elevated psychological state combined with the hunting culture (where adrenaline increases when the hunt is good) most likely made them unaware of their tiredness. For these fishers, spending more energy and having peace of mind from knowing that the trip would pay well resulted in better sleep. Higher rankings on the fishers' physical fatigue scale were associated with greater sleep efficiency, unlike higher levels of sleepiness which did not seem to significantly impact it. Only with ship movement do these two outcome variables move in different directions owing to the impact that rolling has on sleep. Even though we did not get significant results from all our exposure variables, we believe that most of them should be included if conducting related studies in the future.

RECOMMENDATION FOR FUTURE STUDIES

Future studies to determine the influence of noise should focus on control groups and individually worn noise metres rather than merely relying on measuring stations. In the current study, we only found significant effects when analysing it as a single variable against the outcome variables despite the high noise exposures. It was also observed that fishers used earmuffs in the noisiest workstations. Interpreting the result and concluding that noise is not a problem would be a mistake, and most likely a type II error as the high dB(A) noise levels during work and time off exceeded recommendations by the Danish Maritime Authority's technical regulations which state that the daily personal noise exposure during 12 hours of work should not exceed 83 dB(A). Maximum exposure in rest areas is set to be 60 dB(A) for bedrooms, 65 dB(A) for leisure rooms and 65 dB(A) for dining rooms and living spaces. We believe that the explanation for the minimal effects observed is found in the lack of variance as all vessels scored high on noise. In view of this, we recommend that researchers in noise-exposed and loud working environments use dosimeters and make comparisons with groups in low noise-exposed working environments. They should also include a variable that takes into account the wearing of earmuffs and other noise protection gear, and whether or not they are used. We are inclined to believe that the subjective ratings of noise disturbance are reliable, as found by other authors, e.g. Hansen and Holmen (2011) [17]. The lack of effect found in this study is likely due to the limited variance in noise levels measured by the objective method and the inability to assess and monitor the use of protective aids like earmuffs.

Work environments should be designed to meet human physiological requirements and compensate for its limitations in order to ensure the wellbeing and safety of those who work at sea. Our study points to several factors that could be taken into consideration to help move toward this goal. One of the best investments would be to design and construct fishing vessels that would have reduced ship movement. Making a buffer for the increased risk of the circadian nadir by adding an extra person on the bridge during the early morning hours (when the risk of falling asleep is greatest) could improve the safety of crew and vessel. Additionally, if respite from duties for fishers is possible, we recommend that this be done preferably between the hours of 02:00 to 06:00 in order to reduce the risk of fatigue and sleepiness which inevitably increase the risk of accidents and other eventualities onboard vessels.

We hope that through this research we succeed in alerting the relevant personnel to further recognise and acknowledge the urgent need to address the health and safety issues that fatigue causes in fishers. Our sincere desire is that this study encourages dialogue on how it is influenced by individual factors and organisational practices. This, we believe, could result in finding more constructive ways to evaluate, manage, prevent or minimise fatigue and its effects amongst workers in this vital industry.

Conflict of interest: None declared

REFERENCES

1. Christiansen JM, Hovmand SR. Prevention of accidents at work in Nordic fisheries – What has worked? In: Nordic Council of Ministers. TemaNord, Copenhagen 2017.
2. Jensen OCC, Petursdottir G, Holmen IM, et al. A review of fatal accident incidence rate trends in fishing. Int Marit Health. 2014; 65(2): 47–52, doi: 10.5603/IMH.2014.0011, indexed in Pubmed: 25231324.
3. Thorvaldsen T, Kaustell K, Mattila T, et al. What works? Results of a Nordic survey on fishers' perceptions of safety measures. Marine Policy. 2018; 95: 95–101, doi: 10.1016/j.marpol.2018.06.022.
4. Wadsworth EJK, Allen PH, McNamara RL, et al. Fatigue and health in a seafaring population. Occup Med (Lond). 2008; 58(3): 198–204, doi: 10.1093/occmed/kqn008, indexed in Pubmed: 18310605.
5. Smith AP, Allen PH, Wadsworth EJK. Crew, manning and fatigue. In: Pocket D, Patraiko D (eds). Navigation Accidents and their Causes. The Nautical Institute, www.nautinst.org 2015.
6. Ricci JA, Chee E, Lorandeau AL, et al. Fatigue in the U.S. workforce: prevalence and implications for lost productive work time. J Occup Environ Med. 2007; 49(1): 1–10, doi: 10.1097/01.jom.0000249782.60321.2a, indexed in Pubmed: 17215708.
7. Barnett M, Zhao Z, van Leeuwen WMA. Project MARTHA: The Final Report. January 2017. https://doi.org/10.13140/RG.2.2.30339.30249.
8. Oldenburg M, Jensen HJ. Stress and strain among merchant seafarers differs across the three voyage episodes of port stay, river

passage and sea passage. PLoS One. 2019; 14(6): e0217904, doi: 10.1371/journal.pone.0217904, indexed in Pubmed: 31163071.
9. Silvetti A, Munafò E, Ranavolo A, et al. Ergonomic risk assessment of sea fisherman part III: manual handling and static posture. Adv Intelligent Systems Computing. 2019: 379–392, doi: 10.1007/978-3-030-20145-6_38.
10. Akerstedt T. Work hours and sleepiness. Neurophysiol Clin. 1995; 25(6): 367–375, doi: 10.1016/0987-7053(96)84910-0, indexed in Pubmed: 8904199.
11. Åkerstedt T. Shift work. Encyclopedia of Sleep. 2013: 197–201, doi: 10.1016/b978-0-12-378610-4.00040-1.
12. Breidahl T, Christensen M, Jepsen JR, et al. The influence of ship movements on the energy expenditure of fishermen. A study during a North Sea voyage in calm weather. Int Marit Health. 2013; 64(3): 114–120, indexed in Pubmed: 24072536.
13. Duncan CA, MacKinnon SN, Marais JF, et al. Energy cost associated with moving platforms. PeerJ. 2018; 6: e5439, doi: 10.7717/peerj.5439, indexed in Pubmed: 30186679.
14. Akerstedt T, Gillberg M. Subjective and objective sleepiness in the active individual. Int J Neurosci. 1990; 52(1-2): 29–37, doi: 10.3109/00207459008994241, indexed in Pubmed: 2265922.
15. Abrahamsen A, Weihe P, Fróði D, et al. Sleep, sleepiness, and fatigue on board Faroese fishing vessels. Nat Sci Sleep. 2022; 14: 347–362, doi: 10.2147/NSS.S342410, indexed in Pubmed: 35264889.
16. Åkerstedt T, Kecklund G, Axelsson J. Subjective and objective quality of sleep. Somnologie - Schlafforschung und Schlafmedizin. 2008; 12(2): 104–109, doi: 10.1007/s11818-008-0342-z.
17. Hansen JH, Holmen IM. Sleep disturbances among offshore fleet workers: a questionnaire-based survey. Int Marit Health. 2011; 62(2): 123–130, indexed in Pubmed: 21910116.
18. World Health Organization. Burden of Disease from Environmental Noise 2011; 128.
19. Costa G. Shift work and occupational medicine: an overview. Occup Med (Lond). 2003; 53(2): 83–88, doi: 10.1093/occmed/kqg045, indexed in Pubmed: 12637591.
20. Parkes KR. Age, smoking, and negative affectivity as predictors of sleep patterns among shiftworkers in two environments. J Occup Health Psychol. 2002; 7(2): 156–173, doi: 10.1037//1076-8998.7.2.156, indexed in Pubmed: 12003367.
21. Richardson G, Tate B. Hormonal and pharmacological manipulation of the circadian clock: recent developments and future strategies. Sleep. 2000; 23 Suppl 3: S77–S85, doi: http://europepmc.org/abstract/MED/10809190, indexed in Pubmed: 10809190.
22. Härmä M, Partinen M, Repo R, et al. Effects of 6/6 and 4/8 watch systems on sleepiness among bridge officers. Chronobiol Int. 2008; 25(2): 413–423, doi: 10.1080/07420520802106769, indexed in Pubmed: 18484371.
23. Short MA, Agostini A, Lushington K, et al. A systematic review of the sleep, sleepiness, and performance implications of limited wake shift work schedules. Scand J Work Environ Health. 2015; 41(5): 425–440, doi: 10.5271/sjweh.3509, indexed in Pubmed: 26103467.
24. Olafsdóttir L. The relationship between fishermen's health and sleeping habits. Work. 2004; 22(1): 57–61, indexed in Pubmed: 14757907.
25. Cole RJ, Kripke DF, Gruen W, et al. Automatic sleep/wake identification from wrist activity. Sleep. 1992; 15(5): 461–469, doi: 10.1093/sleep/15.5.461, indexed in Pubmed: 1455130.
26. Akerstedt T, Gillberg M. Subjective and objective sleepiness in the active individual. Int J Neurosci. 1990; 52(1-2): 29–37, doi: 10.3109/00207459008994241, indexed in Pubmed: 2265922.
27. Buysse DJ, Reynolds CF, Monk TH, et al. The Pittsburgh Sleep Quality Index: a new instrument for psychiatric practice and research. Psychiatry Res. 1989; 28(2): 193–213, doi: 10.1016/0165-1781(89)90047-4, indexed in Pubmed: 2748771.
28. Smets EM, Garssen B, Bonke B, et al. The Multidimensional Fatigue Inventory (MFI) psychometric qualities of an instrument to assess fatigue. J Psychosom Res. 1995; 39(3): 315–325, doi: 10.1016/0022-3999(94)00125-o, indexed in Pubmed: 7636775.
29. Wickham H, Averick M, Bryan J, et al. Welcome to the Tidyverse. J Open Source Software. 2019; 4(43): 1686, doi: 10.21105/joss.01686.
30. Read T, Files E. Package 'readxl' 2022.
31. Time TP, Date D, Implements D, Mit L, Utf LE, Kirill A, Kirill M, Date RC. Package 'hms' 2022.
32. Bates D, Mächler M, Bolker B, et al. Fitting Linear Mixed-Effects Models Using lme4. J Statistical Software. 2015; 67(1): 1–48, doi: 10.18637/jss.v067.i01.
33. Kuznetsova A, Brockhoff P, Christensen R. lmerTest Package: Tests in Linear Mixed Effects Models. J Statistical Software. 2017; 82(13): 1–26, doi: 10.18637/jss.v082.i13.
34. Package T. Package 'ordinal' 2022.
35. Linear T, Mixed N, Models E, Fit D, Hmisc S. Package 'nlme' 2022.
36. Zeileis A, Fisher J, Hornik K, et al. Colorspace: a toolbox for manipulating and assessing colors and palettes. J Statistical Software. 2020; 96(1): 1–49, doi: 10.18637/jss.v096.i01.
37. Package T. Package 'gridExtra' 2022.
38. Østergaard H, Poulsen TR, Remmen LN. Ergonomisk arbejdsmiljø, fysisk belastning og fatigue på danske fiskefartøjer. 2015. https://www.sdu.dk/-/media/files/om_sdu/institutter/ist/maritimsundhed/rapporter/ergonomisk+arbejdsmiljø+fysiske+belastninger+og+fatigue+på+danske+fiskefartøjer.pdf.
39. Boter H, Mänty M, Hansen AM, et al. Self-reported fatigue and physical function in late mid-life. J Rehabil Med. 2014; 46(7): 684–690, doi: 10.2340/16501977-1814, indexed in Pubmed: 24819423.
40. Watt T, Groenvold M, Bjorner JB, et al. Fatigue in the Danish general population. Influence of sociodemographic factors and disease. J Epidemiol Community Health. 2000; 54(11): 827–833, doi: 10.1136/jech.54.11.827, indexed in Pubmed: 11027196.
41. Dietch JR, Taylor DJ, Sethi K, et al. Psychometric Evaluation of the PSQI in U.S. College Students. J Clin Sleep Med. 2016; 12(8): 1121–1129, doi: 10.5664/jcsm.6050, indexed in Pubmed: 27166299.
42. Jepsen JR, Zhao Z, van Leeuwen WMA. Seafarer fatigue: a review of risk factors, consequences for seafarers' health and safety and options for mitigation. Int Marit Health. 2015; 66(2): 106–117, doi: 10.5603/IMH.2015.0024, indexed in Pubmed: 26119681.
43. Smith A, Allen P, Wadsworth E. Seafarer fatigue: the Cardiff Research Programme. November 2006.
44. Akerstedt T, Anund A, Axelsson J, et al. Subjective sleepiness is a sensitive indicator of insufficient sleep and impaired waking function. J Sleep Res. 2014; 23(3): 240–252, doi: 10.1111/jsr.12158, indexed in Pubmed: 24750198.
45. Lützhöft M, Dahlgren A, Kircher A, et al. Fatigue at sea in Swedish shipping-a field study. Am J Ind Med. 2010; 53(7): 733–740, doi: 10.1002/ajim.20814, indexed in Pubmed: 20187001.
46. van Leeuwen WMA, Kircher A, Dahlgren A, et al. Sleep, sleepiness, and neurobehavioral performance while on watch in a simulated 4 hours on/8 hours off maritime watch system. Chronobiol Int. 2013; 30(9): 1108–1115, doi: 10.3109/07420528.2013.800874, indexed in Pubmed: 23879695.

47. Lack LC, Lushington K. The rhythms of human sleep propensity and core body temperature. J Sleep Res. 1996; 5(1): 1–11, doi: 10.1046/j.1365-2869.1996.00005.x, indexed in Pubmed: 8795795.
48. Monk TH. Subjective ratings of sleepiness: the underlying circadian mechanisms. Sleep. 1987; 10(4): 343–353, doi: 10.1093/sleep/10.4.343, indexed in Pubmed: 3659732.
49. Oldenburg M, Jensen HJ, Latza U, et al. Seafaring stressors aboard merchant and passenger ships. Int J Public Health. 2009; 54(2): 96–105, doi: 10.1007/s00038-009-7067-z, indexed in Pubmed: 19288290.
50. Sąlyga J, Kušleikaitė M. Factors influencing psychoemotional strain and fatigue, and relationship of these factors with health complaints at sea among Lithuanian seafarers. Medicina (Kaunas). 2011; 47(12): 675–681, indexed in Pubmed: 22370467.
51. Sunde E, Bratveit M, Pallesen S, et al. Noise and sleep on board vessels in the Royal Norwegian Navy. Noise Health. 2016; 18(81): 85–92, doi: 10.4103/1463-1741.178481, indexed in Pubmed: 26960785.
52. Tamura Y, Horiyasu T, Sano Y, et al. Habituation of sleep to a ship's noise as determined by actigraphy and a sleep questionnaire. J Sound Vibration. 2002; 250(1): 107–113, doi: 10.1006/jsvi.2001.3900.
53. Hilgard ER, Atkinson RC, Atkinson RL. Introduction to psychology. 8th Ed. Harcourt Brace Jovanovich, 1983.
54. McNamara R, Smith A. Combined effects of fatigue indicators on the health and wellbeing of workers in the offshore oil industry. J Health Med Sci. 2020; 3(3), doi: 10.31014/aior.1994.03.03.122.

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REVIEW ARTICLE

Medical training of seafarers: International Maritime Health Foundation (IMHF) Expert Panel Consensus Statement

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ABSTRACT

Background: *Medical emergencies and on-going medical conditions on board may seriously impair seafarers' health and safety, and also negatively impact on future work prospects for seafarers. When a seafarer gets ill or injured on a ship, medical treatment often relies on the competences on his colleagues on board. The aim of this project was to establish a consensus-based minimum standard for medical education for seafarers, in order to ensure competency for adequate management of ill-health on board.*

Materials and methods: *International Maritime Health Foundation (IMHF) conducted a workshop on medical training of seafarers. A research-based approach to gain consensus on core learning outcomes/competences developed by the Tuning Project, has been used. This method was used by Tuning (Medicine) to gain consensus on core learning outcomes for primary medical degrees (Master of Medicine) across Europe.*

Results: *The result of the project is a set of learning outcomes/competences in medical training for merchant seafarers.*

Conclusions: *The project resulted in a set of learning outcomes/competences on medical training of the seafarers that will be submitted to the relevant bodies of International Maritime Organization (IMO) in the process of the development of model courses 1.13, 1.14 and 1.15.*

(Int Marit Health 2023; 74, 1: 15–23)

Key words: medical training, seafarers, learning outcomes

INTRODUCTION

Established in June 2018 as a non-profit scientific foundation with scientific objectives and international activities, the International Maritime Health Foundation (IMHF) has the responsibility for the maintenance of the scientific journal 'International Maritime Health'. Its objective is to pursue the development of science, to increase and disseminate knowledge of maritime medicine and adjacent fields. It also initiates and supports scientific and research activity, contribution to improvement of safety, hygiene at work and health of seafarers and other persons who work at sea worldwide [1, 2]. IMHF's intention is to assemble scientific and academic expertise, to continually monitor and address relevant health issues and developments, in order to help solve or ameliorate problems in the maritime environment [3]. IMHF considers that consensus documents

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that are the result of the work of expert panels from different countries or several organizations, will be of significant benefit to maritime industry. Such consensus documents summarise current knowledge and guidelines on topics, and draft operative protocols and recommendations identifying current gaps and providing next steps. Appropriately, International Maritime Health Foundation's Expert Panel (IMHF EP) is a group of medical professionals concerned with all aspects of seafarers' health, including prevention and treatment of medical conditions on board.

Medical emergencies and various medical conditions on board may seriously impair seafarers' safety and health, as well as future work aspects [4–12]. Therefore, IMHF EP intends to participate in the development or revision of International Maritime Organization (IMO) model courses 1.13, 1.14 and 1.15 in accordance with the provisions of the Revised Guidelines for the development, review, and validation of model courses (MSC-MEPC.2/Circ.15) [13, 14].

The quality of medical help on board depends on the competence of the onsite responder, established structures and procedures, medical manuals used, medical equipment on board and the quality of available tele-medical assistance service (TMAS), including e-health applications; medical training being the core element of such a system of medical help [15–18]. All those elements must be completely coordinated and interoperative [19]. Synergy within the rescue chain including rescue services, other medical assistance services and ashore medical facilities, is needed. Between all agencies, there must be a mutual understanding and this must be reflected not only in training, but also in equipment (Ship's medicine chest) and procedures established (Medical Guide for Ships) [20–25]. All aspects of medical support form links in a chain of survival, and deficiency in any link may have a profoundly negative effect on the present care and future health of a seafarer [26].

The IMHF EP holds that although a model course should not go beyond what is required in the The International Convention of Standards of Trainig Certification and Watchkeeping for Seafares (STCW), it should address the common best practice and state-of-the-art technology and, in this case, treatment guidelines. Present-day medical state of the art provides an array of options, even for first aiders, that were not available, when the present IMO model courses were developed [27].

Rapid scientific advances constantly require adaptation in the training and education of professional as well as non-professional first aiders [28]. Medical guidelines usually require continuous review in order to reflect the scientific advances made encompassing new procedures and new equipment [29–33]. Changes to medical guidelines inevitably should mandate changes to the curriculum of medical training too [34]. In order to comply with the Maritime Labour Convention (MLO), 2006, as amended, title 4 requirements, IMHF EP deems it mandatory to include new procedures into the model courses. Finally, and most importantly, new and more continuous learning methods, should be considered.

SUCCESSFUL MODELS FOR CREATING GLOBALLY TUNED EDUCATION PROGRAMMES AND THEIR APPLICATION IN MODEL COURSES

Until recently, the main obstacle to creating universally acceptable training programmes in national medical education were the differences in training programmes and methods of education [35]. Modern globalisation and advances in educational sciences now are enabling different learning traditions and systems to be coordinated and to provide the same results [36, 37].

Outcome-oriented learning is such a system where various parties with different teaching traditions agree not on the training programmes but on the learning outcomes, so all students come out of the education process with the same competences, regardless of the program they undergo [38]. The European Union funded projects MEDINE 1 and MEDINE 2 were projects where such a process was applied to European medical education, enabling free movement of doctors through Europe [39, 40]. Several methods for defining the learning outcomes were used in those projects including a tuning process where outcomes are tuned by all stakeholders, providing an agreeable and most realistic outcome [41, 42].

A research-based approach to gain consensus on core learning outcomes/competences was developed by the Tuning Project, and used by Tuning (Medicine) to gain consensus on core learning outcomes for primary medical degrees (Master of Medicine) across Europe [43, 44]. That work was undertaken as part of the MEDINE Thematic Network for Medical Education in Europe, 2004–2007, and supported by funding from the Life Long Learning Programme of the European Commission [45]. The results have been widely accepted and influential. For example, the 'Outcomes' section of the third version of Tomorrow's Doctors from the UK General Medical Council (GMC), draws heavily on the Tuning (Medicine) outcomes, which are also referenced in that document [46].

IMHF EP proposes that before the existing curricula on medical training of seafarers are revised, such a system should be applied in the revision of the existing learning competences first. Learning outcomes based on agreed competences and achieved through a tuning process that will include all stakeholders, will enable not only an adequate training programme curriculum for model courses but also globally tuned results of seafarers' health training and their competences in maritime health.

Creating/revising learning outcomes/competences first, will also enable standardised approach in providing TMAS globally as it will define expected competences on both sides of the TMAS (providers and receivers) and, finally, the creation of adequate medical manual and medical chest. Defining those learning outcomes will enable each country to design its own training programmes or textbooks that will have the same training outcomes as IMO model courses. Similarly medical guides and medical chests will be for the first time designed based on globally agreed elements.

MATERIALS AND METHODS

The aim of this project was to develop learning outcomes based on agreed competences and achieved through a tuning process that will include all stakeholders. IMHF EP created a medical working group/expert panel on learning outcomes/competences and from 18–19 March 2022, in Bergen, Norway, held the 2nd IMHF Workshop on Maritime Health on Board — Medical Training of Seafarers. Academic experts, with experience in establishing teaching policies for maritime students and maritime authorities' representatives, were also invited to this meeting.

2ND IMHF EP WORKSHOP ON MARITIME HEALTH ON BOARD — MEDICAL TRAINING OF SEAFARERS

The 2nd IMHF EP Workshop on Maritime Health on Board — Medical Training of Seafarers was held from 18–19 March 2022, in Bergen, Norway in cooperation with The Norwegian Centre for Maritime Medicine and Diving Medicine. In total, ten expert participants from international maritime medicine institutes, universities, legislative bodies and industry, actively participated in the workshop, namely: Dr. Haga Jon Magnus (NCMDM), Dr. Tülsner Jens (MMS), Capt. Årland Per Otto (NMA), Dr. Lund-Kordahl Inger (NCMDM), Dr. Simolin Pernilla Cecilia (NCMDM), Dr. Horneland Alf Magne (NCMDM), Capt. Kavanagh Bill (NMCI), Dr. Seidenstucker Klaus (IMHF), Dr. Briggs Spike (NHS/MSOS), and Dr. Nebojša Nikolić (MCOHR).

The aim of the workshop was to evaluate the Learning Outcomes/Competences for Undergraduate Medical Education in Europe in the context of medical training for the designated medical personnel on board of merchant ships. In the light of this evaluation, the next aim was to reach consensus on the learning outcomes/competences for medical training of designated officers and crew onboard merchant ships [47].

Altogether ten expert participants from international maritime medicine institutes, universities, legislative bodies and industry actively participated in the workshop. Eight participants were allocated to four task-teams (TT in further text); each TT discussed, evaluated and tuned four groups of 12 major "Level 1" learning outcomes/competences as defined by the Tuning (Medicine) Project — MEDINE Thematic Network for Medical Education in Europe, and validated by an Expert Panel of the European Commission. Two participants participated in the workshop with the presentations on previously determined topics and actively participated in the work of the TTs and tuning sessions.

The first part of the workshop (Day One: 0930-1115): was dedicated to introductions and six presentations on previously planned topics. The second part of the workshop (Day One: 1145-1445) comprised four TT presentation sessions. All four TT simultaneously worked on the same allocated topic and one team then presented allocated topic to other teams. Each session comprised 10 minutes of working on the topic, 10 minutes of discussion among the team members and finally 10 minutes for presentation on the TT allocated topic — one presenter discussing the allocated learning outcomes from their TT point of view. Each of the sessions were closed with brief comments on the topic by the other workshop participants.

After all four TT presentations were complete, each TT had 1.5 hour to design their position paper. The rest of the non-allocated participants cooperated as required with each TT, whether by invitation or by their free interest and expertise in the topic.

Fourth part of the workshop (Day One: 1600-1900) comprised six parallel workgroup sessions where each TT presented their position paper to other task teams. After each TT presented their position paper, all teams tuned their position papers in combined sessions.

The fifth part of the workshop (Day Two) was organized in the format of a plenary session where all task group position papers were included in the final position paper, and subsequently discussed and tuned. There were several topics considered of essential importance to medical care on board, that were considered to require a more detailed outcome than could be achieved in the timeframe of the workshop. Several participants undertook to prepare a paper on each of these areas for evaluation by all participants subsequent to closure of the workshop. One team was committed to draft a supplement to the agreed list of learning outcomes referring to experiential learning and explaining the reasoning of the Level 5 in the Likert scale (Does in real practice) not used in the agreed list of competences.

CONSENSUS PROCESS

The resulting draft position paper results from the workshop was submitted for wider evaluation in the format of the online survey among stakeholders who assessed it online (Qualtrics) for validity, feasibility and clarity, using a 1–9 Likert scale. The on-line questionnaire was structured with 14 questions according to the main Level 1 learning outcomes from the questionnaire used in the workshop. A higher score indicated a recommendation being more valid, feasible or clear. Recommendations with an average score < 4 were discarded, recommendations with a score ≥ 7 were retained, and recommendations with a score in-between were revised in the second round of tuning among the members of the workgroup. In addition, the online assessment offered participants the opportunity to provide open comments about each recommendation, which were considered during the revision process. Results of the survey reviled an overall mean score of 7.12 for validity, 6.75 for feasibility and 7.31 for clarity. Five questions had the mean score ≥ 7, none had the score < 4 and 9 questions had a score between 4 and 6. Of those 9 questions, 3 had that score in all three assessment categories, 3 had that score in two categories and 3 had that score in one category. Following the survey, after two rounds of tuning, 12 recommendations that received a score between 4 and 6 in at least one of the assessment categories, were amended and validated. These revisions of the workshop's results were finally approved by all the authors.

After competition of the survey, final tuning of the results has been made by panellists of the IMHF EP who formally adopted it as a consensus paper.

RESULTS

The result of the workshop and further tuning process is a set of learning outcomes/competences in medical training for merchant seafarers, presented below.

QUESTIONNAIRE DESIGN AND LEARNING OUTCOMES/COMPETENCES AS AGREED AT THE 2ND IMHF EP WORKSHOP

For each of the learning outcomes/competences arising from the Tuning (Medicine) Project, participants of the workshop were asked: "to rate the following learning outcomes/competences on the extent to which they think they should have been achieved by a designated provider/crew on board who has successfully completed the training in medical help on board" on the following Likert scale, which is based on "Miller's triangle" [48, 49]:

- Not learned — allocated "1" on Likert scale;
- Knows (about it) — allocated "2" on Likert scale;
- Knows how (to do it) — allocated "3" on Likert scale;
- Shows how (in simulation) — allocated "4" on Likert scale;
- Does (in real practice) — allocated "5" on Likert scale.

After the training in medical help on board, designated provider on board/crew who has successfully completed the training will have the ability to:

Outcomes	Designated provider	All personnel
Carry out a consultation with a patient		
Take a history	4	2
Carry out physical examination	4	2
Make judgements and decisions	2	1
Provide explanation and advice	3	1
Provide reassurance and support	3	3
Assess the patient's mental state	3	2
Assess clinical presentations, order investigations, make differential diagnoses, and negotiate a management plan		
Recognise and assess the severity of clinical presentations (concept of triage — presentations that can be handled independently and those requiring outside assistance, e.g., TMAS)	4	2
Order appropriate investigations and interpret the results	2	1
Make differential diagnoses	2	1
Negotiate an appropriate management plan with patients and TMAS (use of ATMIST, AVPU or similar form of reporting)	4	1
Provide care of the dying and their families	2	2
Manage chronic illness	2	1
Provide immediate care of medical emergencies, including first aid and resuscitation		
Recognise and assess acute medical emergencies (prioritising actions)	4	4
Treat acute medical emergencies (burns, choking, bleeding management, drowning and near drawing)	4	2
Provide basic first aid	4	4

Provide basic life support and cardio-pulmonary resuscitation according to current guidelines	4	4
Use of automatic defibrillator (D-CPR)	4	4
Provide trauma care according to current guidelines	4	2
Prescribe drugs		
Prescribe clearly and accurately to selected medical emergencies	3	1
Match appropriate drugs and other therapies to the clinical context	2	1
Review the appropriateness of drug and other therapies and evaluate potential benefits and risks	2	1
Treat pain and distress	2	2
Carry out practical procedures		
Measure blood pressure (automatic BP machine) and temperature	4	2
Cannulation of veins and intraosseous cannulation	4	1
Administer IV therapy and use infusion devices	4	1
Intramuscular injection/Use of local anaesthetic agents	4	1
Administer oxygen	4	4
Move and handle patients (evacuation stretchers, log-roll)	4	4
Wound management/suturing (stapling, skin glue, skin adhesive strips)	4	1
Bladder catheterisation	4	1
Point of care testing (urine, glucose, pregnancy testing)	4	1
Splints/bandages including cervical and spinal immobilisation	4	2
Otoscopy	4	1
Pulse oximetry	4	1
Communicate effectively in a medical context	4	2
Ability to apply ethical and legal principles in medical practice		
Maintain confidentiality	3	4
Concept of "Acting in the patients' best interest"	3	4
Obtain and record informed consent	4	2
Assess psychological and social aspects of a patient's illness		
Assess psychological factors in presentations and impact of illness	3	2
Assess social factors in presentations and impact of illness	3	2
Detect stress in relation to illness	3	2
Detect alcohol and substance abuse, dependency	4	4
Apply the principles, skills and knowledge of evidence-based medicine		
Keep accurate and complete clinical records	4	2
Use information and information technology effectively in a medical context (medical guide, electronic databases, drug formularies)	4	1
Promote health, engage with population health issues and work effectively in a health care system		
Provide patient care which minimises the risk of harm to patients	3	1
Apply measures to prevent the spread of infection (hygiene, sterility, disinfection, procedures of illness prevention and prophylaxis)	4	4
Recognise own health needs and ensure own health does not interfere with professional responsibilities	3	4
Conform with professional regulation and certification to practise	3	1
Engage in health promotion	3	2

Outcomes in medical professionalism	Designated provider	All personnel
Professional working		
Ability to recognise limits and ask for help	4	4
Communicate port health authorities regarding IHR-requirements	4	1
Ability to communicate with shore-based TMAS and SAR services	4	1
Capacity and ability to organize and plan medical support and rescue (in water, helicopter, lifeboat)	4	1
The medical provider as expert		
Capacity to learn (including lifelong self-directed learning)	4	1
Capacity for applying knowledge in practice	4	4
Ability to lead and teach others	4	1
Dealing with multiculturality — global medical provider		
Appreciation of diversity and multiculturality in perception of disease	3	3
Knowledge of medical terminology in English	4	4
Commitment to maintain skill competency and knowledge	4	4

After the training in medical help on board, designated medical provider on board/crew who has successfully completed the training should be able to demonstrate knowledge of:

Knowledge outcomes	Designated provider	All personnel
Basic sciences		
Normal function (physiology)	3	2
Normal structure (anatomy)	3	2
Clinical sciences		
Abnormal structure and mechanisms of disease (pathology)	2	1
Infection (microbiology)	3	2
Drugs and prescribing		
Use of antibiotics and antibiotic resistance	3	1
Principles of prescribing	3	1
Drug side-effects	3	2
Drug interactions	2	1
Individual drugs	3	1
Public health		
Disease prevention (esp. infectious diseases)	4	3
Lifestyle, diet and nutrition	2	2
Health promotion	2	1
Screening for disease and disease surveillance	2	1
Gender issues relevant to health care	2	2
Cultural and ethnic influences on health care	2	1
Ethical and legal principles in medical practice		
Rights of patients	2	2
Role of the designated medical person on board in health care systems		
Laws relevant to medicine on ships	3	1
Systems for health care delivery on ships	3	1

After the training in medical help on board, designated provider on board/crew who has successfully completed the training should be able to:

General care	Designated provider	Crew
Care of acutely medically ill patients including mental first aid	4	1
Care of trauma patients	4	1
Care for the dying	3	1
Care for mentally ill patients	3	1

EXPERIENTIAL LEARNING

Training according to STCW competence requirements usually includes experiential learning to reach a certain level of competence and get a maritime certificate.

In the area of medical care it is difficult to organize such training, as:

- relevant medical care situations on board a merchant ship do not happen more than 2–4 times a year — too infrequent to assess whether Likert scale level 5 is reached;
- there is no medical superior on board to carry out an appraisal;
- it may prove difficult for seafarers to get such training and appraisal in hospitals.

The highest level on the Likert scale that can be achieved during a course is Likert scale level 4. The students are, however, on completion of the course, supposed to carry out the procedures in real life, corresponding to Likert level 5. This emphasizes the importance of combining traditional coursework with continuous education and training in medical care on board ships and that there is a low threshold for the designated person on board to seek assistance from TMAS services ashore.

Infrequency of real medical situations on board and corresponding lack of experience may be mitigated through a mandatory system of continuous learning.

We recommend the following:

- a mandatory basic course covering identified learning outcomes;
- a mandatory refresher course every 5 years;
- a mandatory system of continuous learning, consisting of exercises and drills to be carried out on a regular basis, at least 4 times a year:
  - drills under the supervision of the master;
  - exercises in connection with a TMAS training centre ashore;
  - a log of completed drills/exercises should be provided together with a refresher course diploma to get an extension of their competence, alternatively the person should attend the basic course once more, instead of a refresher course.

LIMITATIONS OF THE STUDY

Learning outcomes used in this study are the core learning outcomes Level 1/2 used by Tuning (Medicine) to gain consensus on core learning outcomes for primary medical degrees (Master of Medicine) across Europe [43, 44]. Although recognizing that there are additional areas of the study of interest for seafarers onboard, authors agreed to keep the consistency of the paper by not adding the new learning outcomes, foreseeing that further changes will be necessary, based on gathered experience of course developers and feedback from the users. In updating the list, the same method should be used.

CONCLUSIONS

The result of the project is a set of learning outcomes/competences in medical training for merchant seafarers that will be submitted to the relevant bodies of IMO in the process of the review of model courses 1.13, 1.14 and 1.15 [13].

Conflict of interest: None declared

REFERENCES

1. Horneland AM, Jeżewska M, Jaremin B, et al. Establishment of the International Maritime Health Foundation: the next step in scientific publishing in maritime health. Int Marit Health. 2018; 69(3): 153–156, doi: 10.5603/IMH.2018.0024, indexed in Pubmed: 30270421.
2. International Maritime Health, Via Medical Journals. https://journals.viamedica.pl/international_maritime_health (Accessed on 06.11.2022).
3. International Maritime Health Foundation. https://www.imhf.pl/ (Accessed on 06.11.2022).
4. ILO Guidelines for implementing the occupational safety and health provisions of the Maritime Labour Convention 2006, Geneva, Switzerland: International Labour Office; 2015. Sectoral Policies Department and International Labour Standards Department: 3-5.
5. Carter T. Mapping the knowledge base for maritime health: illness and injury in seafarers. Int Marit Health. 2011; 62(4): 224–240, indexed in Pubmed: 22544497.
6. Sagaro GG, Dicanio M, Battineni G, et al. Incidence of occupational injuries and diseases among seafarers: a descriptive epidemiological study based on contacts from onboard ships to the Italian Telemedical Maritime Assistance Service in Rome, Italy. BMJ Open. 2021; 11(3): e044633, doi: 10.1136/bmjopen-2020-044633, indexed in Pubmed: 33727272.
7. Grappasonni I, Petrelli F, Amenta F. Deaths on board ships assisted by the Centro Internazionale Radio Medico in the last 25 years. Travel Med Infect Dis. 2012; 10(4): 186–191, doi: 10.1016/j.tmaid.2012.06.006, indexed in Pubmed: 22819258.
8. Roberts SE, Marlow PB. Traumatic work related mortality among seafarers employed in British merchant shipping, 1976-2002. Occup Environ Med. 2005; 62(3): 172–180, doi: 10.1136/oem.2003.012377, indexed in Pubmed: 15723882.

9. McKay MP. Maritime health emergencies. Occup Med (Lond). 2007; 57(6): 453–455, doi: 10.1093/occmed/kqm053, indexed in Pubmed: 17652345.
10. Montocchio-Buadès C, Daurat M, Ducombs M, et al. Management of a polytrauma in the maritime environment. Int Marit Health. 2018; 69(2): 126–128, doi: 10.5603/IMH.2018.0018, indexed in Pubmed: 29939389.
11. Herttua K, Gerdøe-Kristensen S, Vork JC, et al. Age and nationality in relation to injuries at sea among officers and non-officers: a study based on contacts from ships to Telemedical Assistance Service in Denmark. BMJ Open. 2019; 9(12): e034502, doi: 10.1136/bmjopen-2019-034502, indexed in Pubmed: 31843856.
12. Oldenburg M, Baur X, Schlaich C. Occupational risks and challenges of seafaring. J Occup Health. 2010; 52(5): 249–256, doi: 10.1539/joh.k10004, indexed in Pubmed: 20661002.
13. IMO model courses 1.13, 1.14, 1.15. London: IMO; 2001.
14. Revised Guidelines for the development, review, and validation of model courses (MSC-MEPC.2/Circ.15). https://homeport.uscg.mil/Lists/Content/Attachments/55317/Enclosure%205d%20-%20Sample%20Model%20Course%20Terms%20of%20Reference%20Template,%20IMO%20Format.pdf (Accessed on 06.11.2022).
15. Brebner EM, Brebner JA, Ruddick-Bracken H, et al. The importance of setting and evaluating standards of telemedicine training. J Telemed Telecare. 2003; 9 Suppl 1: S7–S9, doi: 10.1258/135763303322196150, indexed in Pubmed: 12952704.
16. Blignault I, Kennedy C. Training for telemedicine. J Telemed Telecare. 1999; 5 Suppl 1: S112–S114, doi: 10.1258/1357633991932793, indexed in Pubmed: 10534864.
17. Sood S, Mbarika V, Jugoo S, et al. What is telemedicine? A collection of 104 peer-reviewed perspectives and theoretical underpinnings. Telemed J E Health. 2007; 13(5): 573–590, doi: 10.1089/tmj.2006.0073, indexed in Pubmed: 17999619.
18. Guitton MJ. Telemedicine at sea and onshore: divergences and convergences. Int Marit Health. 2015; 66(1): 18–21, doi: 10.5603/IMH.2015.0005, indexed in Pubmed: 25792161.
19. Oldenburg M, Rieger J, Sevenich C, et al. Nautical officers at sea: emergency experience and need for medical training. J Occup Med Toxicol. 2014; 9: 19, doi: 10.1186/1745-6673-9-19, indexed in Pubmed: 24817903.
20. Nikolić N, Horneland A, Denisenko I, et al. A Medical Support in Offshore Racing Workshop on Learning Competences/Outcomes, 4–5 November 2016, Barcelona, Spain. Int Marit Health. 2017; 68(3): 178–182, doi: 10.5603/imh.2017.0033.
21. Norum J, Gunnar Moksness S, Larsen E. A Norwegian study of seafarers' and rescuers' recommendations for maritime telemedicine services. J Telemed Telecare. 2002; 8(5): 264–269, doi: 10.1177/1357633X0200800504, indexed in Pubmed: 12396854.
22. Schlaich C, Reinke A, Savenich C, et al. Guidance to the International Medical Guide for Ships 3(rd) edition: interim advice regarding the best use of the medical chest for ocean-going merchant vessels without a doctor onboard: joint statement of WHO Collaborating Centres for the health of seafarers and the International Maritime Health Association – 2009 version. Int Marit Health. 2009; 60(1-2): 51–66.
23. Quantification addendum: international medical guide for ships, third edition. Geneva, Switzerland: World Health Organization; 2010. WHO Press. https://apps.who.int/iris/handle/10665/44341 (Accessed on 13.11.2022).
24. International Medical Guide for Ships, Third Edition. http://apps.who.int/iris/bitstream/handle/10665/43814/9789240682313_eng.pdf?sequence=1 (Accessed on 06.11.2022).
25. Doarn CR, Doarn CR. Challenges and barriers to development of telemedicine programs. Stud Health Technol Inform. 2004; 104: 41–48, indexed in Pubmed: 15747962.
26. Zeidler F, Načinović A, Rubinić M, et al. Frequency and quality of radio-medical advice service calls in Rijeka/Croatia. Medicina. 1999; 35: 55–59.
27. Luger TJ, Giner R, Lorenz IH. Cardiological monitoring of sailors via offshore Internet connection. J Sports Med Phys Fitness. 2001; 41(4): 486–490, indexed in Pubmed: 11687768.
28. Wyckoff MH, Singletary EM, Soar J, et al. COVID-19 Working Group. 2021 International Consensus on Cardiopulmonary Resuscitation and Emergency Cardiovascular Care Science With Treatment Recommendations: Summary From the Basic Life Support; Advanced Life Support; Neonatal Life Support; Education, Implementation, and Teams; First Aid Task Forces; and the COVID-19 Working Group. Resuscitation. 2021; 169: 229–311, doi: 10.1016/j.resuscitation.2021.10.040, indexed in Pubmed: 34933747.
29. Dahl E. Briefing notes on maritime teledermatology. Int Marit Health. 2014; 65(2): 61–64, doi: 10.5603/IMH.2014.0014, indexed in Pubmed: 25231327.
30. Dehours E, Roux P, Tabarly J, et al. French maritime procedures concerning the Ebola infection, experience of the French Tele-Medical Assistance Service (TMAS). Int Marit Health. 2015; 66(3): 184–185, doi: 10.5603/IMH.2015.0036, indexed in Pubmed: 26394321.
31. Amenta F. The Centro Internazionale Radio Medico Symposium "The Way Forward of Maritime Telemedicine". Int Marit Health. 2016; 67(1): 56, doi: 10.5603/IMH.2016.0012, indexed in Pubmed: 27029932.
32. Sagaro GG, Amenta F. Past, present, and future perspectives of telemedical assistance at sea: a systematic review. Int Marit Health. 2020; 71(2): 97–104, doi: 10.5603/IMH.2020.0018, indexed in Pubmed: 32604452.
33. Battineni G, Amenta F. Designing of an Expert system for the management of Seafarer's health. Digit Health. 2020; 6: 2055207620976244, doi: 10.1177/2055207620976244, indexed in Pubmed: 33343918.
34. Kulasegaram K, Mylopoulos M, Tonin P, et al. The alignment imperative in curriculum renewal. Med Teach. 2018; 40(5): 443–448, doi: 10.1080/0142159X.2018.1435858, indexed in Pubmed: 29490525.
35. Trainor A, Richards JB. Training medical educators to teach: bridging the gap between perception and reality. Isr J Health Policy Res. 2021; 10(1): 75, doi: 10.1186/s13584-021-00509-2, indexed in Pubmed: 34915929.
36. DeBoer G. The globalization of science education. JRST. 2011; 48(6): 567–591, doi: 10.1002/tea.20421.
37. Dale R. Globalisation, knowledge economy and comparative education. Comparative Education. 2005; 41(2): 117–149, doi: 10.1080/03050060500150906.
38. Carr SJ. Assessing clinical competency in medical senior house officers: how and why should we do it? Postgrad Med J. 2004; 80(940): 63–66, doi: 10.1136/pmj.2003.011718, indexed in Pubmed: 14970290.
39. Gruppen LD. Outcome-based medical education: implications, opportunities, and challenges. Korean J Med Educ. 2012; 24(4): 281–285, doi: 10.3946/kjme.2012.24.4.281, indexed in Pubmed: 25813324.
40. Ross MT, Nikolić N, Peeraer G, et al. Report of the MEDINE2 Bachelor of Medicine (Bologna First Cycle) tuning project. Med Teach. 2014; 36(4): 314–321, doi: 10.3109/0142159X.2014.887836, indexed in Pubmed: 24593658.

41. Tuning Educational Structures in Europe – Final Report Pilot Project. http://tuningacademy.org/wp-content/uploads/2014/02/TuningEUI_Final-Report_EN.pdf (Accessed on 09.11.2022).
42. Tuning Educational Structures in Europe: A Guide to Formulating Degree Program Profiles. http://tuningacademy.org/wp-content/uploads/2014/02/A-Guide-to-Formulating-DPP_EN.pdf (Accessed on 09.11.2022).
43. Gonzales J, Wagenaar R, Donà dalle Rose L. The Pilot Project "Tuning Educational Structures in Europe" and the Object-specific Competences for University Physics Students. In: Marisa Michelini ed. Quality Development in Teacher Education and Training. Second International GIREP Seminar 2003, Selected contributions. 2004: 333–343.
44. Cumming AD, Ross M. The tuning project for medicine: learning outcomes for undergraduate medical education in Europe. Med Teach. 2007; 29(7): 636–641, doi: 10.1080/01421590701721721, indexed in Pubmed: 18236249.
45. Lifelong Learning Program 2007-13. https://eur-lex.europa.eu/EN/legal-content/summary/lifelong-learning-programme-2007-13.html (Accessed on 09.11.2022).
46. Tomorrow's doctors. Outcomes and standards for undergraduate medical education. General Medical Council 2099. http://www.ub.edu/medicina_unitateducaciomedica/documentos/Tomorrows-Doctors_2009.pdf (Accessed on 13.11.2022).
47. Cumming AD, Ross M. The Tuning Project (Medicine) – Learning outcomes / competences for undergraduate medical education in Europe. https://www.researchgate.net/publication/297419241_The_Tuning_Project_Medicine_-_Learning_outcomes_competences_for_undergraduate_medical_education_in_Europe. DOI:10.13140/RG.2.1.4620.7765 (Accessed on 13.11.2022).
48. Miller GE. The assessment of clinical skills/competence/performance. Acad Med. 1990; 65(9 Suppl): S63–S67, doi: 10.1097/00001888-199009000-00045, indexed in Pubmed: 2400509.
49. Sullivan GM, Artino AR. Analyzing and interpreting data from likert-type scales. J Grad Med Educ. 2013; 5(4): 541–542, doi: 10.4300/JGME-5-4-18, indexed in Pubmed: 24454995.

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REVIEW ARTICLE

Bibliometric and systematic literature review on safety management in the shipping industry and further development in Indonesia

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ABSTRACT

This study aims to analyse safety management in the shipping industry and suggest further research. Safety management is a critical component in preventing accidents within the shipping industry. Unfortunately, ship accidents are relatively common. To improve safety management in the shipping industry, it is necessary to identify various problems and solutions from previous studies. This study uses comprehensive mapping, utilising bibliometric and systematic reviews, to analyse 669 articles within the Scopus database. The findings indicate an increase in the number of publications, while the number of citations is decreasing. China is identified as the most influential country in terms of publication numbers and international collaborations. Co-authorship analysis reveals that only 24 out of 1,773 authors collaborated with other authors. Based on the systematic review, this study concludes that the human factor plays a crucial role in the effectiveness of safety management. Therefore, further research focusing on support systems that can reduce human error in safety management is important. Additionally, research on the relationship between cultural and structural aspects in safety management is necessary to reduce friction between the two aspects. This research contributes to the mapping of previous research and can be used to determine the topic of further research.

(Int Marit Health 2023; 74, 1: 24–35)

Key words: safety management, bibliometric, systematic, risk, accident, literature, Indonesia

INTRODUCTION

The shipping industry has an important role, both for economy and national defence. In the economic field, the shipping industry is a means of transportation used by various countries, including in international trade. Based on data, 90% of goods shipments use ships as a means of transportation. On the other hand, various countries use ships as a means of transportation and state military defence [1, 2]. Especially for archipelagic countries, the presence of ships and other equipment with various specifications is vital to detect exploitation by other parties. However, the data show that the number of accidents in ship transportation is high. For example, Marine Accident and Incident Reports show that there were 20 accidents in 2018–2019. This data is only accident data reported by the Japan Transport Safety Board and does not include accidents in other countries. Based on the Transportation Safety Board of Canada, there were 520 maritime accidents during 2014–2021 [3]. Especially in Indonesia, National Transportation Safety Committee (2021) shows that during 2018–2021 there were 483 ship accidents or 120 accidents per year. Thus, safety management in the shipping industry is crucial.

Looking at the above phenomenon, research in the field of safety management is fundamental in finding new solutions to improving safety management. Thus, it is necessary to map the research potential using bibliometric and systematic review to develop the important aspect on the safety

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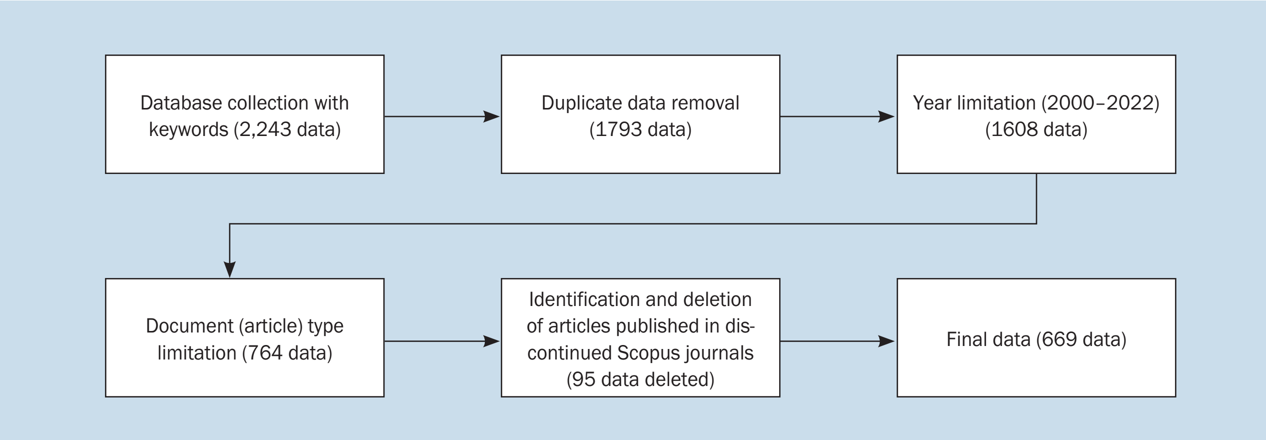

Figure 1. Data selection process. Source: Data processing result, compiled by author

management. Previous research has been conducted by Gil et al. [4], who conducted bibliometric and systematic literature reviews with a focus on policy systems in preventing accidents on ships and linking them to the Technology of Readiness Level, and Fu et al. [5], who conducted a bibliometric and systematic literature review with a focus on risk management in maritime accidents. However, previous studies analysed the literature on particular topics. Thus, a broader literature analysis is needed.

This study analyses the safety management literature in the shipping industry using bibliometric methods and a systematic literature review. Bibliometric Literature Review is used to analyse literature regarding research trends, authors with the most publications, most influential countries, the collaboration of authors, journals with the most publications, and frequently used keywords. A systematic Literature Review analyses comprehensive information on what can be developed in safety management in the shipping industry. The data is sourced from Scopus by entering various keywords. This study sets a limitation year from 2000–2022 to present relevant literature on current conditions. Finally, to conduct a systematic literature review, this study ranks all publications and groups them into several topics for in-depth analysis.

RESEARCH METHOD

BIBLIOMETRIC LITERATURE ANALYSIS

This study uses a qualitative approach with a bibliometric literature review to analyse the development of research in the safety management in the shipping industry. This method has been used by previous studies such as Del Giudice et al. [6] to evaluate the literature on digital technology for the sustainability of the shipping business, Gil et al. [4] to evaluate onboard disaster prevention policy systems, and Munim et al. [7] to evaluate big data in the maritime industry.

The data used were sourced from the Scopus by searching for the keywords “ship” AND “safety management”, “shipping” AND “safety management”, “ship” AND “safety security”, “shipping” AND “safety security”, “ship” AND “safety system”, “shipping” AND “safety system”, “ship” AND “safety law”, “shipping” AND “safety law”, “ship” AND “risk”, “ship” AND “accident”, and “ship” AND “accident” AND “management.” The Scopus was chosen with the consideration that (1) the Scopus index is an index for reputable international journals, and (2) various universities and other institutions use it as an indicator in performance appraisal. In total, there were 2,243 publications with these keywords. Then, the authors conducted various screening processes (Fig. 1).

After the screening process, 669 data from Scopus database will be analysed further. This research used Vos Viewer software and Microsoft Excel to map the data. Vos Viewer was used to visualise the network, while Microsoft Excel was used to tabulate data. Thus, the data analysis included the language used, the number of publications and citations per year, research trend, the most influential country, the most influential author, the journal with the highest number of publications, and frequently used keywords.

SYSTEMATIC LITERATURE REVIEW

This study also used a systematic literature review, which refers to Gil et al. [4]. This study determined the ranking of published articles based on the most frequent citations. Finally, this research analysed 5% of the articles with the most frequent citations. The article was selected in systematic literature review will be analysed to gather comprehensive information on the safety management in shipping industry and the implications offered to related stakeholders.

RESULTS AND DISCUSSION

BIBLIOMETRIC REVIEW ANALYSIS

This study analysed the literature on safety management in the shipping industry from the Scopus database. Considering the sharpness and quality of the literature, this research only analyses "article" type with a total of 669 publications after screening processes, as shown in Figure 1. The articles were mainly written in English, as shown in Table 1. This condition shows that researchers publish more articles in international languages so that they can be read easily. Furthermore, Chinese became the second language used.

Research on safety management in the shipping industry started in the 1980s. However, the researcher limits the literature analysis from 2000–2022 to get relevant research.

Table 1. Use of language in article publication

Language	Total publication	Percentage (%)
Chinese	32	0.048
English	624	0.931
French	4	0.006
German	4	0.006
Italian	2	0.003
Portuguese	1	0.001
Russian	1	0.001
Serbian	1	0.001
Croatian	2	0.003
Total	669	100

Source: Data processing result, compiled by author

Based on the number of publications, the trend shows an increase in publications every year, with 2021 being the year of most publications. However, when compared to the total citations, the most numerous citations were in 2013, whereas at that time, there were only 20 articles (Table 2).

This condition indicates that although there is an increasing trend in the number of published articles, this condition differs from the total citation, which shows a decreasing trend. This is an opportunity and challenge for researchers to develop research by paying attention to the relevance and quality of research articles with current and future conditions (Fig. 2).

China has the highest number of articles with 156 publications, followed by the United States and the United Kingdom with 71 and 61 publications. There are several reasons China and the United States have the highest publicity. First, China and the United States are countries with strong militaries [1]. The shipping industry in China and the United States is not only related to economic purposes but also for military and national defence interests. Thus, it is a must to have a high level of safety and good management in shipping industry. Therefore, many things can be researched to produce the highest number of publications (Table 3).

However, the United Kingdom became the country with the most citations. This result can occur because the United Kingdom is one of the countries that has a leading security regime in the offshore sector [8], and also marine is one of the economic assets in the United Kingdom; thus, safety management is important aspect [9]. There is an asymmetry in the number of articles and citations. Thus, further researchers need to improve the quality and relevance of the topics to increase the number of citations.

Table 2. Number of publications and citations per year

Year	TP	TC	Year	TP	TC	TAP	TAC
2000	11	295	2012	24	327	669	12135
2001	5	88	2013	20	1051		
2002	13	194	2014	36	1048		
2003	11	69	2015	25	667		
2004	8	57	2016	32	652		
2005	9	143	2017	35	624		
2006	16	576	2018	41	681		
2007	23	671	2019	51	794		
2008	19	498	2020	72	566		
2009	24	920	2021	79	405		
2010	26	1029	2022	65	74		
2011	24	706					

Source: Data processing result, compiled by author; TP — total publications; TC — total citations; TAP — total all publications; TAC — total all citations

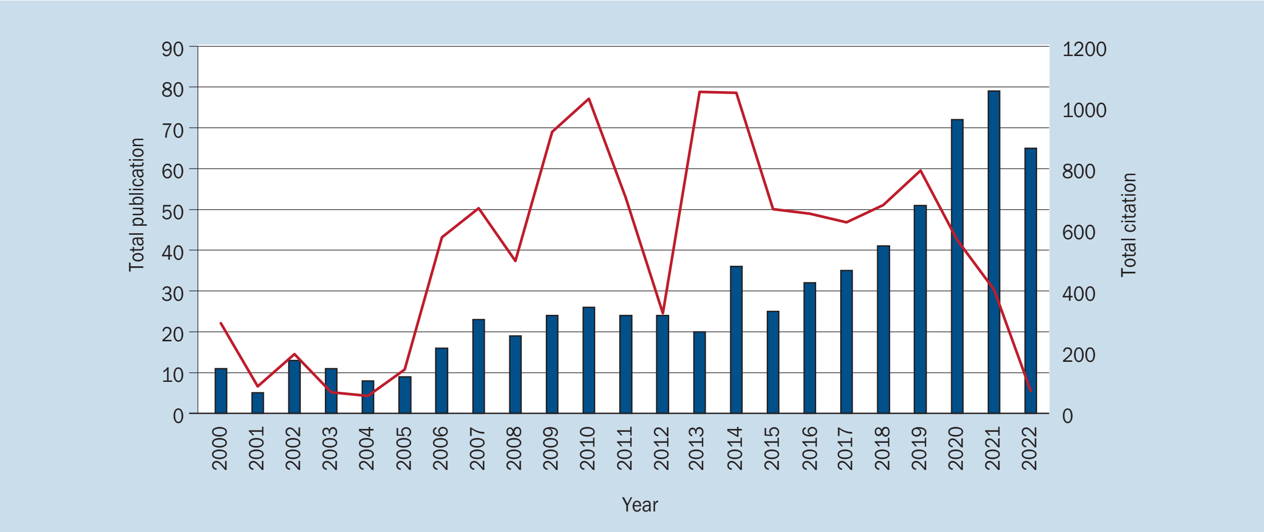

Figure 2. Publication and citation trends per year. Source: Data processing result, compiled by author

Table 3. Countries with the highest number of publications

Countries	TP	TC	TP/TC
China	156	1416	9
United States	71	1032	15
United Kingdom	61	1746	29
Norway	50	1310	26
Turkey	45	1218	27
Finlandia	32	1186	37
Italia	26	664	26
Canada	25	548	22
South Korea	25	162	6
Greece	23	323	14

Source: Data processing result, compiled by author; TP — total publications; TC — total citations

Based on network analysis, researchers from China most collaborated with researchers in other countries, followed by the United States, the United Kingdom, and Norway. This condition shows that researchers need to collaborate with researchers in other countries. This aims to increase insight in article writing and as collaboration in strengthening the urgency of research to be built. In addition, research on safety management in the shipping sector needs to get references from management from other countries to strengthen research (Fig. 3).

This study analyses the number of publications by each author with a minimum of 5 publications. The data shows that Pentti Kujala has the highest number of publications. Moreover, only 24 of 1.773 authors have 5 publications, while other authors only have 1 or 2 publications in the field of safety management in the shipping industry. This condition shows that there are still limited authors who have a focus on safety management in the shipping industry (Table 4).

This condition is also reflected by the limited collaboration between authors which shows that no network connects all the existing authors (Fig. 4). In addition, many authors publish their articles as a single author. Thus, collaboration between authors is needed to produce articles with better quality, because of the different points of view between authors.

Safety Science is the journal that publishes the highest number of articles, with a total of 51 publications, followed by *International Maritime Health*, *Ocean Engineering, Journal of Marine Science and Engineering*, and *Reliability*

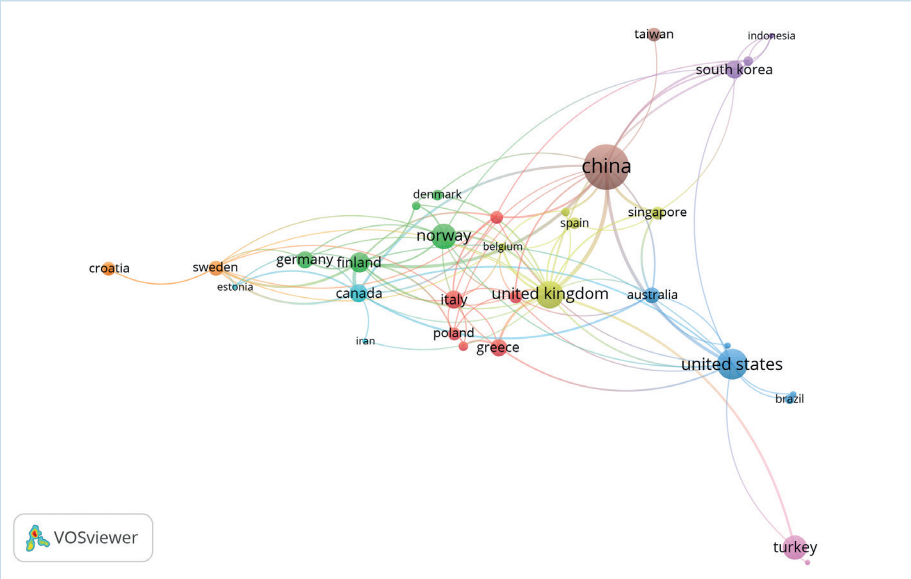

Figure 3. Author collaboration based on country analysis. Source: Data processing result, compiled by author

Table 4. Five authors with the highest number of publications

Author	Affiliation	Countries	TP	TC	H-index
Pentti Kujala	Aalto University	Finlandia	16	829	41
Floris Goerlandt	Dalhousie University	Canada	15	703	35
Metin Celik	Istanbul Teknik University	Turkey	13	771	24
Jin Wang	Liverpool John Moores University	United Kingdom	10	533	56
Shanshan Fu	Shanghai Maritime University	China	9	83	9

Source: Data processing result, compiled by author; TP — total publications; TC — total citations

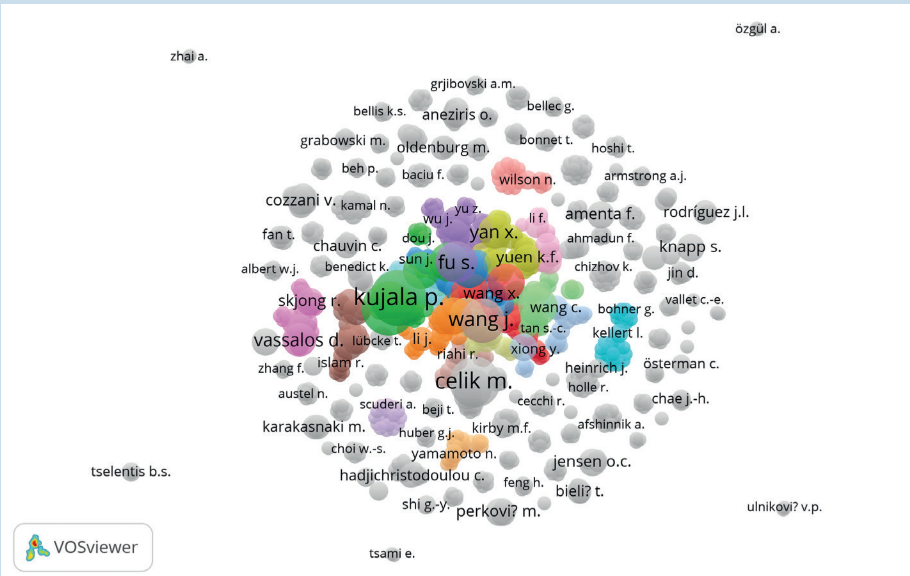

Figure 4. Co-authorship network by number of publications. Source: Data processing result, compiled by author

Table 5. Journals with the highest number of publications

Journal	TP	TC	Publisher	Rank	SJR
Safety Science	51	2183	Elsevier	Q1 in "Safety Research", "Safety, Risk, Reliability and Quality", "Public Health, Environmental and Occupational Health", and "Building and Construction"	1.438
International Maritime Health	31	119	Via Medica	Q3 in "General Medicine"	0.245
Ocean Engineering	23	440	Elsevier	Q1 in "Ocean Engineering" and "Environmental Engineering"	1.381
Journal of Marine Science and Engineering	21	82	MDPI	Q2 in "Ocean Engineering" and "Civil and Structural Engineering", and Q3 in "Water Science and Technology"	0.542
Reliability Engineering and System Safety	17	671	Elsevier	Q1 in "Safety, Risk, Reliability and Quality", "Industrial and Manufacturing Engineering"	1.842

Source: Data processing result, compiled by author; TP — total publications; TC — total citations; MDPI — Multidisciplinary Digital Publishing Institute

Table 6. Publications with the highest number of citations

Authors	Title	Source title	Total citation
Hetherington et al. [12]	Safety in shipping: The human element	*Journal of Safety Research*	427
Chauvin et al. [10]	Human and organizational factors in maritime accidents: Analysis of collisions at sea using the HFACS	*Accident Analysis and Prevention*	310
Harati-Mokhtari et al. [13]	AIS: Data reliability and human error implications	*Journal of Navigation*	241
Celik and Cebi [11]	Analytical HFACS for investigating human errors in shipping accidents	*Accident Analysis and Prevention*	211
Akhtar and Utne [14]	Human fatigue's effect on the risk of maritime groundings: A Bayesian network modelling approach	*Safety Science*	156
Xiao et al. [15]	Comparison study on AIS data of ship traffic behaviour	*Ocean Engineering*	133
Martins and Maturana [16]	Application of Bayesian belief networks to the human reliability analysis of an oil tanker operation focusing on collision accidents	*Reliability Engineering and System Safety*	131
Lu and Yang [17]	Safety leadership and safety behaviour in container terminal operations	*Safety Science*	130
Celik et al. [18]	A risk-based modelling approach to enhance shipping accident investigation	*Safety Science*	128
Hänninen [19]	Bayesian networks for maritime traffic accident prevention: Benefits and challenges	*Accident Analysis and Prevention*	125

Source: Data processing result, compiled by author; AIS — automatic identification system; HFACS — Human Factors Analysis and Classification System

Engineering and System Safety. This journal is indexed by Scopus Q1–Q3, which shows that the journal publishes quality articles and focuses on research and scientific development about safety research in the shipping industry (Table 5).

Based on the publication with the most frequent citations, 7 out of 10 publications discuss human factors in the safety management as shown by Hetherington et al. [12], Chauvin et al. [10], Harati-Mokhtari et al. [13], Celik and Cebi [11], Akhtar and Utne [14], Martins and Maturana [16], and Lu and Yang [17]. This result is reasonable because 80–85% of ship accidents are caused by human error [13]. The article entitled "Safety in shipping: The human element" by Hetherington et al. [12] is the article with the highest number of citations. It analysed the literature on safety in three areas: common themes of accidents, the influence of human error, and interventions to make shipping safer. The author emphasizes the importance of monitoring and modifying human factors in improving maritime safety performance. In this regard, the question arises about how effective monitoring of human factors can improve safety management. Thus, future research focusing on these topics can be developed. On the other hand, Chauvin et al. [10] emphasize the importance of Bridge Resource Management and human reliability in dealing with critical situations on board. Harati-Mokhtari et al. [13] argue that automatic identification system (AIS) has the potential to reduce human errors and improve safety management (Table 6) [10–19].

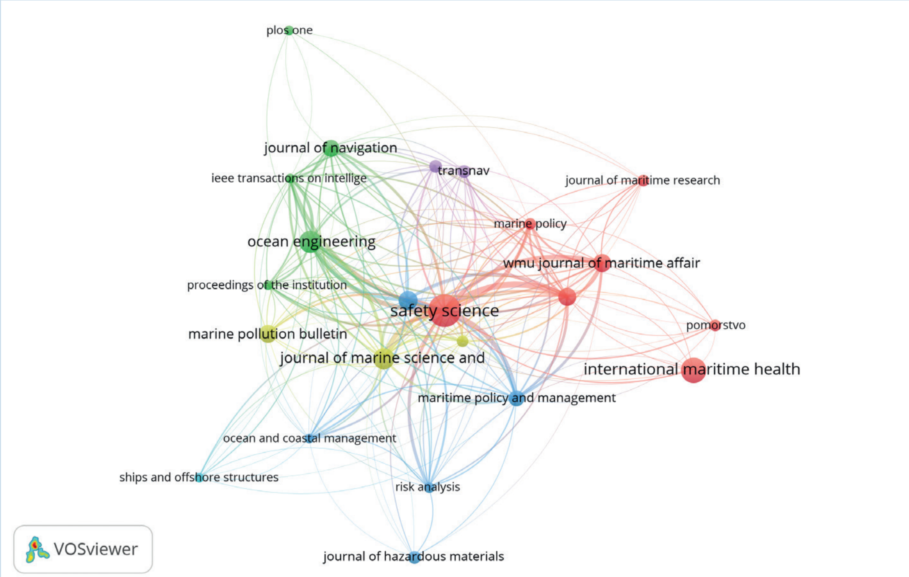

Figure 5. Publication network based on journal analysis. Source: Data processing result, compiled by author

Table 7. Frequently used keywords based on author keyword

Author keyword	Frequency
Maritime safety	33
Safety	29
Safety management	27
Risk assessment	24
Risk management	22
ISM code	21
Human factor	19
Risk analysis	15
Seafarers	15
Safety culture	14

Source: Data processing result, compiled by author

Table 8. Frequently used keywords based on keyword index

Index keyword	Frequency
Ships	280
Article	180
Human	153
Risk assessment	150
Ship	128
Accidents	122
Humans	121
Safety	115
Accident prevention	110
Risk management	88

Source: Data processing result, compiled by author

This study identified the journals that publish the highest number of articles with a minimum of 5 publications. It has been noted that there are 25 journals with a minimum of 5 publications and are divided into 6 network clusters. Based on the Table 6, *Safety Science* is the journal with the highest number of publications (Fig. 5).

Based on the keywords used, this study analysed keywords based on "author keywords" and "index keywords". This was to show the keywords provided by the author in the original article and keywords from the automatic algorithm that is read from the article's title cited in a paper. This study analysed keywords with a minimum of 5 publications by each author (Tables 7, 8).

The keyword "maritime safety" is often associated with "safety management", "ism code", "risk management", "risk analysis", "human factors", "safety culture" and other topics as shown in Figure 6. Meanwhile, based on the "index keywords", there are differences in keywords that are often used. The keyword "ships" is often used, which is then followed by "article", "human", "risk assessment", and "ship".

Safety management also concerns the safety culture that already exists and will be built after various evaluations. Meanwhile, based on the "index keywords", research in the field of "safety management" in the shipping sector focuses not only on how to manage safety ideally but also

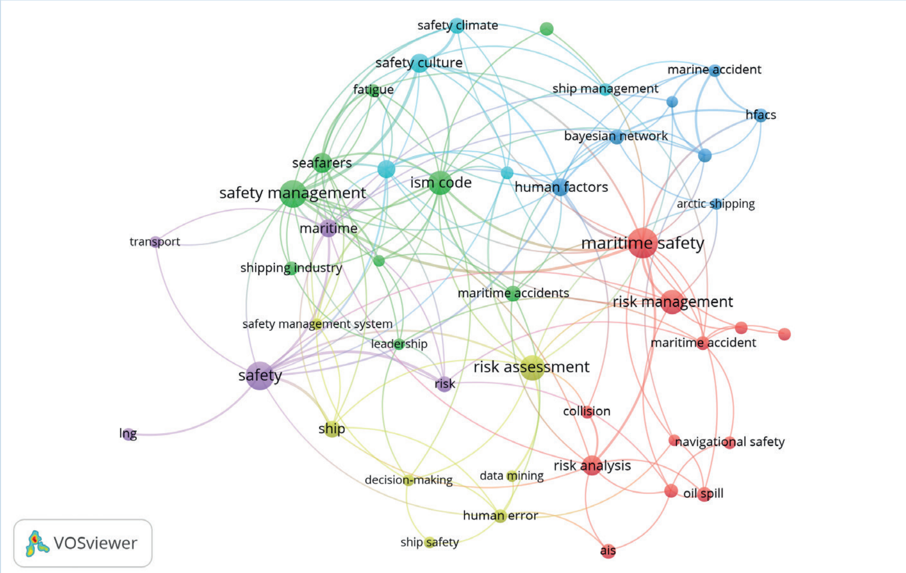

Figure 6. Network visualisation based on the keyword "author keyword". Source: Data processing result, compiled by author

on how to involve "humans" in the management process and their impact on "humans".

SYSTEMATIC LITERATURE REVIEW ANALYSIS

Apart from using bibliometric analysis for literature mapping, this study also used a systematic review to analyse research findings and what lessons can be taken for further development. This study assigned a ranking based on the number of citations to filter articles to be analysed more comprehensively, as shown in Table 9 [10–34].

Table 9 categorizes the articles into five categories: human factors, accident information systems, accident, risk analysis, and culture. Human factor and risk analysis are the categories with the highest number of articles. The human factor is crucial in building and improving safety management to prevent accidents. Although research on humans in the shipping industry has been carried out a lot, the researcher argues there are still things that can be developed in further research. Table 6 can also explain the importance of research on human factors, where 7 out of 10 widely cited publications are research on human factors in safety management performance. The existence of risk analysis manifests this condition to detect various factors, standards, strategies, and evaluation models to improve safety in ship transportation.

However, an interesting thing is shown in the culture category, where there is only 1 article with the highest number of citations. Based on keywords, the category "culture" is also not included in frequently used keywords. Based on Antonsen [34], it can be learned that the need for synchronisation between management and culture to improve safety on ships. Each country has its own culture in adjusting the implemented safety system. Researchers argue that the existence of this culture has the potential to become a reference for every country in improving safety management. Future research that analyses safety management in various countries with an emphasis on culture is important to study.

FURTHER DEVELOPMENT OF SAFETY MANAGEMENT IN INDONESIA

Research on safety management in Indonesia still needs to be more extensive. Indonesia is the second country with the longest coastline in the world, and 62% of Indonesia's area is oceans. Therefore, safety management research is a topic that is needed by the community. As an archipelagic country, Indonesia only has three documents discussing safety management in the shipping industry in the Scopus database. The number of publications needs to be increased, considering the facts in Indonesia. First, ships are a primary means of transportation that play a strategic role in connecting inter-island trade in growing the Indonesian economy. Second, in addition to economic interests, ships are one of the tools of national defence interests. Third, data from the National Transportation Safety Committee (2021) shows that during 2018–2021 there were 483 ship accidents or 120 accidents per year. The research results to become one of the input references for stakeholders, both the government and the shipping industry, in improving safety management in shipping. However, this condition is

Table 9. Systematic review for articles with the most citation

Category	Author	Finding	What can be learned
Human factor	Chauvin et al. [10]	Most crashes are caused by mistakes in decision making	The importance of bridge human resources for pilot navigation situations in confined waters
	Celik and Cebi [11]	This study builds the HFAS mechanism to identify human error factors in ship accidents	Human error is a contributing factor at various levels of the organization
	Hetherington et al. [12]	Accidents on ships caused by individual or organizational behaviour can be moderated and reduced to improve safety	The importance of proper management to address the various human factors that affect safety
	Harati-Mokhtari et al. [13]	The information in AIS is not fully valid because there is manual input which can result in inaccurate information being presented	The need for strict supervision of all information contained in AIS
	Akhtar and Utne [14]	The strongest fatigues associated with top management were ship certification, crew resources, and quality control	Fatigue is a major risk factor
	Martins and Maturana [16]	Methodology based on Bayesian network for analysing human factors on the risk of accidents by collision	The importance of methods to reduce the risk of ship accidents caused by human error
	Schröder et al. [20]	Ship traceability investigators will not examine organizational-sourced factors if the guidelines in the IMO are complied with	The importance of complying with applicable standards and guidelines
	Zhang et al. [21]	Origin-to-destination pairs and navigation routes in Singapore's port waters have remained stable over time	The importance of knowing the various factors that cause accidents that occur in all water conditions
	Lu and Yang [17]	Safety motivation and concern for safety positively influence safety behaviour	Improve safety in container terminal operations
AIS	Harati-Mokhtari et al. [13]	The information in AIS is not fully valid because there is manual input which can result in inaccurate information being presented	The need for strict supervision of all information contained in AIS
	Xiao et al. [15]	There are similarities and differences in the characteristics of AIS analysis in the Dutch Case and Chinese Case that affect ship traffic behaviour	This study only examines direct information, without indirect information on AIS
	Zhang et al. [21]	Origin-to-destination pairs and navigation routes in Singapore's port waters have remained stable over time	The importance of knowing the various factors that cause accidents that occur in all water conditions
	Kao et al. [22]	Precise prediction of collision time and position can be achieved using the GIS spatial analysis module	The importance of predicting the right information to avoid accidents
Accident	Hassel et al. [23]	50% of accidents go unreported	Users of ship accident statistics must apply certain standards to analyse inadequate reporting, as well as to produce appropriate analysis
	Lu and Tsai [24]	The dimensions of work safety have the most important influence on ship accidents	There are many factors to consider in safety management
	Kirby and Law [25]	Risk, impact and mitigation in accidents at sea	The importance of an impact assessment and monitoring program after an accident
	Psarros et al. [26]	There are incomplete reports of accidents	It is important to fully report accident data
	Akyuz [27]	Accident analysis model with HFACS with ANP integration	The importance of various models in accident analysis
	Hänninen [19]	Bayesian network is a fairly precise tool for maritime safety management and decision making	The importance of standards or models in safety management

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Table 9. (**cont.**) Systematic review for articles with the most citation

Category	Author	Finding	What can be learned
Risk analysis	Akhtar and Utne [14]	The strongest fatigues associated with top management were ship certification, crew resources, and quality control	Fatigue is a major risk factor
	Celik et al. [18]	Integration of FFTA into SAI to ensure database consistency for accident analysis and prevention efforts in the maritime industry	It is important to investigate the occurrence of accidents on ships as a precautionary measure
	Zhang et al. [21]	Origin-to-destination pairs and navigation routes in Singapore's port waters have remained stable over time	The importance of knowing the various factors that cause accidents that occur in all water conditions
	Goerlandt et al. [28]	Development of fundamental issues on the concept of risk in the Collision Alert System	The importance of analysing risks in the shipping industry
	Bonvicini and Spadoni [29]	New methodology for selecting the best route for transportation based on risk analysis	The importance of determining ship transportation traffic routes to prevent collisions
	Khan and Khan [30]	Building an object-oriented Bayesian network model for accident prevention in icy waters	The importance of developing a maritime traffic strategy especially in extreme climates
	Banda et al. [31]	Navigation in icy waters is more complex and is the type of navigation with the highest reported accidents	The importance of analysing risks especially in extreme climates
	Kirby and Law [25]	Risk, impact and mitigation in accidents at sea	The importance of an impact assessment and monitoring programme after an accident
	Cicek and Celik [32]	Adaptation of marine technology that is integrated with operational aspects to prevent ship explosion failures	The importance of innovation in improving machine system reliability and operational safety
	Lu and Yang [33]	The dimensions of work safety have the most important influence on ship accidents	It is important to improve the safety of ship operations
Culture	Antonsen [34]	A lot of friction between the cultural aspect and the structural aspect	Need synchronisation between management and culture to improve safety on ships

Source: Data processing result, compiled by author; AIS — Automatic Identification System; ANP — Analytical Network Process; HFACS — Human Factors Analysis and Classification System; FFTA — Fuzzy Extended Fault Tree Analysis; GIS — Geographic Information System; SAI — Shipping Accident Investigation; IMO — International Maritime Organization

a potential for researchers to develop research in the field of safety management in Indonesia. Based on the author's identification using advanced data from the Scopus database totalling 160 data with the keywords "ship" and "maritime" processed through the Vos Viewer, it was shown that Indonesian researchers are more interested in discussing "automatic identification systems (AIS)", "computation fluid dynamics", and "illegal fishing" rather than safety management. Activation of AIS on ships is also one of the safety standards in the Safety of Life at Sea (SOLAS) so that traffic in the ocean is not disturbed. AIS activation in Indonesia is essential because of the many cases of illegal ships entering Indonesian waters. However, safety management does not only cover AIS but also includes other factors such as human error [9–11]. Thus, the development of research in the field of safety management in Indonesia is important.

RESEARCH IMPLICATION

This research has theoretical and practical implications. Theoretically, using a bibliometric review, this study analyses the extent to which the literature on safety management and topics that researchers widely discuss include keywords that researchers often use. This mapping makes it easier for future researchers to fill the research gap. The results of this study indicate that there are several publications in the field of safety management. However, the number of publications is separate from the trend in the number of citations. Thus, researchers must focus on the published articles' quality and quantity.

In addition, this study also uses a systematic review method to provide recommendations for further research from the results of a systematic analysis of articles with the highest number of citations. The existence of an analysis related to the lessons taken from the article makes it easier for stakeholders, both government and practitioners in the shipping industry, to make decisions to improve the effectiveness of safety management, in the shipping industry, including the shipping industry in Indonesia. The proposals for the following research topic can be seen in Table 10.

Table 10. Proposed next research

No.	Theme	Research topic
1	Mapping	Analysis of systematic literature review of safety management topics using the Web of Science database
2	Experiment	Comparison of the cost and benefit of the shipping industry between those who implement safety management and those who do not
3	Behaviour	Factors causing low safety management
4	Human factor	Factors of human error and the potential for accidents
5	Accident	Accident prediction model
6	Risk analysis	Ship industry risk analysis model
7	Culture	The cultural differences of each shipping industry around the world
8	Management	Shipping Industry management model with benefit, opportunity, cost, and risk approach
9	Accounting	Cost accounting for safety management and its impact on the shipping industry

Source: Data processing result, compiled by author

CONCLUSIONS

This study used a bibliometric method to analyse the development of "safety management" in the shipping industry by reviewing articles published in Scopus-indexed journals. This study provided information related to the language used, the number of publications and citations each year, the trend of publications and citations, the country with the highest number of publications, the author with the highest number of publications, the journal with the highest number of publications, and frequently used keywords based on the "author keyword" and "index keywords".

Research on safety management has become an exciting topic, especially the developments in the shipping industry carried out by governments in various countries. Trend analysis shows an increase in the number of articles published annually, with 2021 being the year with the highest number of publications. However, this condition is inversely proportional to the number of citations, which shows a decreasing trend. China has the most significant number of publications with many collaborations. On the other hand, the analysis of co-authorship shows that only 24 out of 1,773 collaborated with other authors, while others were single authors. This condition shows the importance of collaboration between researchers in developing research. In addition, we conclude that human factors are the most important factor in increasing safety management in the shipping industry.

The novelty of this research lies in the broader use of safety management topics. In contrast, previous research has focused more on specific topics, namely maritime accidents and the level of technological readiness in preventing accidents on ships. In addition, to identify the most cited topics, this study uses a systematic literature review method to identify findings and lessons that stakeholders can draw. Based on the systematic review, further research can focus on each country's "culture" of safety management by analysing the relationship between culture and human factors and risk analysis. In developing research in Indonesia, this research emphasizes the importance of research on safety management, especially in human factors and risk analysis.

This study has limitations. First, this research only analyses data from the Scopus database with the type of "article" document and does not analyse the type of book, proceeding, and so on. Therefore, further research can develop research by multiplying the databases used, such as the Web of Sciences, Sinta Index, and other indexations, to increase the amount of data to be analysed. Second, this research also focuses on further development in Indonesia so that further research can use a bibliometric and systematic review by focusing on safety management in each country.

Conflict of interest: None declared

REFERENCES

1. Chen H, An M, Wang Q, et al. Military executives and corporate environmental information disclosure: Evidence from China. J Clean Prod. 2021; 278: 123404, doi: 10.1016/j.jclepro.2020.123404.
2. Erdağ R. Security environment and military spending of Turkey in the 2000s. Contemp Rev Middle East. 2020; 8(1): 120–139, doi: 10.1177/2347798920976294.
3. Panagiotidis P, Giannakis K, Angelopoulos N, et al. Shipping accidents dataset: data-driven directions for assessing accident's impact and improving safety onboard. Data. 2021; 6(12): 129, doi: 10.3390/data6120129.
4. Gil M, Wróbel K, Montewka J, et al. A bibliometric analysis and systematic review of shipboard Decision Support Systems for accident prevention. Safety Science. 2020; 128: 104717, doi: 10.1016/j.ssci.2020.104717.
5. Fu S, Goerlandt F, Xi Y. Arctic shipping risk management: A bibliometric analysis and a systematic review of risk influencing factors of navigational accidents. Safety Science. 2021; 139: 105254, doi: 10.1016/j.ssci.2021.105254.

6. Del Giudice M, Di Vaio A, Hassan R, et al. Digitalization and new technologies for sustainable business models at the ship–port interface: a bibliometric analysis. Marit Policy Manag. 2021; 49(3): 410–446, doi: 10.1080/03088839.2021.1903600.
7. Munim Z, Dushenko M, Jimenez V, et al. Big data and artificial intelligence in the maritime industry: a bibliometric review and future research directions. Marit Policy Manag. 2020; 47(5): 577–597, doi: 10.1080/03088839.2020.1788731.
8. Acheampong T, Akumperigya R. Offshore risk regulation: A comparative analysis of regulatory framework in Ghana, the United Kingdom and Norway. Energy Policy. 2018; 113: 701–710, doi: 10.1016/j.enpol.2017.10.009.
9. Stebbings E, Papathanasopoulou E, Hooper T, et al. The marine economy of the United Kingdom. Marine Policy. 2020; 116: 103905, doi: 10.1016/j.marpol.2020.103905.
10. Chauvin C, Lardjane S, Morel G, et al. Human and organisational factors in maritime accidents: analysis of collisions at sea using the HFACS. Accid Anal Prev. 2013; 59: 26–37, doi: 10.1016/j.aap.2013.05.006, indexed in Pubmed: 23764875.
11. Celik M, Cebi S. Analytical HFACS for investigating human errors in shipping accidents. Accid Anal Prev. 2009; 41(1): 66–75, doi: 10.1016/j.aap.2008.09.004, indexed in Pubmed: 19114139.
12. Hetherington C, Flin R, Mearns K. Safety in shipping: the human element. J Safety Res. 2006; 37(4): 401–411, doi: 10.1016/j.jsr.2006.04.007, indexed in Pubmed: 17046789.
13. Harati-Mokhtari A, Wall A, Brooks P, et al. Automatic identification system (AIS): data reliability and human error implications. J Navig. 2007; 60(3): 373–389, doi: 10.1017/s0373463307004298.
14. Akhtar M, Utne I. Human fatigue's effect on the risk of maritime groundings: A Bayesian Network modeling approach. Safety Science. 2014; 62: 427–440, doi: 10.1016/j.ssci.2013.10.002.
15. Xiao F, Ligteringen H, Gulijk Cv, et al. Comparison study on AIS data of ship traffic behavior. Ocean Engineering. 2015; 95: 84–93, doi: 10.1016/j.oceaneng.2014.11.020.
16. Martins M, Maturana M. Application of Bayesian Belief networks to the human reliability analysis of an oil tanker operation focusing on collision accidents. Reliab Eng Syst Saf. 2013; 110: 89–109, doi: 10.1016/j.ress.2012.09.008.
17. Lu CS, Yang CS. Safety leadership and safety behavior in container terminal operations. Safety Science. 2010; 48(2): 123–134, doi: 10.1016/j.ssci.2009.05.003.
18. Celik M, Lavasani S, Wang J. A risk-based modelling approach to enhance shipping accident investigation. Safety Science. 2010; 48(1): 18–27, doi: 10.1016/j.ssci.2009.04.007.
19. Hänninen M. Bayesian networks for maritime traffic accident prevention: benefits and challenges. Accid Anal Prev. 2014; 73: 305–312, doi: 10.1016/j.aap.2014.09.017, indexed in Pubmed: 25269098.
20. Schröder-Hinrichs JU, Baldauf M, Ghirxi KT. Accident investigation reporting deficiencies related to organizational factors in machinery space fires and explosions. Accid Anal Prev. 2011; 43(3): 1187–1196, doi: 10.1016/j.aap.2010.12.033, indexed in Pubmed: 21376918.
21. Zhang M, Zhang Di, Goerlandt F, et al. Use of HFACS and fault tree model for collision risk factors analysis of icebreaker assistance in ice-covered waters. Safety Science. 2019; 111: 128–143, doi: 10.1016/j.ssci.2018.07.002.
22. Kao SL, Lee KT, Chang KY, et al. A fuzzy logic method for collision avoidance in vessel traffic service. J Navig. 2006; 60(1): 17–31, doi: 10.1017/s0373463307003980.
23. Hassel M, Asbjørnslett BE, Hole LP. Underreporting of maritime accidents to vessel accident databases. Accid Anal Prev. 2011; 43(6): 2053–2063, doi: 10.1016/j.aap.2011.05.027, indexed in Pubmed: 21819835.
24. Lu CS, Tsai CL. The effect of safety climate on seafarers' safety behaviors in container shipping. Accid Anal Prev. 2010; 42(6): 1999–2006, doi: 10.1016/j.aap.2010.06.008, indexed in Pubmed: 20728654.
25. Kirby MF, Law RJ. Accidental spills at sea: risk, impact, mitigation and the need for co-ordinated post-incident monitoring. Mar Pollut Bull. 2010; 60(6): 797–803, doi: 10.1016/j.marpolbul.2010.03.015, indexed in Pubmed: 20381098.
26. Psarros G, Skjong R, Eide MS. Under-reporting of maritime accidents. Accid Anal Prev. 2010; 42(2): 619–625, doi: 10.1016/j.aap.2009.10.008, indexed in Pubmed: 20159087.
27. Akyuz E. A marine accident analysing model to evaluate potential operational causes in cargo ships. Safety Science. 2017; 92: 17–25, doi: 10.1016/j.ssci.2016.09.010.
28. Goerlandt F, Montewka J, Kuzmin V, et al. A risk-informed ship collision alert system: Framework and application. Safety Science. 2015; 77: 182–204, doi: 10.1016/j.ssci.2015.03.015.
29. Leonelli P, Bonvicini S, Spadoni G. Hazardous materials transportation: a risk-analysis-based routing methodology. J Hazard Mater. 2000; 71(1-3): 283–300, doi: 10.1016/s0304-3894(99)00084-9, indexed in Pubmed: 10677666.
30. Khan MA, Khan S. Inflation and the economic growth: evidence from five Asian countries. Pakistan J Appl Econ. 2018; 28(2): 235–252.
31. Valdez Banda OA, Goerlandt F, Montewka J, et al. A risk analysis of winter navigation in Finnish sea areas. Accid Anal Prev. 2015; 79: 100–116, doi: 10.1016/j.aap.2015.03.024, indexed in Pubmed: 25819212.
32. Cicek K, Celik M. Application of failure modes and effects analysis to main engine crankcase explosion failure on-board ship. Safety Science. 2013; 51(1): 6–10, doi: 10.1016/j.ssci.2012.06.003.
33. Lu CS, Yang CS. Safety climate and safety behavior in the passenger ferry context. Accid Anal Prev. 2011; 43(1): 329–341, doi: 10.1016/j.aap.2010.09.001, indexed in Pubmed: 21094331.
34. Antonsen S. The relationship between culture and safety on offshore supply vessels. Safety Science. 2009; 47(8): 1118–1128, doi: 10.1016/j.ssci.2008.12.006.

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VIA MEDICA

ORIGINAL ARTICLE

Scientific shallow saturation dive expedition using diving rebreathers and a specific dry habitat: medical management of the "Capsule" programme

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ABSTRACT

Background: *Scientific underwater exploration could benefit from professional diving facilities. This could allow marine research for durations far exceeding anything currently possible. The closed-circuit rebreather expansion provides new perspectives by unleashing divers and their diving bell. "Under the Pole Expeditions" developed an innovative compact underwater habitat for this purpose.*

Materials and methods: *The habitat's depth was fixed at 20 m. Saturation lasted 3 days and was followed by a 245 min long decompression procedure with mandatory in-water phase. Isolation and environmental constraints will require specific medical and safety procedures. "In situ" medical concerns were considered, and a specific evacuation plan was established. This report describes the medical management of this atypical project and the systematic clinical follow-up mostly targeted on the cardiovascular system, fatigue and psychological tolerance.*

Results: *Seventeen individual saturation exposures were performed. All selected divers were professional. Neither severe illness nor decompression sickness was observed. These short-term saturation exposures appeared to be well tolerated. There was a relatively low bubble grade after decompression. Psychological tolerance appeared good. However, a transient moderate orthostatic hypotension suggested cardiovascular deconditioning after dive.*

Conclusions: *This first experiment demonstrates the interest and feasibility of a shallow revisited saturation dive with rebreather use. This isolation requires medical accompaniment and rigorous preparation. Medical and physiological risks assessment is essential in this context and must be consolidated by new experiences.*

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Key words: risk management, diving at work, decompression tables, pressure chambers, helium, oxygen

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INTRODUCTION

In the second half of 20th century, we saw birth of undersea habitats and accordingly saturation diving expansion. The first 'serious' undersea habitats were conducted by Edwin Link and Jacques-Yves Cousteau in 1963 with the "Man in Sea" and "Precontinent I" programmes, respectively. Their projects have paved the way to deeper and longer undersea exploration. However, budgetary constraints have restricted the undersea habitat's democratisation.

In contrast, with bounce dives, staying at pressure for a long time will lead to saturation diving. Divers live in dry hyperbaric complex chambers. They work in water linked to their pressurised diving bell. Their whole body is saturated at equilibrium with partial pressure of inspired gases. The decompression time for a given depth is at a maximum and will not increase with additional time at depth. The objectives are to decrease physiological stresses and increase work efficiency index [1]. The French company COMEX^SA^, in collaboration with the French navy, has been a pioneer in the development of saturation diving. Their research topics were focused on different gas mixtures with current records in open seawater at 534 msw and in simulated dry chamber at 701 msw [2]. Currently, saturation diving is considered safe and effective. Responses to stressful conditions have been documented using various physiological, biochemical, and psychological measures [1]. The complexity and cost of these facilities restrict use for industrial purpose. Other fields, like marine biology, could benefit from these technological advances.

A French underwater exploration programme "Under the Pole Expeditions" combines scientific research, innovation and awareness to better knowledge and ocean preservation. This team carried out this original saturation project during its third expedition (2017–2021) in an ambitious marine biology coral-reef programme. They developed a small portable underwater "Capsule" to perform research for durations far exceeding anything currently possible. Divers will be able to live several days underwater and to move freely around with SCUBA gear while commercial divers are restricted by their umbilical.

This paper describes the "Capsule" programme with technical and diving procedural aspects followed by the medical management and perspectives.

MATERIALS AND METHODS

In preventive consideration and the need to early detected any adverse effect, a rigorous large clinical medical examination of each diver seemed imperative [3]. This was performed in accordance with usual clinical practices in diving medicine by the medical team. All divers were informed about the potential risks and discomforts associated with this programme and gave their consent prior to beginning. All medical data were collected and analysed to follow-up health status in accordance with the Helsinki Declaration [4].

TECHNICAL SPECIFICATIONS AND OPERATIONAL MANAGEMENT

The habitat needed to be simple, light, compact, safe and relatively autonomous. Under the Pole and its engineering office designed and made this "Capsule" and its specific electronic system (Fig. 1). It is about 5-times more confined than professional complexes. A Wi-Fi floating buoy was linked to the capsule. Direct video, audio transmission and monitoring data were sent continuously to an onshore control centre, which is located at 2.2 km. This programme took place in October 2019 in Moorea Island, French Polynesia. Ambient temperature inside the Capsule was 29 °C with hygrometry at 90%. Water temperature was 27 °C. Divers used JJ-CCR rebreathers DiveCAN® (JJ-CCR ApS, Presto, Denmark) for their excursion dives. In water, divers wore neoprene 5 mm wet suit with a hood.

Single decompression procedure after multiple excursions is the main interest in such a saturation programme. Under the Pole, in conjunction with decompression specialists, created specific diving procedures. The purpose was to achieve multi-day stay under pressure allowing for continuous marine life research. In operation, the 'Capsule' cannot be mobilised and there is no wet bell. Therefore, in-water decompression was mandatory. A 20 msw depth was determined with a maxi-

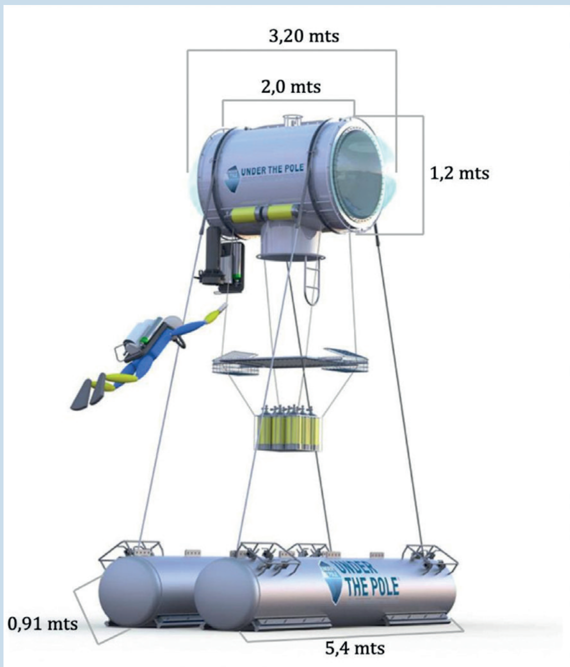

Figure 1. Technical drawing of the submarine habitat "Capsule" designed by Under the Pole Expeditions. The "Capsule" is a cylinder of 4.5 m^3 fitted with two domes and a below access lock. Continuous gas monitoring allows electronic fine adjustment of oxygen partial pressure. Metabolic production of carbon dioxide is removed by soda lime and other gaseous contaminants by activated charcoal

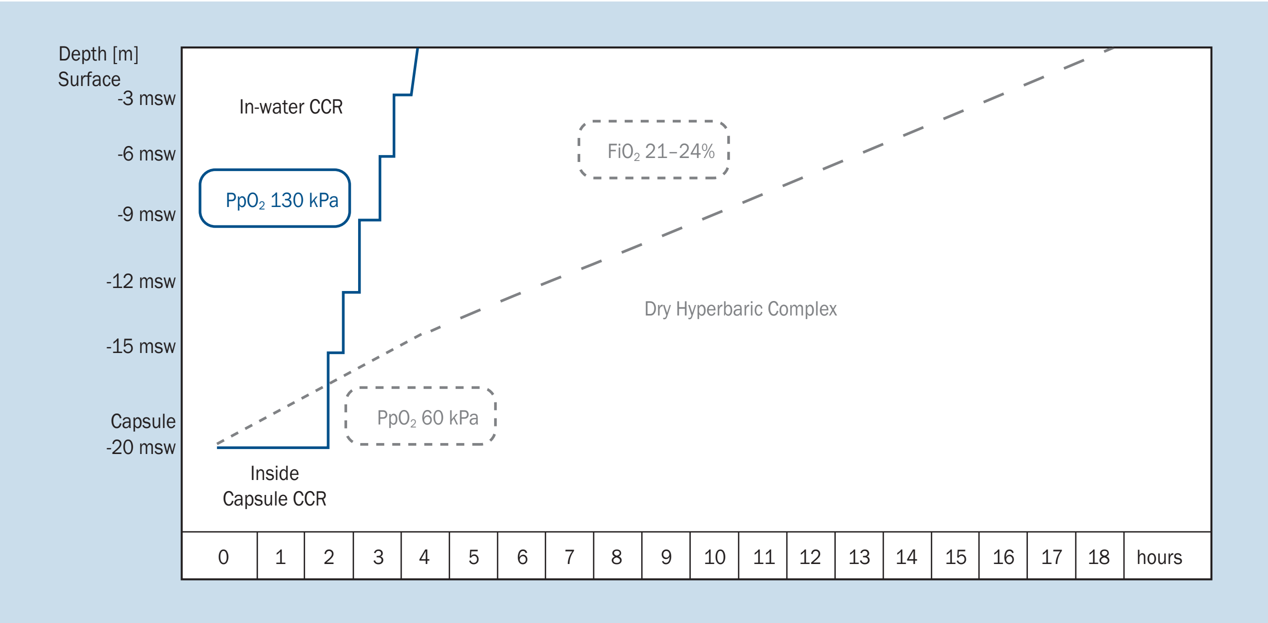

Figure 2. Final decompression procedure. It began by a 2-h pre-oxygenation in the "Capsule" followed by linear in-water decompression (solid blue line). The dotted grey line represents final decompression procedure for helium-oxygen saturation by table of French Ministry of Labour (1992); CCR — closed circuit rebreather

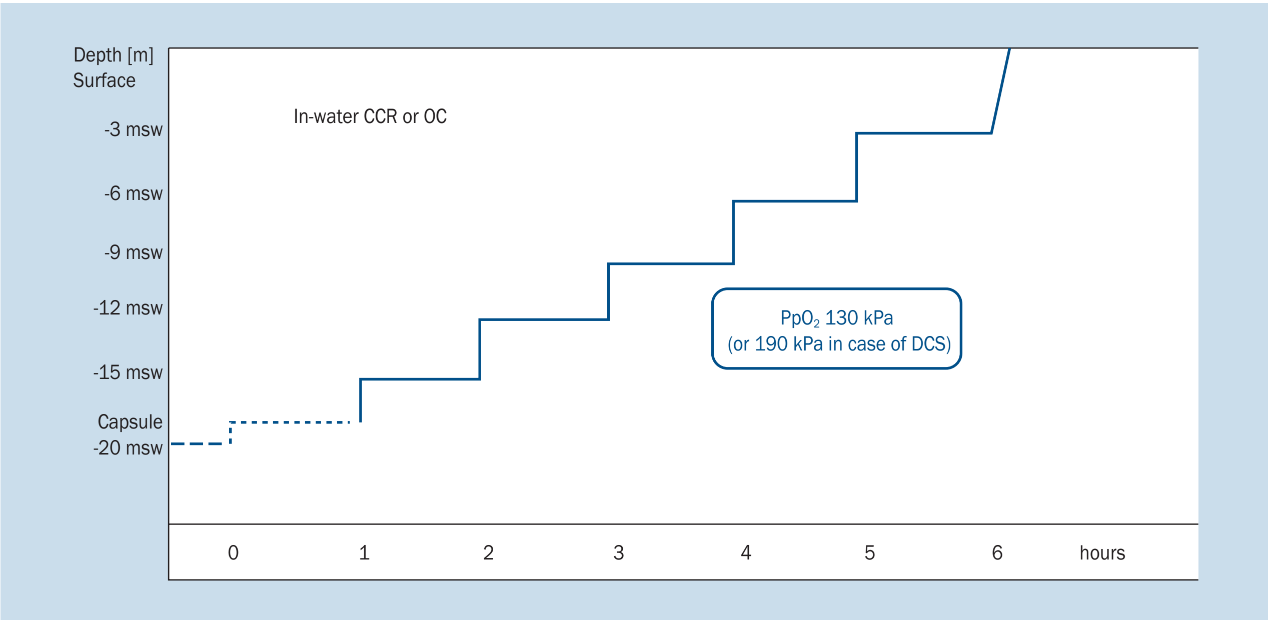

Figure 3. Final emergency decompression procedure. The solid line represents the final emergency decompression procedure. The dotted line represents an optional first one-hour stop at 18 msw in case of severe decompression sickness (DCS); CCR — closed circuit rebreather; OC — open circuit (safety tanks)

mum length of 3 days at depth. The breathing atmosphere was composed by a helium-oxygen gas mixture. The environmental PpO_2 was maintained at level of 40 kPa as it occurs in commercial diving [1]. Rebreather with usual setpoint at 130 kPa was used for excursion and decompression [5]. Excursion dives were allowed between 15 and 36 msw without decompression requirement to reach the habitat.

The "final decompression procedure" is shown in Figure 2. This decompression protocol was used during the whole saturation programme. It resulted in a total time decompression of 4 hours. If dry pre-oxygenation could not be done (e.g. major technical trouble, unbreathable atmosphere...), an "emergency procedure" provided a 5-hour in-water decompression in five one-hour stops (Fig. 3).

Each diver had a little scuba tank inside the capsule for an emergency evacuation. Three safety lines fitted open scuba cylinders with optimal gas mixture were located near the "Capsule". This allowed final decompression in case rebreathers were not useable.

MEDICAL AND SAFETY CONSIDERATIONS

A medical team was associated with this project for safety procedure management. In expedition medicine, prevention represents one of the keystones to minimise risk [3]. Nevertheless, risk reduction could not exclude all dangers and illnesses from arising. Access to definitive medical care involves prolonged evacuation over many hours due to mandatory decompression.

Barotrauma and decompression sickness (DCS) appear to be the most common bounce diving related injuries [6]. However, staying in closed, wet and helium hyperbaric environment for a long time would expose to inherent health problems, such as fluid balance and haemodynamic dysregulation, infectious risk, hypothermia, nutritional aspect or psychological intolerance [1]. Traumatic injuries or accidental toxic exposure also had to be envisaged. Specific risks with autonomous rebreathers may occur like biochemical accident or loss of saturated diver who does not reach the habitat [5, 7].

Diver selection

All divers were recruited by the expedition's leader. They were trained rebreather scientific deep-divers. None had experienced saturation dives before. None had chronic illness or took medication and they were medically fitted to dive.

Safety and medical management

For excursions, divers were accompanied by bounce divers and visibility was always clear which limits the risk of getting lost. Rebreathers were refurbished (gas and soda lime) and tested every day by the surface team. In dive, particular attention was paid to fluid intake with unrestricted access to drinking water. Moreover, fatigue and diet may have a significant impact in saturation tolerance [8, 9]. Rest periods were mandatory and three individual retractable bench seats were available. The caloric intake was increased. Divers could seek medical advice at any time.

At saturation, decompression is a compulsory phase resulting in poor health outcomes if not completed. Considering this, the medical team had to be able to manage any medical incidents inside the "Capsule" for the primary care and stabilisation before through-water evacuation. A first care pharmacy with usual oral drugs (analgesics, antiemetic, anti-vertigo, antiseptic, bandage...) was inside and could be used with medical advice. Furthermore, an intensivist and hyperbaric physician was in the safety divers' team. Various submersible medical kits and supplies were available, depending situation (intravenous access and fluid, second-line medications, urinary catheter or chest tube...). Due to limitations in acute care capabilities, we focused on the most likely and severe conditions [3].

Decompression sickness becomes a rare occurrence in saturation dives. However, acute muscular and joint pains or, less likely, vestibular manifestations have been shown [1, 10]. Depth at 20 msw allowed accessibility for logistics and rescue. If symptoms appeared, the "Capsule" would have been firstly used for hyperbaric oxygen therapy with rebreather (to reduce atmosphere contamination) to maintain manually PpO_2 near 280 kPa as in therapeutics with pure oxygen breathing. The therapeutic processes depending on circumstances of occurrence are available in Supplementary Appendix (see journal website). After a few hours of inside care and medical evaluation, in-water decompression is envisaged. This is based on an "emergency procedure" for 5-to-6-hour durations with an elevated PpO_2 of 190 kPa considering the therapeutic approach [11, 12]. Rebreather use with mouthpiece head-strap was preferred but open-circuits SCUBA with facial mask or regulators were available on the safety line.

For this atypical in-water primary care request and extended timeline, a specific emergency evacuation plan was provided upstream to local health authorities. Medical care facility including hyperbaric chamber was available less than 1 hour after surfacing with helicopter evacuation. All medical evacuation procedures were simulated and practised. Inside oxygen administration with rebreather was tested for several hours, without significant change in the composition of atmosphere. The "emergency decompression procedures" with a five-hour in-water decompression were also tested.

Methods for medical assessment

For the medical team, the purpose was to assess the health condition of divers during this specific programme. The medical assessment was performed prior to diving, 1 hour after surfacing and at 24 hours after surfacing. Based on the expected health implications, this thorough medical check-up mostly targeted the cardiovascular system, fatigue and psychological tolerance [1, 8, 13].

To ensure haemodynamic tolerance, non-invasive arterial blood pressure (ABP) and heart rate were measured at rest in supine position with multi-parametric monitor Datex-Ohmeda S/5 (GE Healthcare, Vélizy Villacoublay, France). To test orthostatic tolerance, heart rate and blood pressure were measured with divers in the supine position after 10 min rest and then upright at 5 and 15 min after rapid standing up. This test was performed for the last 8 expositions following a standing-up severe hypotension associated with syncope arising in one diver. Considering that body fluid balance can be evaluated by body mass loss, body weight was measured with an electronic balance [14].

To detect any sign of emotional distress, a self-reported mood survey was administered daily to each diver. The Positive and Negative Affect Schedule (PANAS) form was developed to provide brief measures of positive (PA) and negative affect (NA). A 5-point scale is used for scoring items and reveals the importance of each affect. Low level of NA indicates a state of calm and serenity, whereas high level of NA is a characteristic of anxiety [15]. Furthermore, medical interview allowed to report psychological or physical well-being or any other complaints. They were not quantified and will be anonymously summarised.

Divers could self-measure their decompression tolerance in bubble monitoring by a commercial connected ultrasonic sensor O'dive system (Azoth Systems, Ollioules, France) on bilateral subclavian vein at rest in the sitting position at 30, 50 and 100 min after surfacing [16]. Venous gas emboli (VGE) detected by this device are often quantified as a marker of decompression stress. VGE were graded from 0 to 4, according to Spencer scale and considering the peak value [17].

STATISTICAL ANALYSIS

Statistical analysis was performed with GraphPad Prism v9.0.2 (GraphPad Software Inc., San Diego, CA, USA). All data are presented as median (1st and 3rd quartile). Normality of distribution is assessed by Shapiro-Wilk test. ANOVA for repeated measures is used to analyse more than two related groups followed by multiple comparison Tukey's post-hoc test. Statistical significance was set at $p < 0.05$.

RESULTS

Eleven males and one female successfully completed saturation dives in groups of two or three divers. On average two excursions of 30 min each per day, with a maximum depth of 35 msw, were performed. Five divers did two stays with a minimal 15 days interval between each saturation. This represents 17 individual expositions. Table 1 presents demographic data.

There was no acute illness except in one diver who suffered headache after the first night linked with inadequate fluid intake. Favourable outcome was observed after hydration and oral analgesia allowing the continuation of the saturation dive.

None of the divers developed any symptoms of DCS during or after dives. After surfacing, all divers performed bubbles monitoring. The bubble grades did not exceed grade 2 except one diver who presented a transient grade 3 (Fig. 4).

Table 1. Demographic data of the participating divers (n = 11)

	Median [Q1;Q3]	Min–Max
Age [years]	37 [29–39]	26–61
Height [cm]	182 [176–86]	168–200
Weight [kg]	73 [67–77]	56–92
BMI [kg/m^2]	21.5 [20.9–24.8]	19.4–28.1

BMI — body mass index; Min–Max — minimum–maximum

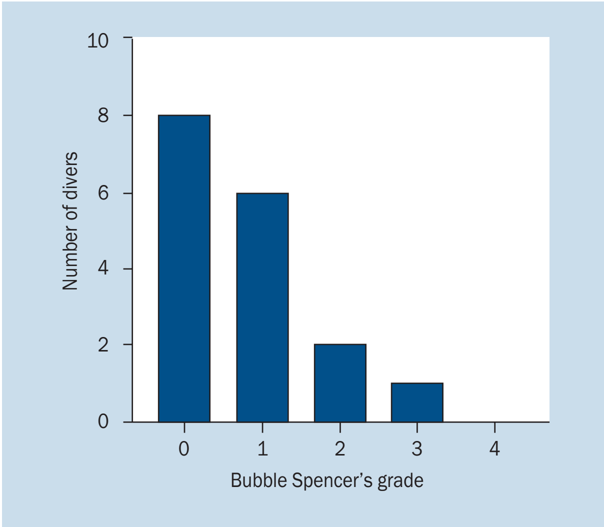

Figure 4. Maximal vascular gas emboli after surfacing according to Spencer's grades. Post dive bubble self-monitoring with peak value on bilateral subclavian vein (n = 17)

Systolic ABP showed a tendency to decrease after the dive which did not reach statistical significance (p = 0.05). No change was found in diastolic or mean ABP. Orthostatic tests showed a significant difference in systolic ABP (p = 0.03). In post hoc analyse, ABP measured at 5 min of upright position was lower than initial measurement with –9 [–7; –21] mmHg (Fig. 5). This orthostatic decreasing ABP was neither shown before dive nor at 24 h post-dive. A significant body mass loss with –1.4 [0.6; 2.3] % of total body weight was shown just after surfacing ($p < 0.0001$) with a baseline return at 24 h (p = 0.6) (Fig. 6).

The PANAS indicated no change in PA (p = 0.1) but a significant decrease in NA (p = 0.0001). From the second diving day, NA score was lower than baseline in post-hoc analyse and remained after surfacing (Fig. 7). Apart from one diver describing a brief migraine after his two stays, no other complaints were reported during medical review. Confined living space and workload caused a certain "self-reported" level of fatigue that divers considered compatible with their mission. There were no reports of sleep disorders or thermal discomfort except during the long in-water "emergency decompression procedures" test.

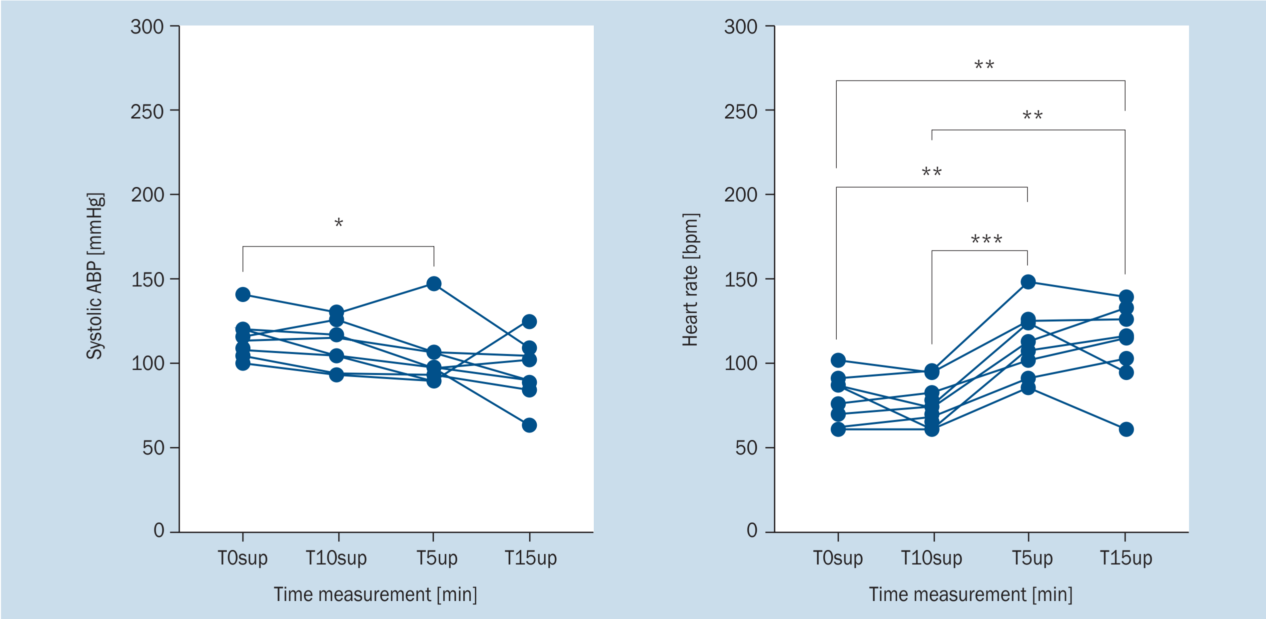

Figure 5. Variation of systolic arterial blood pressure (ABP) and heart rate in orthostatic test immediately after surfacing; Sup — at rest in supine position; Up — after standing up in upright position; *p < 0.05; **p < 0.01; ***p < 0.001

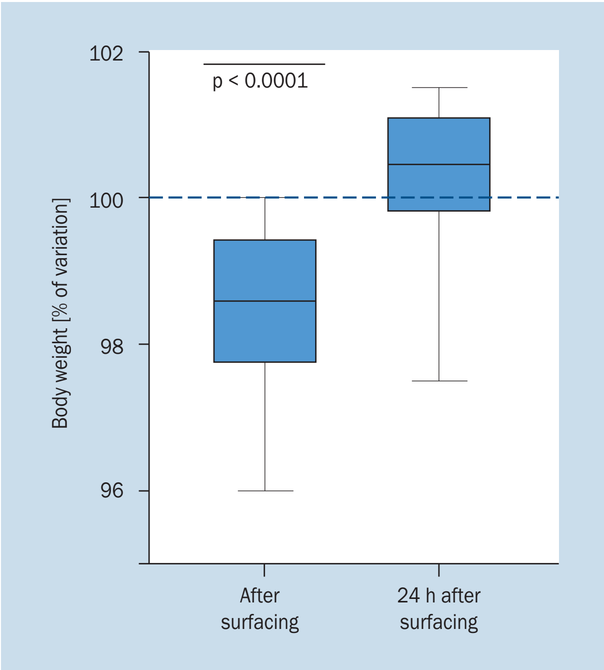

Figure 6. Percentage of body mass variation after surfacing. Variation of body mass is expressed in percentage versus predive measurement

DISCUSSION

This innovative scientific diving programme was successful. All marine biology projects were led without any major technical or medical incident during multi-day underwater stays. Fortunately, no evacuation from the capsule was necessary. From medical point of view, this first report shows the feasibility and relevance of this type of habitat, but we cannot conclude extensive outcomes to general population and other habitat's configuration (location, depths or dive time). Medical follow-up was reassuring without significant symptoms of poor tolerance.

Absence of any signs of DCS and the medical follow-up appear to show a good clinical tolerance of the decompression. All divers had a low bubble grade except one with grade 3 without clinical symptom. Although the physiopathological mechanisms of DCS are still debated, VGE and DCS occurrences are associated with positive correlation [18, 19]. Most studies indicate this correlation is also true in saturation diving but DCS cases not accompanied by VGE seems to be higher than for bounce diving [10]. The O'dive is a new self-measurement device. It allows a simple and fast testing procedure. It makes divers immediately aware of the potential consequences of decompression. However, considering that the correlation between this device and the VGE score in two-dimensional-echocardiography is not clear, we acknowledge that this system was not the preferred method to assess saturation stress [16, 20]. This would require additional precordial measures and a greater number of subjects to validate the "decompression procedures" used during this programme. Helium is usually used to dive deeper than 50 msw. It is more diffusible and had low solubility. The use of oxygen-helium mixture despite the shallow depth allowed a manoeuvrable decompression and faster than with nitrogen. The "decompression procedures" considered that speed rate is determined by the oxygen concentration [21]. However, oxygen may be toxic with acute neurological toxicity and long-term effects on lungs [22]. This model driven by oxygen appear effective as previously suggested by Kot

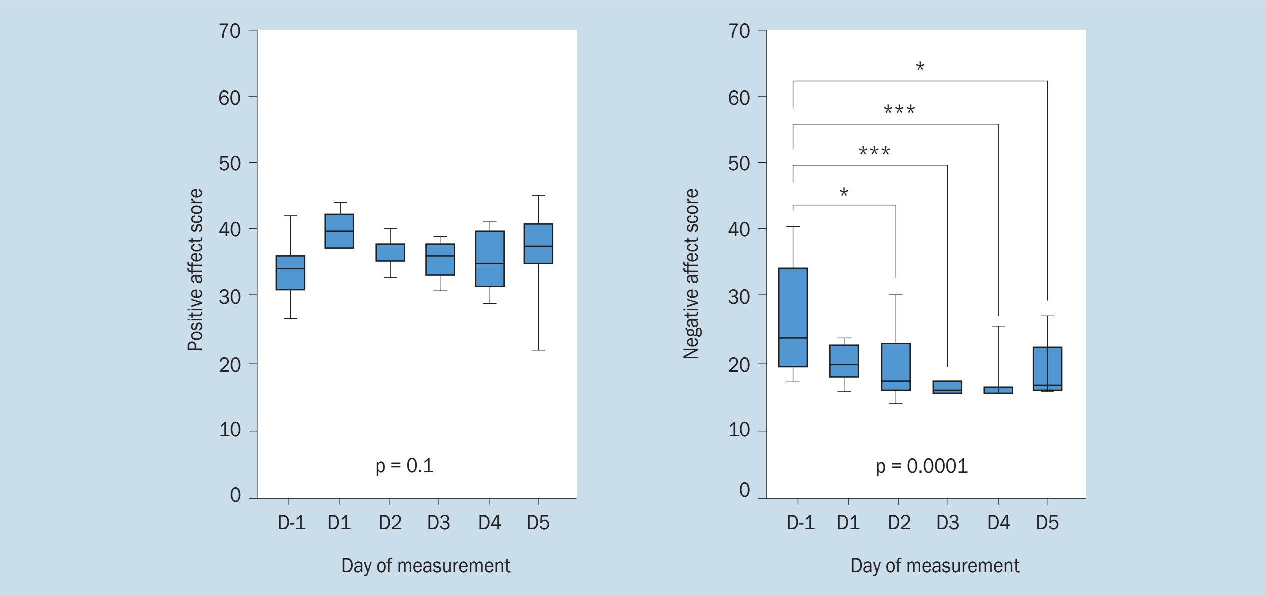

Figure 7. Positive and Negative Affect Schedule (PANAS) survey score during and after dive. D-1, D4 and D5 were performed at surface before and after dive. Measurements between D1 and D3 were performed during saturation dive; *p < 0.05; ***p < 0.001

et al. [23] in Nitrox saturation dives or Blatteau et al. [24] without VGE detection and non-significant spirometric alteration. Procedures were based on the COMEX database which allowed the development of regulatory procedures in professional diving in France and the REPEX oxygen toxicity threshold [22, 25]. However, the cumulative oxygen limits could be exceeded for deeper or prolonged dives with special consideration for pulmonary toxicity. In the therapeutic approach at 20 msw, pure oxygen breathing is close to what is used therapeutically with a low risk of hyperoxic seizure. Electro-galvanic oxygen sensor capacity is exceeded at this PpO_2 and manual oxygen adjustment without monitoring would be impractical for a deeper habitat.

Examination after the dives suggested cardiovascular deconditioning like it is described in microgravity. This cardiovascular deconditioning is demonstrated by haemodynamic changes and reduced exercise capacity [26]. Cardiovascular homeostasis involves autonomous nervous and neuro-endocrine systems. Orthostatic hypotension is defined as a reduction of systolic ABP > 20 mmHg or diastolic ABP > 10 mmHg after standing up [27]. Thus, after surfacing our divers had moderate delayed non neurogenic orthostatic hypotension with abnormal heart rate acceleration. The exposure in saturation dive at 46 and 37 ATA had already shown reduced plasma volume and evidence of this orthostatic intolerance [13]. Considering that dehydration plays a role in decompression stress, hydration was favoured to limit these effects [28]. The body mass loss just after surfacing suggests a moderate negative hydric balance. Divers lived in a very confined space without possibility to stand upright inducing a 'bed rest' effect [29]. The transient cardiovascular deconditioning in this shallow programme will be considered for prolonged or deeper mission.

Divers seemed enthusiastic about their experience according to PANAS psychometric testing, a widely used clinical measure [15]. Our results did not show any sign of anxiety during this short-confined exposition. All divers were selected and actively engaged in this programme. Conversely, many studies report a negative impact on emotional stability during long saturation dives and shift-work. Data show substantial increase in fatigue and hostility with an accompanying decline in perceived well-being [1]. A 7-day shallow nitrox saturation dive has shown reduction in total sleep time and efficiency. Authors suggest that these changes were related to long stays in a confined environment and not by environmental pressure [30]. Sleep disorders could also be a trigger of headaches reported by divers. These aspects will demand special attention for longer stays in this very confined habitat or if a wider non selected population have to stay (e.g. scientists or other professionals).

In this specific tropical environment, divers did not experience thermal discomfort except during the "emergency decompression" test. In case of DCS, prolonged in-water decompression would have required adequate thermal protection in dry-suits with a heating system which could be brought to the "Capsule". These data are reassuring but could not be transposed into more temperate waters in the absence of a specific protection system for divers and the habitat. Thermal protection would be an important challenge in another environment.

Finally, physiological short and long-term evaluations would be necessary to fully assess this new approach of diving procedures. The main limitation of our report is the small sample of selected professional and fit divers. The excursions carried out had very conservative and short duration. This could be explained by spontaneous limitation to stay in safe areas of procedures because that was the first saturation experience for divers.

CONCLUSIONS

This innovative habitat allows performing research for durations far exceeding anything currently possible. Under the Pole demonstrates the interest and feasibility of saturation dive methods using rebreather. Medical consideration is essential in this context of in-water interventions which does not allow an immediate return to the surface in case of emergency. That requires medical accompaniment and rigorous preparation. A medical plan with an ability to operate directly underwater must be absolutely considered because of the high level of isolation. Other saturation experiments with divers monitoring seem necessary to validate these procedures and the field of exploration offered by this new type of scientific dive concept.

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REFERENCES

1. Brubakk AO, Ross JAS, Thom SR. Saturation diving; physiology and pathophysiology. Compr Physiol. 2014; 4(3): 1229–1272, doi: 10.1002/cphy.c130048, indexed in Pubmed: 24944036.
2. Gardette B, Delauze HG. [Techniques of underwater intervention: means, methods, research and outlook]. Bull Acad Natl Med. 1996; 180(5): 975–983, indexed in Pubmed: 8963715.
3. Shaw MTM, Dallimore J. The medical preparation of expeditions: the role of the medical officer. Travel Med Infect Dis. 2005; 3(4): 213–223, doi: 10.1016/j.tmaid.2005.02.002, indexed in Pubmed: 17292040.
4. World Medical Association Declaration of Helsinki: Ethical Principles for Medical Research Involving Human Subjects. JAMA. 2013; 310(20): 2191, doi: 10.1001/jama.2013.281053.
5. Mitchell SJ, Doolette DJ. Recreational technical diving part 1: an introduction to technical diving methods and activities. Diving Hyperb Med. 2013; 43(2): 86–93, indexed in Pubmed: 23813462.
6. Monnot D, Michot T, Dugrenot E, et al. A survey of scuba diving-related injuries and outcomes among French recreational divers. Diving Hyperb Med. 2019; 49(2): 96–106, doi: 10.28920/dhm49.2.96-106, indexed in Pubmed: 31177515.
7. Gempp E, Louge P, Blatteau JE, et al. Descriptive epidemiology of 153 diving injuries with rebreathers among French military divers from 1979 to 2009. Mil Med. 2011; 176(4): 446–450, doi: 10.7205/milmed-d-10-00420, indexed in Pubmed: 21539168.
8. Imbert JP, Balestra C, Kiboub FZ, et al. Commercial divers' subjective evaluation of saturation. Front Psychol. 2019; 9: 2774, doi: 10.3389/fpsyg.2018.02774, indexed in Pubmed: 30692957.
9. Deb SK, Swinton PA, Dolan E. Nutritional considerations during prolonged exposure to a confined, hyperbaric, hyperoxic environment: recommendations for saturation divers. Extrem Physiol Med. 2016; 5: 1, doi: 10.1186/s13728-015-0042-9, indexed in Pubmed: 26744625.
10. Gardette B. Correlation between decompression sickness and circulating bubbles in 232 divers. Undersea Biomed Res. 1979; 6(1): 99–107, indexed in Pubmed: 462655.
11. Doolette DJ, Mitchell SJ. In-water recompression. Diving Hyperb Med. 2018; 48(2): 84–95, doi: 10.28920/dhm48.2.84-95, indexed in Pubmed: 29888380.
12. Blatteau JE, Pontier JM, Buzzacott P, et al. Prevention and treatment of decompression sickness using training and in-water recompression among fisherman divers in Vietnam. Inj Prev. 2016; 22(1): 25–32, doi: 10.1136/injuryprev-2014-041464, indexed in Pubmed: 25991710.
13. Claybaugh JR, Lin YC, Schafstall HG, et al. Cardiovascular and endocrine responses to 90 degree tilt during a 35-day saturation dive to 46 and 37 ATA. Aviat Space Environ Med. 2007; 78(11): 1042–1049, doi: 10.3357/asem.2014.2007, indexed in Pubmed: 18018436.
14. Castagna O, Desruelle AV, Blatteau JE, et al. Alterations in body fluid balance during fin swimming in 29 °C water in a population of special forces divers. Int J Sports Med. 2015; 36(14): 1125–1133, doi: 10.1055/s-0035-1555854, indexed in Pubmed: 26422054.
15. Crawford JR, Henry JD. The positive and negative affect schedule (PANAS): construct validity, measurement properties and normative data in a large non-clinical sample. Br J Clin Psychol. 2004; 43(Pt 3): 245–265, doi: 10.1348/0144665031752934, indexed in Pubmed: 15333231.
16. Balestra C, Guerrero F, Theunissen S, et al. Physiology of repeated mixed gas 100-m wreck dives using a closed-circuit rebreather: a field bubble study. Eur J Appl Physiol. 2022; 122(2): 515–522, doi: 10.1007/s00421-021-04856-5, indexed in Pubmed: 34839432.
17. Spencer MP. Decompression limits for compressed air determined by ultrasonically detected blood bubbles. J Appl Physiol. 1976; 40(2): 229–235, doi: 10.1152/jappl.1976.40.2.229, indexed in Pubmed: 1249001.
18. Sawatzky KD, Nishi RY. Assessment of inter-rater agreement on the grading of intravascular bubble signals. Undersea Biomed Res. 1991; 18(5-6): 373–396, indexed in Pubmed: 1746065.
19. Eftedal OS, Lydersen S, Brubakk AO. The relationship between venous gas bubbles and adverse effects of decompression after air dives. Undersea Hyperb Med. 2007; 34(2): 99–105, indexed in Pubmed: 17520861.
20. Karimpour K, Brenner RJ, Dong GZ, et al. Comparison of newer hand--held ultrasound devices for post-dive venous gas emboli quantifica-

tion to standard echocardiography. Front Physiol. 2022; 13: 907651, doi: 10.3389/fphys.2022.907651, indexed in Pubmed: 35755430.
21. Vann RD. Decompression from Saturation Dives. Report No.: Third Annual Canadian Ocean technology Congress. Toronto, Canada; 1984. p. 175–88. https://apps.dtic.mil/sti/citations/ADA151743 (Cited 2022 Jun 29).
22. Hamilton Jr, RW. Tolerating Oxygen Exposure. SPUMS J. 1997; 27: 43–47.
23. Kot J, Sicko Z, Doboszynski T. The extended oxygen window concept for programming saturation decompressions using air and nitrox. PLoS One. 2015; 10(6): e0130835, doi: 10.1371/journal.pone.0130835, indexed in Pubmed: 26111113.
24. Blatteau JE, Hugon J, Castagna O, et al. Submarine rescue decompression procedure from hyperbaric exposures up to 6 bar of absolute pressure in man: effects on bubble formation and pulmonary function. PLoS One. 2013; 8(7): e67681, doi: 10.1371/journal.pone.0067681, indexed in Pubmed: 23844058.
25. Gardette B, Plutarque M. COMEX, 50 Years of Research and Innovations. Club des anciens de COMEX. 2012; self-published edition.
26. Gallo C, Ridolfi L, Scarsoglio S. Cardiovascular deconditioning during long-term spaceflight through multiscale modeling. NPJ Microgravity. 2020; 6: 27, doi: 10.1038/s41526-020-00117-5, indexed in Pubmed: 33083524.
27. Joseph A, Wanono R, Flamant M, et al. Orthostatic hypotension: a review. Nephrol Ther. 2017; 13 (Suppl 1): S55–S67, doi: 10.1016/j.nephro.2017.01.003, indexed in Pubmed: 28577744.
28. Gempp E, Blatteau JE, Pontier JM, et al. Preventive effect of pre-dive hydration on bubble formation in divers. Br J Sports Med. 2009; 43(3): 224–228, doi: 10.1136/bjsm.2007.043240, indexed in Pubmed: 18308884.
29. Levine BD, Zuckerman JH, Pawelczyk JA. Cardiac atrophy after bed-rest deconditioning: a nonneural mechanism for orthostatic intolerance. Circulation. 1997; 96(2): 517–525, doi: 10.1161/01.cir.96.2.517, indexed in Pubmed: 9244220.
30. Nagashima H, Matsumoto K, Seo Y, et al. Sleep patterns during 30-m nitrox saturation dives and in a confined atmospheric environment. Psychiatry Clin Neurosci. 2002; 56(3): 267–268, doi: 10.1046/j.1440-1819.2002.01021.x, indexed in Pubmed: 12047589.

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Dispositional resilience predicts psychological adaptation of seafarers during and after maritime operations

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ABSTRACT

Background: *Seafarers, whether on cargo, fishery, or naval ships, may be exposed to unique and unusual psychological demands related to the often isolated, confined, and extreme environments associated with ocean-going vessels. This necessitates optimal psychological adaptation to maintain individual well-being during the mission and afterwards. This study set out to explore whether psychometric measures could predict psychological adaptation of seafarers, specifically navy sailors, during and after maritime operations. It used emotional regulation as marker of adaptation, and examined the role of psychometric measures of dispositional resilience and emotional regulation to predict psychological adaptation at subsequent time-points.*

Materials and methods: *A total of 168 sailors completed the Brief Sailor Resiliency Scale, Dispositional Resilience Scale 15, and Mental Toughness Questionnaire 18 prior to departing for sea, as well as the Brunel Mood Scale at 5 time points over a 12-month operational cycle.*

Results: *Higher resilience scores were consistently associated with more adaptive emotional regulation. Multiple linear regressions indicated that the Brief Sailor Resiliency Scale predicted emotional regulation over the shorter term, while the Mental Toughness Questionnaire 18 predicted emotional regulation over the longer term. Further, mid-mission emotional regulation also predicted emotional regulation at the end of deployments.*

Conclusions: *The findings support several practical applications. Firstly, formal organizational initiatives to promote resilience could be useful to enhance adaptation during and after missions. Secondly, measuring seafarers' dispositional resilience could allow the streaming of vulnerable individuals towards appropriate mental health support services. Thirdly, past indicators of adaptation could be useful to enhance decision-making regarding subsequent utilisation. This may be applicable to seafarers in both naval services and commercial shipping, and to personnel in remote weather stations or other isolated and inaccessible research facilities.*

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Key words: dispositional resilience, emotional regulation, isolated, confined, and extreme environments, MTQ-18, navy deployments, psychological adaptation, seafarers

INTRODUCTION

Maritime operations can be demanding, and maintaining optimal psychological adaptation is necessary for both the success of the mission and the well-being of individual seafarers during the mission and afterwards. This study set out to explore whether dispositional resilience — measured

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through various scales — could predict psychological adaptation of seafarers, specifically navy sailors, during and after maritime operations.

It has previously been suggested that personal disposition may influence the psychological adaptation of individuals working in unusual environments. For example, specific personality configurations have been shown to support the adjustment of individuals in so-called isolated, confined, and extreme (ICE) environments [1, 2], and recent research suggested that a brief dispositional resiliency scale could predict adjustment during naval deployments [3].

DISPOSITIONAL RESILIENCE IN MILITARY AND ICE ENVIRONMENTS

Isolated, confined, and extreme environments refer to settings that are characterised by isolation and confinement, often due to hostile external conditions, and are associated with a range of context-specific physical, mental, and social stressors [4].

Dispositional resilience refers to that personal quality that allows people to overcome hardships and even thrive in the face of it [5, 6]. It is usually considered an internal trait, which allows an individual to constructively work though life's adversities, and is further considered a predictor of adaptation to stress/trauma, as well as mental health [7, 8]. Such resilience constructs, which includes for example hardiness, mental toughness, and sense of coherence, are thought of as dispositional, in that they are approaches or orientations towards life that individuals develop over time.

Hardiness is a psychological orientation associated with people who remain healthy and continue to perform well in a range of stressful conditions [9, 10]. Hardiness is a psychological construct with three facets, namely commitment, control, and challenge [11]. Hardiness has been shown to influence outcomes among soldiers in training, combat duty and peacekeeping, across various national contexts [12–16]. There is evidence that hardier soldiers are less likely to develop posttraumatic stress disorder and other mental health conditions after exposure to combat [13, 17–20] and may adapt better both during and after operational deployments [21].

Mental toughness is a psychological orientation particularly associated with perseverance [22, 23]. It is partially derived from the theoretical foundations of hardiness, with a fourth facet included, namely confidence [24]. Mental toughness is associated with both mental health and coping strategies [25–30], as well as performance in military contexts [31–33]. Mental toughness has recently been associated with good adaptation during military diving and submarine operations [34].

PSYCHOLOGICAL ADAPTATION

Psychological adaptation generally refers to "an individual's ability to adjust to changes in their environment, to optimise personal functioning" (The technical definition refers to the "ongoing process, anchored in the emotions and intellect, by which humans sustain a balance in their mental and emotional states of being and in their interactions with their social and cultural environments". Miller-Keane Encyclopaedia and Dictionary of Medicine, Nursing, and Allied Health, 7th ed. Saunders, Elsevier, Inc. 2003). Within the so-called ICE environments (including naval ships at sea), three broad domain markers are often used to indicate adaptation, namely quality of work output, quality of interpersonal interaction, and emotional regulation [1, 35–37].

Emotional regulation (ER) refers to a "set of automatic and controlled processes involved in the initiation, maintenance, and modification (i.e., 'regulation') of the occurrence, intensity, and duration of feeling states" [38–41]. Emotional regulation underpins personal performance across many aspects of daily life, including family, work, and sport [39]. As such it can be used to operationalise psychological adaptation [4], in that individuals with more adaptive ER would be expected to effectively manage their personal performance across work output, social interactions, and affective states, especially under the psychologically rigorous demands found in ICE environments. In contrast, individuals with less adaptive ER could be expected to have difficulty managing their personal performance across these three indicators.

One way of describing ER would be through using Brunel Mood State Scale profiles (BRUMS; described in detail later). The BRUMS is sensitive to changes in affective states and could indicate compromised emotional regulation. Scale profiles and/or changes in specific contexts may therefore reflect either good or poor psychological adjustment to that context [4]. Psychological adaptation in ICE environments can be predicted by a number of situational factors [2, 42], which raises the question of the extent to which dispositional factors [1] may also influence this.

PSYCHOLOGICAL DEMANDS ON OCEAN GOING SEAFARERS

Ocean going vessels (e.g., cargo, fishery, military) may be examples of ICE environments: Once at sea, crewmembers may be isolated from the outside world, for example through limited communication with home for prolonged periods of time. They face confinement inside the hull or superstructure, particularly in ships with citadel designs, where they have to contend with the overlap of workspace and living quarters, and the associated social stress of high-density

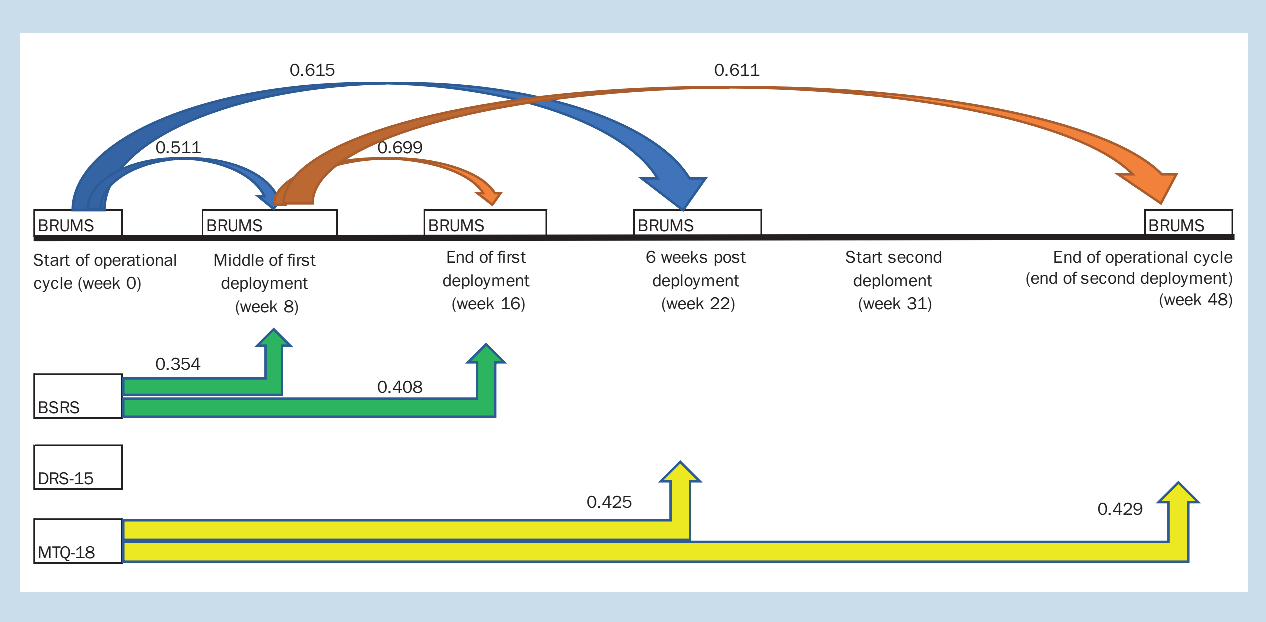

Figure 1. Significant beta coefficients predicting psychological adaptation across the deployment cycle. Numbers refer to standardised beta values; BRUMS — Brunel Mood Scale; BSRS — Brief Sailor Resiliency Scale; DRS-15 — Dispositional Resilience Scale 15; MTQ-18 — Mental Toughness Questionnaire 18

living spaces, lack of privacy, and social monotony (i.e., confinement with the same set of individuals for an extended period). They also have to endure the effects of extreme weather conditions (e.g., during rough seas) on their personal wellbeing and ability to maintain task performance. In this regard there has been a remarkable consistency in the reported psychological demands and stress across seagoing contexts [43–49]. Additionally, naval ships, and their crews, are exposed to often unique, and at times dangerous, operational demands, also deploy for extended periods of time, and face a high risk for adverse experiences associated with the operational nature of their mission (e.g., injuries during maritime interdiction operations). All of this reflects both specific demands on ocean going vessels as ICE environments, as well as the requirement to adapt effectively to this environment in order to maintain quality work output and complete the mission.

AIMS AND OBJECTIVES

As discussed earlier, psychological adaptation in ICE environments is often conceptualised across three domains, namely work-ability, sociability, and emotional regulation. This paper focuses on one indicator of psychological adaptation, namely ER. This study's primary aim was to explore the role of dispositional resilience scales in predicting ER at four different time points during and after naval deployments. This secondary aim was to explore the utility of any time-point measure of ER to predict ER at subsequent time-points during and after operational deployments.

MATERIALS AND METHODS

OVERVIEW OF STUDY

South African Navy (SAN) sailors completed psychological measures at five different time-points during a 12-month cycle of operational deployments. Figure 1 offers a graphic representation. This was done as part of the SAN occupational health surveillance programme administered by the Institute for Maritime Medicine in Simon's Town, South Africa. File data were available for sailors on a naval vessel that completed two 4-month deployments over their 12-month deployment cycle, and was accessed for this study by means of a retrospective file review. The study was conducted according the principles set out in the Declaration of Helsinki (2013), and Institutional Review Board approval was obtained for the use of psychological data.

PARTICIPANTS

A total of 168 sailors consented to their information being included in this study. The sample had a mean age of 31.3 years (standard deviation [SD]: 6.4, range 21–59), and 22.9% were women. Occupational specialities are presented in Table 1; categories comprising less than 2% of the total sample were collapsed into an 'Other' category. The sample reflected the general population of sea-going SAN personnel. Not all sailors completed all the measures at each administration, and cases were included if more than one dispositional and one ER measure were completed.

Table 1. Descriptive data for the sample and dispositional scales

Mustering	Per cent	Scale	N	Mean	SD	Range	α
Admin	7.0	BSRS	160	39.07	6.2	26–54	0.857
Catering	7.9	DRS-15	168	34.49	5.5	18–45	0.738
Combat officers	14.9	MTQ-18	168	68.96	8.2	45–90	0.774
Communications	5.3	BRUMS (week 0)	137	–8.85	6.0	–16, 14	
Engineering/technical	22.3	BRUMS (week 8)	100	–5.75	9.7	–16, 50	
Weapons operators	10.5	BRUMS (week 16)	112	–5.62	8.1	–16, 25	
Radar operators	3.0	BRUSM (week 22)	71	–8.93	7.2	–16, 24	
Other	15.0	BRUMS (week 48)	168	–3.43	10.0	–16, 31	0.799

BRUMS — Brunel Mood State Scale; BSRS — Brief Sailor Resiliency Scale; DRS-15 — Dispositional Resilience Scale 15; MTQ-18 — Mental Toughness Questionnaire 18; SD — standard deviation

MEASURES AND VARIABLES

Socio-demographic data (namely age, gender, naval speciality) was available, and used to describe the sample profile.

Emotional regulation was measured at five time points, namely immediately prior to the first deployment (week 0), mid-way through the first deployment (week 8), at the end of the first deployment (week 16), and 6 weeks after returning from the first deployment (week 22). A further measurement was done at the end of the second deployment (week 48).

Emotional regulation was measured using the Brunel Mood State Scale (BRUMS). The BRUMS is a 24-item self-report inventory that measures six transient affective mood states [50]. It has been used extensively, and a substantial body of literature exists on its use in many domains — from sport performance [51] to sleeping patterns [52] to academic achievement [53], as well as a marker of mental health [54]. Pertinent to naval seafarers, the BRUMS has reportedly been able to predict post-traumatic stress symptoms after maritime interdiction operations [55]. Good concurrent and criterion validity has been reported [50]. A total mood state score (range: 16 to 80) can be calculated and was used for this study. While lower total scores typically represent more adaptive ER, certain score profiles, and/or large changes in scores, could be indicative of risk for poor psychological adaptation. The BRUMS total score reflects the outcome of ER (not the process of ER), and as such was used here as indicator of psychological adaptation.

The dispositional variables were measured by three instruments, who all purport to assess aspects of personal resilience. By definition they were assumed to be stable constructs that would not change substantially over the period of about 12 months. For all three instruments, higher scores represent greater psychological resilience. All dispositional data was collected immediately prior to the start of the first deployment.

The Brief Sailor Resiliency Scale (BSRS) has been validated previously in South African military settings [3, 56], and measures dispositional resiliency across four domains, namely mental, physical, social, and spiritual. A comprehensive sailor resiliency score can also be calculated, ranging from 0 to 60, and which was used in the analysis below. A Cronbach alpha of 0.86 was calculated for the current sample.

The Dispositional Resilience Scale 15 (DRS-15) [57], has been extensively used to measure hardiness in military and non-military samples [21]. Good psychometric properties and criterion-related validity across multiple international samples have been reported [13, 58–61]. A previous South African study found acceptable internal reliability, but could not replicate the original factor structure [62]. Scores range from 0 to 45, with a Cronbach alpha of 0.74 calculated for the current sample.

Mental toughness is an extension of the hardiness construct, and is aggregated over six dimensions [24]. The Mental Toughness Questionnaire 18 (MTQ-18) provides an overall score for mental toughness [24]. A previous South African study found high internal reliability [62]. Scores range from 18 to 90, with a Cronbach alpha of 0.77 calculated for the current sample.

DATA MANAGEMENT AND STATISTICAL ANALYSES

The scales were administered in their standard format, and the respective total scores were calculated according to standard procedures. Only total scale scores were used in this study. The data were first analysed using Pearson's correlation coefficients, with significance set at $p < 0.05$. The association of dispositional factors and time-point ER measures were explored through calculating correlation coefficients for the BSRS, DRS-15, MTQ-18 and five BRUMS administrations.

Thereafter multiple linear regressions were conducted for each outcome variable, namely ER at 8, 16, 22,

Table 2. Correlations between dispositional resilience scales and psychological adaptation at five time points

Psychological adaptation	Scale	N	r	P
BRUMS (week 0)	BSRS	136	–0.391	< 0.001**
	DRS-15	87	–0.256	0.017*
	MTQ-18	87	–0.273	0.010*
BRUMS (week 8)	BSRS	94	–0.356	< 0.001**
	DRS-15	62	–0.167	0.196
	MTQ-18	62	–0.274	0.031*
	ER (week 0)	81	0.511	< 0.001**
BRUMS (week 16)	BSRS	101	–0.250	0.012*
	DRS-15	71	–0.305	0.010*
	MTQ-18	71	–0.297	0.012*
	ER (week 0)	86	0.385	< 0.001**
	ER (week 8)	87	0.641	< 0.001**
BRUMS (week 22)	BSRS	66	–0.287	0.019*
	DRS-15	54	–0.414	0.002**
	MTQ-18	54	–0.403	0.003**
	ER (week 0)	54	0.488	< 0.001**
	ER (week 8)	53	0.382	0.005**
	ER (week 16)	59	0.289	0.026*
BRUMS (week 48)	BSRS	106	–0.129	0.186
	DRS-15	168	–0.322	< 0.001**
	MTQ-18	168	–0.389	< 0.001**
	ER (week 0)	87	0.279	0.009**
	ER (week 8)	62	0.391	0.002**
	ER (week 16)	71	0.432	< 0.001**
	ER (week 22)	54	0.374	0.005**

*p < 0.05, **p < 0.01; BRUMS — Brunel Mood State Scale; BSRS — Brief Sailor Resiliency Scale; DRS-15 — Dispositional Resilience Scale 15; ER – emotional regulation; MTQ-18 — Mental Toughness Questionnaire 18

and 48 weeks. The role of dispositional factors in predicting ER was examined through entering BSRS, DRS-15, and MTQ-18 scores as predictors for each of the four ER time points. Similarly, the utility of using earlier time-point measures of ER to predict ER at subsequent time points during and after deployment was examined through entering all BRUMS scores from earlier time-points as predictors for each of the four outcome variables. All statistical analyses were conducted using SPSS-27.

RESULTS

Descriptive data for the dispositional scales can be found in Table 1. Mean scores, as well as Cronbach alphas, closely followed available normative data for local samples.

The correlations between the three dispositional scales and ER measured at five time points are presented in Table 2. Of the measures, the DRS-15 and BSRS were significantly correlated to ER at three time points, and the MTQ-18 at all five time points. Higher scores on these measures of dispositional resilience were associated with more adaptive ER. Further, each time-point measure of ER was significantly correlated to ER at each subsequent time point during and after the deployments.

Multiple linear regression analyses were performed to assess the ability of dispositional resilience measures, as well as earlier measurements of ER, to predict ER at the four subsequent time points. The predictor variables were entered stepwise, backward, and forward, and the results were the same across the three methods. The results are shown in Table 3 and graphically represented in Figure 1.

Pre-deployment ER scores predicted ER during mid-mission (week 8) and during the maintenance cycle (week 22), while mid-mission ER (week 8) predicted ER at end of 1st and 2nd deployments (weeks 16 and 48). The BSRS

Table 3. Results for linear regression analysis for four time-point measures of emotional regulation

Outcome	Adjusted R^2	ANOVA	Predictor	Standardised β	P
Week 48	34.5%	F = 13.310	BRUMS week 8	0.611	0.002
			MTQ-18	0.429	< 0.001
Week 22	35.9%	F = 20.079	BRUMS week 0	0.615	< 0.001
			MTQ-18	0.425	0.002
Week 16	45.5%	F = 57.461	BRUMS week 8	0.679	< 0.001
			BSRS	0.408	0.001
Week 8	25.2%	F = 27.901	BRUMS week 0	0.511	< 0.001
			BSRS	0.354	0.006

BRUMS — Brunel Mood State Scale; BSRS — Brief Sailor Resiliency Scale; MTQ-18 — Mental Toughness Questionnaire 18

predicted ER over the shorter term (8 to 16 weeks), while the MTQ-18 predicted ER over the longer term (22 to 48 weeks). The DRS-15 did not meaningfully add to any predictive model.

DISCUSSION

This study aimed, firstly, to explore the role of dispositional resilience scales in predicting ER during and after naval deployments, and some of the measures did appear useful in predicting ER across time. The study aimed, secondly, to explore the utility of earlier measurements of ER to predict ER at subsequent time-points, and again some of the ER time-point measurements appeared useful in predicting subsequent ER in the same context.

PREDICTION OF EMOTIONAL REGULATION

Two of the dispositional resilience scales showed promise in predicting ER during and after naval deployments, with the BSRS predicting adaptation over the shorter term, and the MTQ-18 predicting adaptation over the longer term. The BSRS has previously been associated with adjustment during short-duration maritime deployments [3]. However, its failure to predict longer term ER scores in the present study may suggest a temporal limit on the utility of such measures. The BSRS was first administered about 11 months before the final ER measure, and the passing of time may have resulted in the original BSRS score no longer reflecting sailors' current life situation. Once-off measurements of psychological characteristics may have a limited 'shelf-life', and for it to be used to dynamically predict performance in ICE environments (or elsewhere) may require repeated measurements across longer periods of time.

In contrast to the BSRS, the MTQ-18 scores offered strong predictions over longer time periods, and the consistency of the MTQ-18's correlations with ER across all time points mark it as a useful scale to explore in future research. Mental toughness has been associated with behavioural perseverance [22, 23], also in military contexts [31–33], as well as with greater emotional stability during stressful events [63]. Such a personal strength would therefore be a benefit in ICE environments when adverse conditions are encountered, as it would facilitate an individual's ability to handle pressure and remain focussed in stressful situations [64], which would in turn be visible in the maintenance of adaptive emotional regulation. Additionally, mental toughness has also been associated with more problem-solving coping and less avoidant coping [27, 30], which may be considered as generally desirable approaches in ICE environments.

The failure of DRS-15 to predict ER — despite previously being associated with adaptation during and after military operations [21] — may point to poor scale validity in the South African context, consistent with what was previously reported [62]. Of practical relevance, the maritime industry includes people from all races and cultures, and caution would be necessary when using internationally available scales that have not yet been validated for local cultural-linguistic groups. Psychological measures are only suitable for use if context-appropriate validation has been confirmed.

In spite of significant correlations, not all time-point measurements of ER predicted subsequent ER scores in this ICE context. Of particular interest was the observation that mid-mission scores predicted end-of-mission scores (for both deployments), suggesting that measurements representing similar contexts of situational adaptation (i.e., while immersed in ICE environment) may be particularly useful in predicting subsequent adaptation. The theory of behavioural consistency posits that past behaviour is the best predictor of future behaviour [65–67]. The consistency of the ER scores across time emphasises the value of considering past adaptation when making decisions on future utilisation of personnel, particularly where circumstances are comparable. This may be particular pertinent in the context of maintaining a high operational tempo through repeated deployments.

PRACTICAL APPLICATION

The application of these findings may be three-fold. Firstly, if it is possible to predict psychological adaptation, then it is also possible to promote psychological adaptation. If better resilience predicts better psychological adaptation, then enhancing resilience as a formal objective of military preparation needs to be emphasised. This can be done through facilitating formal developmental experiences (military training courses; graded exposure to operational demands), and/or through specific deployment preparation programmes for ships' companies.

Secondly, if better resilience predicts better psychological adaptation, there may be value in measuring resilience, with the aim of identifying potentially vulnerable individuals, in order to stream them towards support services (e.g., social work services, chaplaincy) that could assist them in developing greater resilience for subsequent deployments. In this regard the BSRS was reportedly sensitive to the development of resiliency through either specific life experiences or formal interventions [3], and may remain useful to guide the development of resilience in preparation of shorter-term missions.

Thirdly, if psychological adaptation during and after deployments can be predicted by previous measures of psychological adaptation in similar contexts, then the inclusion of available measures of psychological adaptation in any decision-making processes for subsequent deployments needs to be emphasised. However, for this to be practically useful, more inclusive measures of psychological adaptation may need to be developed, to more closely reflect the components of the original Antarctic Triarchy, in particular, measures of work-ability and sociability.

The above initiatives, namely 1) formal organisational intervention to promote resilience, 2) screening to identify the need for further individual intervention to develop resilience, and 3) using existing data on adaptation to guide future utilisation — could possibly be implemented not only in the naval context, but in other ICE environments too, from commercial shipping (whether cargo or fisheries), remote weather stations or polar outposts, to other isolated and inaccessible research facilities.

LIMITATIONS AND FUTURE DIRECTIONS

This study used a small sample in a very specific setting. The findings may thus be context bound, and possibly only applicable to psychological adaptation in similar or at least comparable settings. Further research is required to replicate the findings in the expanded settings of other ICE environments, for example commercial ocean-going vessels or remote weather or research outposts. As psychological demands across ICE environments appear remarkable consistent, the need for a resilient disposition to maintain and enhance psychological adaptation might be considered similar across industries. Additional research will be required to determine the effects of different situational factors, such as varying lengths of tours of duty, or environmental demands, or workload, on the role of resilience.

Further, all the significant predictors only explained a relatively small proportion of variance (see low Adjusted R^2 in Table 3). ER offers a single representation of psychological adaptation, and as mentioned, a wider range of markers would be necessary to confirm the principle that dispositional resilience truly predicts psychological adaptation — across quality of work output, interpersonal interaction, and emotional regulation — in ICE contexts. It would remain important to ensure that participants are exposed to the same or at least similar stressors, to demonstrate that differences between individuals reflect their resilience rather than their exposure to stressors.

Although the resilience concepts used in this study were constructed as dispositional, true personality traits not were measured. Some resilience constructs appear to be associated with, for example, the Big Five factors [28, 63, 68], as are ER [69], which leaves the possibility that any association between resilience and ER may be mediated by personality traits. For example, personality traits like negative affectivity have been reported to influence the appraisal of situations and subsequent emotional regulatory responses [27, 70]. Future research may need to include measures of personality to clarify the relationship between resilience and ER. And finally, it may be particularly productive for future studies to use the subscales of the BRUMS, not just the total score, when considering the association of dispositional reliance and psychological adaptation.

CONCLUSIONS

Measures of dispositional resilience, in particular the BSRS and MTQ-18, appeared useful in predicted psychological adaptation during and after maritime deployments. Similarly, measures of ER predicted subsequent measurements of ER, providing evidence of psychological consistency that could be constructively used in supporting seafarers to enhance their personal adaptation during and after maritime operations.

Conflict of interest: None declared

REFERENCES

1. Palinkas LA. The psychology of isolated and confined environments. Understanding human behavior in Antarctica. Am Psychol. 2003; 58(5): 353–363, doi: 10.1037/0003-066x.58.5.353, indexed in Pubmed: 12971084.

2. Sandal GM. Coping in Antarctica: is it possible to generalize results across settings? Aviat Space Environ Med. 2000; 71(9 Suppl): A37–A43, indexed in Pubmed: 10993307.
3. Wijk CV, Martin J. A Brief Sailor Resiliency Scale for the South African Navy. Afr J Psychol Assess. 2019; 1, doi: 10.4102/ajopa.v1i0.12.
4. Wijk CV, Martin J. Promoting psychological adaptation among navy sailors. Scientia Militaria. 2021; 49(1), doi: 10.5787/49-1-1260.
5. Richardson GE. The metatheory of resilience and resiliency. J Clin Psychol. 2002; 58(3): 307–321, doi: 10.1002/jclp.10020, indexed in Pubmed: 11836712.
6. Sagone E, Caroli ME. A correlational study on dispositional resilience, psychological well-being, and coping strategies in university students. Am J Educ Res. 2014; 2(7): 463–471, doi: 10.12691/education-2-7-5.
7. Luthar SS, Brown PJ. Maximizing resilience through diverse levels of inquiry: Prevailing paradigms, possibilities, and priorities for the future. Dev Psychopathol. 2007; 19(3): 931–955, doi: 10.1017/S0954579407000454, indexed in Pubmed: 17705909.
8. Maddi S. The story of hardiness: Twenty years of theorizing, research, and practice. Consult Psychol J. 2002; 54(3): 173–185, doi: 10.1037/1061-4087.54.3.173.
9. Bartone P, Roland R, Picano J, et al. Psychological hardiness predicts success in US Army special forces candidates. Int J Select Assess. 2008; 16(1): 78–81, doi: 10.1111/j.1468-2389.2008.00412.x.
10. Kobasa SC, Maddi SR, Kahn S. Hardiness and health: a prospective study. J Pers Soc Psychol. 1982; 42(1): 168–177, doi: 10.1037//0022-3514.42.1.168, indexed in Pubmed: 7057354.
11. Kobasa SC. Stressful life events, personality, and health: an inquiry into hardiness. J Pers Soc Psychol. 1979; 37(1): 1–11, doi: 10.1037//0022-3514.37.1.1, indexed in Pubmed: 458548.
12. Bartone PT. Stress and hardiness in US peacekeeping soldiers. Paper presented at the Annual Convention of the American Psychological Association, Toronto, Canada 1996.
13. Bartone P. Hardiness protects against war-related stress in Army Reserve forces. Consult Psychol J. 1999; 51(2): 72–82, doi: 10.1037/1061-4087.51.2.72.
14. Bartone P, Johnsen B, Eid J, et al. Factors influencing small-unit cohesion in Norwegian navy officer cadets. Military Psychology. 2009; 14(1): 1–22, doi: 10.1207/s15327876mp1401_01.
15. Florian V, Mikulincer M, Taubman O. Does hardiness contribute to mental health during a stressful real-life situation? The roles of appraisal and coping. J Pers Soc Psychol. 1995; 68(4): 687–695, doi: 10.1037//0022-3514.68.4.687, indexed in Pubmed: 7738771.
16. Johnsen B, Bartone P, Sandvik A, et al. Psychological Hardiness Predicts Success in a Norwegian Armed Forces Border Patrol Selection Course. Int J Select Assess. 2013; 21(4): 368–375, doi: 10.1111/ijsa.12046.
17. Bartone PT. Hardiness as a resiliency factor for United States forces in the Gulf War. In: Violanti JM, Paton D, Dunning C (Ed.) Posttraumatic stress intervention: Challenges, issues, and perspectives. C. Thomas, Springfield, IL 2000: 115–133.
18. Bartone PT, Hystad SW, Eid J, et al. Psychological hardiness and coping style as risk/resilience factors for alcohol abuse. Mil Med. 2012; 177(5): 517–524, doi: 10.7205/milmed-d-11-00200, indexed in Pubmed: 22645877.
19. Escolas S, Pitts B, Safer M, et al. The protective value of hardiness on military posttraumatic stress symptoms. Military Psychology. 2017; 25(2): 116–123, doi: 10.1037/h0094953.
20. Pietrzak RH, Johnson DC, Goldstein MB, et al. Psychological resilience and postdeployment social support protect against traumatic stress and depressive symptoms in soldiers returning from Operations Enduring Freedom and Iraqi Freedom. Depress Anxiety. 2009; 26(8): 745–751, doi: 10.1002/da.20558, indexed in Pubmed: 19306303.
21. Britt TW, Adler AB, Bartone PT. Deriving benefits from stressful events: the role of engagement in meaningful work and hardiness. J Occup Health Psychol. 2001; 6(1): 53–63, doi: 10.1037//1076-8998.6.1.53, indexed in Pubmed: 11199257.
22. Giles B, Goods PSR, Warner DR, et al. Mental toughness and behavioural perseverance: A conceptual replication and extension. J Sci Med Sport. 2018; 21(6): 640–645, doi: 10.1016/j.jsams.2017.10.036, indexed in Pubmed: 29248306.
23. Gucciardi DF, Peeling P, Ducker KJ, et al. When the going gets tough: Mental toughness and its relationship with behavioural perseverance. J Sci Med Sport. 2016; 19(1): 81–86, doi: 10.1016/j.jsams.2014.12.005, indexed in Pubmed: 25554654.
24. Clough P, Earle K, Sewell D. Mental toughness: The concept and its measurement. In: Cockerill I (Ed.) Solutions in Sort Psychology. Thomson Learning, London 2002: 32–46.
25. Gerber M, Brand S, Feldmeth A, et al. Adolescents with high mental toughness adapt better to perceived stress: A longitudinal study with Swiss vocational students. Pers Individ Dif. 2013; 54(7): 808–814, doi: 10.1016/j.paid.2012.12.003.
26. Gerber M, Feldmeth AK, Lang C, et al. The relationship between mental toughness, stress, and burnout among adolescents: a longitudinal study with swiss vocational students. Psychol Rep. 2015; 117(3): 703–723, doi: 10.2466/14.02.PR0.117c29z6, indexed in Pubmed: 26652888.
27. Kaiseler M, Polman R, Nicholls A. Mental toughness, stress, stress appraisal, coping and coping effectiveness in sport. Pers Individ Dif. 2009; 47(7): 728–733, doi: 10.1016/j.paid.2009.06.012.
28. Lin Y, Mutz J, Clough PJ, et al. Mental toughness and individual differences in learning, educational and work performance, psychological well-being, and personality: a systematic review. Front Psychol. 2017; 8: 1345, doi: 10.3389/fpsyg.2017.01345, indexed in Pubmed: 28848466.
29. Mutz J, Clough P, Papageorgiou K. Do individual differences in emotion regulation mediate the relationship between mental toughness and symptoms of depression? J Individ Differ. 2017; 38(2): 71–82, doi: 10.1027/1614-0001/a000224.
30. Nicholls A, Polman R, Levy A, et al. Mental toughness, optimism, pessimism, and coping among athletes. Pers Individ Dif. 2008; 44(5): 1182–1192, doi: 10.1016/j.paid.2007.11.011.
31. Godlewski R, Kline T. A model of voluntary turnover in male Canadian forces recruits. Military Psychology. 2012; 24(3): 251–269, doi: 10.1080/08995605.2012.678229.
32. Gucciardi DF, Hanton S, Gordon S, et al. The concept of mental toughness: tests of dimensionality, nomological network, and traitness. J Pers. 2015; 83(1): 26–44, doi: 10.1111/jopy.12079, indexed in Pubmed: 24428736.
33. Gucciardi D, Lines R, Ducker K, et al. Mental toughness as a psychological determinant of behavioral perseverance in special forces selection. Sport Exerc Perform Psychol. 2021; 10(1): 164–175, doi: 10.1037/spy0000208.
34. van Wijk C. Psychological profiles of resilience in extreme environments: Correlating measures of personality and coping and resilience. Scientia Militaria. 2022; 50(1), doi: 10.5787/50-1-1256.
35. Gunderson EKE. Individual behavior in confined or isolated groups. In Rasmussen JE (Ed.) Man in isolation and confinement. Aldine, Chicago 1973: 145–164.
36. Palinkas LA, Gunderson EK, Holland AW, et al. Predictors of behavior and performance in extreme environments: the Antarctic

space analogue program. Aviat Space Environ Med. 2000; 71(6): 619–625, indexed in Pubmed: 10870821.
37. Palinkas LA, Keeton KE, Shea C, et al. Psychosocial characteristics of optimum performance in Isolated and Confined Environments. NASA Center for AeroSpace Information: Report NASA/TM-2011-216149. 2011.
38. Eisenberg N, Fabes RA, Guthrie IK, et al. Dispositional emotionality and regulation: their role in predicting quality of social functioning. J Pers Soc Psychol. 2000; 78(1): 136–157, doi: 10.1037//0022-3514.78.1.136, indexed in Pubmed: 10653511.
39. Gross J. (Ed). Handbook of emotion regulation. Guilford Press, New York 2007.
40. Gross J, Thompson RA. Emotion regulation: conceptual foundations. In Gross J (Ed.) Handbook of emotion regulation. Guilford Press, New York 2007: 3–26.
41. Lane AM, Beedie C, Devonort TJ. Measurement issues in emotion and emotion regulation. In: Thatcher J, Jones M, Lavallee D, editors. Coping and Emotion in Sport (2nd ed). Taylor & Francis, London 2011: 79–101.
42. Suedfeld P, Steel GD. The environmental psychology of capsule habitats. Annu Rev Psychol. 2000; 51: 227–253, doi: 10.1146/annurev.psych.51.1.227, indexed in Pubmed: 10751971.
43. An Ji, Liu Y, Sun Y, et al. Impact of work-family conflict, job stress and job satisfaction on seafarer performance. Int J Environ Res Public Health. 2020; 17(7), doi: 10.3390/ijerph17072191, indexed in Pubmed: 32218272.
44. Iversen RTB. The mental health of seafarers. Int Marit Health. 2012; 63(2): 78–89, indexed in Pubmed: 22972547.
45. Jensen HJ, Oldenburg M. Potentially traumatic experiences of seafarers. J Occup Med Toxicol. 2019; 14: 17, doi: 10.1186/s12995-019-0238-9, indexed in Pubmed: 31164911.
46. Lodde B, Jegaden D, Lucas D, et al. Stress in seamen and non seamen employed by the same company. Int Marit Health. 2008; 59(1-4): 53–60, indexed in Pubmed: 19227738.
47. Oldenburg M, Jensen HJ. Stress and strain among seafarers related to the occupational groups. Int J Environ Res Public Health. 2019; 16(7), doi: 10.3390/ijerph16071153, indexed in Pubmed: 30935082.
48. Oldenburg M, Jensen HJ. Needs and possibilities for ship's crews at high seas to communicate with their home. Int J Occup Med Environ Health. 2019; 32(6): 805–815, doi: 10.13075/ijomeh.1896.01436, indexed in Pubmed: 31663520.
49. Oldenburg M, Jensen HJ, Latza U, et al. Seafaring stressors aboard merchant and passenger ships. Int J Public Health. 2009; 54(2): 96–105, doi: 10.1007/s00038-009-7067-z, indexed in Pubmed: 19288290.
50. Terry PC, Lane AM, Fogarty GJ. Construct validity of the Profile of Mood States — Adolescents for use with adults. Psychol Sport Exerc. 2003; 4(2): 125–139, doi: 10.1016/s1469-0292(01)00035-8.
51. Lane AM, Jackson A, Terry PC. Preferred modality influences on exercise-induced mood changes. J Sports Sci Med. 2005; 4(2): 195–200, indexed in Pubmed: 24431976.
52. Pedlar CR, Lane AM, Lloyd JC, et al. Sleep profiles and mood states during an expedition to the South Pole. Wilderness Environ Med. 2007; 18(2): 127–132, doi: 10.1580/06-WEME-BR-039R1.1, indexed in Pubmed: 17590059.
53. Thelwell R, Lane A, Weston N. Mood states, self-set goals, self-efficacy and performance in academic examinations. Pers Individ Dif. 2007; 42(3): 573–583, doi: 10.1016/j.paid.2006.07.024.
54. Brandt R, Herrero D, Massetti T, et al. The Brunel Mood Scale Rating in Mental Health for Physically Active and Apparently Healthy Populations. Health. 2016; 08(02): 125–132, doi: 10.4236/health.2016.82015.
55. van Wijk CH, Martin JH, Hans-Arendse C. Clinical utility of the brunel mood scale in screening for post-traumatic stress risk in a military population. Mil Med. 2013; 178(4): 372–376, doi: 10.7205/MIL-MED-D-12-00422, indexed in Pubmed: 23707819.
56. Schoeman D, Cassimjee N. Psychometric properties of the Brief Sailor Resiliency Scale in the South African Army. Afr J Psychol Assess. 2022; 4, doi: 10.4102/ajopa.v4i0.100.
57. Bartone PT. Dispositional Resilience Scale-15: Normative data, adults and college students. 2014. www.kbmetrics.com.
58. Bartone PT. A short hardiness scale. Paper presented at the Seventh Annual Convention of the American Psychological Society, New York, NY. 1995.
59. Bartone PT. Test-retest reliability of the dispositional resilience scale-15, a brief hardiness scale. Psychol Rep. 2007; 101(3 Pt 1): 943–944, doi: 10.2466/pr0.101.3.943-944, indexed in Pubmed: 18232452.
60. Hystad SW, Eid J, Johnsen BH, et al. Psychometric properties of the revised Norwegian dispositional resilience (hardiness) scale. Scand J Psychol. 2010; 51(3): 237–245, doi: 10.1111/j.1467-9450.2009.00759.x, indexed in Pubmed: 20028488.
61. Kardum I, Hudke-Knezevic J, Krapic N. The structure of hardiness, its measurement invariance across gender and relationship with personality traits and mental health outcomes. Psychol Topics. 2012; 3: 457–507.
62. Arendse D, Bester P, Van Wijk C. Exploring psychological resilience in the South African Navy. In: Dodd NM, Bester PC, Van der Merwe J (Ed.) Contemporary Issues in South African Military Psychology. African Sun Media, Stellenbosch 2020: 137–160.
63. Horsburgh V, Schermer J, Veselka L, et al. A behavioural genetic study of mental toughness and personality. Pers Individ Dif. 2009; 46(2): 100–105, doi: 10.1016/j.paid.2008.09.009.
64. Jones G, Hanton S, Connaughton D. A framework of mental toughness in the world's best performers. Sport Psychologist. 2007; 21(2): 243–264, doi: 10.1123/tsp.21.2.243.
65. Funder DC, Colvin CR. Explorations in behavioral consistency: properties of persons, situations, and behaviors. J Pers Soc Psychol. 1991; 60(5): 773–794, doi: 10.1037//0022-3514.60.5.773, indexed in Pubmed: 2072255.
66. Sauerberger K, Funder D. Behavioral change and consistency across contexts. J Res Pers. 2017; 69: 264–272, doi: 10.1016/j.jrp.2016.04.007.
67. Sherman RA, Nave CS, Funder DC. Situational similarity and personality predict behavioral consistency. J Pers Soc Psychol. 2010; 99(2): 330–343, doi: 10.1037/a0019796, indexed in Pubmed: 20658847.
68. Delaney P, Goldman J, King J, et al. Mental toughness, reinforcement sensitivity theory, and the five-factor model: Personality and directed forgetting. Pers Individ Dif. 2015; 83: 180–184, doi: 10.1016/j.paid.2015.04.020.
69. Barańczuk U. The five factor model of personality and emotion regulation: A meta-analysis. Pers Individ Dif. 2019; 139: 217–227, doi: 10.1016/j.paid.2018.11.025.
70. Suls J, Martin R. The daily life of the garden-variety neurotic: reactivity, stressor exposure, mood spillover, and maladaptive coping. J Pers. 2005; 73(6): 1485–1509, doi: 10.1111/j.1467-6494.2005.00356.x, indexed in Pubmed: 16274443.

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How can the seafarers do it? Qualitative research in psychosocial risks of South Italy's seafarers

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ABSTRACT

Background: *Psychosocial risk factors play an important role in the lives of seafarers on board. Not only physical but also mental health influences the performance of seafarers. This study aims to investigate the psychosocial aspects of life on board among southern Italian seafarers.*

Materials and methods: *Semi-structured interviews were conducted between January and April 2021 with a sample of 20 seafarers using the snowball method. Griffith and Gonzales' (2000) guidelines for conducting face-to-face interviews were used. Interview topics were analysed using paper and pencil.*

Results: *The majority (90%) of seafarers were married or living in a romantic relationship. The seafarers worked more than 10 hours per day without a day of rest during their time on board. The main stressor for participants was the lack of family (16/20), followed by conflicts between work and rest (12/20), pressure from crew members (9/20) and feeling lonely (8/20). Seafarers were generally involved in traumatic events such as fatal accidents (5/20), injuries at work (4/20) and pirate attacks (4/20). The most important personal resources are the opportunity to travel (12/20), followed by passion for this type of work (9/20). The most common suggestion for a better quality of life on board concerns improving the quality of training (6/20).*

Conclusions: *The results of this study are alarming for the working and living conditions of seafarers. Shipping companies should implement social policies to prevent an increase in psychosocial risks on board. Future studies could include the administration of a questionnaire to examine psychosocial stressors, seafarers' protective factors, and well-being and discomfort outcomes at work.*

(Int Marit Health 2023; 74, 1: 54–61)

Key words: maritime human factor, psychosocial risks onboard, quality of life onboard, seafarers

INTRODUCTION

The ever-changing labour market, globalisation and technological advances are changing the quality of life on board a ship every day, highlighting a growing need for training on stress management for seafarers [1]. A recent study looking at fatal accidents at sea from 1972 to 2019 shows that accidents often start when alertness is low, between 7 pm and 7 am [2]. Most studies in the literature focus on workplace safety and the physical health of professionals [3], neglecting all the psychological factors that affect crew members' lives on the ship.

In Italy, the profession of seafarer is not considered a physically demanding profession, but there are general risks that affect the health of the worker and are recognised as a cause of physical and psychological disorders [4–8]. These diseases are examined by a doctor every 2 years, but there is a lack of interest in assessing the psychosocial risks.

The analysis of psychosocial risks in seafarers is increasing in the international literature [9, 10], but there is no treatise on psychosocial factors at work on Italian seafarers. Seafarers need to work in a safe environment and should comply with safety regulations [11], but international research reports psychosocial risks related to excessive bureaucracy on board, lack of professionalism, leadership management [12], mental health disorder [1], piracy and harassment on board [13], lack of rest [14], automation of machinery, long working hours, workplace fatigue [15] and multiculturalism [3, 16].

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The aim of this study is to investigate the psychosocial risks in a sample of southern Italian seafarers through qualitative research.

The occupational activities of seafarers are comprehensively regulated by conventions and codes, some of which focus on the regulation of seafarers' training, leisure and working time, as well as provisions on watchkeeping on board ships, such as the Standards of Training, Certification and Watchkeeping for Seafarers (STCW) [17] or Maritime Labour Convention (MLC) [11].

Health, well-being and safety at work are some of the objectives set by organizations concerned with the protection of seafarers, such as the International Labour Organization (ILO) and the World Health Organization (WHO) [18]. On board, seafarers live in the same confined space in which they work. This factor affects the quality of recreation, leisure, interpersonal relationships and psychophysical health, which in turn affects performance [12].

Psychosocial stress for merchant fleet officers is caused by high levels of responsibility, bureaucracy, lack of crew qualifications, conflicts between safety and profitability, and ship management in port areas [3, 19]. In addition, work-related stress is typical for seafarers because there is no separation between work and rest time, which means constant accessibility, fatigue and insomnia due to night work and changeable weather [9, 14, 19]. Catecholamine levels of seafarers, especially pilots, are significantly elevated after duty [20].

The automation of technology on ships has led to a change in the perception of officers, who were once seen as operators and now monitor equipment and machinery [21] and develop other specific technical and management skills. The length of the voyage and the time spent in port affect crew safety [22]. In addition, seafarers are subject to overload from work that has nothing to do with watchkeeping or cargo handling, which affects fatigue levels, such as excessive bureaucracy [9, 23]. There is a positive correlation between the increase in working hours due to the reduction of crew members and the lack of social relations due to worker fatigue. The constant rotation of crew prevents the development of friendly bonds within the ship, which affects mental health and increases perceived stress levels and the possibility of suicide on board [7]. In addition to fatigue, loneliness, lack of home, multinationalism, sleep disturbance and limited leisure activities are also perceived as possible psychosocial stresses for seafarers [9, 24].

MATERIALS AND METHODS

PARTICIPANT

The sample included in this study consisted of 20 seafarers with the following characteristics: all male, age 42.89 (16.11), registered in the "seaman's book" for more than 1 year. The daily working time reported by the sample, including overtime, is 10.2 hours and all respondents reported working all days of the week during their time on board (Table 1).

Table 1. Sample description and hours worked per day

Crew status	**Number**
Chief officers	16
Deck department	6
Engine department	10
Deck rating	1
Captains	2
Cook	1
Crew status	**Mean hours worked per day**
Cook chief	11.5
Chief engineer	13.2
Third engine engineer	9.75
Cadet engineer	8.5
Master	11
Third deck officer	10
Second deck officer	11
First deck officer	9
Cadet deck officer	8.5
Sailor	12

A city in southern Italy was chosen because of the large number of people working in the shipping industry there (2500 seafarers out of a population of less than 17000 people). Snowball sampling was used for two main reasons: privacy and convenience of the respondents. In Italy it is not possible to see the seafarers' book [25] and the snowball system allows to establish a relationship of trust between interviewer and respondent.

PROCEDURE

From January to April 2021, 20 semi-structured face-to-face interviews were conducted. Initial contact was made with a phone call to enquire about the seaman's availability and to arrange a time for the interview. A suitable setting was created for the interview to ensure the privacy and safety of the interviewee. Rules were followed during the interview to prevent the spread of the COVID-19 virus. It was explained how the data would be used and written consent was requested to record the audio of the interview.

Each interview consisted of two main topics: 1) oceanographic and navigational data; 2) analysis of the job's themes extrapolated through the psychosocial risk analysis scoring grid [26].

Table 2. Description of the topic's groups

Group number	Subjects
1	Crew status; Age; Company flag; Travel routes; Nationality of the crew; Gender of the crew; Department of the seafarer; Hour of watchkeeping; Typology of ship; Sentimental situation; Overwork hours; Presence of alcohol and drugs on board
2	Checklist of the activities of the seafarer during his routine
3	Affirmations related to the quality of rest and relaxation on board
4	Psycho-social risk factors associated with an experience of work stress
5	Traumatic events
6	Effects of the traumatic events to the job performance
7	Work resources
8	Suggestions that seafarers expressed to improving the quality of life on board
9	Checklist of psychosocial risks that there is in the Carter's paper [24]

DATA ANALYSIS

The research was conducted following the grounded theory methodology [27]. This is an approach that provides an inductive approach to the culture being interviewed. The researcher was expected to discover the theory during the interviews, ignoring previous experiences and knowledge on the same topics. The transcription was done with Microsoft Word.

RESULTS

After transcribing the interviews, the arguments that emerged were grouped together (Table 2). Each interview citation listed in the results included the seafarers' age and status on board.

CREW ACTIVITIES

The activities carried out by seamen can be categorised according to both the status of the crew and the department to which they belong (engine or deck).

The deck officer carries out the maintenance work of the deck department on the basis of the activities assigned to him by the planned maintenance system and communicated by an officer or the boatswain. The deck officer, together with the master, takes care of navigation, the management of inspections on board and the management of the crew. In addition, interviews have revealed that records of crew members' rest periods (which are checked at port state control) are deliberately falsified. Since the 1980s, shipowners have reduced their staff due to the increasing automation of ships. This situation makes it impossible to distribute a correct workload among crew members. Deck officer trainees carry out the safety drills on board, observe and help with all the work carried out by the deck officers. The captain takes care of the management of the leadership on board. During navigation, a situational style of leadership is usually used, but during manoeuvres or emergencies it becomes authoritarian. The activities of the cook relate to the preparation of canteens for the seafarers. The activities of the machinery engineers relate to the maintenance of the machinery department and the determination of activities for the ship's operation. The maintenance of the machinery is not in the job description of the machinery engineers but is entrusted to the machinists. However, due to the shortage of personnel, it is necessary for the engineer to assist the machinery officer.

Engineer trainees assist the engineer officers, carry out inspections and take part in exercises.

Chief engine officers look after the management of the ship's operations, plan the activities of the engine crew, report consumption to the company and help the staff when the ship is in dry dock.

PSYCHO-SOCIAL RISK FACTORS ASSOCIATED WITH WORK STRESS

On the psychosocial risk aspects causing stress on board, the interview results show that lack of family attention is the most common theme (16/20), respondents said phrases like: "not being able to see my children grow up", "fear of not being there for the family", "being away from home", "thoughts of home", "missing all the events of private life".

The concept of work-recovery conflict (12/20) included all statements highlighting the difficulty of resting on board, such as: "being on call 24 hours a day", "never sleeping" (25, third deck officer), "not having time to rest", "no time for leisure", "no way to take time off from work", "...you do not go home in the evening" (24, third deck officer), "...you cannot tell day from night..." (25, engine cadet), "the rules for rest time were not respected", "sleep interruption", "no rest time", "...you live in a world where you can never switch off..." (55, chief engineer) and "sleeping badly".

Pressure from crew members (9/20) included endorsements related to: "pressure from crew members", "competition", "working fast", "no mistakes possible" or "working under pressure".

Feelings of loneliness and isolation are common on board (8/20). Seafarers said about them "...you live in bubbles..." (54, captain), "it's a floating prison" (25, third deck officer), "four months a hermit on a ship" (65, cook), "I felt worse than a prisoner" (61, chief engineer), "I did not feel welcome the first week" (21, engine cadet).

Bad weather and working hours were mentioned 8 times in the interviews as a cause of stress. All the seafarers interviewed stated that they worked every day of the week, without a day of rest, and some seafarers stated that they were "on shift 12 hours a day" (61, sailor). The constant criticism and reprimands of the crew (7/20) included statements such as, "...always guns at the ready..." (55, chief machinist), "...toxic crew" (27, third deck officer), "...constantly criticising each other..." (24, deck cadet), "...if you made mistakes, you are condemned..." (61, chief engineer), "there is only criticism" (44, engine director). Other aspects perceived as a cause of stress were lack of professionalism, a negative work environment, the typology of the work contract and the mob of the organization (5/20). The negative work environment included statements such as "...third Reich environment" (24, third engineer), "...it only takes one crew member to ruin the environment" (61, chief engineer). Issues like monotony, bureaucracy, scrutiny/port state control, prejudice/envy, high pressure/vibration/noise are mentioned 4 times. Low quality of food, unsatisfactory retribution, time on board, activities of other colleagues, dealing with cultural diversity on board, internet prices/misrepresentation, length of routes, time at home, lack of union protection are also issues that are perceived as causing stress (3/20).

The last aspect mentions, authoritarian hierarchy, time change, lack of protection from pirate attacks, accidents, living with crew members, new safety norms, mobbing, lack of social recognition, high temperature, design of the hub, artificial light exposure, and stun effect (Fig. 1).

TRAUMATIC EVENTS

Now the number of seafarers who had traumatic experiences on board or witnessed them is reported.

Two of the interviewees experienced war scenarios during their time on board, namely the war between Iraq and Iran in the 1980s, the second Gulf War in 2003 and the bombings in Libya in 2011. One interviewee reported hiding the bodies of people who were likely victims of human trafficking in the Mediterranean by moving them further away from the reach of the rig. The bodies were tied together with rope and put into black bags normally used for garbage. Three interviewees reported that the migrant rescue was a particularly stressful event because of the difficulty of managing multicultural crowds on a cargo ship. The term 'atypical behaviour' was used to describe all those atypical manifestations that can be claimed as psychopathologies of adulthood, quoting the interviews: "...the electrician looked like a crazy person" (25, third deck officer); "...I saw people playing with his head [....] we had to lock him in the cabin" (53, captain); "at the first embarkation the captain was paranoid" (53, captain); "...there was a bit of a strange situation, they see him every now and then, he goes away, he goes out, so you know, you keep an eye on him, you never know, it could be that he jumps in [...] or if it's people who might have alcohol in the cabin, it could happen that they get drunk and go..." (30, third engineer). Accidents on board are common (4/20) and had the following consequences: Second degree burns to the foot, stab wounds, amputation of the ring finger and coccyx fractures. Three out of 20 crew members were victims of abuse of authority by military personnel during inspections on board and victims of bullying by other crew members. There were also reports of crew members being kidnapped and ships being seized, i.e. 1 respondent was kidnapped by pirates for 33 days, another reported that the ship he was on was seized off Nigeria for a week and a final seafarer reported that he was on board the ship for 7 months during the COVID-19 pandemic with a broken boiler without touching land. Five different people reported assisting in fatal accidents and being victims of pirate attacks. Two seafarers faced fire on board during their careers, while another survived a hull explosion on his first route.

WORK RESOURCES

Different personal and organizational labour resources are mentioned in the interviews, as you can see in Table 3.

For the last statement of Table 3, it is important to describe that this sample used to need support from the Merchant Marine Fund, which can provide money for time spent recovering at home. This situation, as they expressed, is due to the lack of retribution during the time at home. Statements were made in relation to work resources such as: "I have experienced some negative events [he was abducted in the forests of Guinea Gulf], and I realised that... yes, it is true that I complain, but it is also true that I really miss it... by now I have arrived in the maritime culture" (50, first deck officer); "you eat there on the topside, in the briefing room, you stand there, we cook and spend the whole evening there, maybe stop in port and eat, and these are the little things that make you say: OK, I am in a familiar environment, a calm environment, I'll be back!" (27, third

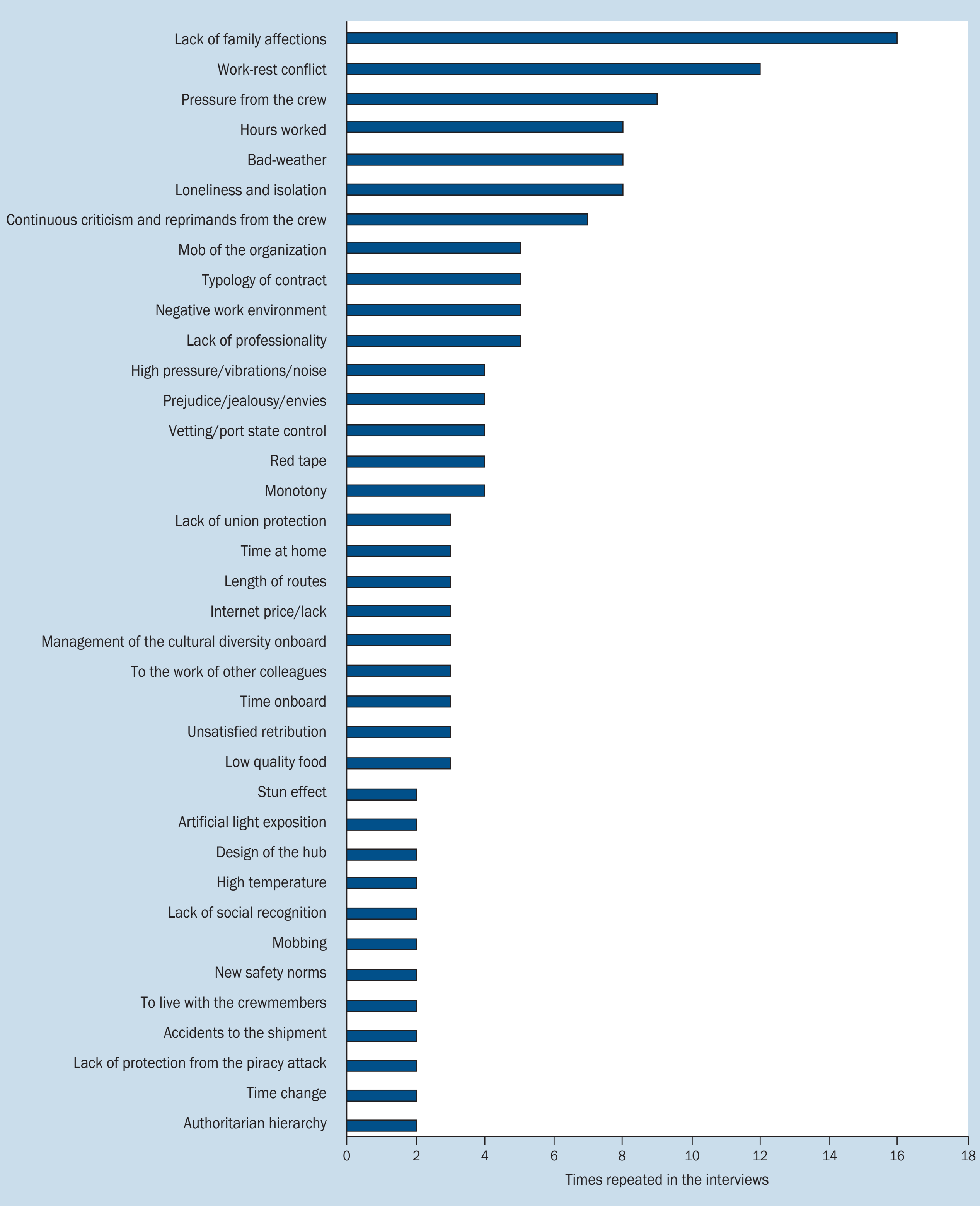

Figure 1. Psychosocial risk factors associated with an experience of work stress

deck officer); “now I can live [referring to the long routes that now leave him more time for himself]” (53, captain); “the change to let off steam after work [hitting a punching bag]” (25, engine cadet).

PSYCHOPHYSICAL EFFECTS OF LIFE ON BOARD

Regarding the psychophysical effects of life on board, the seamen interviewed expressed symptoms such as dissatisfaction, nostalgia, deterioration of eyesight, sleep

Table 3. Work resources

Work resources	Times
Personal resources	
Opportunity travel	12/20
The passion for the type of work	9/20
To know new people	7/20
To learn from the experience at work	4/20
To know how to manage stressful experience	3/20
To coming back home or the communication that soon you will go home	2/20
Self-knowledge	2/20
The pleasure to see the sea	2/20
To speak different languages	1/20
To help the others	1/20
Organizational resources	
High salary	11/20
Positive work environment	5/20
Recognition from the colleagues	5/20
Duration of the rest at home	4/20
The ability on board to keep up with technological innovation	3/20
To have an own space on board	3/20
Constant retribution	3/20
To have responsibility	1/20
The possibility to make a career	1/20
The advantages of easily gaining from the fund for merchant marine during leave	1/20

disorders, headaches, cardiac arrhythmia, burns, broken bones, physical fatigue, mental exhaustion, nervous exhaustion, ulcers, colitis, anxiety, hearing loss, psychophysical well-being after reaching destinations, seasickness, general malaise, leg complaints, nervousness, anxiety and gastritis (Fig. 2). They expressed: "the stress we accumulated on the routes is cumulative" (50, first deck officer); "we had a cabin below sea level" (45, second deck officer); "I cannot take it anymore, I want to go home […] you start talking to yourself […] it's like the captain is another person" (25, third deck officer).

SUGGESTIONS FOR A BETTER QUALITY OF LIFE ON BOARD

The suggestions expressed by seafarers during the interviews to improve the quality of life in the maritime sector are to improve the quality of training (6/20), increase the number of crew members and reduce the cost of internet for better connection with the rest of the world (5/20), shorter time on board (4/20), psychological care ashore or at sea and more consideration for employees by the company (3/20), use of offshore contracts, more recreational space on the ships, social recognition of the seafaring profession as strenuous work, granting a basic salary during time at home, better work organization (2/20).

DISCUSSION

There are alarming findings in the literature about the working and living conditions of seafarers [9, 24]. The main objective of this study is to investigate the psychosocial risks in a sample of southern Italian seafarers through some semi-structured interviews.

The activities of the sample crew are always controlled by the planned maintenance system and reported by the captain, but the excessive workload due to the lack of crew members could have an impact not only on the falsification of the logbook but also on the safety of the ship.

The findings show that there is no weekly rest day and the daily working hours exceed 8 hours, which could affect the quality of sleep and attention during work and jeopardise the safety of the entire crew and cargo. However, lack of sleep and attention are not the main causes of stress reported by seafarers. The absence of family members and the inability to contact or be with them is the most common cause of stress among crew members. The absence of family members could have an impact on work-life balance, work-family conflict or work-family spill over.

The seafarers in this sample typically assist with or are involved in traumatic events, but not all of them were supported by the company in coping with the experience.

Work resources show that discovering the world and passion for the type of work are the most common personal resources for this sample. Instead, high salary is the most common organisational resource, followed by efforts to create a positive work environment.

The results on the psychophysical impact of life on board show that there are a significant number of common symptoms related to quality of life on board for seafarers.

All the suggestions in the sample can be seen as needs of the seafarers. It is interesting to see that there is a link between the psychosocial stressor they expressed and the most frequently mentioned suggestion. Instead, the first suggestion was to improve the quality of training, followed by a way to overcome the distance to the rest of the world and to reduce the cost of internet on board.

LIMITATIONS OF THE STUDY

The sample used in this study is gender limited as the seafarers interviewed were all men. The data cannot be standardised, and the sample is not representative of seafarers in southern Italy. This study focused on a single city in southern Italy. It is not possible to understand

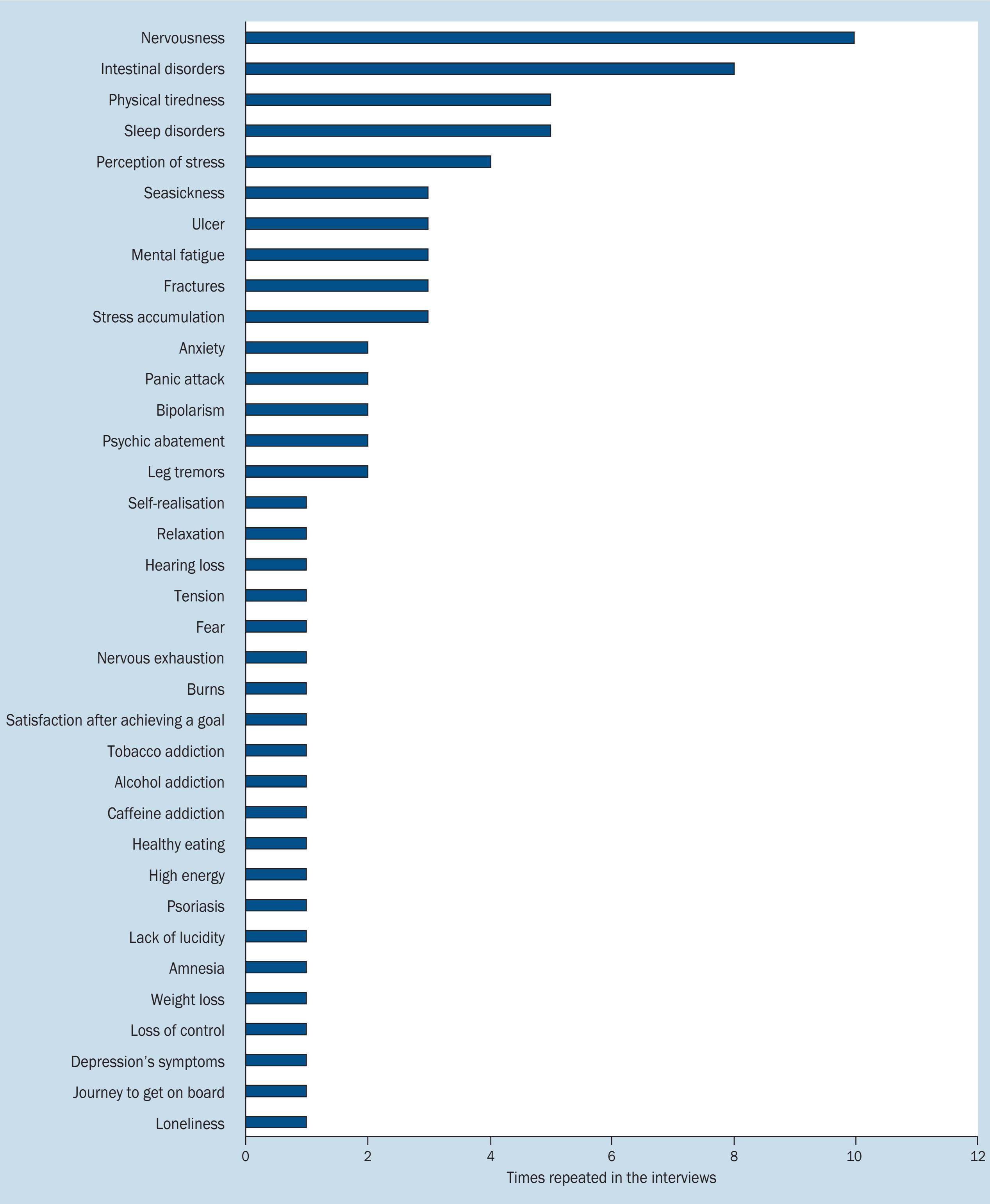

Figure 2. Psychophysical effects of the life on board

whether the company flag or company management is related to the well-being of the seafarers in the sample. The narratives of the sample could be influenced by false memories, as the reported experiences are not always related to the last embarkation.

CONCLUSIONS

The work stressors reported by the sample, particularly the lack of family and the conflict between work and rest, may play an important role in seafarers' quality of life. These findings are only a preliminary investigation to serve as a basis for a future study analysing the role of psychosocial risks among Italian seafarers. From the interviews, it can be concluded that the sample perceived a low level of well-being at work, which can be attributed to the lack of attention paid by shipowners to the application of MLC [11] and STCW [17].

Conflict of interest: None declared

REFERENCES

1. Rozanov V. Mental health problems and suicide in the younger generation — implications for prevention in the Navy and merchant fleet. Int Marit Health. 2020; 71(1): 34–41, doi: 10.5603/imh.2020.0009.
2. DeLoughery E. Characteristics of fatal marine accidents. Int Marit Health. 2022; 73(3): 115–116, doi: 10.5603/imh.2022.0022.
3. Jensen HJ, Oldenburg M. Training seafarers to deal with multicultural crew members and stress on board. Int Marit Health. 2020; 71(3): 174–180, doi: 10.5603/imh.2020.0031.
4. Forsell K, Eriksson H, Järvholm B, et al. Work environment and safety climate in the Swedish merchant fleet. Int Arch Occup Environ Health. 2016; 90(2): 161–168, doi: 10.1007/s00420-016-1180-0.
5. Calhoun SR. Human Factors in Ship Design: Preventing and Reducing Shipboard Operator Fatigue, 2006.
6. Paschold H, Sergeev A. Whole-body vibration knowledge survey of U.S. occupational safety and health professionals. J Safety Res. 2009; 40(3): 171–176, doi: 10.1016/j.jsr.2009.02.008.
7. Dobie TG. Critical Significance of Human Factors in Ship Design, 2003.
8. Main L, Chambers T. Factors affecting maritime pilots' health and well-being: a systematic review. Int Marit Health. 2015; 66(4): 220–232, doi: 10.5603/imh.2015.0043.
9. Carotenuto A, Molino I, Fasanaro AM. Psychological stress in seafarers: a review. Int Marit Health. 2012; 63(4): 188–194.
10. McVeigh J, MacLachlan M, Cox H, et al. Effects of an on-board psychosocial programme on stress, resilience, and job satisfaction amongst a sample of merchant seafarers. Int Marit Health. 2021; 72(4): 268–282, doi: 10.5603/imh.2021.0051.
11. ILO. Original MLC Convention Annexes.
12. De La Campa Portela MR, Pérez MEG. Psychosocial risks of the seafarers. In: Psychosocial risks of the seafarers. Seafarers: an international labour market perspective. Editorial Gomylex; 2016: 41.
13. Anele K. A study of the role of seafarers in combating piracy off the coast of Nigeria. WMU J Marit Affairs. 2016; 16(3): 313–349, doi: 10.1007/s13437-016-0111-y.
14. Hystad S, Eid J. Sleep and fatigue among seafarers: the role of environmental stressors, duration at sea and psychological capital. Safety Health Work. 2016; 7(4): 363–371, doi: 10.1016/j.shaw.2016.05.006.
15. Yancheshmeh FA, Mousavizadegan S, Amini A, et al. Poor sleep quality, long working hours and fatigue in coastal areas: a dangerous combination of silent risk factors for deck officers on oil tankers. Int Marit Health. 2020; 71(4): 237–248, doi: 10.5603/imh.2020.0042.
16. Little A. Driving Safety Culture: Identification of Leadership Qualities for Effective Safety Management Final Report to Maritime and Coastguard Agency. 2004; 44.
17. International Maritime Organization, International Conference on Training of Seafarers. C. STCW 1978: International Convention on Standards of Training, Certification, and Watchkeeping for Seafarers, 1978: with resolutions adopted by the International Conference on Training and Certification of Seafarers, 1978. Published online 1993.
18. Joint ILO/WHO Committee on Occupational Health. PSYCHOSOCIAL FACTORS AT WORK: Recognition and control, 1986.
19. Andresen M, Domsch M, Cascorbi A. Working unusual hours and its relationship to job satisfaction: a study of European maritime pilots. J Labor Res. 2007; 28(4): 714–734, doi: 10.1007/s12122-007-9010-5.
20. Zorn EW, Harrington JM, Goethe H. Ischemic heart disease and work stress in West German sea pilots. J Occup Med. 1977; 19(11): 762–765.
21. Schager B. When technology leads us astray: a broadened view of human error. J Navig. 2007; 61(1): 63–70, doi: 10.1017/s0373463307004493.
22. Gregory D, Shanahan P. The Human Element a guide to human behaviour in the shipping industry. The Stationery Office 2010.
23. The United Kingdom Mutual Steam Ship Assurance Association (Bermuda) Limited. DIRECTORS' REPORT & FINANCIAL STATEMENTS, 2006.
24. Carter T. Working at sea and psychosocial health problems. Report of an International Maritime Health Association. Travel Med Infect Dis. 2005; 3(2): 61–65, doi: 10.1016/j.tmaid.2004.09.005.
25. Giunta P. Gazzetta Ufficiale. 2009; 2003: 2004–2006.
26. Cox T, Griffiths A, Rial-González E. Research on work-related stress, 2000.
27. Glaser BG, Strauss AL. The discovery of grounded theory: strategies for qualitative research. Aldine Publishing 1967.

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Assessment of mental health and psychosocial factors in French merchant officer cadets

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ABSTRACT

Background: *Several studies have demonstrated the existence of psychological pathologies and psychosocial risks among seafarers, particularly merchant navy officers. To date, there is no study of merchant navy officer cadets. First aims are to assess anxiety and depression disorders, framework, work strain and social support in this population.*

Materials and methods: *A questionnaire including demographic and sailing data to which we added the Hospital Anxiety and Depression Scale (HAD) and Karasek questionnaire was developed. All students were approached and completed the questionnaire anonymously by electronic means.*

Results: *One hundred and seventy questionnaires could be included. The population was predominantly male (76.4%), and the average age of the students was 21.7 years. The means of the HAD anxiety and HAD depression were 6.9 and 5.37, respectively. According to Karasek classification, we noted that the "active" class was the most represented with 29.4% of students, followed by the "high strain" and "low strain" classes with 27.6%. The "passive" class was the least represented with 15.3%.*

Conclusions: *We found a predominance of anxiety disorders but few signs of depression. Signs of "high strain" according to Karasek were found in 27.6% of the population of these young officers. Job demand was linked to mean of anxiety and depression disorders declared in HAD questionnaire. Being a woman was associated with anxiety but not depression symptoms. Prevention programme to decrease the level of job demand and increase decision latitude and social support seems relevant for mental health disorders in merchant officers.*

(Int Marit Health 2023; 74, 1: 62–69)

Key words: psychosocial, high-risk population, job stress, workplace safety, seafarers, cadets

INTRODUCTION

In recent decades, studies increased knowledge on occupational physical and psychological stressors exposure in seafarers [1]. Some, like fatigue, boredom and social isolation are linked to social and technology modifications. Global economic growth is coupled with shipping trade and maritime technology has to respond to globalisation signals. Globalisation encouraged transactions of goods and service "just in time" in smaller packets. Maritime transport, shipping but also fishing is now directly impacted by worldwide globalisation.

Oldenburg and Jensen [2] recently published an article on stress and strain among seafarers considering their jobs on board. With a sample of 323 seafarers employed on 22 container ships, they conducted an interview-based study with a questionnaire addressing stressors among seafarers validated in a previous study [2]. Specific job-related factors such as sailing route, trip duration at sea, physical stressors (e.g. noise and seasickness) and psychosocial stressors (e.g. shift to new ship and social problems due to migration) were assessed. Nautical officers

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more frequently felt mentally stressed than the ratings, which the authors attributed to their higher maximum working hours and higher work-related demands. They also found that watchkeepers had significantly shorter sleeping periods than daytime workers (i.e. 5.5 h vs. 5.8 h) and significantly lower scores for effectiveness of sleep, the overall average of which was 69.6% (odds ratio 0.48; 95% confidence interval 0.26 to 0.88). In view of those findings, the authors proposed a possible relationship between chronic fatigue and human error during maritime disasters. By job type, officers complained more often than non-officers about high stress levels due to time constraints and administrative tasks [2].

Fatigue is considered as an important maritime safety and mental health problem [3]. The youngest are more burdened by stress, especially because of the lack of good social relationships, physical fatigue and lack of control [4]. A French survey with 74 seafarers on oceanographic vessels studied stress using the Karasek demand-control-model. Of all respondents, 17% were at the low end of the decision level in the model of Karasek and regarded as an expression of high stress risk, which is believed to be associated with a high risk of stress. There were 33% with mental stress in the overall health tests [5].

As coronavirus disease 2019 (COVID-19) continues to adversely impact seafarers, an estimated 400,000 of whom are stranded on vessels around the world; many working within the maritime industry have become increasingly concerned about the damaging effects of extended time on board, as well as complications with repatriation and the financial problems resulting from unexpected unemployment. The well-being of seafarers during on-board COVID-19 outbreaks was evaluated with the General Health Questionnaire-12, where 60% of the sample had mean Likert-scores below 15 (i.e. "No problems"), whereas 40% had scores from 15 to 23 (i.e. initial problems). In response to other items, half of the seafarers did not feel safe performing their jobs and 60% did not think that every precaution had been taken to ensure their health at work due to the pandemic. Another 30% suffered from insomnia to the extent of becoming concerned, while 26% reported being unhappy and depressed during their latest tour of duty [6].

In 2010, Beaucher et al. [7] analysed qualitatively first embarkment reports of French merchant officer trainees. Major stress sources described were vessels operations, piracy, damages and meteorological conditions. At the end, most of them concluded that this first onboard experience confirms their professional choice [7].

In another French study involving younger students from marine college and using the GHQ12 questionnaire, we found 43.2% of students with psychological distress (unpublished).

Linked to these, we think that it could be interesting and relevant to perform a study on French Merchant Officer trainees.

First aims are to assess anxiety and depression disorders, framework, work strain and social support in this population.

MATERIALS AND METHODS

We conducted an observational study of self-evaluation using an anonymised questionnaire. The first part of the questionnaire focused on demographic and professional data (gender, age, year of training, type and duration of internships) and then participants were asked to answer two internationally validated questionnaires: the Hospital Anxiety and Depression Scale (HAD) and Karasek questionnaires [8, 9].

A hyperlink, created via the Sphinx Online software, to the questionnaire was sent to the students in their student mailboxes.

An e-mail was sent on 02/02/2022; a reminder was sent on 03/03/2022. The link was deactivated on 15/03/2022.

The entire population was composed of 637 students distributed as follows: 162 in the first year of a Bachelor's degree, 155 in the second year of a Bachelor's degree, 122 in the third year of a Bachelor's degree, 109 in the first year of a Master's degree and 89 in the second year of a Master's degree.

INFORMED CONSENT

All information on the survey was included in the first page of the questionnaire and detailed in the email send with the link.

TESTS

The Karasek questionnaire or Job Content Questionnaire (JCQ) was developed for a self-assessment of the psychosocial environment constraints at work. In this test, a work situation is characterised by the combination of psychological demand (workload or job demand) and decision latitude. By crossing these characteristics, four work situations can be defined, including low strain, passive, active and high job strain [10].

It then introduces another dimension, which is social support at work (colleagues or superiors).

The HAD is a questionnaire for the detection of anxiety and depressive symptoms [8].

STATISTICS

The questionnaire was carried out using the "Sphinx" software. The data were extracted and coded on the Sphinx software and then the statistical analysis was carried out with the XL Stat software (Addinsoft 2022). The data were anonymised and stored on a secure server in the hospital department with a password.

For the HAD, we followed the recommendations of these authors for coding. If the sum was greater than or equal to 11, we considered that there was a proven symptomatology [8].

For the Karasek model questionnaire, we assigned a value of –2, –1, +1, +2 to each response. The sum was made in each of the three categories: job demand, decision latitude and social support. When the sum was less than 0, we considered the job demand to be low, and when it was greater than 0, we considered it to be high. When the sum was less than 0, we considered decision latitude to be low and when it was higher, we considered it to be high. Finally, when the sum was less than 0, we considered social support to be low and when it was greater than 0, we considered it to be high. When the sum was equal to 0, we excluded the students from the analysis.

The statistical analysis of the data was carried out using XL Stat software (Addinsoft 2021). It includes a descriptive phase of the data expressed in numbers and percentages, Then, a comparison by work situations according to Karasek model was carried out by Chi-square test when the statistical conditions allowed it or by Yates corrected Chi-square. The means of the anxiety and depression scores were compared between the different categories of the Karasek score using the Z test for comparison of means. For all statistical tests, the p significance level was set at 0.05.

We also performed a linear regression analysis between the anxiety and depression values of the HAD questionnaire with the explanatory variables: age, gender, decision latitude, social support and job demand as independent variables.

Next, a Pearson correlation test and linear regression were performed for the anxiety and depression values of the HAD test.

RESULTS

The questionnaire was sent to 637 students and 178 responded. The response rate was therefore 27.9%.

We chose to remove from the analysis the 8 people who had obtained the sum of 0 on the Karasek score for work constraints or for decision latitude. This would not have allowed us to classify them in one of the four Karasek categories. The rest of the results would therefore be presented with a student population of 170, except for the student characteristics.

The population was predominantly male (76.4%). The average age of the students was 21.67 years. 23.6% had not carried out any training. Of the 76.4% who had completed at least one placement, a majority had completed more than 60 days at sea (84.6%).

We found that 19.1% of the students' report having experienced one or more traumatic events during their onboard training.

The main characteristics of the included population and those of the embarkations are described in Table 1.

The average scores of HAD anxiety and HAD depression were 6.871 ± 3.8 and 5.371 ± 3.3, respectively.

Of the 170 students, 31 showed symptoms of anxiety, representing 18%. Fewer of them showed depressive symptoms, 13 or 7.6% (Table 2).

Table 1. Demographic characteristics of included students

Features	Per cent	Workforce
Response rate	100%	
Gender:		
Male	76.4%	136
Woman	23.6%	42
Age [years]:		
< 20	24.2%	43
20–24	63.5%	113
25–29	9.6%	17
30–34	1.7%	3
35–39	0.6%	1
> 40	0.6%	1
Average		21.67
Year of training:		
L1	21.3%	38
L2	28.1%	50
L3	24.2%	43
M1	14%	25
M2	12.4%	22
Number of on-board courses:		
0	23.6%	42
1	10.7%	19
2	19.1%	34
3	23.6%	42
4	7.3%	13
5	4.5%	8
> 5	11.2%	20
Average duration of internships [weeks], Average		8.98

→

Table 1 (cont.). Demographic characteristics of included students

Features	Per cent	Workforce
Maximum duration of traineeships [weeks], Average		11.79
Total number of course days [J]:		
< 10	0.7%	1
10–20	0.7%	1
21–30	2.2%	3
31–40	0.7%	1
41–50	7.4%	10
51–60	3.7%	5
> 60	84.6%	115
Type of vessel:		
Passenger ship	67.6%	92
Freight ship	50%	68
Raw material transport vessel	30.9%	42
Special ships	28.7%	39
Port vessels	7.4%	10
Other	11.8%	16
Nationality of the shipping company:		
French	99.3%	135
Foreign	13.2%	18
Language spoken on board:		
French	19.9%	27
English	8.8%	12
French + English	71.3%	97
Traumatic events:		
Yes	19.1%	26
No	80.9%	110

Table 2. Results of the HAD questionnaire in classes

	No. of students	Questionnaire results	Number	Frequency (%)
HAD anxiety	170	> or equal 11	31	18.2
		< 11	139	81.7
HAD depression	170	> or equal 11	13	7.6
		< 11	157	92.3

HAD — Hospital Anxiety and Depression Scale

The profile of the students was very diversified; we found mainly three classes which were almost equal in terms of numbers. The "active" class was the most represented with 29.4% of the students, followed equally by the "tense" and "relaxed" classes with 27.6%. The "passive" class was the least represented with 15.3%.

Description of different variables for each Karasek class are presented in Table 3 with same frequencies of gender in different classes.

The comparison of the means of the HAD questionnaire according to the category of the Karasek questionnaire showed a significant increase in the level of anxiety in the high strain (also named "tense") group compared to the active, passive and, especially, low strain group. The depression score was also significantly worse in the tense group compared to the low strain and passive group, as shown in Table 4.

When performing analysis of correlation using Pearson test, we found that for anxiety and depression rated by the HAD questionnaire, there was a significant and positive relationship with job demand and a negative one for decision latitude and social support (Table 5).

Interestingly, Table 6 shows the results of the linear regression. It shows that age had no influence on the different HAD scores. But gender, especially female, was significantly related to depression scores but not to anxiety. The data from the Karasek model had a strong impact on the variance of overall health, anxiety and depression. When it was added to the equation, the variance increased by almost 30% for both entities (anxiety and depression). More specifically, work constraints and social support had an impact on anxiety and depression. Decision latitude, on the other hand, had no significant effect.

DISCUSSION

In this study, we were able to assess the psychological health of French merchant navy cadets using internationally validated tests. Anxiety-type pathologies were detected thanks to the HAD test, but only few depressive syndromes were observed. Interestingly, the analysis of the Karasek questionnaire showed that more than a quarter of the students were included in the high strain "tense" class. The main factors influencing depressive symptoms were female gender and job strain with a protective effect of social support. For anxiety symptoms, the influence of gender was not found, but the influence of stress and social support was similar to that of depression.

A study published in 2014 among French seafarers evaluated, by means of the HAD questionnaire, a score of anxiety and depression respectively > 11 in 17.9% and 7.7% of officers and 20.5% and 7.7% for other crew members [11]. These figures are very close to ours for officers, de-

Table 3. Description of variables for each Karasek class in number and frequencies

		Karasek class			
		Active	**Low strain**	**Passive**	**High strain**
Gender	Woman	12 (24%)	12 (25.5%)	7 (26.9%)	10 (21.3%)
	Male	38 (76%)	35 (74.4%)	19 (73.1%)	37 (78.7%)
Year of training	L1	13 (26 %)	10 (21.2%)	5 (19.2%)	9 (19.1%)
	L2	9 (18%)	13 (27.6%)	11 (42.3%)	15 (31.9%)
	L3	13 (26%)	10 (21.2%)	5 (19.2%)	12 (25.5%)
	M1	8 (16%)	9 (19.1%)	2 (7.7%)	6 (12.7%)
	M2	7 (14%)	5 (10.6%)	3 (11.5%)	5 (10.6%)
HAD anxiety	11 and over	9 (18%)	5 (10.6%)	3 (11.5%)	14 (29.8%)
	< 11	41 (82%)	42 (89.3%)	23 (88.5%)	33 (70.2%)
HAD depression	11 and over	4 (8%)	2 (4.2%)	2 (7.692%)	5 (10.6%)
	< 11	46 (92%)	45 (95.7%)	24 (92.3%)	42 (89.4%)

Table 4. Comparison of results (by Chi-square) of the HAD questionnaire according to the type of position according to the Karasek classification, p-values

HAD anxiety				
Active	1			
Low strain	**0.005**	1		
Passive	0.366	0.101	1	
High strain	**0.043**	**< 0.0001**	**0.010**	1
HAD depression				
Active	1			
Low strain	**0.045**	1		
Passive	0.152	0.860	1	
High strain	0.353	**0.005**	**0.036**	1

HAD — Hospital Anxiety and Depression Scale

spite differences in the population in terms of average age and the exclusive presence of men in the study by Jégaden et al. [11]. Interestingly, the authors did not find any significant difference in the average anxiety and depression scores between seafarers and sedentary controls, nor between seafarers and operational staff. Concerning the use of medication, 2.5% of the officers were taking anxiolytic or antidepressant treatments compared to 10.3% and 5% for the other seafarers [11]. In this study, the authors evaluated the disposition to boredom by questionnaire. They highlighted the existence of this state of boredom predominantly among the operational staff and that it would be linked to less external stimulation (monotony, loss of meaning at work, different relationship to time).

As for anxiety and depression, it seems that French cadets have the same health assessment as their elders. The GHQ12 questionnaire was recently used in a study

Table 5. Correlation test (Pearson) between HAD questionnaire anxiety, depression scores and job type according to Karasek classification

	Anxiety HAD	**Job demand**	**Decision latitude**	**Social support**
HAD anxiety	1			
Job demand	0.394***	1		
Decision latitude	–0.305***	–0.212**	1	
Social support	–0.457***	–0.340***	0.388***	1
	Depression HAD	**Job demand**	**Decision latitude**	**Social support**
HAD depression	1			
Job demand	0.379***	1		
Decision latitude	–0.174**	–0.212**	1	
Social support	–0.428***	–0.340***	0.388***	1

*p < 0.05;**p < 0.005;***p < 0.0001; HAD — Hospital Anxiety and Depression Scale

Table 6. Linear regression between the anxiety and depression values of the HAD questionnaire with explanatory variables

	HAD anxiety		HAD depression	
	t	R^2	t	R^2
Demographic:		0.01		0.05
Age	–0.02		0,01	
Gender	0.39		1.7**	
Karasek models:	9***	0.29	6.55***	0.27
Job demand	1.27***		1.1***	
Decision latitude	–0.9		0.08	
Social support	–1.66***		–1.4***	

*p < 0.05;**p < 0.005;***p < 0.0001; HAD — Hospital Anxiety and Depression Scale

including 72 seafarers sailing in the Adriatic Sea, the average score was 13.9, very similar to our study. A high proportion, 30%, suffered from insomnia and 26% said they were depressed or sad when they last sailed [6].

In our study, we find a high percentage of students classified as tense (24.6%) according to the Karasek model and therefore more at risk of developing psychological and cardiovascular pathologies linked to stress. This percentage is higher than those of French studies from 2008 (10%) and 2010 (13.5%). The two population samples are different, with an exclusively male population over 40 years old and including the entire crew (officers and operational staff) for Loddé et al. [5].

The difference in results can be explained by the young age of the students, who are entering working life. Being students, on placement they have less decision latitude than an officer but strong demands because they are apprentices.

In recent publications on the mental health of seafarers, several factors causing occupational stress have been highlighted, such as remoteness, long working hours, loneliness on board, multi-ethnicity, limited recreational activities and sleep deprivation. Interestingly, almost 20% of the students reported having experienced a traumatic situation during boarding. We do not have more precise data on these events. However, in their study on the psychological impact of the first embarkation, Beaucher et al. [7] described the main stress factors reported by the students as including 32% related to the operation of the ship, 14% related to damage, 14% related to piracy and then weather conditions. Stress prior to embarkation was reported by 23%.

Similarly, seafarers are commonly exposed to situations at risk of post-traumatic stress disorder as noted for 35.9% of the 323 German seafarers interviewed: maritime disasters, threats or major maritime accidents, including piracy on board (17.0%) and stowaways (39%) [12].

Another possible source of discomfort was the atmosphere on board with possible difficulty in integrating and language barriers. In Beaucher et al. [7] study 23% described a more difficult integration, but the overall feeling was positive.

Some difficulties were described with the language barrier with some crew members speaking little English. In our study, in 71% of cases French and English were spoken on board, rarely one language. We did not ask if there were other languages spoken.

The period of the COVID-19 pandemic may have influenced these results, as students are faced with uncertainty about their future and worries about what to expect from internships or their future work. A meta-analysis of 176 studies published in December 2021 found a prevalence rate of 30.6% for depression and a prevalence rate of 28.2% for anxiety among post-secondary students during the COVID-19 pandemic, worldwide [13]. It should be noted that these studies were conducted in different countries and among students from different fields. However, it is clear that anxiety and depressive symptoms can be very high among students.

COVID-19 also influenced the maritime field, as shown in a recent article which, comparing papers before and during the COVID-19 period, found that the pandemic contributed to significantly higher levels of depression and anxiety among seafarers. They found a significant difference for both depression and anxiety, indicating a significantly higher average for depression and anxiety symptoms during the pandemic than before [14]. Another study from 2021 conducted during the COVID-19 period found a prevalence of depression, anxiety, stress, self-reported anxiety general psychiatric disorders and poor perceived health of 12.3%, 11.6%, 5.9%, 2.1%, 42.6%, and 4.3%, respectively [15]. In addition, non-officer seafarers experienced significantly less psychosocial distress, such as anxiety and stress, than officers [14].

We can ask ourselves whether the period of the COVID-19 pandemic still influences the psychological health of seafarers or not.

In a Swedish case-control study including more than 700 engine officers and 300 British engineers working ashore, the authors showed no significant differences between the two populations for perceived job strain, impact of family-work and work-family conflict and global health assessment via the GHQ12. However, they noted a higher level of perceived stress and role conflict among seafarers. This perceived stress and impact on mental health was more significantly related to the conflict dimension than to role ambiguity [16]. As in our study, the factor in the job-demand model influencing stress was job strain. Contrary to our results, social support had no impact on the analysis models.

Further analysis in the population of 731 Swedish engineer officers revealed that age had no impact on the occurrence of mental illnesses or on the deterioration of work stress. On the other hand, age had a significant impact on perceived stress and the interaction between age and work stress had an impact on the stress level and mental health of seafarers. Thus, the authors concluded that the impact of job strain on stress and mental health was greater in older officers [17].

This is in line with the data from the study of French seafarers, which found the same proportion of 'tense' among officers as among operational staff, but a majority of officers classified as active (30%) and passive (53.8%) among other crew members. With age, the officers went from passive to active and the operational staff increased their passive character [18].

The high proportion of officer cadets classified in our study as tense raises questions about their future psychological stability and the risk of developing psychological pathologies.

Sickness reports of 22,763 American seafarers were analysed in the 1980s to determine the relationship between work-related stressors and the occurrence of eight stress-related diseases (cardiovascular disease, hypertension, myocardial infarction, psychoneurosis, suicide, peptic ulcer disease, gastritis, arthritis and asthma). Hierarchical position was found to be the main determinant of the rate of disease occurrence. Deck and engine officers had a significantly higher percentage of stress-related illnesses. By job category, licensed deck personnel showed higher rates of cardiovascular disease, suicide and asthma, and engine engineers of myocardial infarction and asthma. The explanatory factors expressed by the authors were the high level of responsibility, adaptation to technological and situational changes and the general ageing of the merchant marine workforce [19].

It emerges that, within the corporation of merchant navy officers, the psychosocial factors with the greatest impact on the overall and mental health of seafarers are work constraints and, more particularly, conflicts, contradictory demands and their resolution. This is in line with the latest work on German ships which found a higher level of stress among officers, which the authors linked to a regularly increasing administrative workload and sleep deprivation [2]. The intensification of rotations between the various ports, the administrative constraints of customs but also of health and the increase in profitability within maritime transport are very likely sources of this. Within our population of cadets, social support has an important protective role which can be explained by the apprenticeship period and the status of being an overcrowded cadet within the crew with special attention from the tutor. It would compensate for the high levels of stress.

Despite the good participation in our study, a selection bias with an over-representation of students aware of health and its prevention is likely. Similarly, we can assume that some students were not able to respond to the study because they were on a work placement. The length of the study's inclusion period and the reminders helped to limit this bias.

The maritime sector is essentially male. However, 23% of the respondents were women, which is not a negligible figure. We can assume that the officer community is becoming more feminine. According to the website of officers cadets school (https://www.supmartine.fr), the class of engineers who entered Marseille in 2020 was 23% female. According to national insurance figures for 2018, out of 38,956 active seafarers there were 3,072 active women, i.e. 7.9% for all sectors. In the trade sector there were 11.3% women.

LIMITATIONS OF THE STUDY

We did not ask in our questionnaire whether the respondents were taking medication such as anxiolytics or antidepressants, nor whether they were being followed up by a doctor or psychologist for these anxiety or depressive symptoms. These data would have been interesting to estimate the intensity and the impact on daily and professional life of these symptoms.

Officer cadets have short embarkations with potentially less impact on mental health and less representative of the overall merchant navy officer population.

CONCLUSIONS

The assessment of anxiety, depressive disorders and psychosocial factors in this population of French officer cadets shows the preponderance of anxiety disorders. It also highlights factors influencing their occurrence, such as female gender, high work demands and protective factors such as better decision latitude and social support. These data open up the prospects of prevention programme that take into account the reduction of the impact of these psychosocial factors or the development of protective factors in this specific population of workers.

Conflict of interest: None declared

REFERENCES

1. Oldenburg M, Hogan B, Jensen HJ. Systematic review of maritime field studies about stress and strain in seafaring. Int Arch Occup Environ Health. 2013; 86(1): 1–15, doi: 10.1007/s00420-012-0801-5, indexed in Pubmed: 22915144.
2. Oldenburg M, Jensen HJ. Stress and strain among seafarers related to the occupational groups. Int J Environ Res Public Health. 2019; 16(7): 1153, doi: 10.3390/ijerph16071153.
3. Allen P, Wadsworth E, Smith A. Seafarers' fatigue: a review of the recent literature. Int Marit Health. 2008; 59(1-4): 81–92, indexed in Pubmed: 19227741.
4. Jeżewska M, Leszczyńska I, Jaremin B. Work-related stress at sea self estimation by maritime students and officers. Int Marit Health. 2006; 57(1-4): 66–75, indexed in Pubmed: 17312695.
5. Lodde B, Jegaden D, Lucas D, et al. Stress in seamen and non seamen employed by the same company. Int Marit Health. 2008; 59(1-4): 53–60, indexed in Pubmed: 19227738.
6. Pesel G, Canals ML, Sandrin M, et al. Wellbeing of a selection of seafarers in Eastern Adriatic Sea during the COVID-19 pandemic 2020. Int Marit Health. 2020; 71(3): 184–190, doi: 10.5603/IMH.2020.0033, indexed in Pubmed: 33001430.
7. Beaucher AS. Le premier stage embarqué des Elèves Officiers de l'Ecole Nationale Supérieure Maritime: une mise en situation humaine et professionnelle. First onboard course of French cadets: a human and occupational situation. French Brest: Université de Bretagne Occidentale. 2012; 34.
8. Stern AF. The hospital anxiety and depression scale. Occup Med (Lond). 2014; 64(5): 393–394, doi: 10.1093/occmed/kqu024, indexed in Pubmed: 25005549.
9. Karasek R, Brisson C, Kawakami N, et al. The Job Content Questionnaire (JCQ): an instrument for internationally comparative assessments of psychosocial job characteristics. J Occup Health Psychol. 1998; 3(4): 322–355, doi: 10.1037//1076-8998.3.4.322, indexed in Pubmed: 9805280.
10. Karasek R, Choi B, Ostergren PO, et al. Testing two methods to create comparable scale scores between the Job Content Questionnaire (JCQ) and JCQ-like questionnaires in the European JACE Study. Int J Behav Med. 2007; 14(4): 189–201, doi: 10.1007/BF03002993, indexed in Pubmed: 18001234.
11. Jegaden D, Menaheze M, Lucas D, et al. Don't forget about seafarer's boredom. Int Marit Health. 2019; 70(2): 82–87, doi: 10.5603/IMH.2019.0013, indexed in Pubmed: 31237666.
12. Jensen HJ, Oldenburg M. Potentially traumatic experiences of seafarers. J Occup Med Toxicol. 2019; 14: 17, doi: 10.1186/s12995-019-0238-9, indexed in Pubmed: 31164911.
13. Zhu J, Racine N, Xie EB, et al. Post-secondary student mental health during COVID-19: a meta-analysis. Front Psychiatry. 2021; 12: 777251, doi: 10.3389/fpsyt.2021.777251, indexed in Pubmed: 34955924.
14. Pauksztat B, Andrei DM, Grech MR. Effects of the COVID-19 pandemic on the mental health of seafarers: a comparison using matched samples. Saf Sci. 2022; 146: 105542, doi: 10.1016/j.ssci.2021.105542, indexed in Pubmed: 34744311.
15. Deng J, Zhou F, Hou W, et al. The prevalence of depressive symptoms, anxiety symptoms and sleep disturbance in higher education students during the COVID-19 pandemic: A systematic review and meta-analysis. Psychiatry Res. 2021; 301: 113863, doi: 10.1016/j.psychres.2021.113863, indexed in Pubmed: 33984824.
16. Rydstedt LW, Lundh M. An ocean of stress? The relationship between psychosocial workload and mental strain among engine officers in the Swedish merchant fleet. Int Marit Health. 2010; 62(3): 168–175, indexed in Pubmed: 21154304.
17. Rydstedt LW, Lundh M. Work demands are related to mental health problems for older engine room officers. Int Marit Health. 2012; 63(4): 176–180, indexed in Pubmed: 24595972.
18. Jegaden D, Delbrouck P, Jégo C, et al. La santé mentale des gens de Mer. BoD. SFMM. 2022; 1(264).
19. Zeitlin L. Organizational downsizing and stress-related illness. Int J Stress Manag. 1995; 2(4): 207–219, doi: 10.1007/bf01681850.

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VIA MEDICA

LETTER TO THE EDITOR

Call for the National Boards of Health and the Maritime Administrations to introduce valid screening for type 2 diabetes at the maritime medical examinations

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Worldwide, in 2019 there were approximately 463 million adults (20–79 years) with type 2 diabetes mellitus (T2DM), by 2045 this number will have increased to 700 million adults. In addition, 374 million people have precursors to T2DM, prediabetes.

For seafarers and fishermen, there is great social inequity in relation to health, with an increased risk of obesity, metabolic syndrome, T2DM, and hypertension. There is therefore a great need for early and accurate diagnosis as part of prevention and retention in work.

Like several other occupational groups (including lorry drivers), seafarers and fishermen must undergo mandatory health examinations every or every second year by maritime doctors who are general practitioners authorized to carry out these examinations. While around 1.5 million seafarers there are millions of fishermen with medical examinations annual or biannual.

It is a major health problem that significant medical errors occur in these studies in the form of underestimation of the prevalence of T2DM with up to 80% false negatives due to the use of the current method with urine sticks. The prediabetes remains unknown, and an important prevention potential is thus not utilised. Ignorance of the prevalence of prediabetes and T2DM is a serious obstacle to establishing relevant prevention [1–3].

The focus on early diagnosis and prevention of T2DM is based on scientific evidence that preliminary stages of T2DM, prediabetes, are reversible and can be normalised with non-pharmacological measures and, moreover, are assessed to be cost–effective. The international guidelines for the diagnosis of T2DM should use laboratory analyses for long-term blood glucose (glycated haemoglobin [HbA1c]) or fasting blood glucose [4]. However, this does not happen in several European and other countries as seen in a random selection from several countries of copies of the forms used to report the results of the maritime medical examinations. Almost all of them use urine dipsticks instead of blood tests with long-term blood glucose or fasting blood glucose as recommended by the American Diabetes Association (ADA) [4].

The overall goal, seen from a medical and scientific perspective, is to establish an early and accurate diagnosis

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of T2DM during the medical examinations as a background for establishing an effective prevention in collaboration with the maritime doctors, the Maritime Authorities, the shipping companies, and other relevant organizations. Probably as the only country, Spain introduced testing of fasting blood glucose for all seafarers many years ago followed up by a HbA1c test where the fasting glucose is abnormal. Initiatives are currently underway to revise the International Labour Organization/International Maritime Organization (ILO/IMO) guidelines for medical examinations in this area.

In conclusion, there is a need for upgrading the routine “fit for duty” medical examinations also for other transport workers including, truck-, taxi- and locomotive drivers, and airline pilots to replace glucose strip test by either HbA1c or fasting blood glucose test (fasting plasma glucose) for diagnosis of T2DM.

This is hereby a call to the National Boards of Health to revise the national guidelines for the medical doctors on using fasting blood glucose or long-term blood glucose at the medical examinations for precise diagnostics of T2DM. Finally, the medical doctors should report all laboratory results with the key variables to the national occupational/maritime health research centres for analysis on the standard Excel file for use in the research and prevention [5].

Conflict of interest: None declared

REFERENCES

1. Jensen OC, Flores A, Corman V, et al. Screening for type 2 diabetes and hypertension in seafarers’ medical examinations. Int Marit Health. 2022; 73(2): 64–72, doi: 10.5603/IMH.2022.0010, indexed in Pubmed: 35781681.
2. Jensen OC, Flores A, Corman V, et al. Early diagnosis of T2DM using high sensitive tests in the mandatory medical examinations for fishers, seafarers and other transport workers. Prim Care Diabetes. 2022; 16(1): 211–213, doi: 10.1016/j.pcd.2021.12.018, indexed in Pubmed: 34996691.
3. Jensen OC, Flores A, Corman V, et al. Rethinking the use of urine dipstick for early diagnosis of Type 2 diabetes mellitus. Diabetes Res Clin Pract. 2022; 184: 109222, doi: 10.1016/j.diabres.2022.109222, indexed in Pubmed: 35114298.
4. American Diabetes Association. https://diabetes.org/diabetes/a1c/diagnosis.
5. Medical certifications fit-for-duty: Google Drev [Internet]. https://drive.google.com/drive/folders/1f_BtatpVmIReblKd1zxSDOnQh_xc7WTQ (Cited 2023 Jan 24).

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VIA MEDICA

LETTER TO THE EDITOR

Monkeypox virus among seafarers

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We would like to evaluate the article "Monkeypox virus among seafarers is not to be neglected" in which Ogunkola et al. [1] discussed the new problem of emerging monkeypox disease in seafarers. In general, monkeypox infection poses a significant risk and the virus causing the disease can easily spread between people in a suitable environment. This fact is well explained in the article as well as the fact that seafarers are more prone to the infection. The distinction between infectious disease outbreaks and emerging infectious diseases is fundamental with respect to biomedicine and public health. The infection suffered by seafarers follows the basic biomedical principles of infectious disease. To control the situation, it is necessary to understand the disease epidemiology and pathophysiology. In a nutshell, if an unknown but potentially infectious condition emerges, it must be confirmed. This basic strategy is based on the epidemiological theory. First and foremost, any potential interactions between the host (patient), agent, and the environment must be evaluated. If the criteria for epidemiological triad are fulfilled, the infection problem can be confirmed. What matters most from the epidemiological perspective is the fact of identifying the problem. After confirming that an infection exists, the next stage is to provide information about the infectious agent, path of disease transmission, susceptible host, and the extent of infection. This applies to all populations and all environments? Seafaring, like other activities, carries the risk of contracting an infectious disease; therefore, it is prudent to learn the fundamental concepts of the medical epidemiology, pathophysiology, and pathobiological processes of infection.

The epidemiological triad can provide a good explanation for the spread of infections among seafarers. The most important component of the epidemiological triad remains the agent, i.e. the pathogen. Pathogens may be present on board the ship as they could be easily transferred from land onto a ship. The pathogens could be introduced into the ship by a human, animal, or insect vector. The pathogen can easily circulate throughout the entire ship as well as within the confined spaces of the vessel. The pathogenic microorganisms can also be found in seawater [2]. In the ship's environment, the virus can initiate disease pathogenesis. The host is primarily the sailor. Seamen are generally strong men, which may indicate that they have a healthy immune system. However, if a pathogen is particularly virulent, it will be able to replicate itself regardless of the health condition of the host. As previously stated, because of limited space on board a ship it easy for pathogens and hosts to interact. In addition, a maritime journey typically lasts long enough to allow for the spread and development of infections. Limited space and poor sanitation increase the risk of contamination, and the limitations in waste disposal may promote pathogen growth. As a result, sanitation management on board is critical [3]. It is possible that the introduction of the ship disinfection procedure will be necessary. Bacteria, viruses, fungi, and parasites excreted by animals can infect surfaces and are protected by organic materials [3]. Cleaning is an important step in the sanitizing process, and if done correctly, it can remove up to 90% of pathogens [3].

Emerging infectious diseases are defined as novel infectious diseases that have recently appeared in a community or infections which existed in the past but are rapidly expanding in frequency or geographic reach. An infectious disease that is either newly emerging or re-emerging is considered to be an emerging infection. Monkeypox is an illustration of a re-emerging infection, while coronavirus disease 2019 (COVID-19) is a good example of an emerging infectious illness. In 2022, monkeypox became a worldwide health issue. A patient infected with monkeypox typically presents with a fever and disseminated vesicular skin lesions. There are currently no reports available of monkeypox outbreaks on a ship. However, the COVID-19 lesson has

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drawn the attention of maritime medical teams to disease prevention measures are. A thorough screening before boarding the ship is a must.

With regard to maritime activity specifically, there is currently a lack of information on the monkeypox host, agent, and environment. It may not always be easy to diagnose the condition. It is possible that skin lesions will be found in uncommon locations or that the clinical picture will be atypical, or both [4]. A molecular diagnostic test, which is rarely done on board, is typically needed for the correct diagnosis. Additionally, maintaining good sanitation is a crucial component of disease prevention. However, it can be difficult to maintain appropriate sanitation on board [5]. Further research on various clinical presentations of monkeypox in seafarers, the progression of the disease and the metabolism of seafarers under maritime conditions, as well as various treatment approaches that are employed to manage the disease are all of interest in this respect. In general, seamen are as susceptible to infection as any population. In this regard, we must all continue our research into the various clinical issues and illness presentations in seafarers, as well as their progression, responses of the seafarers' metabolism to the environment of the sea and the ship, and available therapeutic options.

Conflict of interest: None declared

REFERENCES

1. Ogunkola IO, Ogbodum MU, Adetola AA, et al. Monkeypox virus among seafarers is not to be neglected. Int Marit Health. 2022; 73(4): 225–226, doi: 10.5603/IMH.2022.0038, indexed in Pubmed: 36583411.
2. Maille A, Paleiron N, Grassin F, et al. [Asbestos in the National Navy: Employment-exposure matrix]. Rev Pneumol Clin. 2018; 74(6): 436–443, doi: 10.1016/j.pneumo.2018.08.002, indexed in Pubmed: 30269937.
3. Cancellotti FM. Aircraft and ship disinfection. Rev Sci Tech. 1995; 14(1): 177–189, doi: 10.20506/rst.14.1.834, indexed in Pubmed: 7548966.
4. Joob B, Wiwanitkit V. Monkeypox: Revisit of the old threat and emerging imported cases. Med J DY Patil Vidyapeeth. 2022; 15(4): 457, doi: 10.4103/mjdrdypu.mjdrdypu_440_22.
5. Tsagkaris C, Eleftheriades A, Matiashova L. COVID-19, monkeypox, climate change and surgery: a syndemic undermines the right to be operated in a clean, healthy and sustainable environment. Perioper Care Oper Room Manag. 2023; 30: 100305, doi: 10.1016/j.pcorm.2022.100305, indexed in Pubmed: 36589906.

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LETTER TO THE EDITOR

Haematological changes in COVID-19: correspondence

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We would like to share ideas on the publication "Haematological changes in sailors who had COVID-19" [1]. Ignatyev et al. [1] set out to investigate how frequently sailors with an acute coronavirus infection experienced haematopoietic alterations. Relative or absolute leukopenia is the most frequent laboratory change in the white blood cell (WBC) count in patients with the prior coronavirus disease 2019 (COVID-19), according to Ignatyev et al. [1]. According to Ignatyev et al. [1], persistent changes in WBC count should be evaluated by a complex of typical alterations because they are not necessarily beyond the reference range for absolute values. Ignatyev et al. [1] came to the conclusion that a patient with a history of COVID-19 warrants a thorough investigation for the post-COVID-19 syndrome if there are any typical alterations in WBC count. We both believe that a thorough examination into the causes of the haematological anomalies is necessary. The COVID-19 may or may not have anything to do with the observed change in the current report. There could be conflicting problems. To begin with, it's important to rule out any concomitant infections. As an illustration, dengue is a potential co-infection that may have an impact on the haematological parameter [2]. Second, underlying haematological conditions may potentially have an impact. It is important to rule out a variety of nutritional issues such iron and folate deficient illnesses as well as hereditary diseases like haemoglobinopathies.

Conflict of interest: None declared

REFERENCES

1. Ignatyev O, Panyita O, Prutiian K, et al. Haematological changes in sailors who had COVID-19. Int Marit Health. 2022; 73(4): 178–180, doi: 10.5603/IMH.2022.0031, indexed in Pubmed: 36583404.
2. Dalugama C, Seneviratne SL. Dengue and COVID-19 co-infections: an important consideration in the tropics. Trans R Soc Trop Med Hyg. 2022 [Epub ahead of print], doi: 10.1093/trstmh/trac114, indexed in Pubmed: 36479900.

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Editorial

Dear Colleagues,

with this issue the International Maritime Health Foundation (IMHF), owner and publisher of this journal, wishes to introduce to you a new section named 'Magazine'.

Among the statutory objectives of the IMHF the most prominent is to provide a platform for the dissemination of knowledge into the maritime health community: the journal you are reading right now!

Despite a long history, the International Maritime Health journal has for a long time struggled to overcome financial challenges. Its editorial staff has gone to extremes to collect, review and publish four issues per year, striving for scientific accomplishment (impact factor!) and recognition by its readers. In October 2021 the IMHF organized an expert workshop aiming to define ways into a sustainable future of the journal and of the foundation in general. A report resulted in numerous recommendations that laid base for the IMHF's strategy plan. You will hear more about that in this journal.

Among the recommendations was the idea to add to the scientific part of the journal a magazine section to foster its impact in the maritime medical practitioner community.

Today this "new kid on the block" enters the stage. We want to provide you with information ranging from announcements of professional events, to chronicles/obituaries, book reviews, educational articles (CME), ongoing research and development projects and many more.

We would also like to encourage our readers to come forward with own info or feedback. We are looking forward to engage in a hopefully vivid communication with you, our readers!

Nebojsa Nicolic
President Management Board
International Maritime Health Foundation

the seafarers' charity

The 'Magazine' section of this journal is supported by the Seafarers' Charity (www.theseafarerscharity.org).

Announcements or Events

EVENTS

The Seafarers' Charity is one of the organizations supporting the International Maritime Health Foundation — owner and publisher of this journal — through a grant for the 2022–2024 period.

Therefore, it is our pleasure to make our readers aware of the two fundraising events planned for 2023:

- Seafarers' Charity has a limited number tickets to join the team 'Seafarers KGFS' at LONDON MARATHON; 23rd April, 2023;
- Seafarers' Charity organizes the '24 PEAKS CHALLENGE 2023'; 1st to 2nd July, 2023.

For more information and application see: www.theseafarscharity.org

SEAFARER MENTAL HEALTH CONFERENCE AND WORKSHOP

Friday 28th April 2023 (9.00am–5.45pm)
National Maritime College of Ireland,
Munster Technological University, Cork, Ireland

The International Maritime Health Foundation (IMHF) is delighted to announce a conference and workshop dedicated to addressing Seafarer Mental Health Challenges.

Conference: The purpose of the conference is to actively address facilitators and challenges in relation to the mental health of seafarers. Conference themes include wellbeing, suicide awareness and prevention, public health management, bullying and harassment, and organisational justice, from a policy, legal, and human rights/social justice perspective.

Who should attend? The IMHF welcomes all who seek to make a positive impact on seafarer mental health challenges.

Workshop: The final session of the day will feature an industry consensus workshop to facilitate active knowledge exchange between attendees and to capture input on how to translate recommendations into policy. All conference attendees are invited to contribute to the consensus workshop.

Register here: https://www.eventbrite.ie/e/seafarer-mental-health-workshop-tickets-544643241597

1983–2023, 40TH ANNIVERSARY OF FRENCH MEDICAL ASSISTANCE AT SEA

On October 12th and 13th, 2023, the French telemedical assistance service will organize a meeting in Toulouse to take stock of its activity and to consider its future.

This event, entitled:

“40 years of Medical Assistance at Sea, a common history”

will bring together all the actors involved in this activity. Sailors, shipyards, maritime prefectures, MRCC, French Navy, ...

You are all invited to come and celebrate this anniversary during the meeting.

You can receive the detailed program during the second quarter.

Further information and registration at: ccmm.secretariat@chu-toulouse.fr

News from the International Organizations

MARITIME HEALTH INFORMATION

Nebojsa Nicolic, Klaus Seidenstuecker

Joint Action Group recommendations to mitigate impacts of health recommendations on transport key workers:

The Joint UN/industry sector Action Group (JAG) was established by the UN Secretary General in December 2021 to review the impact of the COVID-19 pandemic on the world’s transport workers and the global supply chain (TSC). The following organizations cooperate within the JAG-TSC: ILO, WHO, IMO, ICAO, ICS, ITF, IATA, IRU. Since the JAG-TSC has published recommendations. The most recent ones dated January 27, 2023, can be accessed using the following link: https://www.ilo.org/global/about-the-ilo/newsroom/news/WCMS_866326/lang–en/index.htm

Another recent publication on the issue is the WHO’s “Statement on the fourteenth meeting of the International Health Regulations (2005) Emergency Committee regarding the coronavirus disease (COVID-19) pandemic”, dated January 30, 2023. This document can be accessed using the following link: who.int/news/item/30-01-2023-statement-on-the-fourteenth-meeting-of-the-international-health-regulations-%282005%29-emergency-committee-regarding-the-coronavirus-disease-%28covid-19%29-pandemic

For more actual information you can register with the WHO webinars at: https://www.who.int/teams/epi-win/epi-win-webinars

Book Review

TEXTBOOK OF MARITIME HEALTH — A GATEWAY TO UPDATED KNOWLEDGE

By Jon Magnus Haga and Alf Magne Horneland

Third edition of Textbook of Maritime Health was recently published. It provides you with a comprehensive overview of the field of maritime health.

Maritime health is a multidisciplinary field, concerned with all aspects of health of people at sea. Health professionals involved in people at sea, face a context that differs to health work on shore. Seafarers may have limited training in health-related matters, even if they are officers in charge of medical care aboard. Maritime health needs to integrate the medical knowledge with the maritime context.

As a medical field, maritime health is diverse. It encompasses most medical disciplines on shore, including public health, occupational medicine and clinical medicine.

The scope of the book is to provide an updated and comprehensive textbook targeted at all those involved in providing health at sea, covering as many aspects of maritime medicine as possible.

The context of health service provision at sea

People are at sea for a variety of reasons. Some are at sea for work, others for leisure. Some are boarding ships, boats, oilrigs or fish farms. Others swim or dive into the sea. Some people travel long distances, others stayed where they are. The maritime domain is diverse. So is maritime health.

A ship is a 24 hours society. Seafarers work, eat, sleep and spend their free time aboard. Thus, maritime health is not only individual-oriented health care, but also health promotion, disease prevention and planning of good healthcare services aboard. Moreover, as health at sea is not only a personal matter, but rather intimately connected with safety and risk of others, maritime health builds on a larger picture of health and maritime safety.

The history of the textbook

The predecessor of the current textbook of maritime health, the Textbook of Maritime Medicine, was first published online in 2009. The textbook contained contributions from a number of authors and was edited by Aksel Schreiner. The textbook was well received, and gained a broad readership in Norway and abroad. Following its success, it was later extensively revised and edited by Tim Carter and republished as a second edition in 2013.

Since 2017 preparation of the third edition has been ongoing. Again, the content was extensively revised and amended. Furthermore, the scope of the textbook was extended to include more topics on the health and welfare of seafarers and the challenges of the maritime industries in general. In the third edition, less focus has been placed on the management of a number of clinical conditions as in previous editions, as these topics have now been covered in the new online Mariners Medico Guide (www.medicoguide.com) developed in parallel with the textbook.

More than 60 international experts were invited to contribute as authors in the third edition These were experts from across the sector and across the world. The texts were edited by a team of clinicians experienced in maritime medicine at the Norwegian Centre for Maritime and Diving Medicine, including Sue Stannard, Tim Carter, Alf Magne Horneland and Jon Magnus Haga.

In order to ensure quality and direction throughout the project, an international advisory board chaired by Alf Magne Horneland has supervised the work with all three editions of the textbook. The editorial board included Luisa Canals (Spain), Tim Carter (United Kingdom), Lisa Loloma Froholdt (Denmark), Henrik Hansen (Denmark), Klaus Seidenstücker (Germany), Suzanne Stannard (United Kingdom), Arne Johan Ulven (Norway) and Rob Verbist (Belgium).

A dynamic publication

The aim of this textbook is to provide information on health services to people at sea, as well as the contextual specifics to health service providers that aims at working with people at sea — thus promoting health at sea. Although it is comprehensive, the textbook is by no means final or complete. The field of maritime health is large and ever growing. Thus, the textbook remains a dynamic publication, subject to improvement and amendment as the field develops and suggestions for change or additional topics are brought to the attention of the editors.

Health builds on knowledge. Knowledge is to be shared. The textbook is provided online and free of charge. All those interested in maritime health are invited to read and to share — and to contribute with their expertise to future amendments.

Link to the full textbook: https://textbook.maritimemedicine.com/

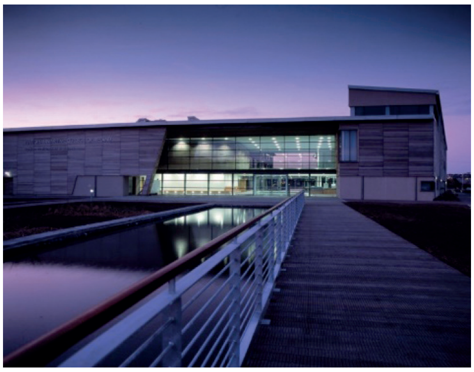
Presentation of Institutes

The National Maritime College of Ireland (NMCI) is a constituent college of Munster Technological University (MTU) and is located in the port of Cork. The NMCI is part of a Public Private Partnership in association with the Irish Naval Service and Focus Education. The college provides education and training for those who wish to embark on a maritime career and also provides continuous professional development for practicing seafarers. Most of the courses provided are aligned with the requirements for professional qualifications according to the Standards of Training and Certification of Watchkeepers (STCW) but uniquely, are also aligned with academic qualifications, presently up to Bachelors' honours degree standard (National Framework of Qualifications at Level 8).

The college provides various entry levels from secondary school leavers to those who work at sea on deck and also personnel who work in shore-based industry. There are four main areas of study; Nautical Science, Marine Engineering, Marine Electrotechnology and Supply Chain/Logistics, all of which are coordinated by the Department of Maritime Studies. Successful students gain qualifications up to Master (Unlimited), Chief Engineer, and Chief Electrotechnology Officer. A related department, NMCI Services, provides a range of courses for professional qualification updating, bespoke courses for the maritime industry such as specific ship simulation, and short courses for the offshore industry.

Mandatory STCW short courses in Elementary First Aid, Medical First Aid and Medical Care are provided. Also, before going to sea, all students/cadets are given lectures on how to adapt to shipboard life in terms of working in a multicultural environment, living away from home and shipboard stress. The college has a full-time student counsellor who meets regularly with students and addresses common mental health issues. The counselling service provides one-to-one meetings for both shore-based and sea-based students. The college was the first third-level college to work with the International Seafarers' Welfare and Assistance Network (ISWAN). Senior students complete a module on the human element, and this enables them to implement management decisions for crew welfare and to enhance safe ship operations.

NMCI, in association with the professional organisations, the Nautical Institute (NI) and the Irish Institute of Master Mariners (IIMM), held a successful conference in Autumn 2022 on Seafarer Wellness. In the Spring of 2023 ($27^{th}/28^{th}$ April), international workshops and a conference on Seafarer Mental Health will be held in the college with the objective of addressing maritime policy for the benefit of seafarers worldwide.



The National Maritime College of Ireland/Munster Technological University

INFORMATION FOR AUTHORS

The International Maritime Health will publish original papers on medical and health problems of seafarers, fishermen, divers, dockers, shipyard workers and other maritime workers, as well as papers on tropical medicine, travel medicine, epidemiology, and other related topics.

Typical length of such a paper would be 2000–4000 words, not including tables, figures and references. Its construction should follow the usual pattern: abstract (structured abstract of no more than 300 words); key words; introduction; participants; materials; methods; results; discussion; and conclusions/key messages.

Case Reports will also be accepted, particularly of work-related diseases and accidents among maritime workers.

All papers will be peer-reviewed. The comments made by the reviewers will be sent to authors, and their criticism and proposed amendments should be taken into consideration by authors submitting revised texts.

Review articles on specific topics, exposures, preventive interventions, and on the national maritime health services will also be considered for publication. Their length will be from 1000 to 4000 words, including tables, figures and references.

Letters to the Editor discussing recently published articles, reporting research projects or informing about workshops will be accepted; they should not exceed 500 words of text and 5 references.

There also will be the section Chronicle, in which brief reports will be published on the international symposia and national meetings on maritime medicine and health, on tropical parasitology and epidemiology, on travel medicine and other subjects related to the health of seafarers and other maritime workers. Information will also be given on training activities in this field, and on international collaborative projects related to the above subjects.

All articles should be submitted to IMH electronically online at www.intmarhealth.pl where detailed instruction regarding submission process will be provided.

Only English texts will be accepted.

Manuscripts should be typed in double line spacing on numbered pages and conform to the usual requirements (Ref.: International Committee on Medical Journals Editors. Uniform Requirements for Manuscripts Submitted to Biomedical Journals, JAMA, 1997; 277: 927–934).

Only manuscripts that have not been published previously, and are not under consideration by another publisher, will be accepted.

Full texts of oral presentations at meetings (with abstracts printed in the conference materials) can be considered.

All authors must give written consent to publication of the text.

Manuscripts should present original material, the writing should be clear, study methods appropriate, the conclusions should be reasonable and supported by the data. Abbreviations, if used, should be explained.

Drugs should be referred to by their approved names (not by trade names). Scientific measurements should be given in SI units, except for blood pressure, which should be expressed in mm Hg.

Authors should give their names, addresses, and affiliations for the time they did the work. A current address of one author should be indicated for correspondence, including telephone and fax numbers, and e-mail address.

All financial and material support for the reported research and work should be identified in the manuscript.

REFERENCES

References should be numbered in the order in which they appear in the text. At the end of the article the full list of references should give the names and initials of all authors (unless there are more than six authors, when only the first three should be given followed by: et al.).

The authors' names are followed by the title of the article; the title of the journal abbreviated according to Medline; the year of publication, the volume number; and the first and last page numbers. **Please note:** References you should include DOI numbers of the cited papers (if applicable) – it will enable the references to be linked out directly to proper websites. (e.g. Redon J, Cifkova R, Laurent S et al. Mechanisms of hypertension in the cardiometabolic syndrome. J Hypertens. 2009; 27(3): 441–451, doi: 10.1097/HJH.0b013e32831e13e5.).

Reference to books should give the title, names of authors or of editors, publisher, place of publication, and the year.

Information from yet unpublished articles, papers reported at meetings, or personal communications should be cited only in the text, not in References.

For full information for authors refer to the web page: www.intmarhealth.pl.

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