

Factors Influencing Psychoemotional Strain and Fatigue, and Relationship of These Factors With Health Complaints at Sea Among Lithuanian Seafarers

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Key words: seafarers, psychoemotional strain; fatigue; health.

Summary. The aim of the study was to identify the factors influencing psychoemotional strain and, fatigue among Lithuanian seafarers and relationship of these factors to health complaints at sea.

Material and Methods. Two questionnaire surveys were carried out during mandatory health examination at the Maritime Medicine Center of Klaipėda Seamen's Hospital in 2003 and 2007. From November to December 2003, 998 seafarers aged 20–64 years were interviewed (first study). The second study carried out during November–December 2007 involved 932 20–64-year-old seafarers. The questionnaire comprised questions on sociodemographic data, factors of maritime industry, experienced psychoemotional strain and fatigue, and subjective evaluation of health.

Results. The first study showed that older seafarers aged from 35 to 54 years were more likely to experience psychoemotional strain ($P < 0.001$). Long working hours (9–10 hours and 11–12 hours) in harmful conditions and increased eyestrain were associated with psychoemotional strain among seafarers in the first study as well ($P < 0.001$). Higher education level and detrimental factors to health (vibration and noise) were significant risk factors for the occurrence of psychoemotional strain among seafarers in the second study ($P < 0.05$). The relationship between many risk factors related to seafarers' work, demographic data, and subjectively evaluated psychoemotional strain and fatigue appear to be accumulative in character. Health complains at sea (insomnia, depression, waist and spinal pain) were related to psychoemotional strain, but sleep disorders were associated with fatigue.

Conclusions. Seafarers employed on a certain ship, under particular conditions, and being exposed to risk factors or their combination may experience health disorders related to increased fatigue and psychoemotional strain.

Introduction

In 1991, the report of the Joint Maritime Commission named the development of maritime technologies as a cause of decrease in employment in a vessel (1). It was stressed that automatization and a variety of technical innovations would lead to the decreased number of crew, increased working hours, development of fatigue and isolation, and a need for highly qualified seafarers. Ship building technologies give rise to the fast development of the volumes of loads and dock infrastructure (1–6).

Processes taking places on ships are a complex sociotechnic system that consists of technologies, human beings, organizational structures, and external environment. The four dimensions of sociotechnic system are interrelated – alterations of one of them affect the other 3. Due to this basic interrelation, the arrival of technologies should not be evaluated in an isolated way or even at the level of subsystems; rather, the whole system should be

evaluated. Introduction of new technologies may or may not ensure safe recruitment of crew – this will depend on whether appropriate changes take place in other 3 dimensions of the sociotechnic system. If unforeseen changes occur or the macrosystem into which the ship system is integrated undergoes alterations, then a decrease in the general number of crew will cause unfavorable changes threatening health and work safety. Namely, the human factor in the man–environment–transport system can be seen under such conditions (7–10).

Nowadays changes in environment, shipload operations, and commercial goals of owners dictate the development of docks in the outer areas of urban centers. Perspectives of ship industry – distances and “fast-track” in modern ports – make difficult if not possible to stay on the shore. Some studies have reported the impact of organizational factors on stress and mental health at sea (5, 11). It is necessary to agree that owners of ships should pay their attention to the occurrence of potential stressors due to the decreased number of crew members, increased workload, solitude and social isolation – all of them give rise to stress and fatigue, and incidence

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of potential accidents.

The significance of maritime industry for Lithuania economy is indisputable. In recent years, the country is modernizing its ships, the ships are supplied with newest technologies, physical and social environment on ships and relationships between seafarers are changing, and all these factors have an impact of seafarers' physical and mental health.

Therefore, the aim of this study was to determine factors influencing psychoemotional strain and fatigue among Lithuanian seafarers and relationship of these factors to health complaints at sea.

Material and Methods

Every seafarer who came for his mandatory health examination was asked to fill in a questionnaire. During the first study from November to December 2003, 1131 questionnaires were distributed. The questionnaire was filled in by 998 20–64-year-old seafarers (mean age, 40.8 years [SD, 10.2]). The response rate was 76.7%. During the second study from November to December 2007, 1301 questionnaires were distributed. A total of 932 seafarers, aged 20–64 (mean age, 40.0 years [SD, 11.7]), filled in the questionnaire. The response rate was 88.2%. The questionnaire of the first study comprised 30 questions on sociodemographic data; factors of sea industry (vibration, noise, electromagnetic field, temperature, warmth, forced working position, eye-strain, work in altitude); psychophysiological factors of work (duration of work round the clock, type of work [mostly sedentary, sedentary and/or standing, mobile, involving frequent lifting, carrying, manual work]); and subjective evaluation of health (insomnia, health complaints on the ship, psychoemotional strain). Thus, the question, "Did you experience psychoemotional strain on the ship during the last year (12 months)?" with some possible answers (no strain, some strain, significant strain), which evaluated psychoemotional strain experienced subjectively, was the constituent part of the questionnaire presented previously. The responses to the question evaluating psychoemotional strain were dichotomized including both variants of response: no strain and strain experienced. The study of fatigue was additionally carried out only during the second study to obtain more information about the impact of maritime industry on seafarers' health. In this case, the questionnaire of the second study had the questions of the first study and 5 extra questions related to fatigue: "How often do you experience fatigue at work?" "How would you evaluate sleep quality on the ship?" "How often do you feel sleepy during work?" "How much time in average do you need to fall asleep?" "Do you do shift work?" Thus, the questionnaire of the second study comprised 35 questions. Only 532 seafarers responded

to the questions related to fatigue (response rate, 57.1%). The data were gathered in a database created with Microsoft Access computer software. The methodology was presented widely in the previous published work (12, 13).

Statistical Analysis. The relationships of the analyzed factors with the subjective psychoemotional strain or fatigue (dependent variable) were assessed using univariate and multivariate (forward algorithm) logistic regression analysis. During the first stage of the investigation, the analysis of all separate determinants was performed including separate determinant and age (as a skewing determinant) into a logistic regression analysis. The impact of the analyzed factors on psychoemotional strain and fatigue was quantitatively evaluated using the odds ratio (95% confidence interval, 95% CI). The odds ratio indicates the increase in the risk of being attributed to the group of people affected by psychoemotional stress and fatigue among subjects in some of the categories of classification of the studied factors in relation to the reference category. After that, a stepwise (forward algorithm) procedure was used to include statistically significant variables into the model ($P < 0.05$). Correlations between the determinants were investigated, and if any correlation was detected, the involved determinants were excluded from multivariate regression model. Differences between the proportions were evaluated using the χ^2 criterion. Differences were considered statistically significant if $P < 0.05$. Statistical analysis was performed using the SPSS 11.5 software package.

Results

Demographic characteristics of seafarers are presented in Table 1.

The majority of the respondents who participated in the first and second studies were about 40 years of age. The percentage of seafarers aged up to 25 years was smaller in the first study, but the percentages of seafarers aged 35–44 and 45–54 years was greater compared with those in the second study. In the second study, the percentage of seafarers older than 54 years was greater as compared with the first study. About 50% of seafarers had specialized secondary education in both studies. Moreover, more seafarers in the first study had higher education as well, but fewer seafarers had secondary education compared with the second study. The distribution of seafarers by the type of ships they worked on and by professional groups was very similar and did not differ significantly. The smallest percentages of the respondents in both groups were doing sedentary or hard manual work at sea, while the highest percentages in both groups of the respondents as well were doing mobile work involving frequent lifting, etc. More respondents in the second study worked

Table 1. Demographic Characteristics of Study Population by two Studies

Characteristic	First Study	Second Study	P
Age, years			<0.001
20–24	78 (7.8)	132 (13.4)	
25–34	198 (19.8)	211 (21.4)	
35–44	329 (32.9)	262 (26.6)	
45–54	321 (32.1)	270 (27.4)	
55–64	74 (7.4)	104 (10.5)	
>64	0 (0)	7 (0.7)	
Education			<0.05
Unfinished secondary	13 (1.3)	14 (1.4)	
Secondary	217 (21.7)	256 (26.0)	
Specialized secondary	538 (53.8)	536 (54.4)	
Higher	232 (23.2)	180 (18.2)	
Type of ship			>0.05
Sea transport	644 (64.4)	669 (67.8)	
Fishing	339 (33.9)	301 (30.6)	
Local water transport	17 (1.7)	16 (1.6)	
Professional groups			>0.05
Management	187 (18.7)	171 (17.1)	
Mechanical ship service	406 (40.6)	409 (40.9)	
Deck crew	341 (34.1)	359 (35.9)	
Auxiliary sector	66 (6.6)	61 (6.1)	
Type of work at sea			<0.001
Mostly sedentary	54 (5.4)	50 (5.1)	
Sedentary and/or standing	313 (31.3)	231 (23.4)	
Mobile involving frequent lifting, etc.	557 (55.7)	652 (66.1)	
Hard manual	76 (7.6)	53 (5.4)	
Duration of employment, years			<0.001
<1	15 (1.5)	11 (1.1)	
1–10	528 (52.8)	649 (65.8)	
10–20	276 (27.6)	201 (20.4)	
>20	181 (18.1)	125 (12.7)	

Values are number (percentage).

at sea for less than 10 years compared with those in the first study. Meanwhile, more respondents in the first study spent more than 10 years working at sea compared with the participants in the second study. The duration of employment of seafarers in the first study was longer compared with the second study (11.9 years; 95% CI, 11.3–12.5; and 9.9 years; 95% CI, 9.4–10.4, respectively; $P<0.01$, after adjusting for age). The mean duration of employment of the seafarers at sea during the last year was similar in both the studies: 6.4 months (95% CI, 6.3–6.5) in the first study and 6.5 months (95% CI, 6.4–6.6) in the second one.

The greater proportion of seafarers in the second

study worked in harmful environment (1–6, 9–10, and 11–12 hours) comparing to their counterparts in the first study (Fig. 1). Analysis showed that during the voyage, seafarers of the second study worked for 9.4 hours (95% CI, 9.2–9.7) on the average that was greater than the duration of work reported by the participants of the first study (9.1 hours; 95% CI, 8.8–9.2) ($P<0.01$).

Furthermore, seafarers in the second study worked significantly more hours (9.9 hours; 95% CI, 9.7–10.2) in a vibrating environment than respondents in the first study (9.4 hours; 95% CI, 9.1–9.5) ($P<0.01$). Seafarers of the second study working on the deck were longer exposed to the negative effect

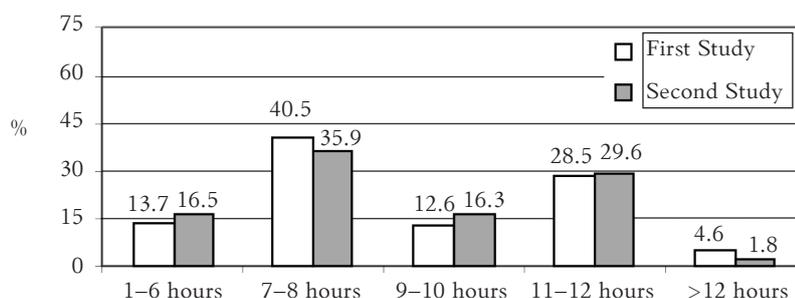


Fig. 1. The distribution of respondents according to duration of exposure to harmful factors in working environment

of temperature (9.9 hours; 95% CI, 9.6–10.4) than the seafarers of the first study (9.3 hours; 95% CI, 9.1–9.6) ($P<0.01$).

According to the data of survey, 63.5% and 46.1% of the seafarers in the second and first studies, respectively, reported that they experienced psychoemotional strain on the ship ($\chi^2=37.42$; $P<0.001$) (Fig. 2). Seafarers of both the studies indicated that they experienced psychoemotional strain to some extent after 2.6 months from the beginning of the voyage.

The associations between experienced psychoemotional strain, and demographic characteristics and working conditions are presented in Table 2.

The relationship of the seafarers' exposure to psychoemotional strain with the demographic data and characteristics of the main working conditions revealed the similarities and basic differences between some determinants (Table 2). In the first study, older seafarers (aged 35–44 and 45–54 years) were more likely to experience psychoemotional strain ($P<0.001$). Long working hours (9–10 hours and 11–12 hours) and increased eyestrain also contributed to an increase of psychoemotional strain

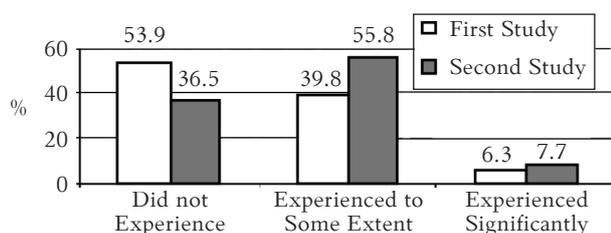


Fig. 2. The distribution of respondents according to exposure to psychoemotional strain

among seafarers in the first study ($P<0.001$). In the second study, higher education level and detrimental factors to health (vibration, noise) were associated with the occurrence of psychoemotional strain ($P<0.05$ and $P<0.01$, respectively).

Prognostic Factors of Experienced Fatigue. More than three-fourths (76.3%) of the seafarers pointed out that they had experienced fatigue at sea. To evaluate the impact of different factors on fatigue, multivariate analysis was carried out (Table 3).

The risk of fatigue was related to arrival at port. The duration of work had a dramatic effect on the prognosis of fatigue symptoms. Long working hours (9–10 hours and 11–12 hours) had a significant impact on fatigue ($P<0.001$). Seafarers who worked in the auxiliary ship sector and had high requirements of working were more likely to experience fatigue ($P<0.001$). Harmful factors at sea and experienced psychoemotional strain were associated with fatigue.

In addition, fatigue was influenced by the number of voyages (Table 4). According to the subjective data, a greater percentage of seafarers (26%) experienced fatigue during 1–2 voyages than during 5 voyages (14%) ($P<0.05$). More than half (62%) of seafarers always or frequently recuperated after fatigue, whereas 18% of them reported that they never fully recovered. The majority (87%) of the seafarers stated that they experienced fatigue-related lack of energy, 42% of them reported that they made slight mistakes, and 29% of them showed poor judgment (Table 4).

Significant correlations between fatigue and long working hours round the clock ($r=0.28$), irregular working hours ($r=0.21$), positions ($r=0.36$), vibration and noise ($r=0.30$), and hazardous work to health and safety ($r=0.29$) were observed ($P<0.01$).

Table 2. Associations Between Risk Factors and Psychoemotional Strain (Multivariate Analysis)

Factor	First Study			Second Study		
	N	OR (95% CI)	P	N	OR (95% CI)	P
Age, years						
20–24*	78	1		132	1	
25–34	197	1.52 (0.85–2.72)	>0.05	211	1.38 (0.74–1.95)	>0.05
35–44	329	2.27 (1.09–4.72)	<0.001	267	1.46 (0.63–1.78)	>0.05
45–54	321	2.49 (1.19–5.21)	<0.001	275	1.49 (0.89–2.52)	>0.05
Education level						
Unfinished secondary*	12	1		16	1	
Higher	232	1.64 (0.88–2.91)	>0.05	181	16.7 (1.59–176.2)	<0.05
The duration of work being exposed to harmful factors round the clock, hours						
1–6*	137	1		153	1	
7–8	405	1.43 (0.94–2.18)	>0.05	324	1.61 (0.94–1.64)	>0.05
9–10	126	2.59 (1.33–5.06)	<0.01	172	1.71 (0.89–1.75)	>0.05
11–12	285	2.07 (1.17–3.64)	<0.01	265	1.48 (0.88–2.48)	>0.05
Factors detrimental to health						
Increased eyestrain	206	1.48 (1.38–2.72)	<0.001	232	2.02 (0.86–2.98)	>0.05
Vibration	666	1.57 (0.95–2.49)	>0.05	738	1.96 (1.27–3.03)	<0.01
Noise	514	1.78 (0.98–3.14)	>0.05	345	2.06 (1.11–3.79)	<0.01

*Reference category.

Table 3. Associations Between Risk Factors and Fatigue (N=542, the Second Study)

Factors	OR (95% CI)	P
The duration of work at sea during the last year, months		
<1*	1	
1–3	0.44 (0.23–0.82)	>0.05
4–6	0.26 (0.13–0.42)	>0.05
Age, years		
≤45*	1	
Older than 45	0.69 (0.50–0.94)	>0.05
Fatigue experienced on arrival at port		
No*	1	
Yes	1.5 (1.07–2.10)	0.02
Duration of work under harmful conditions round the clock, hours		
1–6*	1	
7–8	1.07 (0.73–1.56)	>0.05
9–10	1.84 (1.21–2.95)	<0.01
11–12	2.2 (1.33–2.94)	<0.01
>12	4.90 (0.66–52.65)	>0.05
Positions		
Management sector*	1	
Others	0.49 (0.25–0.97)	>0.05
Ship sector		
Deck crew*	1	
Mechanical ship service	0.95 (0.67–1.34)	>0.05
Auxiliary ship sector	2.77 (1.23–6.22)	<0.001
High requirements of work		
No*	1	
Yes	2.22 (1.61–3.06)	<0.001
Harmful factors at sea		
Vibration	1.72 (1.23–2.42)	0.002
Noise	1.97 (1.32–3.01)	<0.001
Psychoemotional strain		
Did not experience*	1	
Experienced	2.01 (1.23–3.27)	0.005

*Reference category.

Relationship of Psychoemotional Strain and Fatigue With the Subjective Health of Seafarers. Multivariate analysis revealed that subjectively determined psychoemotional strain was related to subjective evaluation of health disorders: waist and spinal pains, in-

Table 4. Fatigue Experienced During Voyages (the Second Study)

Subjective Evaluation of Fatigue	Response Rate, %
Experienced fatigue	
Fatigue during all 5 voyages	14
Fatigue during 3–4 voyages	9
Fatigue during 1–2 voyages	26
Did not experience	52
Recuperation after fatigue	
Always /frequently	62
Rarely	19
Never	18
Effect of fatigue	
Lack of energy	87
Make slight mistakes	42
Show poor judgment	29

somnia, depression that was more expressed at sea than on the shore. These disorders were more expressed during the second study. The second study revealed that poor sleep was associated with fatigue (OR, 1.911; 95% CI, 1.23–2.42; $P < 0.002$) (Table 5). More than 70% of the seafarers pointed out poor sleep at sea. Poor ability to fall asleep was reported by 24%, wakefulness during sleep by 44.6%, waking up due to fatigue by 6.2%, and light sleep by 43.4% of seafarers. Significant correlations between fatigue and quality of sleep ($r = 0.21$) and falling asleep ($r = 0.96$) were documented ($P < 0.05$ and $P < 0.001$).

Discussion

The abovementioned differences in demographic characteristics during the first and second studies could be related to the implementation of new technologies in maritime industry as well as the employment of new workers (younger and among them a bigger percentage with secondary education). All these factors could have an impact on psychoemotional strain. Thus, psychoemotional strain induced by long working duration under harmful factors and increased eyestrain is related to the older age of the first study seafarers. Meanwhile, higher

Table 5. Associations Between Health Disorders and Psychoemotional Strain and Fatigue (Multivariate Analysis)

	First Study			Second Study		
	N	OR (95% CI)	P	N	OR (95% CI)	P
Psychoemotional strain						
Waist pain	31	1.58 (0.98–2.26)	>0.05	27	3.02 (1.12–8.13)	<0.05
Spinal pain	43	1.71 (0.89–2.89)	>0.05	48	2.63 (1.57–4.40)	<0.01
Insomnia	12	8.52 (1.19–71.6)	<0.05	250	1.34 (1.03–1.75)	<0.05
Becoming depressed			<0.001			<0.001
Did not experience*	604	1		439	1	
No more than on the shore	206	5.63 (3.73–8.51)		344	2.63 (1.70–4.06)	
Somewhat more than on the shore	156	6.50 (3.90–10.84)		188	5.46 (3.08–9.71)	
Significantly more than on the shore	34	4.96 (1.73–14.26)		26	15.36 (2.46–95.9)	
Fatigue						
Sleep quality						
Good*		...		120	1	
Poor		...		422	1.91 (1.23–2.42)	0.002

Ellipses indicate no data available. *Reference category.

education and factors detrimental to health (vibration, noise) appeared to be associated with a higher risk of psychoemotional strain for seafarers in the second study than those of the first study. This may be due to career aspirations and lack of adaptation (because of younger age) to the impact of harmful factors. According to the data of Austrian scientists (5), the main factors of maritime industry related to stress (integrating and psychoemotional strain) are harmful working conditions at sea (noise, vibration, thermal working environment, unsuitable lighting, humidity, foul air); being away from home (insufficient time attributed to family, friends), disturbed working and rest regime (unfixed working hours, even during the rest waiting for call is taking place), long working hours, and reforms in sea industry. Long working hours are the main source of stress, chronic fatigue, working strain, and mental health disorders for all seafarers of the professional groups, particularly, for watch services (14). According to our data, long-lasting working hours (in particular, under influence of harmful factors) increased a risk of psychoemotional strain and fatigue. Moreover, fatigue may result from continuous psychoemotional strain. Our data showed that experienced psychoemotional strain increased the risk of fatigue. According to the data of the multivariate analysis, the prognostic factors of psychoemotional strain and fatigue play a role in all dimensions related to risk at work. This demonstrates that the determined relationship between all range of factors and subjectively evaluated psychoemotional strain and fatigue is cumulative in character. The other studies (15, 16) also stress the cumulative relationship of seafarers' experienced fatigue with the factors while working in maritime industry. This proves that a seafarer working on a certain ship under particular conditions may experience increasing psychoemotional strain and fatigue. Thus, the problem of psychoemotional strain and fatigue should be solved by devising a working scheme that would take into consideration both variable and operating risk factors (e.g., duration of voyage, shift work, working under detrimental conditions to health, etc.). Such schemes would help identify the risk of psychoemotional strain and fatigue, and promote effective preventive measures. This is necessary, because dis-

orders such as waist and spinal pains, depression, and insomnia are related to psychoemotional strain. Epidemiological studies also report that there is a relationship between psychosocial working factors and the musculoskeletal diseases (17). Experienced stress (most commonly related to the disorders of the functions of the neuroendocrine system) may disturb the transmission of nerve impulse and influence the abovementioned disorders. Owing to these disorders, many seafarers refuse work at sea. The problems of the musculoskeletal system are one of the main health conditions, determining an early resignation from work at sea (17, 18). Depression-inducing psychoemotional strain may be a factor of severe illnesses, with ischemic cardiac disease among them. Sleep disorders caused by psychoemotional strain – similar to those caused by fatigue – are influenced by a whole range of the factors of the maritime industry; they diminish seafarers' working capacity and concentration of attention, affect mood and work safety (poor judgments are made), and pose a threat to seafarers' health. According to the data of Smith et al. (19), about 25% of seafarers indicated fatigue during their watch; many of them reported that they had fallen asleep, and 50% of them stressed that fatigue diminished the ability to evaluate the situation in dangerous situation and made difficult to predict accidents.

Thus, the factors of maritime industry influencing psychoemotional strain and fatigue contribute to health problems. These problems may be solved by significant changes in maritime industry by regulations of appropriate international organizations (1).

Conclusions

Seafarers employed on a certain ship, under particular conditions, and being exposed to risk factors or their combination may experience health disorders related to increased fatigue and psychoemotional strain. The relationship between disorders at sea (insomnia, depression, waist and spinal pains), psychoemotional strain, fatigue, and sleep disorders may be a cause determining an early reassignment of seafarers from work at sea.

Statement of Conflict of Interest

The authors state no conflict of interest.

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