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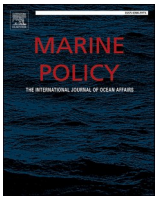

The impact of the COVID-19 pandemic on seafarers' mental health and chronic fatigue: Beneficial effects of onboard peer support, external support and Internet access

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ABSTRACT

While commercial shipping remained vital for maintaining global supply chains during the COVID-19 pandemic, measures imposed to control the spread of infection have disrupted crew changes and impacted interactions with port personnel and among crew members on board. Initial reports indicate that this affected work and life on board, the length of seafarers' time on board as well as seafarers' employment and family concerns. However, the consequences for seafarers' well-being are not well understood. The purpose of this study was to examine the effects of the COVID-19 pandemic on seafarers' mental health and chronic fatigue, and to analyze the role of potential mitigating factors, notably onboard peer support, external support and Internet quality. Survey responses from 622 seafarers on international commercial vessels were analyzed using structural equation modeling. Findings suggested that the impact of the pandemic increased seafarers' fatigue and mental health problems. However, they also indicated ways of mitigating the negative impact of the pandemic and increasing resilience by enhancing support from fellow crew members on board, ensuring the availability of external support and providing fast and reliable Internet access.

1. Introduction

The COVID-19 pandemic has had a substantial impact on the transportation sector, including the maritime industry. While the cruise industry suspended operations in March 2020 [39], commercial shipping continued to operate during the COVID-19 pandemic, albeit at reduced levels in certain sectors and ports [50]. To comply with international maritime conventions that protect the safety, health and welfare of about 1.6 million seafarers worldwide [8], approximately 150,000 crew changes are required each month [50]. However, due to protective measures imposed to control the spread of infection, the repatriation of seafarers has faced unprecedented challenges, leaving many seafarers unable to travel to and from their ship [15,28].

Initial studies explored the impact of the COVID-19 pandemic on seafarers' physical health [40] and on their rights to shore leave, medical care and repatriation [20], while Sliskovic [45], Shan [44] and reports from welfare organizations [12,28] provided insights into the experiences and concerns of seafarers. Recent studies [7,37] examine the prevalence of mental health problems among seafarers during the pandemic, but it remains unclear to what extent and how these mental health problems are linked to the pandemic rather than to pre-existing causes. To our knowledge, there are no survey studies concerning the impact of the pandemic on seafarers' fatigue or about the role of potential mitigating factors. In sum, the effects of the pandemic on seafarers' mental health and fatigue and the influence of potential mitigating factors are not yet well understood.

Fatigue, defined as "a biological drive for recuperative rest" ([53], p. 499), has long been recognized as a key concern in the maritime industry (for a review, see [24]). Here we focus on chronic fatigue, i.e. fatigue that builds up over time when recovery is insufficient [5].

Seafarers' mental health has only recently started to gain attention (for a review, see [42]). Here we focus on two common mental health problems: depression and anxiety [25,26,42]. Depression is characterized by depressed mood and anhedonia, i.e. loss of interest or pleasure in

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daily activities ([4], p. 160). Anxiety is characterized by "excessive anxiety and worry (apprehensive expectation) about a number of events or activities" ([4], p. 222). Depression and anxiety are closely associated: they often co-occur, they have overlapping symptoms and they might have a shared genetic predisposition [25,30]. Hence, in the present study, they are considered jointly as mental health problems.

Previous studies have advanced our knowledge of seafarers' fatigue [24] and have started to examine mental health problems [7,26,37,42]. However, little is known about the ways in which seafarers' fatigue and mental health problems are affected by crises such as the COVID-19 pandemic.

Further, previous studies on seafarers' fatigue focused on stressors [24], but have paid less attention to mitigating factors. This is despite the fact that studies in other work contexts suggest that mitigating factors such as social support play an important role [6,19]. In a seafaring context, research indicates that onboard peer support may have beneficial effects for seafarers' mental health and fatigue [5,36,52,54]. Other factors, such as Internet access or external support, could play a role as well [22,26,42]. However, we know little about the relative importance of mitigating factors, or their effectiveness during a crisis such as the COVID-19 pandemic.

As regulatory frameworks are revisited in light of experiences during the COVID-19 pandemic, a better understanding of the impact of the pandemic and the role of mitigating factors will be important to inform the development of effective policies to prepare for future crises. This study examines the impact of the COVID-19 pandemic on seafarers' mental health and chronic fatigue and analyzes the role of onboard peer support, external support and Internet quality as mitigating factors. To test our hypotheses, we use structural equation modeling to analyze survey responses from 622 seafarers on international commercial vessels.

2. Theoretical framework

According to the allostatic model (for a summary and review, see [31]), mental health problems and fatigue can result from excessive, prolonged and/or repeated exposure to stressors, such as high job demands, stressful life events and chronic negative experiences [4,30]. In addition, mental health problems and fatigue can mutually affect and reinforce each other [3,32,35,46].

In a work context, employees' mental health and fatigue are affected both by job demands and resources [6]. Job demands are "aspects of the job that require sustained physical, emotional or cognitive effort" ([6], p. 392). High job demands (e.g. workload, work hours, physical working conditions) have been associated with increased mental health problems and fatigue [6,19]. Resources are "physical, psychological, social, or organizational aspects of the job that help to either achieve work goals, reduce job demands and the associated physiological and psychological costs, or stimulate personal growth, learning, and development" ([6], p. 392). Key resources identified in previous studies include job control and social support [6,19].

In the next sections, we first consider the impact of the pandemic as a stressor and then turn to the resources that might mitigate its effects on seafarers' mental health and fatigue.

2.1. The impact of the COVID-19 pandemic

The impact of the COVID-19 pandemic on seafarers has been addressed in news coverage and social media reports [39], editorials and overviews of the developments [13,15,48], reports by welfare organizations [12,28] and descriptive studies on seafarers' experiences during the pandemic [20,44,45]. A review of the information available suggests that the impact of the pandemic can be roughly grouped into three categories: (1) the impact on seafarers' work and life on board, (2) the length of time seafarers have been on board and (3) seafarers' employment and family concerns.

First, the COVID-19 pandemic entailed changes to work and life on board [15,20,28,44,45]. This included additional tasks such as enhanced cleaning, disinfecting and more paperwork in connection with port calls, as well as adjustments to working and living arrangements to observe physical distancing. Restricted access to shore-based services and facilities also made it difficult to have contractors on board for maintenance and repair work, to get supplies, or to go ashore for medical care, shopping, or recreation.

Second, due to the delay or cancelation of crew changes, seafarers' time on board may be extended. Thus they may be required to stay on board for longer, in some cases beyond what is permitted under international conventions [13,15,20,28,44,45].

Third, the COVID-19 pandemic may have an impact on seafarers' employment and family concerns. This includes concerns about pay and future employment opportunities, as well as concerns about the health and financial situation of their family [12,20,28,44,45].

Taken together, the pandemic can be considered a stressful life event associated with negative experiences, worries and a sense of vulnerability. Similar to other types of stressful or traumatic experiences [23,43], this may have negative consequences for seafarers' mental health.

Hypothesis 1.. The impact of the pandemic with regard to (a) work and life on board, (b) length of seafarers' time on board and (c) seafarers' employment and family concerns increases mental health problems.

The impact of the COVID-19 pandemic on board can entail higher workloads [15,28,44], due to extra work required by COVID-19 precautions and/or less crew due to the difficulties in arranging crew changes. Job demands such as high workloads, long work hours and insufficient sleep are well known risk factors for fatigue [24,52].

Moreover, seafarers' comments [28,45] indicate that the length of time on board can increase fatigue. This is in line with the allostatic model [31], which suggests that exposure to stressors over a longer time has a more severe impact. Hence we expect:

Hypothesis 2.. The impact of the pandemic with regard to (a) work and life on board and (b) length of seafarers' time on board increases fatigue.

2.2. Support

Research on social capital suggests that both mutual support among group members and support from outside the group are vital for coping with negative events and experiences [2]. Building on these insights, we consider both onboard peer support and external support.

Social support, i.e. the support that individuals receive through their social connections to others, has been widely recognized as a resource that can mitigate stressors, buffer their impact and reduce strain [19,47]. Social support comprises instrumental support, such as providing practical help or information, and emotional support, such as expressing sympathy and caring [47].

In this study, onboard peer support is defined as social support from fellow crew members on board. Previous studies suggest that onboard peer support reduces seafarers' fatigue [5,21,36,52]. Although qualitative studies suggest that onboard peer support might alleviate mental health problems [42], its effect on depression and anxiety has not been tested. However, a few studies have examined its effect on stress. Onboard peer support has been associated with lower levels of stress [21,36] and with higher psychological capital, which in turn reduced the risk of burnout [54]. Hence we expect:

Hypothesis 3. Onboard peer support reduces (a) mental health problems and (b) fatigue.

External support refers to the support received by seafarers from individuals and organizations ashore or from seafarers on other vessels. External support can include formal support (e.g., bonus payments;

changes in task division between crew and shore personnel) and informal support (e.g., shore personnel helping out informally; emotional support from family or friends).

Existing studies indicate the importance seafarers themselves attach to support from friends and family [1,26,42,49] and from port-based welfare services [33,56]. Additional sources of external support may include shipping companies, labor unions, as well as government authorities of port states, flag states and seafarers' home countries. However, neither the support they provide nor its benefits have received much research attention to date. Instead, existing studies tend to highlight the problems seafarers experience with shore personnel [41,55]. But shipping companies and other shore-based organizations may arguably be a source of support as well [15,48].

External support may be beneficial in several ways. For instance, family and friends may alleviate seafarers' worries about the situation at home; individuals and organizations may provide emotional support in person, via telephone or online; shipping companies, port states and seafarers' home countries may cooperate to arrange crew changes; shipping companies' shore personnel may take over some of the extra administrative work caused by the pandemic; or shipping companies may offer flexible payment schemes to support seafarers and their families. Hence we expect:

Hypothesis 4.. External support reduces (a) mental health problems and (b) fatigue.

2.3. Internet quality

Existing survey studies provide little evidence for a direct effect of Internet access on seafarers' mental health or fatigue [26,46]. Here, we propose that Internet access – and especially the quality of Internet access with regard to speed and reliability [22] – has an *indirect* effect on seafarers' mental health and fatigue. First, Internet quality may mitigate the effects of the pandemic on work and life on board and with regard to seafarers' employment and family concerns, for instance by facilitating communication and coordination with shore-based personnel, or by providing up-to-date information about COVID-19 symptoms and treatment, port regulations, or the situation in seafarers' home countries.

Hypothesis 5.. Internet quality has a negative indirect effect on (a) mental health problems and (b) fatigue through work and life on board.

Hypothesis 6.. Internet quality has a negative indirect effect on mental health problems through seafarers' employment and family concerns.

In addition, fast and reliable Internet access facilitates access to external support. Interview studies show that Internet access allows seafarers and their families to receive and provide support, keep up-to-date with events and participate in decision making [1,49]. Similarly, the Internet provides access to support from other individuals and organizations, including shipping companies, government agencies or welfare organizations.

Hypothesis 7.. Internet quality has a negative indirect effect on (a) mental health problems and (b) fatigue through external support.

3. Methods

3.1. Procedure

Data were collected through an online survey between 3 July and 25 September 2020 from a convenience sample of seafarers on international commercial vessels, i.e. cargo, passenger and special purpose vessels with an International Maritime Organization (IMO) ship identification number. The survey was in English, and was distributed as widely as possible through industry organizations, maritime administrations, maritime education and research institutions and welfare organizations, primarily via email, websites and social media. Participation in the study was voluntary and participants were anonymous. Before starting the survey, participants were informed about the study and confirmed that they consented to participate in the survey.

3.2. Sample

The analyses in this study are based on responses from 622 seafarers on international commercial vessels who, at the time of the survey, had been on board for at least one week. For the purpose of this study, respondents on cruise ships and those who had not provided information about ship type were excluded.

Responses to demographic questions showed that most respondents were men (94.7%).[1] They came from over 40 countries on six continents, most (34.1%) from the Philippines, followed by Denmark, Germany and Sweden (7.4% each). Respondents were between 19 and 65 years old (mean = 40.24, SD = 10.22) and had worked between 0 and 47 years at sea (mean = 17.93, SD = 10.66). At the time of the survey, they had been on board between less than a month and eighteen months (mean = 4.09, SD = 3.73). Most respondents worked in the deck department (63.8%) or in the engine department (28.0%); 77.5% were officers.

Most respondents worked on container ships (23.2%), oil tankers (20.9%) or bulk carriers (15.4%). About half (53.1%) worked on vessels with up to 20 crew members and 36.7% worked on vessels with 21–30 crew members. Respondents reported having no (13.7%), limited (51.1%) or unlimited (34.9%) free Internet access on board for personal use. The vessels represented over 40 flag states, with Sweden (13.2%), Denmark (10.9%), Germany (8.7%), Liberia (7.6%), Norway (7.2%) and Malta (6.4%) mentioned most frequently. When asked about the country of their last port of call, respondents named over 80 countries, most frequently China (7.1%), Australia (6.1%), Singapore (5.8%), Sweden (4.8%) and Brazil (4.5%).

3.3. Measures

The wording of items is shown in Table 1. Mental health problems were measured with four items adapted from the PHQ-4 scale [25], which combines items on symptoms of depression and anxiety. Fatigue was measured with three items from the seafarers' fatigue scale [36]. Respondents rated how frequently they had experienced symptoms of mental health problems and fatigue during the last seven days. Answer categories ranged from 1 = "never" to 5 = "every day". A seven-day period was chosen because a short reference period was expected to be more sensitive to rapid changes in local, national and international developments during the pandemic.

The impact of COVID-19 on work and life on board and on seafarers' employment and family concerns was measured with items developed for this study based on reports from welfare organizations and media coverage in spring 2020 (see Section 2.1). Seafarers were asked to rate the seriousness of the pandemic's impact ("How seriously has COVID-19 affected the following?") for each item, with answer categories from 1 = "not at all" to 7 = "to a very high extent".

Length of time on board was measured with two items. The first was the number of months that respondents had been on board. The second item assessed whether respondents had been on board longer than expected, by comparing the number of months on board with the expected length of respondents' work period. The item was coded 2 when respondents had been on board longer than expected, 1 for respondents who were around the end of their expected work period, and 0 otherwise.

Onboard peer support was measured with three items on instrumental and emotional support adapted from social support scales [10,

[1] Percentages in this section were calculated relative to $n = 622$.

Table 1
Confirmatory factor analysis.

Construct	Item	Factor loading	S.E.	AVE
Mental health problems	Feeling sad, depressed or hopeless	0.857	0.019	0.587
	My days have been filled with things that interest me [reverse-coded]	0.499	0.040	
	Feeling afraid, anxious or worried	0.845	0.017	
	Always worrying about something	0.805	0.021	
Fatigue	Feeling exhausted (except after sports)	0.851	0.020	0.663
	Feeling very tired during work	0.875	0.016	
	Having sleeping problems (e.g., unable to fall asleep or not sleeping well)	0.707	0.028	
COVID-19 impact on work and life on board	Work routines on this ship	0.647	0.038	0.388
	The crew's non-work life on board	0.696	0.036	
	Interactions between ship and shore	0.626	0.042	
	Crew changes (e.g., change dates, travel to/ from home) for crew of this ship	0.507	0.045	
COVID-19 impact on employment and family concerns	Health and financial situation of your family	0.781	0.038	0.687
	Your employment (e.g., income, future work opportunities, etc.)	0.874	0.039	
Time on board	Number of months on board	0.902	0.037	0.814
	On board longer than expected	0.902	0.037	
Onboard peer support	When I need help from other crew members, I get it.	0.771	0.031	0.550
	I can rely on other crew members when things get stressful.	0.912	0.026	
	There is at least one person on board with whom I can talk about private things or problems at home.	0.472	0.039	
External support	We received a lot of support.	0.904	0.022	0.828
	We received enough support.	0.916	0.020	
Internet quality	Speed	0.882	0.028	0.801
	Reliability of the connection	0.908	0.025	

Notes: Standardized factor loadings, standard errors and AVE for each variable, based on data from 622 respondents. Model goodness of fit statistics: χ^2 = 427.402, df = 181; RMSEA = 0.047, 90% confidence interval: 0.041–0.053; CFI = 0.959; SRMR = 0.043.

51]. Respondents rated the extent to which they agreed or disagreed with each statement, with answer categories from 1 = "strongly disagree" to 7 = "strongly agree".

The level of external support since the start of the COVID-19 pandemic was measured with two items. Respondents rated the extent to which they agreed or disagreed with each statement, from 1 = "strongly disagree" to 7 = "strongly agree".

Internet quality was measured with two items that assessed key aspects of the quality of onboard Internet access [22], i.e. the speed and reliability of the connection. Respondents were asked to rate their satisfaction with each, from 1 = "very dissatisfied" to 7 = "very satisfied".

In addition, the survey included questions about respondents' gender, age, experience at sea, nationality, hierarchical level (from 0 = "cadet / trainee" to 5 = "captain") and department, as well as about the ship type, flag state, crew size (from 1 = "less than 5" to 9 = "more than 500"), free Internet access for personal use (1 = "no free access", 2 = "limited free access", 3 = "unlimited free access") and country of the last port call of their vessel.

3.4. Analytical approach

To test our hypotheses, we used structural equation modeling (SEM) with robust maximum likelihood (MLR) estimation, using Mplus version 8.4 [29]. This allowed us to take into account the interdependencies between the two dependent variables (mental health problems and fatigue) and to model the effects of the impact of the pandemic, onboard peer support and external support as well as the indirect effects of Internet quality. Missing values were substituted using full information maximum likelihood (FIML) imputation [18,29].

The confirmatory factor analysis (Table 1) indicated a good fit of the measurement model (χ^2 = 427.402, df = 181; RMSEA = 0.047, 90% confidence interval: 0.041–0.053; CFI = 0.959; SRMR = 0.043). All factor loadings were significant and (with two exceptions) exceeded the recommended value of.5 [18]. The exceptions were one item measuring mental health problems and one item measuring onboard peer support (factor loadings: 0.499 and 0.472, respectively). Additional analyses showed that the inclusion or exclusion of these two items did not affect the conclusions concerning the hypotheses. The items were retained on theoretical grounds to ensure that the two variables covered key aspects of the respective concept, i.e. anhedonia for mental health problems and emotional support for onboard peer support. Table 2 shows descriptive statistics and correlations among the variables, together with demographic characteristics of the respondents.

Table 3 shows the results of the hypothesized structural model. In addition to the parameters required to test the hypotheses, the model allowed for correlations between the variables on COVID-19 impacts (impact on work and life on board; impact on employment and family concerns; time on board), and, in line with previous research [4], between fatigue and mental health problems. Correlations between the exogenous variables were included by default. The hypothesized structural model fit the data well (χ^2 = 495.544, df = 188; RMSEA = 0.051, 90% confidence interval: 0.046–0.057; CFI = 0.949; SRMR = 0.060).

To test for mediation (Hypotheses 5–7), we used the Sobel test to assess the significance of the indirect effects of Internet quality on mental health problems and fatigue. Examining the bias-corrected bootstrapped 99% confidence intervals (ML estimation; 10,000 bootstrap samples) of the indirect effects led to the same conclusions.

Respondents' demographic characteristics were not included in the final model (Table 3). We conducted additional SEM analyses where we included hierarchical level, department (engine) and either age or experience at sea[2] as predictors of the endogenous variables, and allowed them to co-vary with the exogenous variables. The inclusion or exclusion of respondents' demographic characteristics did not affect our conclusions concerning the hypotheses.

4. Results

As shown in Table 2, on average respondents had experienced symptoms of mental health problems and fatigue "once" or "several times" during the last seven days. However, there was considerable variation. Concerning mental health problems, 29 respondents had not experienced any symptoms, whereas ten respondents had experienced all four symptoms "every day". Concerning fatigue, 56 respondents had not experienced any symptoms, whereas 21 respondents had experienced all three symptoms "every day".

[2] Due to the small number of female respondents (n = 26), we did not include gender.

Table 2
Descriptive statistics and correlations.

		n[a]	Mean (SD)	α	1	2	3	4
1	Mental health problems	622	2.58 (1.00)	0.83				
2	Fatigue	622	2.63 (1.05)	0.85	0.732 ***			
3	COVID-19 impact on work and life on board	622	4.75 (1.23)	0.71	0.355 ***	0.342 ***		
4	COVID-19 impact on employment and family concerns	622	3.73 (1.84)	0.81	0.326 ***	0.277 ***	0.346 ***	
5	Time on board	574	2.55 (2.34)	0.90[b]	0.289 ***	0.303 ***	0.168 ***	0.251 ***
6	Onboard peer support	618	5.43 (1.16)	0.71	-0.396 ***	-0.372 ***	-0.086 *	-0.137 ***
7	External support	617	3.95 (1.74)	0.91	-0.421 ***	-0.427 ***	-0.229 ***	-0.091 *
8	Internet quality	608	3.52 (1.73)	0.89	-0.268 ***	-0.311 ***	-0.218 ***	-0.140 ***
9	Age (in years)	547	40.24 (10.22)	(-)	-0.144 ***	-0.217 ***	0.063	-0.044
10	Experience at sea (in years)	597	17.93 (10.66)	(-)	-0.117 **	-0.183 ***	0.102 *	-0.068
11	Hierarchical level	609	3.25 (1.43)	(-)	-0.021	-0.085 *	0.158 ***	-0.121 **
12	Department: engine (1 = yes)	612	0.28 (0.45)	(-)	-0.025	0.030	-0.050	-0.017

		5	6	7	8	9	10	11
5	Time on board							
6	Onboard peer support	-0.130 **						
7	External support	-0.096 *	0.375 ***					
8	Internet quality	-0.016	0.310 ***	0.410 ***				
9	Age (in years)	-0.171 ***	0.117 **	0.184 ***	0.094 *			
10	Experience at sea (in years)	-0.177 ***	0.127 **	0.154 ***	0.083 *	0.907 ***		
11	Hierarchical level	-0.251 ***	0.038	0.005	0.061	0.520 ***	0.613 ***	
12	Department: engine (1 = yes)	0.014	0.001	-0.042	-0.118 **	0.050	-0.015	-0.141 ***

Notes: Means, standard deviations and Cronbach's α based on all available cases, and correlations (Spearman's *rho*) with pairwise deletion. Significance levels: * $p < 0.05$, ** $p < 0.01$, *** $p < 0.001$.
[a] Number of cases for each variable.
[b] Based on standardized items.

Table 3
Structural equation model.

		Estimate	*S.E.*	*p-value*
Paths				
Predictor	***Outcome***			
COVID-19 impact on work and life on board	Mental health problems	0.300	0.053	0.000
COVID-19 impact on employment and family concerns	Mental health problems	0.111	0.044	0.011
Time on board	Mental health problems	0.141	0.045	0.002
Onboard peer support	Mental health problems	-0.287	0.054	0.000
External support	Mental health problems	-0.292	0.050	0.000
Internet quality	Mental health problems	0.062	0.047	0.184
COVID-19 impact on work and life on board	Fatigue	0.296	0.047	0.000
Time on board	Fatigue	0.224	0.044	0.000
Onboard peer support	Fatigue	-0.280	0.047	0.000
External support	Fatigue	-0.288	0.047	0.000
Internet quality	Fatigue	-0.015	0.047	0.756
Internet quality	COVID-19 impact on work and life on board	-0.277	0.049	0.000
Internet quality	COVID-19 impact on employment and family concerns	-0.181	0.047	0.000
Internet quality	External support	0.468	0.039	0.000
Correlations				
Mental health problems	Fatigue	0.706	0.042	0.000
COVID-19 impact on employment and family concerns	COVID-19 impact on work and life on board	0.458	0.051	0.000
Time on board	COVID-19 impact on work and life on board	0.201	0.052	0.000
COVID-19 impact on employment and family concerns	Time on board	0.265	0.052	0.000
Internet quality	Time on board	-0.088	0.048	0.068
Internet quality	Onboard peer support	0.413	0.038	0.000
Time on board	Onboard peer support	-0.204	0.047	0.000

Notes: Standardized parameter estimates, standard errors and p-values, based on data from 622 respondents. Model goodness of fit statistics: $\chi^2 = 495.544$, df = 188; RMSEA = 0.051, 90% confidence interval: 0.046–0.057; CFI = 0.949; SRMR = 0.060.

As shown in Table 3, there was a significant positive correlation between mental health problems and fatigue. Further, there were significant positive correlations between the three aspects of the impact of the pandemic.

Fig. 1 visualizes the structural model. Hypotheses 1 and 2 concerned the effects of the COVID-19 pandemic on seafarers' mental health and fatigue. As shown in Table 3, the impact of the pandemic on work and life on board, time on board and employment and family concerns had significant positive associations with mental health problems, suggesting that a more serious impact increased mental health problems. This supported Hypothesis 1a–c.

Moreover, the impact of the pandemic on work and life on board and seafarers' time on board had significant positive associations with fatigue. This supported Hypothesis 2a and b.

Hypotheses 3 and 4 concerned the effects of support. We found significant negative associations between onboard peer support and mental health problems, as well as between onboard peer support and fatigue, suggesting that peer support reduced mental health problems and fatigue. This supported Hypothesis 3a and b.

Further, there were significant negative associations between external support and mental health problems and between external support and fatigue. In line with Hypothesis 4a and b, this suggested that external support reduced mental health problems and fatigue.

Hypotheses 5–7 concerned the indirect effects of Internet quality on mental health problems and fatigue. As shown in Table 3, the direct effects of Internet quality on mental health problems and fatigue were non-significant. However, as expected, there was evidence for negative indirect effects through the impact of the pandemic on work and life on board on mental health problems (estimate = −0.083, SE = 0.022, $p < 0.001$) and fatigue (estimate = −0.082, SE = 0.020, $p < 0.001$). This supported Hypothesis 5a and b. There was a negative indirect effect on mental health problems through seafarers' employment and family concerns (estimate = −0.020, SE = 0.010, $p = 0.038$), supporting Hypothesis 6. Finally, Internet quality had negative indirect effects through external support on mental health problems (estimate = −0.137, SE = 0.026, $p < 0.001$) and fatigue (estimate = −0.135, SE = 0.024, $p < 0.001$), supporting Hypothesis 7a and b.

Additional descriptive data from the survey provided more detailed insights into the sources and types of external support received by

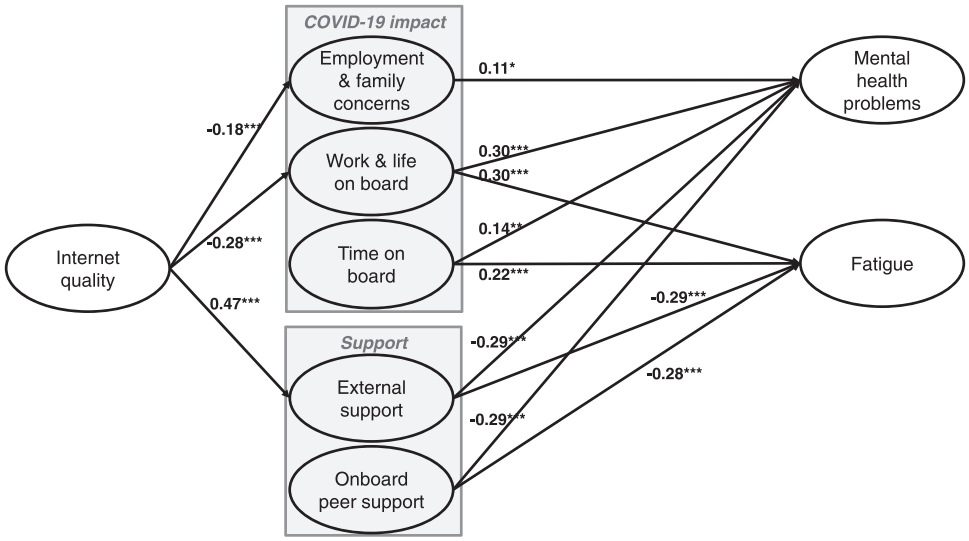

Fig. 1. Visualization of the structural equation model in Table 3, showing the significant paths ($n = 622$). Standardized estimates, significance levels: * $p < 0.05$, ** $p < 0.01$, *** $p < 0.001$.

respondents since the start of the COVID-19 pandemic. Table 4 shows the main sources of external support reported by respondents. Table 5 shows the types of support respondents received from their shipping company.

Independent samples *t*-tests showed that Internet quality was associated with a larger number of sources and more types of support mentioned. Compared to those who were dissatisfied (scores of 4 or lower) with the quality of their Internet connection, satisfied respondents were significantly more likely to mention almost all sources of support. Exceptions were support from family and friends, pilots, unions and "other" sources of support where the difference was smaller and non-significant, and port chaplains, seafarer centers or welfare organizations, which were mentioned somewhat (but not significantly) more frequently by those dissatisfied with the quality of their Internet connection.

Further, respondents who were satisfied with their Internet quality were significantly more likely to report having received each type of support from their shipping company, with the exception of medical advice and "other" types of support where the difference was not significant.

Table 4
Main sources of external support.

Source of support	Percentage
Shipping company (e.g., ship owners, ship operators, crewing agencies, charterers, liner companies)	68.8
Family or friends at home	63.2
Social media (e.g., Facebook, Twitter, Reddit, ...)	50.5
Seafarers on other ships*	34.7
Newspaper, radio, TV	32.3
Agents	23.0
Your home country (e.g., embassy, government)	20.1
Government authorities of the port state (e.g., port state control, customs, immigration, health authorities)	17.8
Your ship's flag state	16.4
Pilots	11.3
Unions	11.3
Port management organization (e.g., harbormaster)	10.3
Port chaplains, seafarer centers or welfare organizations	8.7
Doctors, nurses or medical/health experts	8.0
Other	0.6

Notes. In the survey the list of sources of support was preceded by the question "Since the start of the pandemic: What were the main sources of information or support for you and fellow crew members?" Respondents were asked to "select all that apply". Numbers show the percentage of respondents ($n = 622$) who mentioned a particular source of support. *For this option, included from 25 July 2020, the percentage is based on $n = 499$.

Table 5
Types of support received from the shipping company.

Type of support	Percentage
Medical advice and information on COVID-19 (e.g., symptoms, treatment, etc.)	86.0
Establishing COVID-19 onboard procedures (e.g., social distancing, sharing)	83.6
Medical supplies or equipment for COVID-19	74.4
Information / support with regulatory requirements in port	67.5
Employment contracts (e.g., renewing contracts, income, certificates)	62.1
Getting supplies for the crew or the ship (except medical supplies)	56.4
Crew changes (e.g., travel arrangements, repatriation)	50.6
Work-related matters (e.g., increased digitalization / automation)	39.5
Treatment (if required), incl. transfer to hospital or evacuation	31.4
Mental health support	31.0
Other	1.3

Notes. In the survey the list of types of support was introduced with the stem "Since the start of the pandemic, the shipping company (e.g., ship owner, ship operator, crewing agency, charterer or liner company) provided support with the following", and respondents were asked to "select all that apply". Numbers show the percentage of respondents ($n = 622$) who mentioned a particular type of support.

5. Discussion and conclusions

5.1. Key findings and directions for future research

Taken together, the findings indicated that the impact of the COVID-19 pandemic increased mental health problems and chronic fatigue. Onboard peer support, external support and Internet quality had beneficial effects.

As expected, the pandemic contributed to mental health problems and fatigue through its impact on work and life on board, the length of seafarers' time on board and employment and family concerns. Although the effect of seafarers' employment and family concerns on mental health problems was significant, it was weaker than one might have expected, suggesting the need for future studies to explore this further.

A noteworthy finding was that the length of seafarers' time on board increased chronic fatigue and mental health problems. While this is in line with theoretical and empirical work in other settings [31], the

impact of seafarers' time on board on mental health problems and fatigue has received little attention to date, and findings have varied between studies. For instance, Oldenburg et al. [32] found that seafarers with longer work periods had higher scores on emotional exhaustion, whereas Wadsworth et al. [52] found that acute and chronic fatigue were higher among those with shorter work periods. Doyle et al. [16] and McVeigh et al. [27] found no effect of time on board on perceived stress, whereas Baygi et al. [7] found that longer time on board was associated with higher levels of stress and depression, but not anxiety. Possible explanations for these inconsistencies include differences in the outcomes studied, range restrictions due to sample characteristics and/or correlations between time on board and workload. Given that long periods at sea are considered a severe stressor by seafarers and their families [42,49], there is a need for future research to clarify the effect of length of time on board, taking into account potential confounding variables.

Moreover, whereas previous studies on seafarers' well-being have focused on the impact of job demands [24,52], this study highlighted not only the beneficial effects of onboard peer support [21,36], but also of external support and Internet quality. While external support was defined broadly in this study, future studies might explore the effects of different sources and types of external support to provide a more nuanced understanding.

Finally, the study provided insights into the importance of fast and reliable Internet access on board, suggesting that Internet quality had indirect, rather than direct effects on seafarers' mental health and fatigue [26,46]. A fast and reliable Internet connection reduced the impact of the pandemic and provided access to external support. Seafarers with good Internet access received support from a larger range of sources and received more varieties of support from their shipping company.

5.2. Policy implications

While our study focused on seafarers' mental health and fatigue during the COVID-19 pandemic, the findings have wider implications for improving working conditions and industry preparedness in the future [9].

First, the strong association between mental health problems and fatigue suggests that policy measures affecting one are likely to affect the other as well.

Second, the findings add to concerns about the adequacy and effectiveness of international regulations concerning seafarers' working conditions. One such issue is the use of crewing agencies to recruit seafarers on single voyage contracts [14]. Seafarers under such contractual arrangements are more likely to feel compelled to accept unfavorable employment conditions and/or extensions to their tour of duty, with increased risk of poor health and safety outcomes [14,38]. Another issue, highlighted in a recent study [55], are systemic failures in the implementation of current regulations on seafarers' work and rest hours. Insufficient crewing levels and work hour regulations based on convention rather than scientific evidence were identified as a root cause. Our findings suggest that regulations concerning seafarers' length of time on board deserve equally close attention. According to the International Labour Organization's Maritime Labour Convention (MLC), 2006, the length of time that seafarers serve must not exceed eleven months. Although meant as a maximum allowable limit, it is often used as the actual time on board by shipping companies. Our findings suggest that during the COVID-19 pandemic, time on board was extended even further, with negative consequences for seafarers' fatigue and mental health. To ensure the adequacy and effectiveness of international regulations, a concerted effort is needed to establish a sound evidence base for decision making and to revisit the regulatory framework in light of this evidence. This should include provisions for situations of "force majeure", including strict rules and conditions for the extension of time on board.

Third, crew resilience can be enhanced through social support among crew members. Previous studies suggest that the development of social support can be encouraged for instance by allowing sufficient time for rest and joint leisure activities on board, creating a sense of community by offering job security with repeated deployment on the same vessel and by ensuring seafarers' competence in the ship's working language [1,42].

Fourth, ensuring that external support is available and accessible should be a priority for industry organizations, maritime administrations and welfare organizations, and regulations should be revisited to include the provision of free, fast and reliable Internet access for all crew members. While external support will always be important [42,56], it may be especially important during crises such as the COVID-19 pandemic. Fast and reliable Internet on board is a precondition for accessing most sources of external support; it may even be the *only* way to access external support when physical contact is restricted, as experienced during the COVID-19 pandemic.

Previous studies show that stressful working conditions can have a negative impact on seafarers' job satisfaction, recruitment and retention [11,27]. The impact of the pandemic on working conditions may exacerbate pre-existing challenges regarding recruitment and retention [8]. Hence considering the lessons to be learnt from the COVID-19 pandemic will not only be essential for the industry's ability to deal with future crises [9]. It may also be vital to increase the attractiveness of maritime careers [11].

5.3. Limitations

Similar to previous studies on seafarers' well-being [26,42,45], the survey was distributed as widely as possible using a convenience sampling approach. Compared to industry statistics [8], Chinese seafarers, in particular, were underrepresented in our sample, perhaps due to language barriers [17]. Further, the majority of respondents were officers, perhaps reflecting their better access to Internet on board [34]. Hence replications with different samples are desirable to assess generalizability.

Further, future studies using longitudinal multilevel designs would make it possible to take into account interdependencies among crew members on the same vessel, and provide more definitive conclusions concerning the direction of causality.

5.4. Conclusions

This study investigated the impact of the COVID-19 pandemic on seafarers' mental health and fatigue, based on an online survey among seafarers on international commercial vessels. Findings suggested that the impact of the pandemic increased seafarers' fatigue and mental health problems. However, they also indicated ways of mitigating the negative impact of the pandemic by enhancing support from fellow crew members on board, ensuring the availability of external support and providing fast and reliable Internet access on board.

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Declarations of interest

None.

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