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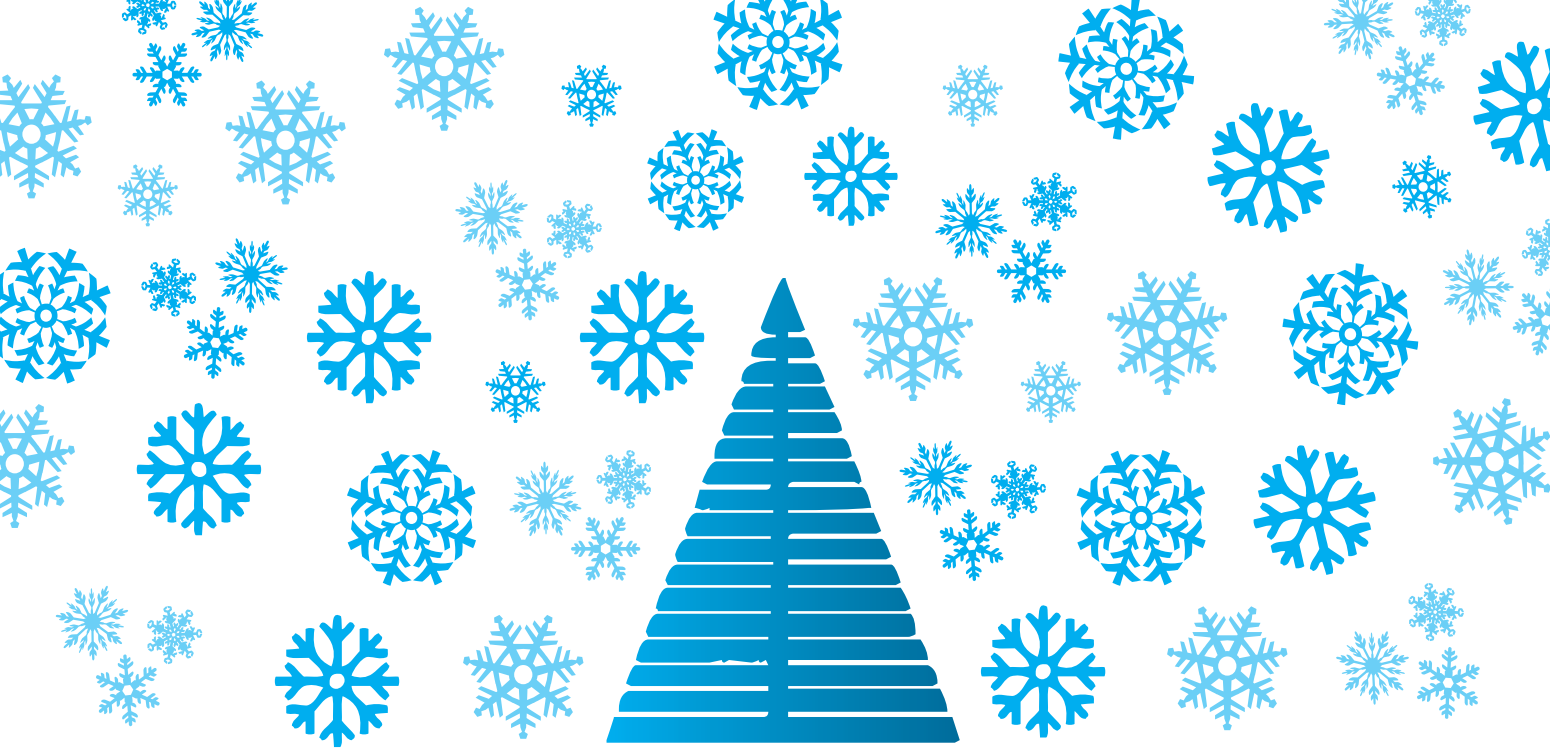

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Health status, sleeping habits and dyssomnia of coastal fishermen

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ABSTRACT

Background: *The aim of this survey was to assess the health status, sleep habits and dyssomnia of coastal fishermen.*

Materials and methods: *This cross-sectional survey involved a representative sample of 948 coastal fishermen. All participants were men and had a regular activity for at least 2 years. We used an individual questionnaire inspired by those of Morphée network, the National Institute for Research and Security of France, and of the Karasek's Job Content Questionnaire.*

Results: *The prevalence of sociodemographic and individual parameters was similar in rotating shiftwork (RW) and in nocturnal work (NW). The average age of the total population was 38.8 ± 8.1 years. The prevalence of sleep habits and alertness disorders was similar in RW and in NW. The average daily sleep time of the total population was 5.5 ± 0.9 hours during the week, and 8.7 ± 0.8 hours during the holidays, Fridays and recovery days. Upon waking, 49.7% of the subjects felt tired and sleepy, 43.2% fit and 7.1% had a headache. 47.2% reported being chronic insomniac. The index of severity of insomnia was moderate to severe in 29.6%. The prevalence of excessive daytime sleepiness (Epworth > 10) was 16.2%. Fatigue, iso-strain and socio-economic concerns were associated with a higher risk of chronic insomnia.*

Conclusions: *Coastal fishermen were at a high risk of chronic dyssomnia and alertness disorders. Education initiatives should be conducted to raise fishermen's awareness on their health and safety consequences.*

(Int Marit Health 2022; 73, 4: 163–171)

Key words: health status, sleep habits, dyssomnia, alertness, stress, costal fishermen

INTRODUCTION

Fishing is a hazardous occupation with high rates of death and injury. Working at sea is associated with a number of occupational risks and challenges, such as high work-load, inconvenient working-hours, prolonged periods of absence from family, and an increased risk of accidents. Seafaring still ranks as one of the most hazardous occupations possible [1]. The dangerousness and complexity of a fisherman's activity is explained by an arduous and laborious work with numerous and countless constraints requiring a sustained degree of attention and alertness.

The main factor of sleep disorders is fatigue related to an extremely demanding occupation that takes place in one of the most dangerous working environments [2] along with stressful working conditions (atypical work schedules, long working-hours, density of work, unsafety of job, etc.) [3–5]. Fishermen are among the most exposed categories to psychosocial risks at the workplace (stress,

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burnout, harassments, etc.). They develop psychosomatic symptoms (neurovegetative, cognitive, mood and sleep disorders, and nervous tension) and chronic diseases (cardiovascular, neuropsychiatric, musculoskeletal, digestive, metabolic, etc.) [6]. The International Maritime Organization (IMO) has identified seafarer fatigue as an important health and safety issue. The 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" [7]. The key factor in minimizing and recovering from fatigue is obtaining adequate sleep on a regular basis [8]. In costal fishing, daily activities tend to vary markedly with factors such as weather conditions, success in finding fish, and damage to fishing gear. These factors necessarily add an element of unpredictability to the workload and sleep recovery opportunities of fishermen at sea. The earnings of a fisherman are related to the size of the catch, this provides an incentive to continue working until the holds are full or until the fishing quota is achieved. For fishermen working under these conditions, seasonal peaks in fish availability represent their best earning opportunity of the year, but it may also mean long periods at sea with minimal and irregular rest opportunities. The unpredictable and demanding working conditions foster a high potential for risks and accidents. Sleep and alertness disorders induce and increase occupational accidents which are often fatal. A fisherman was, in 2011, about 44 times more likely to die at work than workers on land [9]. The death rate on fishing vessels was, in 2006, 33.4-fold higher than that for all other occupations [10]. In the United Kingdom, the fatality rate in fishermen is 12 times higher than the general workforce [11]. Fatigue contributes to 16% of critical and 33% of personal injury accidents across all types of maritime operations [12].

The effects of fatigue include reduced situation awareness, planning deficits and an inability to adapt to new information, and difficulties in focusing attention. These negative effects of fatigue can translate into performance impairments, willingness to take risks and increased accident involvement for fishermen in safety-critical organizations [1].

Perceptions of both risk of personal injuries and ship accidents increase when seafarers are fatigued. Fatigue is related to poor sleep quality, and safety climate predicts both sleep quality and fatigue [1]. Occupational fatigue and dyssomnia represent a serious threat to the general health and well-being of fishermen and can have severe consequences in terms of accidents and fatal disasters. However, few studies have investigated the dyssomnia and alertness disorders of fishermen in Morocco [6, 13, 14]. In the current study, the health status, sleeping habits and dyssomnia and its causes among population of coastal fishermen are assessed.

MATERIALS AND METHODS

FRAMEWORK AND TYPE OF STUDY

This observational and cross-sectional study was conducted in 2018 in two ports of northern Morocco (Assilah and Tangier).

TARGET POPULATION

The survey involved a representative sample of 1,123 coastal fishermen (33.3% of the exhaustive administrative list of 3,369 fishermen working in coastal sectors). All participants were men and had a regular activity for at least two years. The fishermen were working every day, except Friday in sardine boats with nocturnal work (NW) or longline boats with rotating shiftwork (RW). The first boat contains about thirty people and the second ten to twenty. The sardine boats go out daily at sea at sunset and return in the morning at about 8 am. Longline boats go out at sea for 3 to 6 days. The work on board is done with rotating schedules often in two or three shifts. The average duration of one shift is of 11 to 12 hours. The longline boats stay in port for 1 or 2 days.

QUESTIONNAIRE

An individual questionnaire inspired by those of Morphée network [15], National Institute for Research and Security of France (INRS) [16] and the Karasek's Job Content Questionnaire (KJCQ) [17], was used. It comprised four parts.

- **Socio-demographic and professional parameters:** age, family status (living alone, living in couple), dependents (children, parents, and relatives), professional categories, educational levels, length of employment, daily working hours, and work stressors (KJCQ).
- **Health parameters:** harmful habits (tea-coffee, tobacco, cannabis, alcohol, other psychoactive substances and medicines), regular physical activities — sports (at least 3 times a week), body mass index, psychosomatic symptoms [10], and self-reported chronic diseases. The items of psychosomatic symptoms were assessed with responses on a 4-point Likert-type scale from "never" to "often". The answers "never" and "rarely" were considered as rejected and the answers "sometimes", "often" and "always" as occurring.
- **Sleeping habits, chronic insomnia, and its consequences:** daily sleep duration, bedtime and wake-up times, quality of wake-up, nap more than twice a week, chronic insomnia, index of severity of insomnia, and daytime alertness disorders. Insomnia is a complaint that can take different aspects (sleep initiation or maintenance disorder, early awakening or non-restorative sleep). Chronic insomnia is occurring at least 3 times a week and for more than 3 months with consequences on the quality of daytimes. The index of severity of insom-

nia allows assessing the nature of chronic insomnia, the satisfaction of the person in relation to their sleep, their daily functioning and their anxiety about sleep disorders. The scale includes seven items rated from 0 to 4. The score ranges from 0 to 28: absence of insomnia (0 to 7), mild insomnia (8 to 14), moderate insomnia (15 to 21), severe insomnia (22 to 28) [15]. Vigilance refers to the ability of the central nervous system to respond effectively to a stimulus or event. Sleepiness is a decrease in the physiological awakening manifested by a need to sleep. The Epworth scale assesses daytime sleepiness because of decreased alertness. It is based on a subjective self-assessment of the probability of falling asleep in certain commonly encountered in everyday life situations. This probability is rated from 0 (never sleepy) to 3 (strong chance to doze). The score ranges from 0 to 24; it is considered abnormal if it is greater than 10 (excessive daytime sleepiness) [18].

— **The KJCQ covers three dimensions of the psychosocial environment at work:** Psychological Demand (PD) assesses the quantity, speed, complexity, intensity, fragmentation, and predictability of work. Decision Latitude (DL) appreciates room for manoeuvring, acquisition, use and development of skills. Social Support (SS) values professional and emotional support from superiors and colleagues. It has 26 questions: 9 for PD, 9 for DL and 8 for SS. The proposed answers (on a four-point Likert-type scale) are "strongly disagree", "disagree", "agree" and "strongly agree" [17]. These three dimensions allow risk situations to be identified. Job strain is the combination of low decision latitude (score below 71) and high psychological demand (score greater than 20). Iso-strain is the combination of a job strain situation and a low social support of less than 24.

ETHICAL AND DEONTOLOGICAL ASPECTS

The Moroccan Ministry of Fisheries delegate, the representatives of the fishermen associations and the occupational physicians were previously contacted in order to explain the purpose of the study and to obtain their support. The interviews took place within the occupational health service of fishermen and lasted approximatively 20 minutes for each participant. The singular colloquium with each fisherman was carried out with full respect of the confidentiality.

STATISTICAL ANALYSES

The statistical analysis was performed using the SPSS version 11.5 software package. The differences between groups were compared using t-tests for continuous variables and chi-square tests for categorical ones. The statistical level of significance was established at 5%. For a proportion, the lower and upper limits of the 95% confidence intervals (CI) were calculated. In order to assess the association between chronic insomnia and several other factors, we calculated odds ratio (OR) and 95% CI. Multivariable logistic regression analysis including the factors that were statistically significant in bivariate analysis, were calculated. The OR adjusted (ORa) of each of the factors that we found in the final model, independently of the other factors, were computed.

RESULTS

The final sample was composed of 948 people who took part in the study (613 had rotating shift work and 335 had night work). The participate rate was 84.4%. Concerning the different parameters of the study, the comparison between RW and NW showed that there was no significant difference between the two groups.

SOCIODEMOGRAPHIC AND PROFESSIONAL PARAMETERS (TABLE 1)

The average age of the total population was 38.8 ± ± 8.1 years, 69.2% lived in couple, and 75.9% had dependents. Average job seniority was 14.3 ± 4.5 years, and 79.8% worked more than 8 hours a day. The prevalence of work stressors was 82.8% for the high psychological demand, 58.2% for the low decision latitude, and 61.2% for low social support. The prevalence of job strain was 52.1%, and for iso-strain it was 39.3%.

HEALTH STATUS (TABLE 2)

For compensation behaviours, 91.2% consumed daily more than 4 cups of coffee or glasses of tea to be stimulated at work, 63.6% smoked cigarettes or sniffed tobacco, 39.9% smoked cannabis, 27.5% used alcohol, 8.1% regularly took psychotropic medications and 25.5% used analgesics. Regular sports, and/or leisure activities were practiced by 21.3%.

Abnormally high body mass index (BMI) (overweight and obesity) was noticed among 61.6%. Neurovegetative disorders, reported by 59.8% of total population, were palpitations (56.9%), pain in the heart (31.6%), dry mouth, nausea and/or digestive disorders (27.9%), chest tightness (22.6%) and sweats in the absence of effort (25.6%). Pain and/or muscle aches were found in 36.4% of our fishermen. The signs of nervous tension, reported by 57.1%, were manifested by headaches at the end of the day (41.6%), sensations of discomfort (46.3%) and tremor of the extremities (13.9%). Mood disorders, reported by 36.9%, were in the form of anxiety in 39.8%, irritability in 35.9% and depressive states in 26.4%. Cognitive disorders, mentioned by 39.1%, included disorders of concentration (31.6%) and memory (26.7%). Sleep disorders, cited by 51.3%, included difficulties falling asleep (36.3%), night-time insomnia (43.9%) and the feeling of not having slept (29.7%).

Table 1. Sociodemographic and professional parameters

Sociodemographic and professional parameters	Total population (n = 948)	95% confidence interval
Age [years]		
< 30	259 (27.3%)	[24.5; 30.3]
31–40	281 (29.6%)	[26.8; 32.7]
41–50	196 (20.7%)	[18.2; 23.4]
> 50	212 (22.4%)	[19.8; 25.2]
Average age	38.8 ± 10.1	[38.2; 39.4]
Family status		
Living in couple	656 (69.2%)	[66.1; 72.1]
Living alone	292 (30.8 %)	[27.9; 33.9]
Dependents (parents, relatives, children, etc.)	719 (75.9%)	[73.0; 78.5]
Professional categories		
Pilots-copilots	204 (21.5%)	[19.0; 24.3]
Mechanics	130 (13.7%)	[11.6; 16.1]
Fishermen	614 (64.8%)	[61.6; 67.8]
Educational levels		
Illiterate	183 (19.3%)	[16.9; 22.0]
Primary	498 (52.5%)	[49.3; 55.7]
Secondary	251 (26.5%)	[23.7; 29.4]
Superior	16 (1.7%)	[1.0; 2.8]
Work seniority [years]		
≤ 5	129 (13.6%)	[11.5; 16]
6–15	338 (35.7%)	[32.6; 38.8]
> 15	481 (50.7%)	[47.5; 54]
Average	14.3 ± 4.5	[14.2; 14.8]
Daily working [h]		
≤ 8	191 (20.2%)	[17.7; 22.9]
> 8	756 (79.8%)	[77.1; 82.3]
Average daily working hours	11.4 ± 1.2	[11.32; 11.48]
Work stressors		
High psychological demand	785 (82.8%)	[80.2; 85.1]
Low decision latitude	552 (58.2%)	[55.0; 61.4]
Low social support	580 (61.2%)	[58.0; 64.3]
Job strain	493 (52.1%)	[48.8; 55.2]
Iso-strain	372 (39.3%)	[36.1; 42.4]

More than one-third (37.2%) reported one or more chronic diseases. Their prevalence was 32.4% for musculoskeletal disorders, 24.2% for neuropsychiatric diseases (anxiety, depression, migraine and headache), 23.2% for cardiovascular diseases (18.7% hypertension and 15.6% varicose veins), 21.2% for respiratory diseases (18.2% rhinitis, 10.6% asthma, 7.5% chronic obstructive pulmonary diseases and 9.8% chronic bronchitis), 20.3% for digestive diseases (gastritis, reflux and ulcer), and 15.6% for metabolic diseases (8.8% diabetes, 12.1% hypercholesterolemia).

SLEEPING HABITS, CHRONIC INSOMNIA, AND ITS CONSEQUENCES (TABLE 3)

The average daily sleep time of the total population was 5.5 ± 0.9 hours during the week, and 8.7 ± 0.8 hours during the holidays, Fridays and recovery days. For 67.5% of the fishermen, studied, their bedtime schedule was between 22 and 24 pm during the holidays, Fridays and recovery days; 87.9% used to wake up after 8 am on Fridays, holidays and recovery days. Naps occurred more than twice a week for 63.5% of them.

Among our participants, 47.2% reported a chronic insomnia. The prevalence of difficulty falling asleep was 29.3%, midnight insomnia 41.4%, late night 26.5% and the feeling of not having slept was 23.8%. The index of severity of chronic insomnia was moderate to severe for 29.6% of the sample. The prevalence of excessive daytime sleepiness (Epworth > 10) was 16.2%. Upon waking, half of the population (49.7%) felt tired and sleepy, 43.2% fit and 7.1% had a headache.

RISK FACTORS OF CHRONIC INSOMNIA (TABLE 4)

Among participants who reported a chronic insomnia, the multivariate logistic regressions showed that, iso-strain, fatigue, and socio-economic concerns were associated with a higher risk of chronic insomnia.

Table 2. Health status

Health status	Total population (n = 948)	95% confidence interval
Harmful habits		
Tea-coffee consumption	865 (91.2%)	[89.2; 92.9]
Tobacco smoking or snuff	603 (63.6%)	[60.4; 66.7]
Cannabis smoking	378 (39.9%)	[36.8; 43.1]
Alcohol consumption	261 (27.5%)	[24.7; 30.5]
Other psychotropic substances	77 (8.1%)	[6.5; 10.1]
Antalgic drugs	242 (25.5%)	[22.8; 28.5]
Regular physical activities and/or sports	202 (21.3%)	[18.8; 24.1]
Body mass index [kg/m^2]		
Underweight	29 (3.1%)	[2.1; 4.4]
Normal	335 (35.3%)	[32.3; 38.5]
Overweight	531 (56 %)	[52.8; 59.2]
Obesity	53 (5.6%)	[4.3; 7.3]
Average	25.2 ± 2.5	[25; 25.4]
Psychosomatic symptoms		
Neurovegetative disorders	567 (59.8%)	[56.6; 62.9]
Pain and/or muscle aches	345 (36.4%)	[33.3; 39.6]
Nervous tension	541 (57.1%)	[53.8; 60.2]
Mood disorders	350 (36.9%)	[33.9; 40.1]
Cognitive disorders	371 (39.1%)	[36; 42.3]
Sleep disorders	486 (51.3%)	[48; 54.5]
Self-reported chronic diseases	353 (37.2%)	[34.2; 40.4]
Musculoskeletal	307 (32.4%)	[29.4; 35.5]
Neuropsychiatric	229 (24.2%)	[21.5; 27.0]
Cardiovascular	220 (23.2%)	[20.6; 26.1]
Respiratory	201 (21.2%)	[18.7; 24.0]
Digestive	192 (20.3%)	[17.8; 23.0]
Metabolic	148 (15.6%)	[13.4; 18.1]

DISCUSSION

SOCIODEMOGRAPHIC AND PROFESSIONAL PARAMETERS

The average age of our coastal fishermen (38.8 ± ± 8.1 years) was consistent with the literature; for example, a Spanish study in Andalusia found a similar average age (40.3 years) [19].

Fishermen, often of rural origin, are mainly employed in heavy and risky trades (so-called 3D: dirty, dangerous, difficult), namely manual, tiring, dangerous activities, characterised by long and very intense work shifts [20]. The work of the sardines was exclusively nocturnal and that of the long liners was alternating day and night shifts. Ergonomic studies have shown "over-fatigue" of atypical work related to changes in circadian rhythm and the fact that work is done in a state of "nocturnal deactivation", both physiological and psychological [21].

Job strain was present in 52.1% of the sample; and iso-strain in 39.3%. Stress was caused by irregular and long working hours, the irregular rhythm of work (night and rotating shifts) and the particular climatic conditions in this region (strong winds, bad weather, rough seas). The literature considers fishing as a major provider of stress [1, 6, 21]. The particularly stressful activities of fishermen are also important. They have heavy workloads, long working hours. They work in cramped and crowded spaces with long shifts and night shifts that can alter biological cycles, such as glucose and lipid metabolism [22]. Fishermen have, in most cases, low education levels, low income, heavy workloads, long working hours, and they work in crowded space. The lower health-related quality of life in fishermen may be explained by poor social support, living and work conditions [6]. Fishermen could experience more work-related stress and fatigue, secondary to insufficient rest due to overtime work [23, 24]. To reduce work-related stress and foster interpersonal relationships in fishermen, the psychology of sustainable development may be drawn upon, as it promotes greater connection with nature and empathy. Numerous studies highlight the great risk of accidents for fishermen, as they often work in dangerous environments without safety devices available [25].

HEALTH STATUS

Smokers accounted for 63.6% of the study population. A Spanish study of fishermen in the Costa Barbarita reported an even higher percentage of 81.2% [26]. Numerous studies have pointed out that nicotine increases alertness and decreases sleeping time, while sleep disorders make

Table 3. Sleep habits, chronic insomnia and its consequences

Sleep habits, chronic insomnia and its consequences	Total (n = 948)	95% confidence interval
Sleep habits		
Average sleep time [h]		
In week	5.5 ± 0.9	[5.44; 5.56]
Recovery days and holidays	8.7 ± 1.3	[8,62; 8,78]
Bedtime schedule during recovery days and holidays		
20–22 h	38 (4%)	[2.9; 5.5]
22–24 h	640 (67.5%)	[64.4; 70.5]
After 24 h	270 (28.5%)	[25.6; 31.5]
Wake up time during recovery days and holidays		
4–6 h	19 (2%)	[1.2; 3.2]
7–8 h	96 (10.1%)	[8.3; 12.3]
After 8 h	833 (87.9%)	[85.6; 89.8]
Nap > twice a week	602 (63.5%)	[60.3; 66.6]
Chronic insomnia	447 (47.2%)	[43.9; 50.4]
Difficulty falling asleep	278 (29.3%)	[26.5; 32.4]
Midnight	392 (41.4%)	[28.2; 44.6]
Late night	251 (26.5%)	[23.7; 29.4]
Feeling of not having slept	226 (23.8%)	[21.2; 26.7]
Index of severity of chronic insomnia		
Absent	500 (52.7%)	[49.6; 56.1]
Mild	168 (17.7%)	[15.3; 20.2]
Moderate	250 (26.4%)	[23.6; 29.3]
Severe	30 (3.2%)	[2.2; 4.5]
Alertness disorders		
Epworth > 10	154 (16.2%)	[13.8; 18.5]
Quality of awakening		
In shape	410 (43.2%)	[40.1; 46.5]
Tired and sleepy	471 (49.7%)	[46.5; 52.9]
Headache	67 (7.1%)	[5.6; 8.9]

Table 4. Risk factors of chronic insomnia: multivariate logistic regression

Risk factors	Odds ratio adjusted	95% confidence interval	P-value
Iso-strain	27	[16.2; 45.0]	< 0.0001
Fatigue	24	[14.5; 39.9]	< 0.0001
Socio-economic concerns	5.9	[3.0; 11.7]	< 0.0001
Obesity	4.1	[2.9; 12.6]	< 0.0001
Burden of family dependents	0.3	[0.2; 0.4]	< 0.0001
Self-reported chronic diseases	0.2	[0.1; 0.3]	< 0.0001

smoking cessation more difficult [27, 28]. An Italian study has shown that the main health hazard to fishermen is lung cancer secondary to smoking [29]. Tea and coffee were respectively consumed by 91.2% of our fishermen; tea remains the Moroccan national drink. This prevalence of alcohol consumption was 27.5% and remained significantly lower than the European data [4]. Cannabis is the drug of Moroccan fishermen (39.9%) because it is ubiquitous and cheap. Among Andalusian fishermen, the frequency of cannabis use (8.5%) was significantly lower [20]. The relationship between consumption of psychoactive substances and fishermen is complex. There appears to be a multifactorial relationship involving biological, psychological, cultural and social factors. Associations between occupations and heavy or hazardous alcohol consumption were documented. Fishermen, due to the inclement weather, which traditionally offers hazardous work conditions, might explain that the regular consummation of alcohol before going to sea [30, 31]. The high consumption

of psychoactive substances by fishermen can be explained by the combination of several factors, including psychosocial risks and organizational constraints.

The prevalence of regular sports activity among our fishermen was low (21.3%). The pace of the professional activity deemed hard and painful seems to leave no time for leisure [3]. Psychotropic drugs and analgesics were regularly consumed by respectively 8.1% and 25.5%. More than half (51.6%) had an abnormally high BMI. The average BMI was 25.2 ± 2.5 kg/m^2, slightly lower than that of Icelandic fishermen: 26.3 kg/m^2. More than half of the fishermen (61.6%) had a high weight.

One of the possible explanations is the rapid migration from rural areas to urban areas with rapid changes in environmental factors, and greater consumption of energy foods associated with incorrect lifestyles and behaviour patterns. The atypical work, the nibbling, the fried food, snacks with a high fat content, and poor consumption of fruits and vegetables were responsible for the excess weight and were common issues among the fishermen [4, 32, 33].

The pathologies encountered reflected the job's harshness (weather conditions, tides, vibrations, physical loads, handling, etc.). Musculoskeletal disorders (MSDs), including low back pain and gonalgia, were reported by 37.2% of the fishermen. A recent systematic literature review, including 13 studies on work-related musculoskeletal disorders among occupational fishermen reported that MSDs ranged from 15% to 93% [34]. Psychosomatic symptoms and chronic diseases were frequent among fishermen [6, 35].

SLEEPING HABITS, DYSSOMNIA AND ITS CONSEQUENCES

During work days, the average duration of sleep was insufficient (5.5 ± 0.9 h). Similar observations were found in Andalusian [19], Breton [36] and American [37] fishermen. The variable time of falling asleep depended on the physical exertion during the day and the psychological state of the person [38]. The main days of recovery are not desired by fishermen because they are imposed by the bad weather that prevents them from going to sea.

Fishermen work every day, except Fridays, with nocturnal schedules in sardine boats, and with alternating shifts in longline boats. Ergonomic studies have shown that the "excessive fatigue" of the atypical schedule is related to changes in circadian rhythm and the fact that the work is performed in a state of "nocturnal deactivation", both physiological and psychological [38, 39]. Napping, for 63.5% of our fishermen was a good way to recover; however, it was not possible every day given the pace of fishermen's work [32].

Almost half of our fishermen reported being chronic insomniac (47.2%). The chronic insomnia of the middle or end of the night could be explained by the awakening for the prayer at the time of dawn and/or by dreamlike disorders (feeling of being always on board).

A New Zealand study, by actimetry among fishermen during working days and rest days, showed that, for the same duration of sleep, drowsiness was present during working days and absent during rest days. This drowsiness was probably related to fatigue and physical restraint [21]. An actimetric study of Breton fishermen in France showed that the circadian rhythmicity of subjective vigilance was maintained because the intense physical activity of fishermen helps to maintain vigilance and was the best behavioural means to fight against drowsiness [36]. This level of vigilance could be even better if fishermen were able to have a short night sleep: at least three hours in a row every day at the same time [40]; however, this possibility remains unachievable due to the irregular work schedule of the sailors.

Night activity, leading to fatigue and sleep disturbances, has consequences on the behavioural habits of fishermen such as smoking, excessive consumption of excitants, drugs, and thus leads to a decrease in performance at work [36, 41].

Half of our fishermen (49.7%) felt tired when they woke up. Fatigue is a common every day experience in the general working population, with prevalence estimates as high as 22% [42]. Although difficult to define, it is generally considered to be a subjective sensation on a continuum with behavioural, emotional and cognitive components. Working at sea certainly has the potential to be fatiguing [43]. Fishermen's fatigue could impact safety and may be linked to longer-term individual ill-health. It can only be addressed by considering how multiple factors combine to contribute to fatigue [43]. Insufficient sleep and rest are undoubtedly some of the most important contributors to fatigue [43, 44]. For adults, 7–9 hours was suggested as appropriate. In relation to fatigue, another review concluded that having less than 5 hours of sleep in a 24-hour period, or less than 12 hours of sleep in a 48-hour period prior to starting work may increase the risk of fatigue [45]. It is not only the duration, but also the quality of sleep that affects fatigue. Sleep quality can include quantitative aspects of sleep such as number of hours and sleep latency, as well as more subjective assessments such as the depth of sleep [46]. Poor sleep quality is positively associated with fatigue [2]. The majority of our fishermen practiced seasonally during the fishing season for certain varieties of remunerative catches (octopus, swordfish, etc.). Fishermen's income is tied to the size of the catch, giving them an incentive to keep working until the holds are full or until the fishing

quota is reached. Working for long periods at sea, fishermen have only minimal and irregular rest opportunities.

RISK FACTORS OF CHRONIC INSOMNIA

In our study, we found that iso-strain and fatigue are the two highest risk factors leading to having chronic insomnia. Nevertheless, job strain represents a burnout risk factor only if it is associated with insomnia. Insomnia can be considered as a relevant clinical marker that should be targeted in mental health prevention programs at the workplace [47].

LIMITATIONS OF THE STUDY

This cross-sectional study encountered certain limitations. The healthy worker effect may create a selection bias because active fishers would be healthier than the rest of the population because those with impaired health are assumed to be absent. Weaknesses of subjective self-reporting should be highlighted. There is no solution to avoid or limit individual variations. However, our study, having as its main objective a global approach, can be considered as a reliable representation of the situation. Thus, our study provides a clear picture of sleeping habits and dyssomnia in Moroccan fishermen.

CONCLUSIONS

Our Moroccan coastal fishermen are at high risk of chronic dyssomnia and alertness disorders with their causes (fatigue and stress) and consequences (psychosomatic symptoms and chronic diseases). While it is not possible to completely eliminate sleeping disorders in fishermen, it is imperative to help them improve material conditions, the environment on board and overall working conditions. Fishermen's health services should be aware of the causes of fatigue in fishermen which may affect their sleep quality and vigilance when working at sea. The preventive approach needs a cooperative spirit; it will be more accepted and applied if all fishermen and their representatives are involved in its elaboration. While certain procedures fall under the responsibility of the occupational health services (awareness campaigns on sleep disorders and their consequences, the fight against the consumption of psychoactive substances, etc.) and of the shipowners (organization of work), most of them fall under the responsibility of the national occupational health policy.

Conflict of interest: None declared

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Preliminary study after two years of use of Nausicaa system for seasickness management

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ABSTRACT

Background: *Seasickness is a set of clinical signs from which approximately 30% of the population suffers with a severity and frequency that varies according to the state of the sea and according to each individual susceptibility. The medical treatments are varied but may provide annoying side effects. Vestibular rehabilitation has all its advantages in cases of professional unfitness. The objective of this work is to validate the first results of rehabilitation of seasickness using the Nausicaa system developed at the HIA in Brest.*

Materials and methods: *Retrospective study of the first 2 years of use of the Nausicaa system, from commissioning in November 2016 until December 2018. Twenty-eight patients were treated exclusively by the Nausicaa system with a minimum of 1 year of follow-up and a minimum of 90 days at sea per year.*

Results: *The average intensity of seasickness of these sailors decreased from 8.96 to 4.5 and the inability to hold one's post from 8.36 to 3.7 after 10 rehabilitation sessions using this system. The Graybiel and Miller score was markedly improved (decrease of 2 to 3 grades) in 62% of the patients, and partially improved (decrease of one grade) in 20% of the sailors. A total of 82% of rehabilitated patients were improved by this treatment without any side effects.*

Conclusions: *The analysis of the results on a retrospective questionnaire describing clinical signs 1 year later is necessarily subjective. The use of visual analogic scales from 1 to 10 concerning the intensity of motion sickness and the inability to hold one's position seems to be an easy way to assess discomfort. The comparison with other series seems to show a slight superiority of the Nausicaa system compared to optokinetic rehabilitation or by visual simulator alone.*

(Int Marit Health 2022; 73, 4: 172–177)

Key words: sea sickness, motion sickness, virtual reality, sensory conflict, vertical stimulation

INTRODUCTION

Seasickness is the motion sickness generated by the maritime environment. It is the most problematic motion sickness in terms of its intensity and frequency in subjects [1]. Given the impact of the symptoms, sailors risk having to avoid going to sea, which can lead them to professional unfitness [2], and boaters risk giving up their leisure activity.

Information from peripheral sensors is integrated at the central level. A neurosensory conflict results from the integration of both a real movement and an false perception of immobility [3–5]. It provokes neurovegetative reactions sometimes extremely debilitating.

A wide range of therapies can be used [5, 6]. Their effectiveness, however, is variable, each subject responding differently in terms of improvement or side effects. Artificial exposure to mechanisms generating clinical signs often allows for habituation [7, 8]. Vestibular rehabilitation exercises based on optokinetic stimulation, when practiced, have given good results [8–10].

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The development of the management of vestibular and balance rehabilitation has for some years relied on virtual reality [11]. In the case of seasickness, the vertical component of the stimulation feels particularly uncomfortable and thus aggravates clinical signs [12, 13]. With this in mind, we have developed a system (Nausicaa) whose objective is to propose a greater range of vestibular stimulation by adding a vertical component, movements that are particularly harmful to the sailor. Thus, a seat performs vertical movements in order to stimulate the saccule while the subject is experiencing a virtual reality simulated navigation.

The results of the first patients who were able to benefit from this new method of preventing seasickness are reported below.

MATERIALS AND METHODS

This is a retrospective study of the first 2 years of use of the Nausicaa system, from its commissioning in November 2016 until November 2018. Self-administered questionnaire was used in addition to the information found in the subjects' medical files. The studied files concerned patients who benefited from seasickness rehabilitation using the Nausicaa platform, sailing at least 90 days a year, between November 2016 and November 2018.

Fifty-six files were identified. Ten files were excluded due to incorrect or invalid email addresses. Eight were excluded due to sailing less than 90 days. Ten did not reply despite 3 reminders. Twenty-eight subjects were then selected.

Patient care consisted of a clinical examination supplemented by cochleo-vestibular explorations (audiometry, tympanometry, videonystagmography, cervical Vestibular Evoked Myogenic Potential, posturography) in order to make ensure the correct running of the inner ears.

Seasickness was assessed with the Graybiel scale and with a Visual Analogue Scale (VAS). Similarly, working-on-board inability was assessed with a VAS. Other parameters likely to induce seasickness were found in the patient files.

Each patient received 10 rehabilitation sessions using the Nausicaa system (Fig. 1).

This system has been designed and developed by our department in conjunction with the French Government Defence procurement and technology agency (Direction Générale de l'Armement), Actris and the European Centre for Virtual Reality. It generates a sensory conflict using virtual reality instead of optokinetic stimulation and combines it with vertical movements in order to stimulate the saccule. The seat is enslaved to virtual reality so that the movements of the chair are correlated to the swell generated by virtual reality (Figs. 2 and 3). It allows a vertical range of 1.4 m.

The rehabilitation protocol includes 10 sessions of increasing difficulty (by changing the height and direction of the swell, the presence of cross seas, the presence of yawing of the boat). During the sessions, the subject may be asked, as in the case of optokinetic rehabilitation, to perform head movements.

Figure 1. Nausicaa system

Figure 2. Nausicaa system in operation

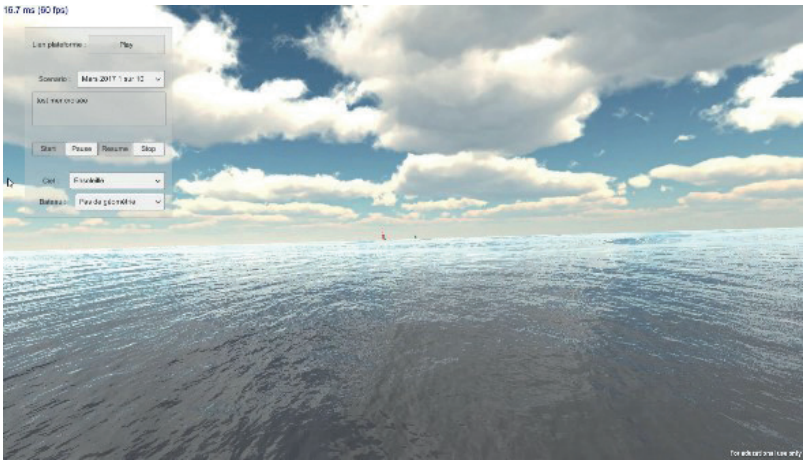

Figure 3. Screen shot of virtual reality (operator view)

Data were analysed with R software version 4.1.2 (2021--11-01). Mean, standard deviation, median and minimum–maximum values were given for descriptive statistics. Results were compared with Wilcoxon test for paired series and Fisher test. $P < 0.05$ was considered statistically significant.

RESULTS

The subjects included 17 (62%) men and 11 (38%) women (Table 1). The average age was 33.18 ± 11.2 years. The average age for men was 32.76 years and 33.81 for women, with no significant difference ($p = 0.795$). The distribution of professions shows 13 military personnel, 10 civilian marine professionals, 4 yachtsmen and a specialised photographer. The average of days at sea was 145 ± 56.6 days (values of 90 to 240 days at sea).

Otoscopic examinations, pure tone audiometers and speech tests were normal.

Several characteristics of the seasickness of these patients were noticed during their initial medical exam (Table 2). Smells (particularly fuel and cooking) were reported to be aggravating for 20 subjects. Similarly, it illustrated that the vertical component of the movement of the boat were more likely to increase clinical manifestations for 20 subjects. The presence of motion sickness in childhood was also found for many subjects (n = 20). Seasickness does not seem to be part of a broader set of motion sickness since in our population only 39% of subjects reported having discomfort in other transportation types in adulthood.

We did not find any psychological characteristics in patients with seasickness: no claustrophobic (82%), agoraphobia (85%), psychiatric history with depressive or anxio-depressive syndromes in our population (89%). Nevertheless, nearly 30% of subjects showed heights dizziness symptoms.

Table 1. Baseline characteristics of the seasickness population

Parameters	N = 28
Age [years]	33.18 (11.20)
Sex	
Male	17 (60.71%)
Female	11 (39.29%)
Professional category	
French Navy	13 (46.43%)
Merchant Navy	4 (14.28%)
Fishermen	3 (10.71%)
Hydrograph	3 (10.71%)
Boater	4 (14.28%)
Photographer	1 (3.57%)
Days at sea	145 (56.60)

Data are number (%) or mean (standard deviation).

Finally, very few patients (14%) reported discomfort on their return to land and none described a mal de débarquement syndrome, as defined by a duration exceeding 1 month. The return to land discomfort is manifested by a feeling of instability during the few hours or days following the return to solid ground.

Sea sickness and inability to hold one's position on board were assessed by VAS before and few months after the rehabilitation protocol (Table 3). In our population we assessed seasickness at 8.68 initially against 4.46, a significant improvement ($p < 0.0001$). Similarly, the inability to work on board decreased from 8.39 to 3.71 after rehabilitation. Here again the difference is significant ($p < 0.0001$). The improvement remains clear and significant according to gender.

Table 2. Characteristics associated with seasickness number (proportion)

Parameters	Yes	No	Do not know
Extrinsic factors			
Smell	20 (71.43%)	5 (17.86%)	3 10.71%)
Vertical component of motion	20 (71.43%)	3 (10.71%)	5 (17.86%)
Intrinsic factors			
Psychiatric history	1 (3.57%)	25 (89.29%)	2 (7.14%)
Heights dizziness	8 (28.57%)	18 (64.29%)	2 (7.14%)
Claustrophobia	2 (7.14%)	23 (82.14%)	3 (10.71%)
Agoraphobia	2 (7.14%)	24 (85.71%)	2 (7.14%)
Maritime experience in childhood	11 (39.29%)	15 (53.57%)	2 (7.14%)
Motion sickness history	20 (71.43%)	6 (21.43%)	2 (7.14%)
Motion sickness in adulthood	11 (39.29%)	15 (53.57%)	2 (7.14%)
Discomfort when returning to land	4 (14.29%)	22 (78.57%)	2 (7.14%)

Table 3. Results of seasickness treatment using Nausicaa system

Parameters	Before	After	P
Sea sickness	8.68 [8–9.50]	4.46 [3.49–5.50]	< 0.0001
Male	8.35 [7.56–9.15]	4.29 [3.16–5.43]	< 0.0001
Female	9.18 [8.45–9.91]	4.72 [3.25–6.21]	0.0002
Working-on-board inability	8.39 [7.99–9.51]	3.71 [2.99–5.00]	< 0.0001
Male	7.94 [6.99–9.01]	3.12 [2.01–5.00]	0.0005
Female	9.09 [9.49–10.00]	4.63 [3.50–6.51]	0.0006

Data are mean [confident interval].

The score obtained on the Graybiel scale before and after treatment, allowed us to order the patients within 4 groups: slight malaise, moderate malaise, severe malaise and frank malaise (Fig. 4). Initially, the patients were all found in groups 3 and 4 (5 at group 3 and 23 at group 4), the most severe.

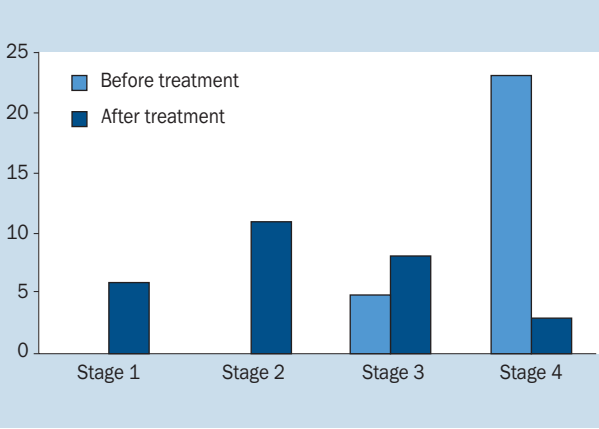

Figure 1. Graybiel's score stages before and after treatment

After rehabilitation, the patients' distribution changed in favour of groups 1 and 2 (6 at group 1, 11 at group 2, 8 at group 3 and 3 subjects remaining at group 4). We would describe it as a partial improvement in case of a reduction of 1 group (n = 6, or 21%) and a frank improvement for the reduction of 2 or 3 groups (n = 17, or 61%). The improvement distribution thus observed towards the first groups was statistically significant (Fisher test p = 0.04).

Among these parameters we observed a correlation coefficient of 0.59 (Pearson correlation test, p = 0.0008) between the intensity of seasickness before and the resulting operative inability (assessment by VAS). This coefficient dropped to 0.38 (p = 0.04) for the link between on-board inability and the Graybiel scale. This correlation between Graybiel score and intensity of the initial naupathy was calculated at 0.29 (p = 0.12).

After rehabilitation, we observed a strong link between intensity of residual seasickness and Graybiel score (r = 0.697, p < 0.0001) and working-on-board inability (r = 0.51, p = 0.005). The correlation between the working-on-board inability after treatment and the Graybiel score was 0.36 (p = 0.58)

DISCUSSION

The low number of studied subjects can be explained thanks to several factors. First of all, it was necessary to set a relatively high number of annual days at sea, in order to have a regularly exposed population and allow a more realistic assessment of seasickness. In effect, this meant ruling out many patients. Furthermore, during the study period, i.e., the beginning of use of Nausicaa, a certain number of patients were undergoing rehabilitation with optokinetic stimulation protocol, thereby reducing the number of potential subjects eligible for this study. Finally, as often, the retrospective nature of a study translates into a certain loss of information. We have clearly observed this in the number of subjects we were unable to submit the questionnaire or subjects not answering the questionnaire.

Our population has an average age of 33.18 years. This young age is partly explained by the profession of the subjects and in particular the military status of nearly half of them.

This age is similar to that observed by Trendel et al. in 2010 [8], with an average age of the subjects studied of 32.2 years.

Similarly, our population mainly comprises sea professionals with only 14% of leisure boaters. In Trendel's, it was 35% boaters. The difference lies in the selection criterion that we initially set as a minimum of 90 days of navigation per year to ensure subjects exposition to the triggering factors.

The vertical component of the movement of the boat is frequently found as to be a key factor favouring the onset of seasickness for 71% of the patients. This fact has already been known for many years [12] and remains true. Smells are another frequent contributory factor to the onset or the aggravation of seasickness (71% of patients). The mentioned smells come from fuel or exhaust gases, and also from the kitchens.

Failure is defined as the persistence of vomiting or the absence of progression of group according to the Graybiel and Miller scale. Indeed, the presence of vomiting automatically sends the patient to group 4 of the Graybiel and Miller scale. Of 28 subjects, 5 meet these failure criteria, i.e., a success rate of 82%. Trendel et al. [8], with the use of optokinetic rehabilitation, obtained 75% success according to the same success criterion. It seems that the combination of virtual reality and saccular stimulation by vertical movements makes it possible to achieve more interesting results. This deserves to be confirmed by a larger study, ideally prospectively.

In another previous study [10], on a larger population, both professional and recreational, the average age was 45 years. A significant improvement in seasickness had already been found after using optokinetic rehabilitation, the score dropping from 7.92 to 4.28.

In 2020, in this study of 141 patients [10], we addressed the notion of ability to work on board; essential element for professionals who, above all, want to be able to practice their profession and would not always have any other option in the event of inability. This often becomes for them a success criterion for the management of seasickness even if there is still discomfort or some symptoms of seasickness.

We have noticed an improvement in operational inability from 7.2 to 3.81, thanks to rehabilitation by optokinetic stimulation. Here we find a score that goes from 8.39 to 3.71 in our population after we have modified the rehabilitation technique by combining virtual reality with saccular stimulation. In 2017, another project carried out in our department on the rehabilitation of seasickness by visual simulation alone, pointed out an improvement from 8.2 to 3.6 [11].

Logically, there is a correlation between the intensity of the initial seasickness and the resulting inability to work on board. When the intensity of seasickness increases, the inability on board also increases by a coefficient of 0.59.

After treatment, the correlation between intensity of residual seasickness and working-on-board inability stands at 0.51, which seems to be of the same order as in the situation before treatment. On the other hand, the coefficient between intensity of residual seasickness and Graybiel scale after treatment is 0.697 whereas it was much less pronounced before. This is due to the very structure of the Graybiel scale and greater subject discrimination in first groups (slight malaise and moderate malaise).

The VAS will allow a more varied assessment of the intensity of seasickness, which can then explain this less pronounced correlation coefficient. Moreover, after treatment, the correlation between Graybiel score and working-on-board inability remains similar (0.38 before treatment and 0.36 after treatment).

CONCLUSIONS

The use of a simple VAS seems to be a good way to assess both the intensity of seasickness and the resulting inability to work on board. In the same way, it allows to assess the intensity of other motion sicknesses if they exist in the subject. The information thus obtained makes it easy to quantify motion sickness, in particular to assess the rehabilitation's effectiveness.

In a professional population, beyond the intensity of seasickness, it is the ability to perform one's job that is at stake. This is why, it is important to assess seasickness itself, and especially the working ability on board. Indeed, a slight or moderate discomfort with no effect on working ability can satisfy the patient even though seasickness persists.

The rehabilitating protocol allows a decrease in seasickness intensity and delays its onset. These first results reinforce our recommendation to combine navigation simulation

in virtual reality with vertical movements that also stimulate the other organs of the inner ear, in particular the saccule. These results obtained with this innovative and unique method must be confirmed by a study on a larger population.

Moreover, given the variability of individual susceptibility to seasickness and the variability of the influence of extrinsic and intrinsic factors, it would be interesting to carry out a study analysing these different factors which are sometimes questionable (ethnicity, gender, etc.).

Finally, using simulation and virtual reality allows us to consider personalized care for each patient by adapting the simulation parameters to the specific characteristics of the boat on which the patient is working.

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Haematological changes in sailors who had COVID-19

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ABSTRACT

Background: *Follow-up of patients who had coronavirus disease 2019 (COVID-19) proves that clinical symptoms persist for months after recovery. A complex of such persistent manifestations is defined as the post-COVID-19 syndrome. One of the criteria for post-COVID-19 syndrome may be typical changes in white blood cell count and white blood cell (WBC) differential. The aim of the work is to study the frequency of haematological changes in sailors who had the acute coronavirus infection.*

Materials and methods: *The retrospective study covered 30 candidate sailors aged 21 to 60 years with a history of COVID-19 and persistent changes in the WBC count and WBC differential and who did not have haematological abnormalities during the previous medical examinations.*

Results: *Analysis of WBC and WBC count at the long-term period after COVID-19 confirmed persistent changes in the form of neutrophilia, lymphopenia, changes in the neutrophils and lymphocytes ratio. The revealed changes in the WBC count were typical and fit into several patterns: A. Absolute leukocytosis, absolute and relative neutrophilia, relative lymphopenia; B. Relative and absolute lymphopenia, relative neutrophilia; C. Relative and absolute lymphocytosis, relative neutropenia; D. Relative lymphopenia, without other changes in WBC differential.*

Conclusions: *The most typical laboratory change in WBC count in patients with the past COVID-19 is relative or absolute leukopenia. Persistent changes in WBC count are not always outside of the reference range for absolute values and should be assessed by a complex of typical changes. The presence of typical changes in WBC count in a patient with the past COVID-19 requires a profound examination for the post-COVID-19 syndrome.*

(Int Marit Health 2022; 73, 4: 178–180)

Key words: coronavirus disease 2019 (COVID-19), post-COVID syndrome, lymphopenia, sailors

INTRODUCTION

Laboratory diagnosis is a leading factor in the fight against the coronavirus disease 2019 (COVID-19) pandemic [1]. Persistent changes in white blood cell (WBC) count can act as confirmation of viral aetiology of clinical manifestations and prove post-COVID-19 syndrome [2, 3]. Due to a healthy lifestyle, self-control and regular medical examinations most of sailors are relatively young and healthy, as evidenced by the results of annual pre-employment inspection. That is why, if health changes are detected after a coronavirus infection, they confirm post-COVID-19 syndrome with a high degree of accuracy.

The aim of this work is to study the frequency of haematologic disorders in sailors who had acute coronavirus infection.

MATERIALS AND METHODS

The study is retrospective. It was performed in the medical centre providing medical services to sailors ("Vivamed", Odessa, Ukraine). The patients were selected during

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pre-employment medical examinations. For the period from 30.12.2021 to 02.02.2022, 30 people were detected with WBC count disorders. All the sailors were men, European race. The age of patients ranged from 21 to 60 years; the median was 40 years (30–52).

Laboratory findings with reference values of indicators were obtained from the digital system of the medical centre laboratory. The detected changes in WBC count were interpreted in accordance with generally accepted standards, with the identification of patterns. The patient informed consent for participation in the study was obtained. It was documented by the bilateral signing of the contract.

RESULTS

Analysis of the previous medical examinations of the sailors who participated in the study revealed no significant changes in WBC count. All patients had COVID-19 from 1 to 6 months before the medical examination (mainly during the autumn 2021 epidemic), which was confirmed by relevant medical documents (medical reports, PCR results, express tests, serological tests).

The identified shifts in WBC count of sailors corresponded to absolute leukocytosis in 13 (43.3%) cases, absolute neutrophilia — 15 (50%), absolute lymphopenia — 5 (16.7%), absolute lymphocytosis — 1 (3.3%), relative neutrophilia — 22 (73.3%), relative lymphopenia — 27 (90%), relative lymphocytosis — 3 (10%), relative neutropenia — 3 (10%) (Fig. 1).

The rates of absolute leukocytosis in candidate sailors after COVID-19 ranged from 9.4 to 14.8 g/L, median — 11.4 g/L (10.3–12.5); absolute neutrophilia — from 7.0 to 12.0 g/L, median — 8.9 g/L (10.3–12.5); absolute lymphopenia — from 0.3 to 1.2 g/L, median — 0.8 g/L (0.6–1.0). There was also a single case of absolute lymphocytosis — 4.7 g/L. Reference values: white blood cells — 4.0–9.0 g/L; neutrophils — 1.5–7.7 g/L; lymphocytes — 1.1–4.5 g/L (Fig. 2).

The values of relative neutrophilia in patients after the past COVID-19 ranged from 77.1 to 86.7%, the median was 80.6% (77.6–83.6); relative lymphopenia — from 8.8 to 19.6%, median — 14.4% (10.5–18.3). The level of monocytes corresponded to the reference values and ranged from 2.1 to 9.6%, the median was 5.4% (4.3–7.9). Reference values: neutrophils — 42.0–77.0%; lymphocytes — 20.0–44.0%; monocytes — 2.0–10.0%. Also, among sailors, 3 cases of relative lymphocytosis (42.7%; 46.8%; 43.4%) were detected in combination with relative neutropenia (42.4%; 45.8%; 43.7%) (Fig. 3).

The changes revealed in the general blood analysis were mainly typical and fit in several patterns:

— A. Absolute leukocytosis, absolute and relative neutrophilia, relative lymphopenia (n = 15) — shifts in this pat-

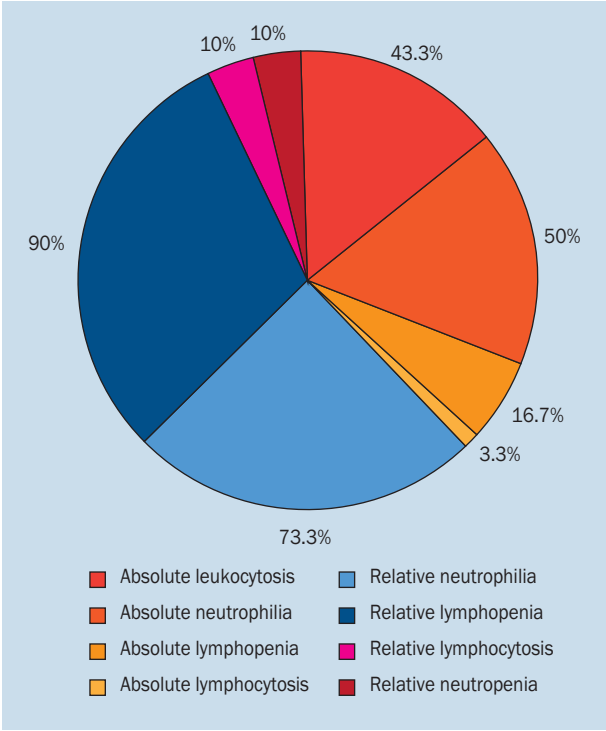

Figure 1. Variants of changes in white blood cell differential of sailors who had COVID-19

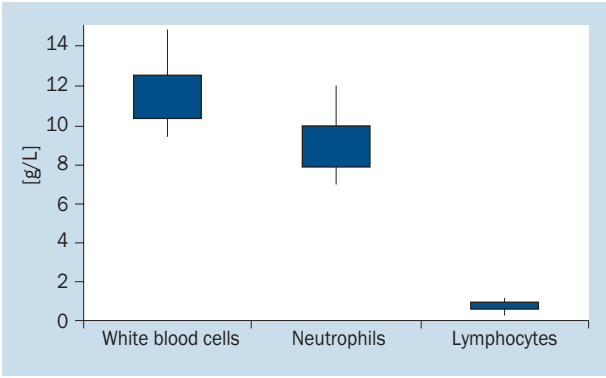

Figure 2. Absolute changes in white blood cell count in sailors after COVID-19

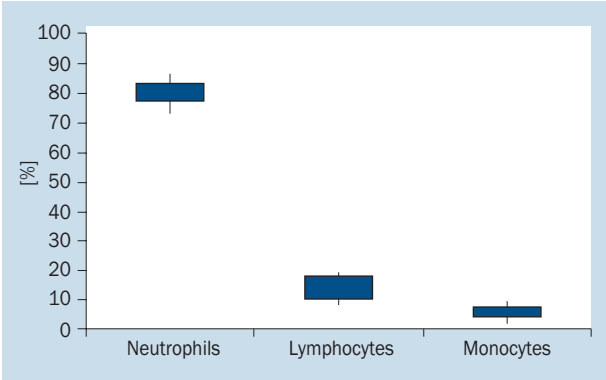

Figure 3. Relative changes in white blood cell count in sailors after the past COVID-19

Table 1. White blood cell differential shift patterns in sailors who had COVID-19

Pattern	White blood cell differential				
	Absolute white blood cells [g/L]	Absolute neutrophils [g/L]	Relative neutrophils [%]	Absolute lymphocytes [g/L]	Relative lymphocytes [%]
Pattern A. Patient K., 34 years old	11.0	8.7	78.6	1.7	15.8
Pattern B. Patient L., 49 years old	7.5	6.5	86.1	0.8	10.5
Pattern C. Patient T., 26 years old	7.6	2.3	30.5	4.7	61.8

tern were due to the apparent absolute growth of neutrophils. All 4 or at least 3 of 4 signs (for example, without absolute leukocytosis);

- B. Relative and absolute lymphopenia, relative neutrophilia (n = 10) — shifts in WBC count were due to a decrease in lymphocytes;
- C. A relative and absolute lymphocytosis, relative neutropenia (n = 3) — changes in WBC count due to an increase in lymphocytes to the upper limit of the reference value or higher against the background of a decrease in neutrophils to the lower limits of absolute values;
- D. Relative lymphopenia (n = 2) without other changes in WBC count (Table 1).

DISCUSSION

Sailors, as a cohort of workers having periodic medical examinations, can be considered as a subject for studying the consequences of COVID-19. However, this approach has certain limitations, as the sailor candidates often hide the non-obvious complaints and functional impairments. The impact of the coronavirus infection caused by COVID-19 on laboratory blood parameters differs significantly from other viral infections by duration and variety of manifestations and requires additional studies.

Persistent changes in WBC count at the long-term period after the past COVID-19 have several typical manifestations, such as neutrophilia, lymphopenia, a change in the neutrophils and lymphocytes ratio.

The presence of typical patterns in WBC count suggests that clinical symptoms at the long-term period in patients who had COVID-19 are a manifestation of post-COVID-19 syndrome.

CONCLUSIONS

The most common laboratory change in WBC count in COVID-19 survivors is relative or absolute lymphopenia. Persistent changes in WBC count do not always go outside of the reference values for absolute values and should be assessed by combination of typical changes.

Conflict of interest: None declared

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The usefulness and practicality of the International Medical Guide for Ships

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ABSTRACT

Background: *The third edition of the International Medical Guide for Ships (IMGS) was published in 2007 and supported a main principle of the newly adopted International Maritime Labour Convention (MLC) 2006: to ensure that seafarers are given health protection and medical care as comparable as possible to that which is available to workers ashore. In 2021, the revisions and drafting of the fourth edition of the IMGS began. Taking the COVID-19 pandemic into consideration, it was decided that a stakeholder study was necessary to ascertain the usefulness and practicality of the guide as well as provide input for which new topics to include.*

Materials and methods: *The study applied data triangulation, with respondents from a geographically broad sample of the International Maritime Organization's five regional areas of the world. The data was analysed using thematic analysis.*

Results: *The results show that the IMGS is widely known and used among persons involved in medical care on board ships, but the IMGS is not as practical as stakeholders would wish it to be. For the guide to be useful, it must be ensured that telemedical advice information is included and if possible, ensure there is one single and global medical guide. Also, there is a need for new medical information, and respondents pointed to pandemic information, medicines list, medical chest, mental health issues, a women's section, updated cardiopulmonary resuscitation instructions, human immune defect virus information (human immune defect-virus) and information on how seafarers may self-monitor and be monitored on board in relation to chronic diseases.*

Conclusions: *Respondents understand a medicine chest on board is mandatory according to the MLC 2006, 98% are familiar with its content, and 86% use the IMGS.*

(Int Marit Health 2022; 73, 4: 181–188)

Key words: medical guide, International Maritime Labour Convention (MLC) 2006, maritime health, seafarers' health, maritime medicine

INTRODUCTION

The first edition of the International Medical Guide for Ships (IMGS) was published by the World Health Organization (WHO) in 1967, with the intention of being the standard source of guidance for medical assistance to seafarers who fell ill or were injured. This was followed by a second edition that was published in 1988. The third and latest edition of the IMGS was published in 2007 [1], which included fully updated recommendations consistent with the latest revisions of both the WHO Model List of Essential Medicines and the International Health Regulations [2].

A year before the publication of the third edition of the IMGS, the International Labour Organization (ILO) convention, the International Maritime Labour Convention

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(MLC) was adopted on 23 February 2006, stipulating that all ships shall carry a medicine chest, medical equipment, and a medical guide [3]. The IMGS supported a main principle of the MLC: to ensure that seafarers are given health protection and medical care as comparable as possible to that which is available to workers ashore, including prompt access to the necessary medicines, medical equipment and facilities for diagnosis and treatment and to medical information and expertise. However, the list of medications in the third edition received some criticism for not providing enough guidance on medicines for minor ailments. This was of particular concern for users from flag states without national lists of medications to supplement the list in the IMGS. In 2009 a group of experts from WHO collaborating centres published an article with complementary guidance on the medical chest for IMGS users in response [4]. The problem of divergent advice for the medical chest was revisited in 2019, as there were still disparities in the regulations concerning the ship medicine chests, calling for harmonization of the requirements [5].

In 2021, the revisions of the fourth edition of the IMGS began, and the coronavirus disease 2019 (COVID-19) pandemic called for new knowledge and guidance. Not only due to the physical and medical consequences of the pandemic but also the increased mental health issues that arose because of it, including abandonment issues, lack of repatriation and restrictions on board. Societal changes and movements, telemedical advancements [6], increased focus on women in the maritime industry [7–9] and MLC 2006 amendments [10] have also contributed to the necessity of a revision. These arguments together with the fact that other medical guides exist or were being drafted, it was decided that a stakeholder study was necessary to ascertain the usefulness and practicality of the guide, and provide input for the revisions. This article reports the results from the stakeholder study.

The guiding research question was, how do stakeholders perceive the usefulness and practicality of the IMGS?

Usefulness relates to how relevant the medical content of the guide is, and practicality to how accessible necessary medical content is in practice.

MATERIALS AND METHODS

Seafaring as an occupation involves high risks when compared to land-based industries. Many studies have also documented cardiovascular risk factors and behavioural risk factors in the sector [11–23]. It is therefore extremely important to ensure equal access to healthcare, ensure health promotion initiatives and provide high quality and research-based information regarding seafarers' health to address the serious health issues that these studies present.

The MLC 2006, which came into effect on the 20th of August 2013, was an important breakthrough in relation to ensuring minimum requirements for seafarers' healthcare. The following amendments have been equally important, providing mechanisms and guidelines for efforts made [10]. As part of the MLC 2006, the IMGS has been a contribution to assisting health protection and medical care for seafarers.

Health promotion initiatives continue to take place, which play a role in assisting the behavioural changes needed to ensure seafarers' health [21]. Seafarers' mental health has received more attention in recent years [22, 23], also in cognizance of the COVID-19 pandemic, with many different industry initiatives and research studies. Ensuring healthy lives and promoting wellbeing are core elements of the United Nations Sustainable Development Goals (SDG), #3, and relevant to discuss in relation to seafarers' health and WHO goals for health and wellbeing in general [24, 25].

MATERIALS

The analyses undertaken in the study were conducted during December 2021–February 2022 by the authors. This study was set in motion by the International Maritime Organization (IMO) in collaboration with WHO to compile information and feedback from maritime stakeholders in relation to the usability and practicality of the IMGS.

The study is based on a combination of three data sources: an online questionnaire, online interviews based on an interview guide, and e-mail correspondence, all in English. This material will be made available from the authors for interested parties. The data corpus comprises 262 responses in all, distributed on:

- 246 questionnaire respondents;
- 10 online interviews;
- 6 email correspondences.

Maritime authorities were contacted based on the aim to acquire a geographically broad sample of respondents from the IMO five regions, Latin America and Caribbean, Asia and Pacific, Africa, Arab States and Mediterranean, Western Asia and Eastern Europe and a sixth sample region, Other States, and entities (Table 1). This was to ensure a response from across the globe and across both developed and developing countries. The purposeful sampling method was used [26] to enhance participation from the theoretically relevant population needed to take part in the survey.

The respondents represented an array of professional roles, ranging from port operators, doctors, and ship crews, to governments, institutions and service organizations, maritime academics, crew and officers unions, non-governmental organizations, charities, training institutes, shipping companies and pilots. Roughly half of the respondents claimed to be usually based at sea and three quarters

Table 1. Study respondent recruitment

Region	Country	Email 1	Email 2	Phone call	Recruit-ment	Question-naire link	Interview (10)
Latin America and Caribean	Argentina	X		X		X	
	Brazil	X	X	X			
	Bolivia	X	X				
	Uruguay	X	X				
	Panama	X	X	X	X	X	X
	Barbados	X	X	X			
Asia and Pacific	Kiribati	X		X		X	X
	Philippines	X			X	X	
	Vanuatu	X	X			X	
	Vietnam	X	X			X	
	Fiji	X	X			X	
	Myanmar	X	X	X		X	
	India	X	X		X	X	
	China	X	X			X	
	Japan	X	X			X	
Africa	Ghana	X	X	X			
	Kenya	X	X		X	X	X
	Liberia	X	X				
	Nigeria	X	X				
	South Africa	X	X				
Arab States and Mediterranean	Egypt	X	X	X	X	X	
	Tunisia	X	X			X	
	Malta	X	X			X	
	Italy	X	X	X		X	
	Kuwait	X	X			X	
	Qatar	X	X	X		X	
	UAE	X	X			X	
Eastern Asia and Eastern Europe	Turkey	X	X	X		X	X
	Cyprus	X	X			X	
	Russia	X	X			X	
	Bulgaria	X	X			X	
	Georgia	X	X			X	
	Ukraine	X	X		X	X	
	Lebanon	X	X	X		X	
Other States and Entities	France	X	X			X	X
	Norway	X	X		X	X	
	Denmark	X	X	X		X	X
	Germany	X	X			X	X
	Canada	X	X			X	
	UK	X	X	X		X	X
	USA	X	X	X		X	XX
	IMHA	X	X			X	
	CIRM	X	X			X	

X – 1; XX – 2

Table 2. Collected information about the respondents

	Number
Professional role	
Ship crew	103
Ship owner/operator/management	40
Government	5
Non-government organizations	9
Medical support	2
Doctor	43
Other (medical maritime teachers and trainers, consultants, retirees, port personnel)	42
Experience with medical care at sea	
Yes	180
No	54
Role when gaining experience with medical care at sea (only among the 180 with experience)	
Patient	3
Healthcare provider at sea	74
Remote shore-based medical assistance	23
Other (master, first aid, crew)	29

of them claimed to be involved in medical care at sea, mostly as a health care provider, Master, or shore-based medical assistance (Table 2). All respondents (89%) indicated to have medical training, some were medical doctors; however, most of them have received their training at a maritime medical care course or as part of their maritime training.

The interviews were analysed using thematic analysis, where meaning units are identified in the transcribed interviews [27]. A theme is formulated that dominates a natural meanings unit, so that the quotes are thematised based on the interview persons' perspective.

Interview and questionnaire questions were the same. However, in the interviews, respondents were asked to reflect or elaborate more on the issues where they seemed to have knowledge or an opinion, using questions such as follow-up questions [28].

Respondents unable to take part in the interviews or questionnaire survey were given the opportunity to contribute with comments to the IMGS, 3rd version or other information.

METHODS

Both qualitative and quantitative methods were used to ensure better validity of the results and to optimize the opportunity to acquire a varied set of responses that could answer the research question [29]. A preliminary questionnaire devised by the WHO was used to create the basis of questions for the interview guide and questionnaire. Questions were further developed and revised 6 times to ensure a set of questions that could provide answers to the research question. Trials were made of the interview to test the length of interviews and questionnaire response time needed. Invitation letters were drawn up and sent out to respondents.

Interviews enabled the compilation of knowledge that is not quantifiable but more in-depth knowledge of relevant issues relating to the IMGS.

The survey questionnaire was devised to capture a larger sample of potential respondents. This method was also chosen to allow respondents easy access to the survey, and to allow and enhance participation for respondents across the globe. This would enable a broad set of answers, across professional groups and geographical spheres. This data was quantified using Survey-Xact.

Purposeful sampling was used, which entails the process of recruiting respondents who are likely to have knowledge about the studied topic [26]. In this case we sought to recruit respondents who would be the target audience for the IMGS.

RESULTS

In reference to the research question, the data compilation was guided by two goals: (1) assess the usefulness of the guide for end users and stakeholders; (2) assess the practicality of the guide for end users and stakeholders.

It can be noted that under the question of usefulness, queries were included as to input for new medical information necessary in the IMGS. The results are presented in accordance with these two goals.

USEFULNESS

The IMGS is both known and used among persons involved with medical care on board ships worldwide according to questionnaire respondents. In fact, 81% of the respondents are familiar with the IMGS.

The respondents across all data sources indicated that the medical problems they had encountered while involved in medical care at sea were various forms of injuries, infections, pains, and cardiovascular diseases. Other less frequently mentioned problems were mental health problems, kidney, or urinary stones, burns, hernia, COVID-19, tooth aches, ectopic pregnancy, diabetes, suicide, and meningitis. In dealing with these situations most of the respondents (70% in the questionnaire survey) used the IMGS. The rest had used other materials such as the CIRM (International Radio Medical Centre based in Rome) or Radio Medical, the Ship Captain's Medical Guide, a company manual, or national Clinical Practice Guidelines.

The following quote sums up several of the issues that respondents raised in the interviews: *"It is too big. It can put people off. It is for a person who is NOT a doctor, and you need to make it easily accessible for a lay person. A seafarer faced with asthma or who is breathless. You need something concise — what is the problem and what you should do? Make it near to a manual. The guide is more a book and more old-fashioned first aid version. They could always get the in-depth in another version. Tele coms are increasing, and they can get valid info, and the IMGS could be better written to suit this. There is a lot of emphasis on the severe conditions which are rare — do the more common things. Present in the accordance to the likelihood of their occurrence"*.

One respondent found that it is difficult to find answers to specific questions. Another response in line with this was, "*incredibly thorough, very comprehensive, but how easy is it to use? How quick can they get to the necessary information?*". Another respondent offered an explanation: "*For most applications, it is too involved. It appears to be geared towards vessels without ready access to shore side physician advisory services. A pared down version with instructions for procedures would be more helpful. Teaching on-board medical personnel how to assess an issue and communicate with shore-based providers is more helpful than trying to train on specific diagnoses*".

Some respondents referred to the discussion about the medical chest in the introduction. They called for an updated list based on an agreed international standard, together with a procedure for keeping it updated and linked to online sources. One interview respondent elaborated: "*The medications are very Eurocentric. In [region] we do not use medical honey. Some of the recommended medications (mebendazole) are unreasonably expensive in [region] without good substitutions. The recommendations for post exposure prophylaxis are inadequate and outdated. Many of the medical chest recommendations are inadequate or outdated*".

The respondents were asked what other materials they had used as a reference. Interview responses were aligned with the questionnaire results, and this included national guides, websites, and YouTube videos. Some respondents also informed that they created their own documents to guide medical staff in assessment and communication with personnel at sea.

E-mail respondents informed that the usefulness of the IMGS may be enhanced by using a maritime doctor in the revisions and further updates. This would enhance a more maritime linguistic approach that would be understood by seafarers using the guide, and this would also lend more trust to the IMGS as a useful resource in maritime health and care. In line with the interview data, e-mail respondents asserted that the IMGS does not in its current form take note of the current use of telemedical services. Respondents also found it vital that it is sought to arrive at a single and global medical guide, as the many diverse documents and origins are confusing and create unnecessary difficulties for seafarers. However, many of these different guides are used by the sector and each of them receives credit from respondents. Some respondents contest the intentions of WHO in engaging in the IMGS, as it is the single maritime health issue involvement. The price of the IMGS book version was also contested.

In conclusion, respondents across data sources requested to add guidance for:

- COVID-19 and pandemics;
- psychological diseases/mental health;
- issues relating to a growing number of female seafarers, such as sexual harassment and diseases or conditions specific to women;
- monitoring of chronic diseases.

The interview and e-mail respondents found mental health issues to be especially important to expand on. The COVID-19 situation has only heightened this necessity. Telemedicine must be more involved in a revised guide as this has developed in comparison to the last version, and restrictions due to COVID-19 have called for telemedical assistance.

PRACTICALITY

For the guide to be more practical, it must include improvements of the medicine chest and the list of medicines, and this was frequently mentioned in the data.

As much as 96% of the respondents were aware that a medicine chest on board is mandatory according to MLC 2006 and 98% reported to be familiar with its content. When asked which medical guides are used in accordance with MLC 2006, 86% answered IMGS, and the remaining responses referred to the Ship Captain's Medical Guide [30], as the most used guide.

The majority (74%) of the respondents had not experienced difficulties in the practical usage of the IMGS. The remaining responses indicated that it was difficult to find the right chapter, the wording in the guide was too technical, or it was too long. Other reasons mentioned were issues with medications:

- *"Lack of clarity on medications. Discusses issues rather than giving clear decision aids";*
- *"Some medicines obsolete";*
- *"Medicine Chest requirements are missing in IMGS 3rd Edition. Supplement does not provide authoritative guidance";*
- *"Medicines not found in the medical chest".*

Despite most respondents having not found difficulties in using the guide, respondents across all data sources

remarked that the IMGS would benefit from being more structured and include easier access to the information needed. The interview data is not representative, with only ten respondents. However, the responses are similar to the questionnaire data.

The responses reflect the questionnaire results well, with injuries and infections being common, and in addition, also chronic diseases, and cardiovascular issues. The pointers to mental/psychological diseases and COVID-19 also correspond to the questionnaire and email results.

In conclusion, the IMGS is not perceived as practical as stakeholders would wish it to be. Although the respondents find what they need, they report that it lacks an appropriate structure and medical information is missing. It is also difficult for respondents when the medicine that they have on board does not correspond to the information in the IMGS. The following suggestions were made to enhance practicality:

- *"A book and an online version are highly preferred and viewed practical";*
- *"Use of pictures, videos or checklists are preferred";*
- *"Use of pull-out pages";*
- *"Include more action-oriented information and general cases";*
- *"Training in usage of the IMGS and new updates";*
- *"Ensure that there is one single, global medical guide";*
- *"Draw up a plan for future publications and consistent revisions of the IMGS".*

DISCUSSION

The study presented here has drawn on three data sources to investigate the usability and practicality of the IMGS across all five IMO regions and a sixth sample region.

There were three predominant tendencies that arose from the data, pointing out the need for more attention to telemedicine, pandemics, and mental health issues in a future revised version of the guide.

Telemedicine has expanded since the previous edition of the guide was published. The more frequent use of telemedicine may tend to make the IMGS more of a supplement than a stand-alone piece, hence the referenced wishes for a shorter version with only the essential information. However, as reported in a recent review article, there are still many limitations to the provision of adequate medical care at sea and there are still vessels operating without telemedicine assistance [6]. This includes the difference in availability between cruise ships and merchant ships, as the latter often has weak or no access to internet facilities. This is a dilemma that needs to be addressed, as we have the technology to provide seafarers with equal access to health, but it is simply not supported. Email and telephone are therefore the principal means of providing medical advice as well as assistance for patients at sea [6]. To ensure equal access to health, the data informs both a need for a comprehensive version and a smaller and more accessible version.

The survey also reports other new tendencies, with frequent mentions in the data of mental health at sea and women's health issues. Mental health issues have received more attention lately, with two important studies prior to the pandemic [22, 23], studies related to post pandemic issues and other precarious situations around the world [31]. This includes seafarers stranded on ships beyond the end of their contracts, unable to be repatriated due to COVID-19 related travel restrictions [32], and restrictions on board vessels that inhibited seafarers' needs for relatedness and wellbeing. Research calls for attention to seafarers' mental health, but also for the need to know how to assist seafarers and supervisors in mental health care situations, monitoring mental health well-being and having access to relevant training [31]. The #metoo movement in society has given more focus to the health care of female seafarers, and as one respondent advised, information as to how to deal with cases of gender-based attention or violence on board is necessary. This might reflect an increased awareness of these issues [7–9], but also an increased prevalence.

Another new tendency is the call for guidance for monitoring and maintenance of chronic diseases. This in part reflects the general population and its ageing workforce. But it also reflects a lack of practical information in the guide, or access to assistance that can help facilitate self-monitoring or access to a medical caregiver who may monitor the condition. Mapping this out could enable more seafarers to stay longer in the industry, in a time when it is difficult to recruit staff, and it could mitigate unnecessary situations involving repatriation or hospitalisation.

LIMITATIONS OF STUDY

The COVID-19 pandemic outbreak impacted a range of things, such as lack of access to respondents due to illness, understaffing, and some organizations had difficulty in allocating a person to participate.

Respondents reverted to emails and telephone calls late in the survey period, forcing the study to be prolonged. However, the extra month used was very instrumental in acquiring the large data corpus that was accomplished. A data category in the form of emails was included, as some respondents could not take part in interviews or questionnaires.

The questionnaire survey was set up to allow respondents to skip questions, to make it as easy as possible to answer. This means that not all respondents answered all questions. However, a large sample was compiled, with many comments written in free-text boxes.

CONCLUSIONS

The findings in the survey were similar across all three data sources. The data was analysed according to two goals: (1) assess the usefulness of the guide for end-users and stakeholders; (2) assess the practicality of the guide for end-users and stakeholders.

In relation to goal 1, respondents find that the IMGS is useful. Eighty-one per cent of the questionnaire respondents were familiar with the guide. The most frequent medical issues were various forms of injury, infections, pains, and cardiovascular diseases. However, despite the knowledge of the guide, telemedical services, medical training, and the Ship Captains Medical Guide [28] were mentioned as the most predominant other sources used to address medical problems. The many and varying sources are confusing for stakeholders. The level of comprehension of the IMGS is not helpful, there is too much information, which makes it difficult for a lay person to use. For the guide to be useful, it must include telemedical advice information and if possible, ensure there is one single global medical guide.

There is a need for new medical information and respondents have provided many suggestions (unprioritized list): Pandemic information and COVID-19, telemedicine, medicines list, medical chest, mental health issues, such as fatigue and stress, a women's section including information on sexual assault, updated cardiopulmonary resuscitation instructions, human immune defect-virus information and information on how seafarers may self-monitor and be monitored on board in relation to chronic diseases.

In relation to goal 2, the IMGS is not as practical as stakeholders would wish it to be. Although the respondents find what they need, the guide lacks some medical information. It is difficult for respondents when the medicine that they do have on board does not correspond to the information in the IMGS. Sometimes the book is too difficult for respondents to use, and it should therefore offer better explanations or guidance in the use of the IMGS. The respondents called for both a book and an online version to facilitate practicality. IT materials and online versions of the guide were suggested, although this should not replace a book version. Respondents suggested that the book should be developed to include more action-oriented cases and more general cases of typical ailments, also using pull-out pages to explain procedures. It was suggested that WHO provides a publication plan with more consistent updates of the IMGS.

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Pulsatile gas-liquid flow resembling Decompression Sickness: Computational Fluid Dynamics simulation and experimental validation

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ABSTRACT

Background: *This work performs two-dimensional Computational Fluid Dynamics (CFD) simulations of pulsatile bubbly flow in a column resembling the flow inside human vena cava during Decompression Sickness (DCS), aiming to illustrate the effect of certain parameters in bubbly blood flow and so facilitate the design of the: a) corresponding in-vitro bubbly flow experiments under pulsatile flow conditions inside a flow loop and b) in-vivo trials on swines for assessing a novel electrical impedance spectroscopy technique on the detection of bubbles (as those found during DCS) in their bloodstream.*

Materials and methods: *The commercially available ANSYS 2019-R3 CFD code was employed to simulate the pulsatile bubbly flow that resembled DCS. Simulations were validated against experiments conducted in a vertical co-current upward pulsatile bubbly flow provided by a flow loop equipped with electrical, optical and pressure diagnostics.*

Results: *CFD simulations under pulsatile conditions were initially validated by oscillatory in-vitro bubbly flow experiments. Then, the influence of pulsation parameters on void fraction, α, and flow velocity, U, profiles was computationally investigated. Intense periodic fluctuations of void fraction were observed along the column and their intensity increases with pulsation amplitude. Moreover, U and α radial profiles were uniform for bubbles 30 μm but showed a core-peaking profile for bubbles 300 μm.*

Conclusions: *CFD simulations of pulsatile bubbly flow resembling DCS provided unconventional information about the influence of different-sized sub-millimetre bubbles on the flow velocity and void fraction profiles, which are expected to improve the design of in-vitro and in-vivo trials for the detection of bubbles such as those found in DCS.*

(Int Marit Health 2022; 73, 4: 189–198)

Key words: CFD, bubbly flow, Decompression Sickness, void fraction, flow velocity

INTRODUCTION

Two-phase (gas-liquid) bubbly flow has been studied extensively for several decades, both theoretically and experimentally. The numerous applications of bubbly flow in different industries, however, makes researchers focus constantly on this, investigating in depth bubble dynamics and interactions, as well as the motion and phase distribution of two-phase systems that govern principally the transfer processes. Bubbly flow is currently encountered in various engineering systems of chemical, petroleum, nuclear and food industries, such as heat exchangers, boilers, steam generators, phase separators, transport pipelines and chemical reactors [1]. All these applications take the advantage of high mixing properties and enhanced heat, mass and momentum transfer during bubbly flow [2].

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Most industrial applications concern steady bubbly flow. However, oscillatory bubbly flow is also found in some cases, increasing significantly the complexity of two-phase flow dynamic behaviour. The introduction of flow unsteadiness may be either beneficial or detrimental for the system under study. The pulsating heat pipes are novel heat transfer components with a simple structure and flexible arrangement, which are utilised in heat recovery systems, electronic cooling systems, space, automobiles, etc. The main difference between pulsating heat pipes and conventional heat pipes is the existence of reciprocating oscillatory flow that results in fast thermal response and higher heat transfer rate [3]. Sometimes, oscillatory bubbly flow can be also employed to enhance mass transfer in bubble columns [4]. On the other hand, the response of multiphase systems to periodic oscillations may be problematic. This is the case of bubbly flow observed in heat exchangers and power plants on-board ocean-going vessels. Unfavourable void fraction distribution in response to ocean waves may affect heat transfer, enhance thermal fatigue and even cause burnout in boiling systems [5].

Interestingly, oscillatory bubbly flow can be also found in human physiology when gas bubbles get into the blood stream during Decompression Sickness (DCS). DCS describes a condition where dissolved gases come out of solution into bubbles inside the human body, in response to acute reduction in ambient atmospheric pressure. It may be experienced in depressurisation events such as extra-vehicular activities of astronauts outside the spacecraft, working in a caisson, underwater diving decompression and flying in unpressurised aircraft [6, 7]. Furthermore, a few bubbles may accidentally enter the blood circulation and form a pulsating bubbly flow during cardio-vascular surgeries, due to extracorporeal blood circulation circuit malfunction. In both cases, bubbles presence may have mechanical, embolic, and biochemical effects with manifestations ranging from itching and minor pain to neurological symptoms, cardiac failure and death [8]. Although oscillatory bubbly flow during DCS is uninvited, it is helpful enough when resulting from purposeful introduction of bubbles in human bloodstream to block the blood supply to tumours in blood vessels [9].

In-depth understanding of two-phase flow behaviour (e.g. void fraction distribution and velocity profile) is necessary to enhance productivity and ensure safety in industrial applications, as well as to facilitate the prevention and treatment of DCS incidents in astronauts and divers. This can be achieved either experimentally or computationally. Experimental study of two-phase flow parameters is limited to lab scale and has to overcome possible technical constraints and high costs. On the other hand, computational modelling is simpler, less expensive and time-consuming and may be extended to larger scale [9]. Furthermore, recent advances in Computational Fluid Dynamics (CFD) multiphase flow domain allow investigating pretty complicated problems much more thoroughly and accurately than simplified models and experimental methods can do. Ideally, modelling is performed complementary to experimental work, but even individually provides valuable information on multiphase flow physics.

Most CFD studies focus on turbulent bubbly flow because of its numerous applications in industry. Laminar bubbly flow, however, is a significant limiting case, whose dynamics are not yet understood completely ("laminar" and "turbulent" flow refers to liquid single-phase flow). Actually, flows generated by injecting bubbles into laminar bulk flow exhibit a "pseudo-turbulent" behaviour that is interesting to investigate [10]. Previous studies have shown that the distribution of void fraction, the key parameter to describe the inter-phase interactions in bubbly flow, varies considerably with the flow conditions and depends strongly on bubble size (referring to uniform bubble size in the order of magnitude of a few mm). For bubbles smaller than 2 mm (nearly spherical bubbles) in upward flows, void fraction distribution is relatively uniform in the core of the channel and has a peak near the pipe walls. For bubbles greater than 3.5–4.0 mm (sufficiently deformable bubbles), on the other hand, void fraction distribution peak shifts to the pipe centre [10, 11]. Interestingly, two-peak void fraction distribution has been also found in laminar bubbly flow for varying experimental conditions, e.g. with bubbles around 2.3 mm and average void fraction of 0.01–0.02 in a pipe of 14.8 mm inner diameter [12]. Void fraction distribution becomes more complex for non-uniform bubble sizes, since distinct bubble sizes have different distributions in the same bubbly flow. The different phase distributions for the small and large bubbles create a more intense fluctuating flow field that flattens void fraction profile peaks [11].

Although literature lacks of CFD studies for bubbly flow in human physiology, several authors have performed computational modelling to solve and analyse problems including blood flow. The majority of these studies investigated blood flow parameters under pathological conditions related to atherosclerosis and cardiovascular diseases. CFD is an appropriate tool to estimate such quantities, since it produces results in fair agreement with those obtained from in-vivo tests that need expensive and specialized medical devices [13, 14].

This work is complementary to previous studies that investigated experimentally the case of vertical, co-current, upward, steady gas-liquid flow, where the examined conditions resemble bubbly flow in human vena cava during DCS [15–19]. Despite the different local characteristics, similar average bubbly flow conditions, combining sub-mil-

limetre bubbles and low void fractions (< 10^{-1}), are also encountered in other two-phase flow applications, e.g. flow boiling in macro-channels [20]. Void fraction and bubble size distribution were studied in a fully automated flow loop employing electrical resistance tomography, an European Union patented ultra-sensitive electrical impedance spectroscopy technique (called I-VED) [21], as well as optical and pressure diagnostics. In addition, measured void fraction values were compared against predicted ones employing well-known drift-flux model based correlations [22]. Here, two-dimensional (2D) CFD simulations were carried out to investigate for the first time axial and radial void fraction distribution as well as velocity profile in this kind of bubbly flow under both steady and pulsatile flow conditions. The primary objective of the study was to facilitate the design of the forthcoming: a) in-vitro experiments for the investigation of bubbly flow resembling DCS under pulsatile flow conditions and b) in-vivo trials on swines for assessing the performance of the abovementioned I-VED electrical impedance method on the detection of infused bubbles (as those found during DCS) in their bloodstream. Validity of CFD simulations in such conditions was assessed with respect to preliminary in-vitro experimental results. Furthermore, this work aimed to compare CFD simulations with the experimental and drift-flux model findings for steady flow conditions and to extend knowledge obtained from experimental studies providing detailed information on the spatial and temporal distribution of the two phases and local bubbly flow peculiarities.

MATERIALS AND METHODS

PROBLEM FORMULATION

The vertical co-current upward bubbly flow that resembles DCS conditions was simulated employing the commercially available ANSYS 2019 R3 CFD code. The vertical column flow problem was simplified down to a 2D axisymmetric case. The height, h, and the inner diameter of the column, D, were 1000 mm and 21 mm (equal to the diameter of human vena cava where bubbles gather during a decompression incident), respectively [8]. Thus, a computational grid was developed consisting of 21,000 elements (1000 × 21) sized from 0.2 to 1 mm, since they are biased near the wall to capture adequately the laminar boundary layer.

Bubbly flow inside the vertical column was modelled by means of the Eulerian multiphase model. Although the most complex one, it is considered tractable enough for this kind of two-phase flow by averaging the equations in space. The two phases are assumed as interpenetrating and interacting continua and separate momentum and mass balance equations are solved for each phase. An advantage of this approach is the convenient two-way coupling between phases [23].

Table 1. Liquid-gas properties at 37 °C and parameters used for two-dimensional simulations (varying parameters in blue colour)

Liquid density [kg/m^3]	1050	
Liquid viscosity [mPa.s]	4.5	
Mean liquid velocity, $U_{l,mean}$ [cm/s]	3	30
Sinusoidal pulsation frequency [Hz]	1	
Sinusoidal pulsation amplitude [% of $U_{l,mean}$]	10	50
Gas density [kg/m^3]	1.225	
Gas viscosity [mPa.s]	1.79 x 10^{-2}	
Bubble diameter, D_b [μm]	30	300
Void fraction, α [–]	0.03	0.10
Gravitational acceleration [m/s^2]	9.81	

Liquid and gas properties as well as parameters used for 2D simulations are listed in Table 1. All physical properties were taken at 37°C, equal to body temperature. Liquid density and viscosity (supposing Newtonian behaviour) simulate blood physical properties, while the applied mean liquid velocities, $U_{l,mean}$ = 3 and 30 cm/s, are representative of bloodstream in human vena cava [8, 24]. For the abovementioned liquid flow rates, the Reynolds number of single liquid phase is 147 and 1470, respectively. Therefore, a laminar flow profile was used as a boundary condition. Pulsating liquid flow was simplified to a sinusoidal flow profile of 1 Hz (corresponding to 60 heart beats) with varying amplitude (± 10% and ± 50% of average flow rate). To compare with, steady bubbly flow simulations were also performed. Gas physical properties correspond to air for simplicity. Two low void fraction values, α = 0.03 and 0.10, as well as two sub-millimetre bubble diameters, D_b = 30 and 300 μm, were also tested in the simulations. To clearly investigate the effect of bubble size on the examined parameters, monodisperse bubble size distributions were only studied. Thus, no mixed bubble size case was tested. A gravity term was also included to account for the buoyancy of the bubbles. The results of 2D simulations are presented in several plots shown below, demonstrating the effect of varying parameters listed in Table 1 on the axial and radial distribution of void fraction and velocity.

EXPERIMENTAL SETUP

Experimental setup for steady flow conditions and applied diagnostics have been previously described in details and, thus, a concise description is given below [15, 16, 18, 19]. Measurements were conducted in a vertical co-current upward bubbly flow provided by a fully controllable

flow loop. The main part of the loop consisted of a vertical tube with inner diameter D = 21 mm (equal to that used in simulations) that accommodates successive test sections of electrical, optical, acoustical and pressure diagnostics employed for void fraction, bubble size and bubble velocity measurements. Test liquid was recirculated by means of a progressive cavity pump (MD 025-6L, Motovario S.p.A.) and bubbles were injected through a cylindrical glass microporous filter (ROBU®; nominal pore size: 1.0–1.6 μm) located at the bottom of the vertical tube. Pulsatile flow conditions were generated by an intermittent flow module consisting of a proportional electromagnetic valve (PSV, electromagnetic valve, Alborg) driven through a signal produced by a function generator (20 MHz Function/Arbitrary Waveform Generator, 33220A, Agilent) and modulated by an electronic driver (PSV-D Driver Module, Alborg). Proper tuning of signal features enables application of varying pulsation frequencies, amplitudes and profiles (sinusoidal, triangular or rectangular). To facilitate validation of CFD simulations, a sinusoidal flow profile with a frequency of 1 Hz and amplitude of ± 50% was applied in this study.

Void fraction measurements were performed by means of an European Union patented, highly accurate and sensitive electrical impedance spectroscopy technique that allows capturing void fraction fluctuations down to 10^{-5} [21]. The operation of this technique has been previously described analytically by the authors [15]. Electrical measurements were conducted by a pair of ring electrodes (electrode width: D/10, separation distance: D/4) located at an axial distance of 59 cm (~28 D) above the gas injection point and synchronised with bubble size measurements applying an optical method described by the authors in previous studies [15, 16]. Bubble size determination was based on image processing of bubbly flow images captured at three radial positions inside the vertical tube (r = 0, r = D/4 and r = D/2) at an axial distance of 75 cm (~36 D) above the gas injection point.

For the needs of the preliminary tests under pulsatile flow conditions, an aqueous solution of NaCl 0.02% w/w (purity > 99.5%, Merck KGaA) resembling the electrical conductivity of tap water was used as test liquid. Bubbles were produced by Helium gas (purity 99.9996%, Air Liquide) due to its low solubility in the liquid phase. In order to limit substantially bubble size polydispersity, 500 ppm of the surface active agent sodium dodecyl sulphate (SDS, purity > 99.0%, Fluka Biochemika) was added in the test liquid resulting in bubbles around 100 μm. Liquid temperature was adjusted at the body temperature, 37°C. Measured physical properties of the test liquid at 37°C were: i) surface tension: 37.0 mN/m, ii) density: 991 kg/m^3, iii) electrical conductivity: 0.5 mS/cm, and iv) dynamic viscosity: 0.70 mPa.s. Measurements were conducted for liquid superficial velocity, $U_{sl} = U_{l,mean} = 3$ cm/s (Reynolds number of liquid phase equal to 860, laminar flow) and gas superficial velocity $U_{sg} = 0.217$ cm/s, that provides void fraction values at the same order of magnitude with those calculated from CFD simulations and, in parallel, clear pulsatile void fraction fluctuations.

RESULTS

VALIDATION OF CFD SIMULATION WITH EXPERIMENTAL RESULTS

Here, calculated void fraction is compared against measured one for vertical, co-current, upward bubbly flow, when employing a sinusoidal flow profile with a frequency of 1 Hz and amplitude of ± 50% for $U_{l,mean} = 3$ cm/s. Figure 1 presents the evolution of calculated centreline void fraction, α_c, and centreline flow velocity, U_c, as a function of column height, when the set parameters at the pipe inlet are: $\alpha = 0.03$, $U_{l,mean} = 3$ cm/s, pulsation amplitude: ± 50% and $D_b = 300$ μm. Numbering of void fraction pulsations has been added for convenience in Figure 1A. As shown, 8 full pulsations occur for $U_{l,mean} = 3$ cm/s along the column height of 1 m. Contrary to CFD simulations that provide axial distribution of void fraction along the column height, experimental study of bubbly flow provides time-series of void fraction signals at a specific column height (59 cm). To facilitate the comparison, height values of x axis (Fig. 1A) were converted to time values when divided by $U_c = 12$ cm/s, that corresponds to h = 590 mm as shown in Figure 1B. As a result, Figure 1A is transformed to a time-series of calculated centreline void fraction at 59 cm. Although measured void fraction concerns the entire cross-section of the column, it is still interesting to compare the features of experimental α and calculated α_c time-series at the same column height (59 cm) and flow conditions ($U_{l,mean} = 3$ cm/s and sinusoidal flow profile with a frequency of 1 Hz and amplitude of ± 50%), Figure 2A. Despite the differences in average void fraction values, bubble sizes and liquid properties, periodic signal fluctuations due to pulsatile flow were clearly shown in both cases. Although duration and amplitude of observed pulsations in the experimental time-series did not vary considerably, they were both attenuating as a function of time in the signal resulted from CFD simulation. Figures 2B, C present the duration and the coefficient of variation (CV) of centreline void fraction (standard deviation of α_c/average value of α_c, %), respectively, for each one of the eight pulsations found in α_c time-series of Figure 2A. To compare with, experimental average values of duration and CV of α are also displayed in Figures 2B, C. It was demonstrated that both experimental average values are between those referring to 4th and 5th pulsation of calculated signal. Based on Figure 1A, this corresponds to a column height of ~60 cm that coincides with the height where measurements were taken. Therefore, the validity of CFD simulations was confirmed by the experimental measurements and the influence

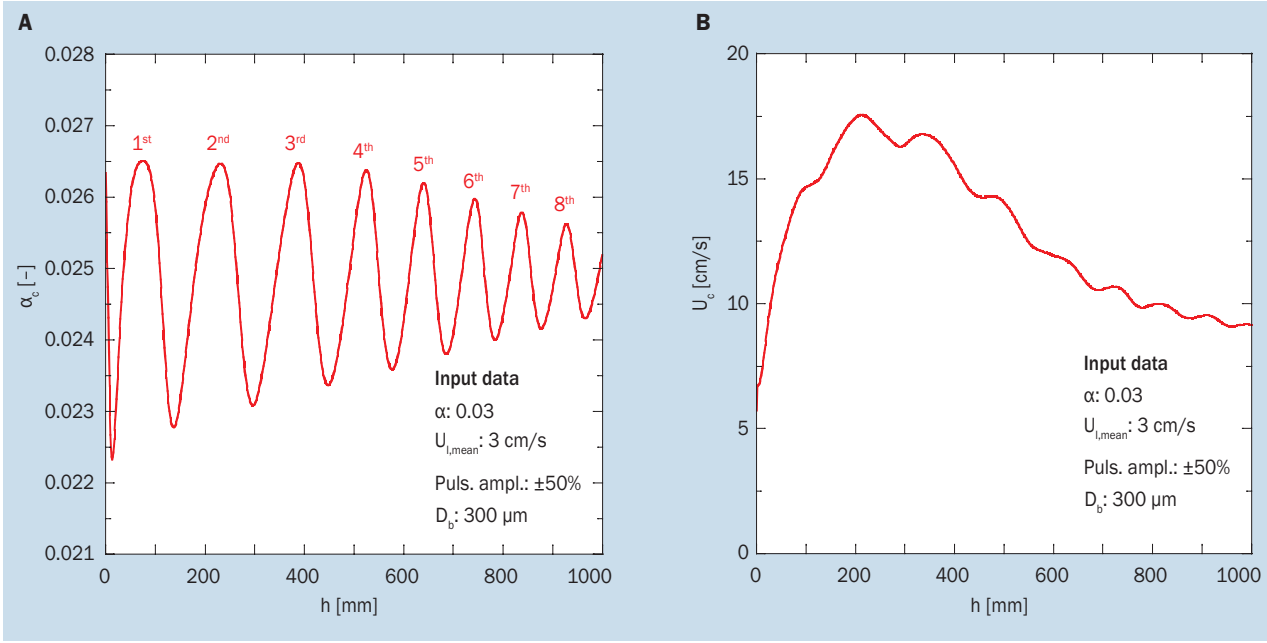

Figure 1. Axial distribution of calculated centreline void fraction, α_c (**A**) and calculated centreline flow velocity, U_c (**B**), along the column for pulsatile (sinusoidal) flow. Input data: $\alpha = 0.03$, $U_{l,mean} = 3$ cm/s, pulsation frequency: 1 Hz, pulsation amplitude: ± 50%, $D_b = 300$ μm

of several parameters on void fraction and velocity profiles was next studied in depth computationally.

EFFECT OF VARYING PARAMETERS ON VOID FRACTION AND FLOW VELOCITY PROFILES

Figure 3 shows the effect of bubble size, D_b, on the flow velocity, U, and void fraction, α, contour plots for pulsatile (sinusoidal) flow conditions. Two monodisperse bubble size distributions of 30 μm and 300 μm were examined, while the set parameters at the inlet of the vertical column were: $\alpha = 0.10$, $U_{l,mean} = 3$ cm/s, pulsation frequency: 1 Hz, pulsation amplitude: ± 50%. For $D_b = 30$ μm, both flow velocity and void fraction radial profiles were pretty uniform. For $D_b = 300$ μm, on the other hand, flow velocity and void fraction presented a core-peaking profile. In addition, an oscillating fluctuation of both quantities was clearly noticed along the column, which attenuated with the increase in axial distance from the entrance of the column. Hereafter, simulations were performed with $D_b = 300$ μm according to the obtained results.

Figure 4 examines the effect of pulsation amplitude on the axial distribution of centreline void fraction, α_c, for two α values, 0.03 and 0.10, and $U_{l,mean} = 3$ cm/s at the inlet of the column. Centreline void fraction was always lower than the set values (Fig. 4A, B) since bubbles accelerated significantly due to buoyancy resulting in the depletion of the column from bubbles. For steady flow, α_c was almost constant along the column. This agrees with previous experimental findings of the authors who investigated the axial evolution of void fraction in similar conditions by means of electrical resistance tomography and differential pressure sensors, without observing any significant variation [16]. When employing pulsatile flow conditions, intense periodic fluctuations of α_c could be noticed, while the mean void fraction was marginally reduced only for the pulsation amplitude of ± 50% (~2%). These fluctuations verged on a sinusoidal form, in accordance to the input liquid flow profile, and their intensity increased with pulsation amplitude and set void fraction value. On the contrary, the amount of α_c fluctuations for the column height of 1 m decreased when increasing α value at the inlet of the column. Also, it is interesting to notice that α_c pulsation amplitude depreciated progressively along the column for the lower input α value, while this behaviour was not observed for the higher input α value.

Next, the radial distribution of flow velocity, U, and void fraction, α, was studied for sinusoidal flow of blood simulant with pulsation amplitude of ± 50% in the presence of bubbles with $D_b = 300$ μm. Figure 5 shows the evolution of U and α as a function of column radius, R, with input data $\alpha = 0.10/U_{l,mean} = 3$ cm/s and $\alpha = 0.03/U_{l,mean} = 30$ cm/s. All radial distributions are given for 4 axial positions along the column: y = 0 mm (pipe inlet), y = 250 mm, y = 500 mm, y = 750 mm (y: axial distance from the entrance of the column). Apart from the core-peaking profile of U and α, already observed in Figure 3, which is depicted more clearly in Figure 5, some more comments can be also made:

a) For $U_{l,mean} = 3$ cm/s (Re = 147) and $\alpha = 0.10$, U increased considerably for R = 0 mm (pipe centre), due

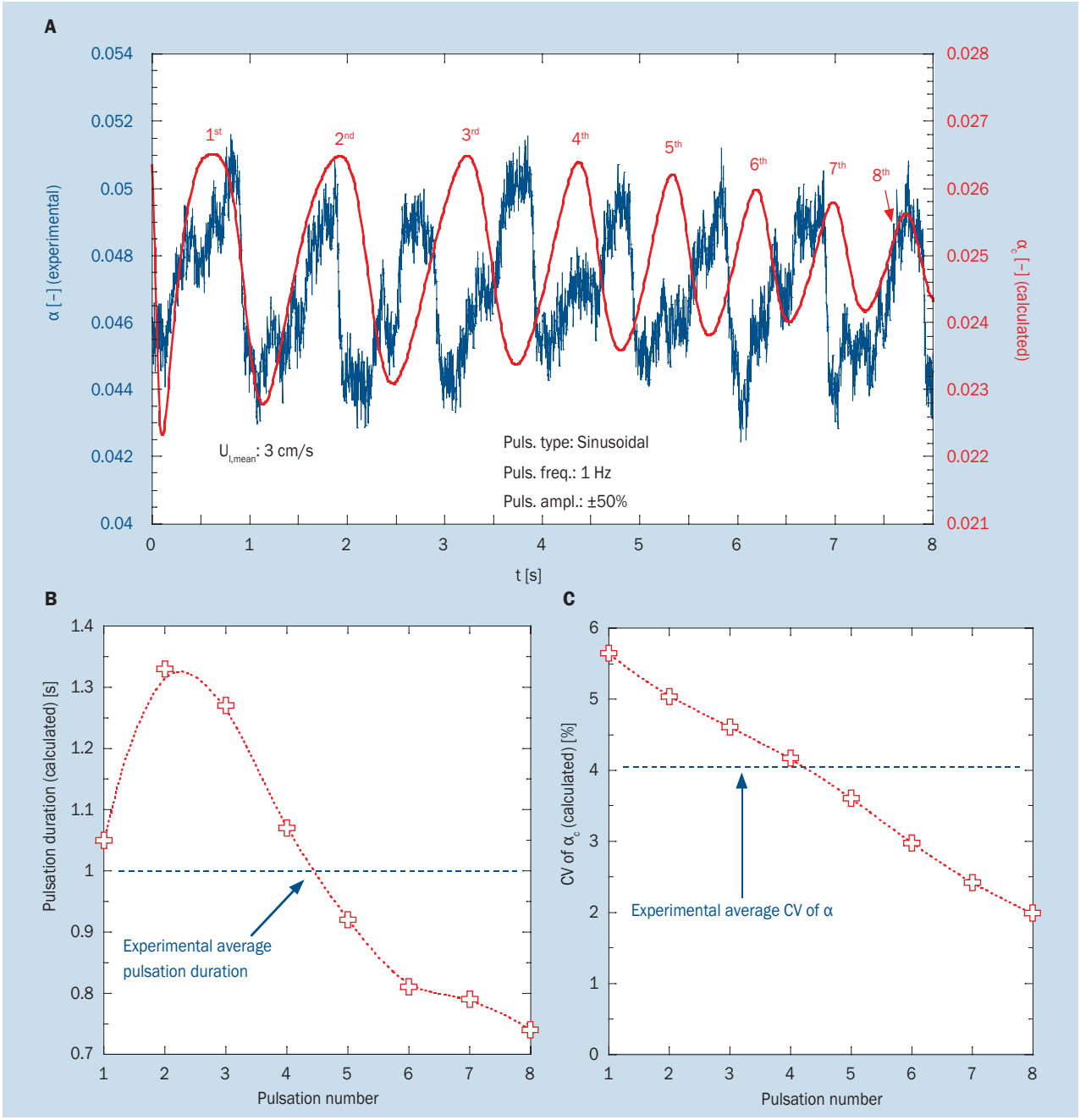

Figure 2. A. Comparison of experimental cross-sectional averaged void fraction, α, and calculated centreline void fraction, α_c, time-series at the same column height (59 cm) and flow conditions ($U_{l,mean}$ = 3 cm/s and sinusoidal flow profile with a frequency of 1 Hz and amplitude of ± 50%); Duration (**B**) and coefficient of variation (CV) (**C**) of centreline void fraction for each one of the eight pulses found in α_c time-series of Figure 1 (experimental average values of duration and CV of α are also denoted for comparison)

to the acceleration of bubbles, at y = 250 mm. This increase attenuated radially up to R = 5 mm and, then, U decreased in comparison to y = 0 mm. Finally, it became zero at the pipe wall (R = 10.5 mm), as shown in Figure 5A. Interestingly, limited reverse flow could be noticed near the pipe wall (slightly negative U values). The opposite trend, as expected, was observed for the radial profile of void fraction (Fig. 5B). At y = 250 mm, α decreases from R = 0 mm to R = 5 mm when compared to y = 0 mm. This decrease was minimum at the pipe centre and increased radially up to R = 5 mm. Next, void fraction slightly recovered because of the reverse flow near the pipe wall, but still remained lower than that at y = 0 mm. Finally, α got zero value at R = 10.5 mm. At higher axial positions inside the column, U and α radial profiles did not vary substantially any more.

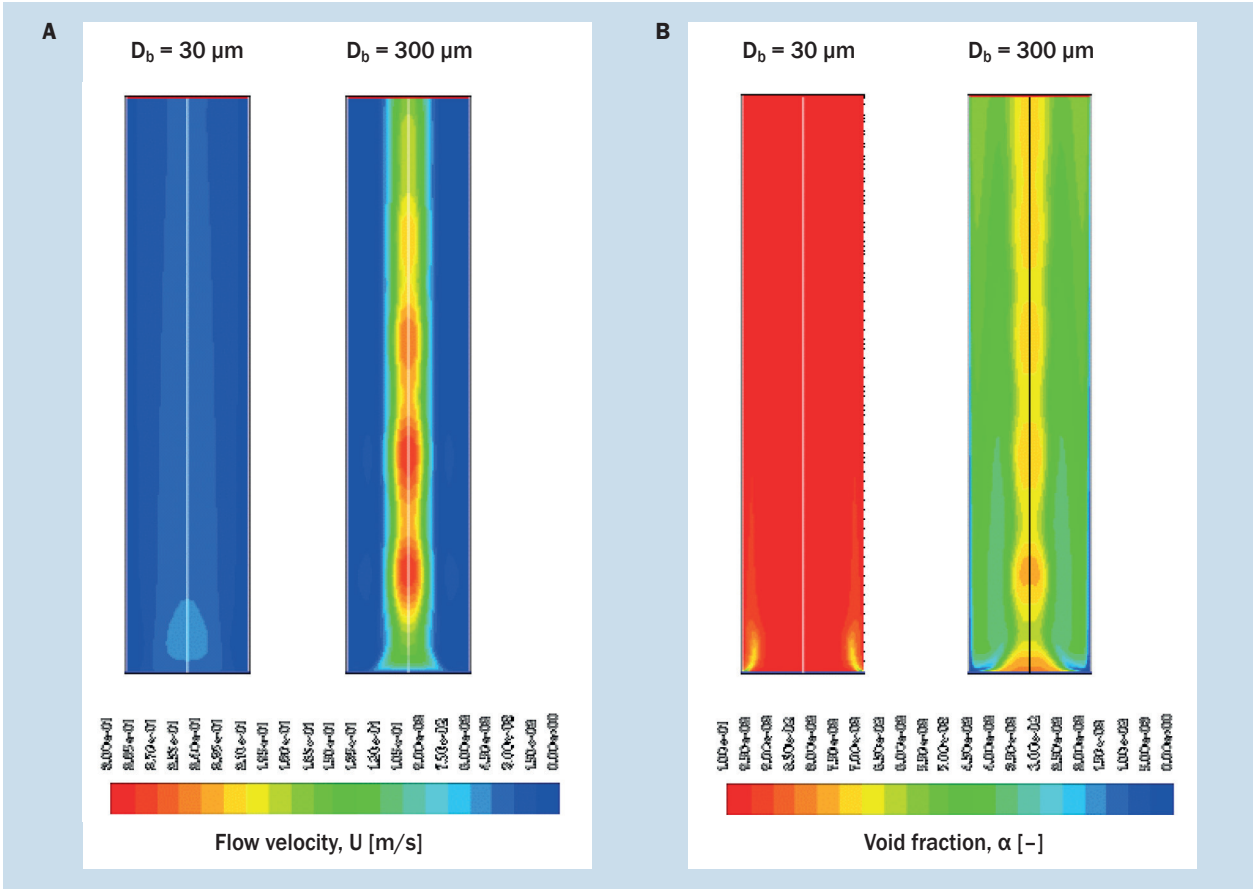

Figure 3. Effect of bubble size, D_b, on the flow velocity, U, (**A**) and void fraction, α, (**B**) contour plots for pulsatile (sinusoidal) flow with input data: α = 0.10, $U_{l,mean}$ = 3 cm/s, pulsation frequency: 1 Hz, pulsation amplitude: ± 50%. The height dimension has been compressed by a factor of 10

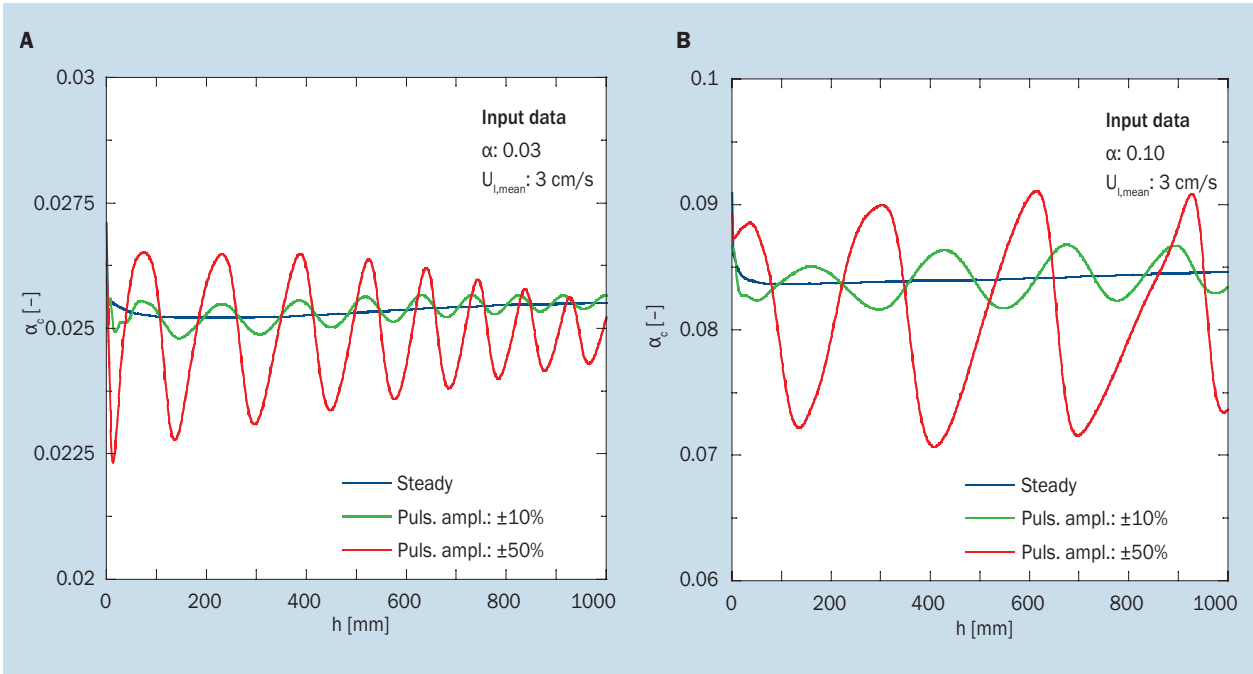

Figure 4. Axial distribution of centreline void fraction, α_c, along the column for steady and pulsatile (sinusoidal) flow at different pulsation amplitudes. Input data: α = 0.03 (**A**); α = 0.10 (**B**); $U_{l,mean}$= 3 cm/s, pulsation frequency: 1 Hz, D_b = 300 μm

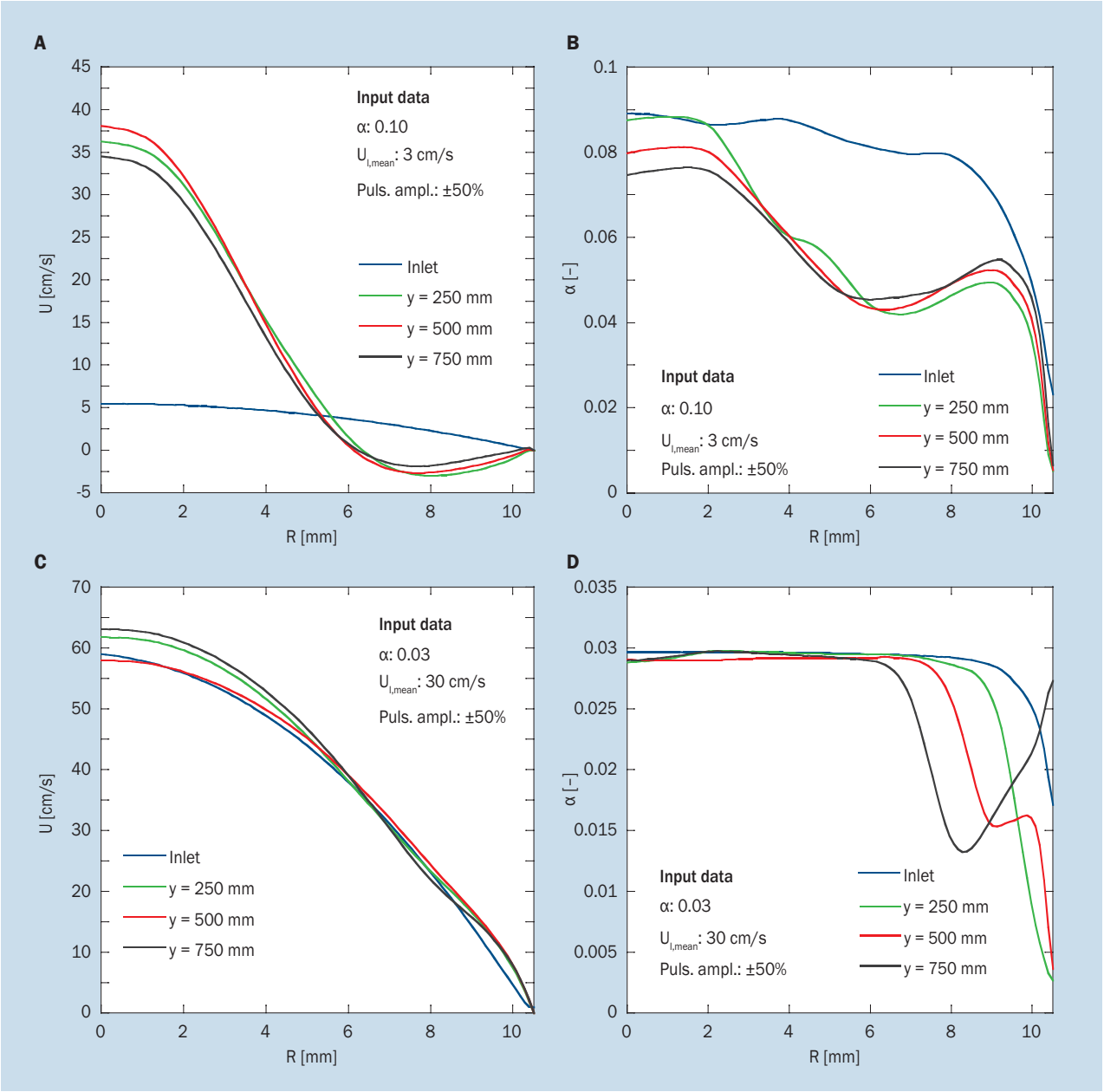

Figure 5. Radial distribution of flow velocity, U (**A**), and void fraction, α (**B**), with input data: α = 0.10, $U_{l,mean}$ = 3 cm/s, pulsation frequency: 1 Hz, pulsation amplitude: ± 50%, D_b = 300 μm and flow velocity, U (**C**), and void fraction, α (**D**), with input data: α = 0.03, $U_{l,mean}$ = 30 cm/s, pulsation frequency: 1 Hz, pulsation amplitude: ± 50%, D_b = 300 μm, at different axial positions along the column for pulsatile (sinusoidal) flow

b) For $U_{l,mean}$ = 30 cm/s (Re = 1470) and α = 0.03, Figure 5C shows that U radial profile remains almost constant along the column. Referring to the radial distribution of void fraction (Fig. 5D), the core-peaking profile is less sharp comparing to Figure 5B, while α decreases near the pipe wall at higher axial positions inside the column.

DISCUSSION

Aiming to facilitate the design of a) in-vitro pulsatile bubbly flow experiments in a column resembling the flow inside human vena cava during DCS in astronauts and divers and b) in-vivo trials on swines for assessing the performance of I-VED technology on the detection of infused bubbles (as those found during DCS) in their bloodstream [21], a number of CFD simulations was performed to investigate both steady and oscillatory gas-liquid flow of sub-millimetre bubbles at low void fractions (< 0.10). Similar bubbly flow conditions were encountered in other two-phase flow applications, e.g. flow boiling in macro-channels, as well [20]. Validity of simulations was first confirmed by preliminary in-vitro bubbly flow

experiments under pulsatile flow conditions inside a fully controllable flow loop, when comparing observed pulsation characteristics: at the same column height, average duration and amplitude of pulsations captured in the experimental void fraction signals coincided with those of the calculated signals.

Next, the influence of varying parameters on void fraction and flow velocity profiles was computationally investigated. Comparing two monodisperse bubble size distributions with D_b = 30 and 300 μm, it was demonstrated that flow velocity and void fraction radial profiles are uniform for the small bubbles and present a core-peaking profile for the large ones. Since void fraction core-peaking profile is characteristic for bubbles greater than 4 mm [10, 11], it is interesting to notice this behaviour for much smaller ones (300 μm) under such special conditions. Although α and $U_{l,mean}$ at the inlet of the column were equal for the two distinct D_b values, void fraction was much lower and flow velocity was much higher for D_b = 300 μm. This was due to the effect of buoyancy that accelerates only the large bubbles in comparison with the liquid velocity. Therefore, these bubbles rised with higher velocity and their residence time in the column decreased, resulting in lower void fraction [10]. The abovementioned results are in fair agreement with previous experimental and drift-flux model findings of the authors for steady flow conditions. Specifically, the dependence of void fraction on bubble size has been validated by performing experiments with Newtonian and non-Newtonian blood simulant test liquids at $U_{l,mean}$ = 3–30 cm/s and α = 0.001–0.1, for two average diameters of polydisperse bubble size distributions which are comparable to the two D_b values used in the simulations [16, 19]. Furthermore, the authors examined the performance of thirteen drift-flux model based correlations on the prediction of void fraction under the abovementioned experimental conditions and concluded that: a) in the case of small bubbles, homogeneous flow model predicts accurately void fraction. This model is a sub-case of drift-flux model, implying uniform void fraction profile across the pipe and zero drift velocity of rising bubbles (they travel with liquid velocity), and b) in the case of large bubbles, three drift-flux models, suggesting core-peaking void fraction conditions, succeed to correlate adequately experimental data, applying King (2001) [25] model for drift velocity calculation [22].

Pulsatile flow conditions caused intense periodic fluctuations of void fraction along the column, whose intensity increased with pulsation amplitude and void fraction. Also, the amount of α_c fluctuations for the column height of 1 m decreased when increasing α value at the inlet of the column. This was attributed to the increased flow velocity for denser bubbly flows where more bubbles accelerate due to buoyancy. Specifically, the maximum centreline flow velocity for α = 0.10 was approximately double the velocity for α = 0.03 (~35 cm/s vs. ~18 cm/s). Inversely, the amount of α_c pulsations for α = 0.10 was half of that for α = 0.03 (4 pulsations vs. 8 pulsations).

The radial distribution of flow velocity for D_b = 300 μm evolved considerably along the column with the decrease in liquid velocity and the increase in void fraction. This behaviour was attributed to the enhancement of bubbles' drift velocity contribution as bubbly flow becomes denser and liquid flow slower [22, 25]. Void fraction profile varied axially accordingly.

CONCLUSIONS

In conclusion, CFD simulations of pulsatile bubbly flow resembling DCS conditions, which were validated by in-vitro pulsatile bubbly flow experiments, provided unconventional information about the influence of different-sized sub-millimetre bubbles on the flow velocity and void fraction profiles. Observed core-peaking void fraction conditions will be seriously taken into consideration when designing electrodes configuration (e.g. geometry and distance of electrodes that affect the sensitivity and the measuring volume inside the vessel under study) of I-VED electrical impedance spectroscopy technique for bubbles detection both in-vitro in a flow loop and in-vivo in the bloodstream of swines.

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Conflict of interest: None declared

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There's something in the water: an overview of jellyfish, their stings, and treatment

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ABSTRACT

An increasing presence on many beaches worldwide, jellyfish are a diverse group of Cnidarians equipped with stinging cells termed cnidocytes. Though few of the over 10,000 species are dangerous to humans, and most that are produce no more than a painful sting, some jellyfish can produce systemic symptoms and even death. Chironex fleckeri, the Australian box jellyfish, has a venom potent enough to kill in less than 10 minutes, and for which there is an antivenom of debatable efficacy. Stings from Carukia barnesi can cause Irukandji syndrome, characterised by severe pain and hypertension. Jellyfish stings have also been associated with Guillain-Barre syndrome and anaphylaxis. Though optimal treatment of stings remains controversial, after removal from the water and addressing any immediate life threats, the tentacles should be removed and the area washed, with seawater being the best choice due to its low likelihood of inducing further cnidocyte discharge. Hot water immersion may be beneficial for pain control for non-tropical jellyfish stings, and cold packs for tropical stings. In general, there is no consensus for the optimal treatment of jellyfish stings, and so further research is needed into species-specific guidelines and whether there are any overarching rules.

(Int Marit Health 2022; 73, 4: 199–202)

Key words: jellyfish, venoms, marine envenomation

INTRODUCTION

Whether local residents or far-flung visitors carried by the currents, jellyfish are a presence on beaches throughout the world [1]. With over 10,000 species, only 100 or so are dangerous to humans, but these produce around 150 million stings per year, primarily during the warmer months [2, 3]. Jellyfish stings are the greatest threat on the coasts of subtropical and tropical Atlantic and Pacific coasts, home to some of the most dangerous jellyfish [1]. In states in southern Brazil, thousands of cases of jellyfish stings are recorded in the summer [4]. Jellyfish blooms have increased in the past few decades, damaging fish stocks and disrupting water-based industries [5]. Among divers in Thailand, almost 32% reported jellyfish stings as their most frequently encountered injury [6]. Given their increasing prevalence worldwide, it is important for clinicians to be familiar with jellyfish, their stings, and treatment of injuries sustained from jellyfish.

OVERVIEW

Although the term 'jellyfish'' is commonly used to refer to any gelatinous water creature equipped with tentacles, only the class Scyphozoa (home to the lion's mane jellyfish among others) are considered true jellyfish [1]. Other well-known 'jellyfish,' such as the Portuguese man-of-war (*Physalia physalis*) or the Australian box jellyfish (*Chironex fleckeri*), belong to different classes (Hydrozoa and Cubozoa, respectively). For the purposes of this review we will consider all members of the subphylum Medusozoa, which includes both the true jellyfish as well as their jellyfish-like cousins, and use the familiar term 'jellyfish' in reference to them both.

As members of the Cnidaria phylum, jellyfish are equipped with cnidocytes, cells commonly found in their tentacles that contain organelles (cnidocyst) which inject venom in a harpoon-like fashion when triggered mechan-

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ically or chemically [4]. The venom differs in composition and potency among species, and can include neurotoxins, catecholamines, histamine, hyaluronidases, and haemolytic toxins among others [1]. In general, the venom causes pain by activating transient receptor potential vanilloid-1 in nociceptive neurons [7]. The cnidarian-exclusive family of pore-forming CrTX/CaTX toxins is found widely among jellyfish, including both Cubozoans and some Scyphozoans [8].

Jellyfish stings can cause localised pain and erythema, with rare (though dependent on the species involved) systemic symptoms [4]. Local skin reaction at the sites of tentacle contact can begin within minutes to hours and is often linear, urticarial and painful [1]. These lesions can progress to becoming vesicular or even necrotic. Generalised skin lesions are likely due to a hypersensitivity response to the venom. Seabather's eruption, a pruritic rash on areas covered by swimsuits, is due to jellyfish larvae that become trapped between the skin and suit [1]. There is no specific treatment for the rash, which may last for days to weeks [9].

A truly unpleasant event, ocular stings have also been reported [10]. Unsurprisingly, pain is the most common symptom but stings can also produce temporary mydriasis and loss of vision. Rarely they are associated with increased ocular pressure. Care is primarily supportive and involves removal of any tentacles and cnidocytes and ophthalmologic consultation.

Envenomation is not the only concern when stung by a jellyfish. Stings can also trigger allergic responses such as anaphylaxis due to the proteins contained within the venom [4]. Sensitisation can occur due to repeat stings during water-based activities or ingestion of jellyfish [11].

SPECIFIC JELLYFISH

The most lethal jellyfish worldwide, *Chironex fleckeri*, or the Australian box jellyfish, is a Cubozoan found in the tropical waters of the Indian and Pacific oceans ranging from Northern Australia to Southeast Asia [1]. Due to the rapid cardiorespiratory depression and death it can cause, an antivenom — the only one of its kind for jellyfish — has been developed, though its efficacy is debatable [1, 12]. Magnesium sulphate may improve efficacy of the antivenom [1]. Stings from *C. fleckeri* initially cause severe pain at the site of contact, which can progress to full-thickness necrosis in 1–2 weeks. Associated systemic symptoms of fever, vomiting, and malaise may also occur, which can progress to respiratory distress, haemolysis, and renal failure [1]. The venom also includes a cardiotoxic component [13]. Death can occur due to respiratory and cardiac arrest from the venom or due to drowning if the individual becomes incapacitated while in the water, and death from envenomation can occur in as little as 2–10 minutes [1, 2].

Another Australian native, *Carukia barnesi* is one species of Cubozoan jellyfish that can cause Irukandji syndrome, which includes delayed onset of muscle cramps, vomiting, anxiety, and diaphoresis sometimes with severe hypertension and cardiac failure [1, 12]. Intracranial haemorrhage from severe hypertension may also result [7]. The pathophysiology of Irukandji syndrome is not entirely clear, but may be primarily though not exclusively due to excess catecholamine release [2, 3, 9]. Formation of pores in myocardial cell membranes may also contribute to cardiac damage [7]. Hospitalisation is often necessary for Irukandji syndrome and IV magnesium sulphate may be helpful in reducing both pain and hypertension, though this is controversial, and pain control will likely require opioids [2, 3, 7, 9]. There is no antivenom. Other species capable of causing Irukandji syndrome include *Carybdea alata*, another Cubozoan, which is common in Hawaiian and Eastern Pacific waters [13].

A Hydrozoan siphonophore, which uses a gas-filled float to ride along the water surface, the Portuguese man-of-war is found in hot non-tropical waters of the Atlantic, Pacific, and Indian oceans as well as the Caribbean and Sargasso Seas [1, 2]. It has tentacles that can reach up to 30 m in length [2]. Stings cause severe pain, which usually subsides in 24 hours, as well as nausea, vomiting and loss of consciousness.

Scyphozoa have increased lately in the Northeast Atlantic and Mediterranean as well as along the coast of Korea, China, and Japan, leading to a decrease in tourism and interference in fishing and aquaculture industries [14]. Although less deadly than other jellyfish, Scyphozoa are responsible for the majority of jellyfish stings, and some envenomations can lead to death. Stings from *Stomolophus meleagris*, found along the southeastern coast of the United States and the eastern Pacific Ocean, can result in myalgias, dyspnoea, shock and death [14]. Common in the Mediterranean, *Pelagia noctiluca* produces painful stings and has also been associated with at least one cause of Guillain-Barre syndrome [14]. The largest jellyfish in the world, *Cyanea capillata* or the lion's mane jellyfish, is found in the northern Pacific and Atlantic oceans as well as the North and Baltic Seas [1]. Its stings can cause systemic symptoms as well as an Irukandji-like syndrome [14]. Rinsing wounds in seawater increases venom delivery for this species by not inactivating the cnidocysts, allowing them to discharge as they are washed off the affected area [15].

A particularly interesting Scyphozoan, *Cassiopea xamachana*, or the upside-down jellyfish, is found in the western Atlantic as well as the Caribbean Sea and the Gulf of Mexico [8]. It discharges 'cassiosomes,' which are cnidocyte-containing masses, into surrounding mucus. The purpose of the cassiosomes is to kill prey via the venom-con-

taining cnidocytes, but unwary swimmers in the area can also be stung, though for humans the venom is primarily an irritation. The venom does contain haemotoxic, cardiotoxic, and dermonecrotic components, suggesting exposure may not be entirely benign to humans. Other members of order Rhizostomeae contain cassiosomes as well, including *Mastigias papua* and *Phyllorhiza punctata*.

MANAGEMENT

Prevention is the best cure for jellyfish stings, and if jellyfish are known to frequent an area it may be best to look elsewhere for recreational activities. Stinger nets or stinger suits, as well as topical sting inhibitors, may be beneficial in preventing stings at the covered areas [1]. If nonetheless a sting occurs, it is important to remember that severity of jellyfish envenomation is related to the dose injected [5]. Therefore, inactivation and removal of any remaining tentacles and cnidocytes is essential. Unfortunately, evidence for optimal treatment of jellyfish stings is limited with no consensus guidelines and with studies being done on only a few species [1, 5]. In general, the first step is to remove the affected individual from the water to prevent drowning and further contact with the jellyfish [1]. The individual should also be advised not to rub the site of contact to avoid discharging more cnidocysts.

Less than 1% of cnidae, for Cubozoans, discharge upon initial contact, so removal of clinging tentacles is essential [16]. Fresh water should not be applied to the site of contact as it can cause cnidocyst firing via osmosis [1]. Seawater can be used to wash off any remaining tentacles, though for some species this may increase cnidocyst discharge, and for others may simply move the still-active cnidocysts to new targets [1, 14, 16]. Clinging tentacles should be removed, though the best method is controversial [1, 14]. Any application of pressure to the tentacles, including pressure bandages, is inadvisable as they may cause the cnidocyst to fire [14]. A variety of home remedies for jellyfish stings exist (vinegar, ethanol, urine, baking soda, meat tenderizer, etc.) but these have limited evidence of efficacy, and in the cases of ethanol, meat tenderizer, urine, and in some cases vinegar, can cause undischarged cnidocysts of some species to fire [1, 5, 17]. The same remedy that produces injurious results in one species can be beneficial in another [5]. Vinegar in particular is a controversial remedy for *Chironex fleckeri* and other Cubozoan stings, with some studies suggesting it has a beneficial effect on the affected site, but one study finding that vinegar increases the amount of *C. fleckeri* venom delivered to victims [1]. The consensus thus appears that there is no one optimal solution for rinsing all jellyfish stings, and that the ideal solution may be species-specific. As this is impractical in the field, seawater appears to be the best compromise as it is readily available and appears to cause the least amount of harm in the majority of envenomations.

Pain is a significant complication of jellyfish stings, and the optimal pain control method is also debated. Cold packs, warm and hot water immersion have all been found to be beneficial, though heat may increase systemic absorption of *C. fleckeri* venom [1]. For non-tropical jellyfish stings, hot water immersion may be optimal, while cold packs may be best for tropical jellyfish stings.

Some sources recommend application of topical antibiotics such as chloramphenicol or erythromycin to the affected site, while others regard this as unnecessary due to low rates of secondary infection [1].

Also key to remember for beachcombers is that jellyfish, including their isolated body parts that wash ashore, still contain active cnidocysts that can discharge and cause envenomation, though discharge rate does decrease after death [1, 13].

Already a cause for concern for swimmers and beach-goers, jellyfish stings are likely only to increase as jellyfish populations rise. Therefore, it is important for the clinician to be familiar with management of jellyfish stings. Although there is broad agreement on the importance of removing tentacles and cnidocysts, pain control, and management of systemic symptoms, the specifics of achieving these goals lacks a consensus and may be species-specific. Clinicians should thus be familiar with local jellyfish and management of their species-specific stings, and more research is needed into if there are any overarching specific principles for treating jellyfish stings.

Conflict of interest: None declared

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The stress model of neuroticism and anxiety symptoms in fishermen

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ABSTRACT

Background: *Marine fishermen experience high levels of environmental and relationship stress and anxiety. The current study explored the role of stress in the relationship between neuroticism and anxiety symptoms among marine fishermen.*

Materials and methods: *Participants (fishermen from Tanmen in Qionghai city, Hainan Province) completed three questionnaires: the NEO-Five-Factor Inventory-Neuroticism Subscale (NEO-FFI-N); the Mental Stressor Investigation Questionnaire (MSIQ); and the Mood and Anxiety Symptoms Questionnaire-30-item-Anxious Arousal Subscale (MASQ-D30-AA) within 1 week before embarking on a fishing trip and then again within 1 week after their return to port. The data were subjected to correlational analyses and structural equation modelling.*

Results: *Positive correlations were found between NEO-FF-N (neuroticism) score, MSIQ score (total stress), MSIQ work-relationship score, ship environmental stress score, and MASQ score (anxiety symptoms). Regression analyses showed environmental stress had a significant moderating effect on the relationship between neuroticism and anxiety symptoms, and further analysis showed a mediating effect of work-relationship stress on the relationship between neuroticism and anxiety symptoms.*

Conclusions: *Marine fishermen with high environmental stress had greater anxiety symptoms than those with low environmental stress. Neuroticism in marine fishermen further affects anxiety symptoms by affecting the level of work-relationship stress.*

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Key words: marine fishermen, neuroticism, stress, stress model, anxiety symptoms

INTRODUCTION

Marine fishing is a difficult and life-threatening occupation. Storms, high winds, and tumultuous waves pose unpredictable threats for working fishermen. Moreover, those who work at sea long-term are prone to developing serious clinical conditions, including cardiovascular disease, hearing loss, digestive system diseases, and urinary system diseases [1]. Marine fishing is recognized as an industry with a very high occupational risk and a very high mortality rate [1]. Indeed commercial fishing industry workers have higher fatality rates than workers in other occupations in many countries (214 deaths/100,000 fishermen annually) [2].

The occupational risks of fishing work extends beyond death and physical injury to risks of mental health disorders. According to the most recent cross-sectional epidemiological study of mental disorders in China, anxiety disorders

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is the most prevalent type of mental disorders (incidence, 7.6%) [3]. Work-related stressors including a heavy workload, intense time pressures, latitude in decision-making, occupational risks, and lack of support from co-workers can contribute to the development of anxiety symptoms [4]. Notably, Melchior et al. [5] found that work stress can precipitate anxiety in working young women and men, and Fan et al. [4] reported that job insecurity was strongly associated with anxiety symptoms. Consistent with previously established associations between workplace stress and anxiety [4], Yu et al. [6] showed that fishermen who face extended periods of work stress are prone to anxiety, and further detected significant differences in anxiety symptom indicators between the early stages (within 15 days) and the later stages of a trip. They further showed that mariners experience sustained high anxiety levels upon returning from long sea voyages, suggesting that the mental health of fisherman and the psychological stressors of working at sea are not being addressed effectively for a long time.

Beyond work stress factors, individual personality factors also play an important role in the development of anxiety [7]. Neuroticism is regarded as a particularly relevant personality characteristic for psychopathology risk, especially with respect to anxiety risk. Individuals with a high level of neuroticism may lack the ability to regulate their emotions effectively and to overcome stressful obstacles, making them prone to anxiety [8]. The reported strengths of the correlation between neuroticism level and anxiety symptoms vary substantially across studies (0.19~0.70) [9, 10]. This variance suggests that the relationship may be modulated by additional factors, such as rumination [11], marital satisfaction [12], and stress exposure [13]. In the present study, we examined the hypothesis that work stress may have a moderating influence on the relationship between neuroticism and anxiety in fishermen, and employed the diathesis-stress model to explore this possibility.

The diathesis-stress model (a.k.a. vulnerability-stress model) of mental illness pathogenesis assumes that everyone has a certain predisposition to develop mental disorders if exposed to sufficient stress [14]. Empirical support for the diathesis-stress model has been published in recent years. For example, Xu et al. [15] found that adolescents with higher hair cortisol levels were more likely to exhibit higher anxiety symptoms than those with lower levels but greater academic stress. Additionally, Cox et al. [16] found that individuals with higher trait disgust proneness were more likely to experience anxiety responses in pandemic-associated high-stress environments.

According to the diathesis-stress model, anxiety disorders develop through an interaction between each individual's anxiety diathesis and their stress exposure. Furthermore, poor cognitive control leads one to have exposure to more stressful events, further favouring the development of anxiety symptoms [17]. Thus, in addition to a diathesis-stress interaction in anxiety symptom development, stress exposure itself may also influence the generation of anxiety through a mediating effect, as postulated in Eberhart et al. [18] stress-generation model. Briefly, the stress-generation model postulates that differing diathesis traits affect the likelihood of experiencing stressful life events, which in turn, further affects susceptibility to mental disorders. Several risk factors, including a negative cognitive style [19], and prior levels of emotional distress [20] have been reported to increase the risk of self-generated stressful events. Most studies that have considered the diathesis-stress and stress-generation models have focused on exploring mechanisms of depression pathogenesis, and the few studies that have examined whether neuroticism is a predictor of anxiety symptoms have yielded inconsistent results [21, 22].

In this study, we sought to better understand the development of anxiety symptoms through the application of the diathesis-stress and stress-generation models. The present analysis segregates environmental stress from work-relationship stress. We considered it appropriate to apply the diathesis-stress model to investigate a potential moderating effect of environmental stress on the relationship between neuroticism and anxiety symptom development. Meanwhile, because work-relationship stress may be affected by neuroticism, we postulated that work-relationship stress may have a mediating effect on neuroticism and anxiety symptoms.

MATERIALS AND METHODS

PARTICIPANTS

A cohort of 397 native Mandarin-speaking Chinese fishermen from the town of Tanmen in Qionghai city, Hainan Province were included in the study. Usually, fishermen are recruited by the captain and familiar with each other, with all crew members engaging in similar tasks. The fishermen participants were recruited through the Hainan Fishery Mutual Protection Association and the local village committee. The inclusion criteria were: participation in ocean-going fishing; no mental disorders; no clinically significant hearing or vision loss; and the ability to understand questionnaire items. Participation was voluntary and all participants signed informed consent prior to data collection. All procedures for this study were in accordance with the ethical standards of the Institutional Research Committee. The flow chart of research is displayed in Figure 1.

MEASURES

Neuroticism. Neuroticism traits were assessed with the NEO-Five-Factor Inventory-Neuroticism Subscale (NEO-FFI-N) [23]; the other four subscales of this instrument were

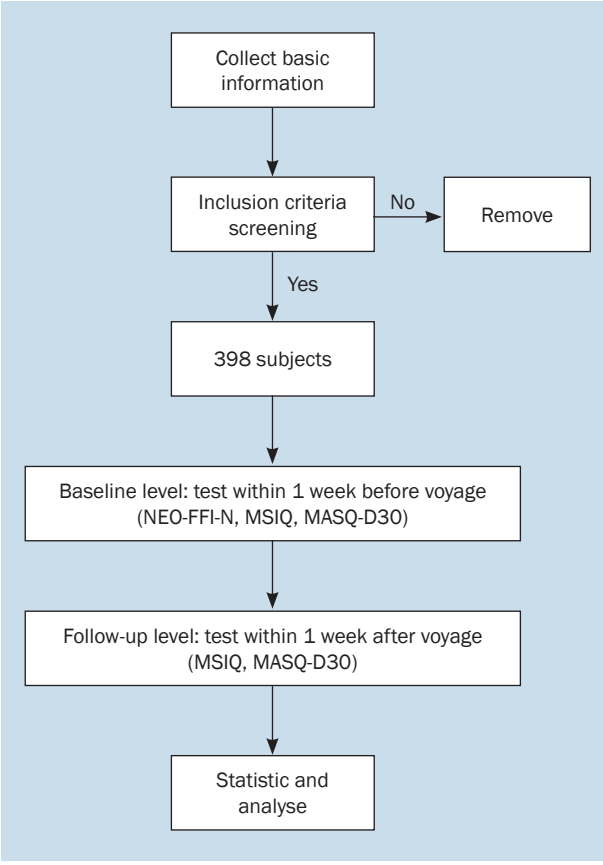

Figure 1. The flow chart of research

not used. The NEO-FFI-N is composed of 12 items, each scored on a 5-point scale, such that higher scores indicate more pronounced neuroticism. The internal consistency of the NEO-FFI-N was 0.81. And found that it had acceptable structural validity with the following fitting index values: χ^2/degrees of freedom (df) = 1.95, comparative fit index (CFI) = 0.94, Tucker Lewis index (TLI) = 0.96, and root mean square error of approximation (RMSEA) = 0.06.

Work stress. Work stress was assessed with the ship environmental stress subscale (27 items) and the work-relationship stress subscale (9 items) of the 36-item Mental Stressor Investigation Questionnaire (MSIQ) [24]. Each item was rated on a 5-point scale with a higher score indicating a greater psychological impact. The internal consistencies of the total MISQ, the ship environmental stress subscale, and the work-relationship stress subscale were 0.95, 0.95, and 0.87, respectively. We found that the scale had good structural validity with the following confirmatory factor analysis fitting index values: χ^2/df = 2.91, CFI = 0.91, TLI = 0.93, and RMSEA = 0.06.

Anxiety symptoms. Anxiety symptoms were assessed with the Mood and Anxiety Symptoms Questionnaire-30-item (MASQ-D30) [25], which has been shown to effectively distinguish between anxiety and depression. The MASQ-D30 is a 30-item abbreviated version of the original 90-item MASQ the Anxious Arousal (AA) subscale, composed of 10 items, each scored on a 5-point scale, was used in the current study [26]. Greater scores on the AA subscale indicate greater anxiety symptom levels. The internal consistency of the AA was 0.7. We further found that the AA had good structural validity, with the following confirmatory factor analysis fitting index values: χ^2/df = 2.87, CFI = 0.88, TLI = 0.91, and RMSEA = 0.07.

STATISTICAL ANALYSES

SPSS 20.0 and Mplus 8.3 (Muthén and Muthén, Los Angeles, CA) software were used for data analyses. First, descriptive statistics were carried out to determine the means and standard deviation (SD) for each scale. Bivariate relationships were examined with Pearson correlations for continuous variables. The structural equation modelling (SEM) included a measurement model and a structural model. We tested the measurement model according to the recommendations of Anderson and Gerbing [27]. In the structural model, we separately verified the moderating effects of ship environmental stress on the relationship between neuroticism and anxiety symptoms and the mediating effect of work-relationship stress.

In the moderating effect model, independent variables and regulating variables were centralized before applying the latent moderating structure equation method. Next, Akaike information criterion (AIC), Bayesian information criterion (BIC), and log-likelihood ratio tests were conducted to compare the relative fit of Model 0 (null model from SEM wherein the interaction is not estimated and therefore assumed to be zero) and Model 1 (alternative model from SEM wherein the interaction is estimated). Finally, to explore the effects of environmental stress on anxiety symptoms across individuals with different levels of neuroticism, the participants were divided into two groups: high ship environmental stress (at least one SD above the mean) and low ship environmental stress (at least one SD below the mean). Lastly, the simple slope test was applied.

The bootstrapping method was used in the mediating effect model. The bootstrap method has a high statistical efficiency compared with other methods for testing mediating effects [28] and it was ideal for testing the mediating effect in the current study. Therefore, the confidence interval was estimated with bootstrap technology, and a total of 1,000 repeated samples were sampled.

Finally, considering that the current model was relatively complex (27 items in the moderating variable and 9 items in the mediating variable), we packaged the moderating variables and mediating variables separately according to previous research [29]. The CFI, the TLI, the standardized

Table 1. Demographic characteristics of the present study cohort of fishermen

Variable	Frequency
Age [years]:	
16–18	9/397 (2.3%)
18–25	61/397 (15.3%)
25–50	275/397 (69.3%)
50–65	51/397 (12.8%)
≥ 65	1/397 (0.3%)
Level of education completed:	
Elementary school or less	91/397 (22.9%)
Middle school	272/397 (68.5%)
Technical secondary school	26/397 (6.5%)
High school or higher	8/397 (2.0%)
Time employed in fishing:	
≤ 1 year	33/397 (8.3%)
1–3 years	56/397 (14.1%)
3–5 years	35/397 (8.8%)
≥ 5 years	273/397 (68.8%)
Marital status:	
Never married	91/397 (22.9%)
Married	299/397 (75.3%)
Divorced	7/397 (1.8%)
Religion:	
None	301/397 (75.8%)
Christianity	12/397 (3.0%)
Buddhism	52/397 (13.1%)
Taoism	30/397 (7.6%)
Other	2/397 (0.5%)

root means square residual (SRMR), and the RWSEA were used to test the goodness of fit of the model. CFI and TLI values > 0.95 indicated that the model fit well, and values > 0.9 were considered acceptable. The model was accepted if it also had SRMR and RMSEA values < 0.08 [30].

RESULTS

DESCRIPTIVE ANALYSES

The mean age (± SD) of the fishermen enrolled in this study was 36.47 ± 11.07 years (range: 16–66 years). The demographic characteristics of the sample are presented in detail in Table 1. The portions of missing data for neuroticism, work stress, and anxiety symptom assessments were 0.5%, 1.6%, and 1.3%, respectively. There were no significant differences in other indicators with missing data (t = 0.6–3.2, p > 0.05), suggesting that all missing data were missing at random. Consequently, the multiple imputations method was used to manage missing data. Descriptive psychometric data obtained for the study sample as reported in Table 2.

Table 2. Descriptive statistics for all observable variables

Instrument observable variable	Mean	SD
NEO-FFI-N:		
T1	28.30	6.76
T2	27.42	6.24
MSIQ:		
Ship environment		
T1	40.36	15.54
T2	42.24	14.26
Work relationships stress		
T1	12.87	4.47
T2	14.71	4.17
MASQ-D30-AA:		
T1	11.87	2.95
T2	14.44	4.29

T1 is the baseline level; T2 is the follow-up level. NEO-FFI-N — NEO-Five-Factor Inventory-Neuroticism Subscale; MSIQ — Mental Stressor Investigation Questionnaire; MASQ-D30-AA — Mood and Anxiety Symptoms Questionnaire-30-item--Anxious Arousal Subscale; SD — standard deviation

CORRELATIONS

As shown in Table 3, Pearson correlational analyses revealed significant positive relationships among NEO--FFI-N scores (neuroticism), total MSIQ scores (overall ship stress), MSIQ-ES scores (ship environmental stress), MSIQ--WR scores (work-relationship stress), and MASQ-D30-AA scores (anxiety symptoms).

MEASUREMENT MODEL

In the measurement model, the SEM fit information obtained indicated that all indicator values were acceptable. The model fit values for each latent variable in the measurement model are reported in Table 4.

MODERATING EFFECT ANALYSIS

Model 0 fit the data well (χ^2/df = 1.803, RMSEA = 0.045, SRMR = 0.046, CFI = 0.944, TLI = 0.939, AIC = 31363.417, BIC = 31801.926, Loglikelihood = –15571.708). The AIC and BIC values for Model 1 were lower than the AIC and BIC values obtained for Model 0, whereas the Loglikelihood value for Model 1 was higher than that obtained for Model 0 (AIC = 31351.946, BIC = 31794.442, Loglikelihood = –15564.973), and the –2LL was significant (p < 0.05). Thus, Model 1 produced a significantly better fit for the data than Model 0.

Table 3. Correlation analysis among neuroticism, stress, and anxiety variables

Variables	1	2	3	4	5	6	7	8	9
T1: Baseline									
1. NEO-FFI-N									
2. Total MSIQ	0.31**								
3. MSIQ-SE	0.29**	0.92**							
4. MSIQ-WR	0.35**	0.91**	0.85**						
5. MASQ-D30-AA	0.27**	0.50**	0.47**	0.53**					
T2: Follow-up									
6. NEO-FFI-N	0.35**	0.18**	0.16**	0.22**	0.21**				
7. Total MSIQ	0.13*	0.34**	0.34**	0.27**	0.19**	0.15**			
8. MSIQ-SE	0.12*	0.32**	0.33**	0.24**	0.18**	0.15**	0.99**		
9. MSIQ-WR	0.12*	0.34**	0.34**	0.29**	0.17**	0.19**	0.89**	0.82**	
10. MASQ-D30-AA	0.19**	0.36**	0.35**	0.37**	0.30**	0.31**	0.29**	0.32**	0.34**

T1 is the baseline level; T2 is the follow-up level. NEO-FFI-N — NEO-Five-Factor Inventory-Neuroticism Subscale; MSIQ — Mental Stressor Investigation Questionnaire; MASQ-D30-AA — Mood and Anxiety Symptoms Questionnaire-30-item-Anxious Arousal Subscale; *p < 0.05; **p < 0.01

Table 4. Measurement model fit index values

Latent variable	χ^2	df	TLI	CFI	SRMR	RMSEA
Neurotic personality	75.842	27	0.959	0.969	0.029	0.067
Ship environment	266.84	119	0.927	0.936	0.040	0.056
Work relationship	5.416	5	0.998	0.999	0.016	0.014
Anxiety symptom	40.913	14	0.972	0.981	0.024	0.069

TLI — Tucker-Lewis index; CFI — comparative fit index; SRMR — standardized root means square residual; RMSEA — root mean square error of approximation

There was a significant interaction (coefficient, 0.111; p = 0.032) indicating that ship environmental stress plays a moderating role in the relationship between neuroticism and anxiety symptoms (path analysis in Fig. 2). A simple slope test showed that the regression coefficient of neuroticism affecting anxiety symptoms was significant in both the low environmental stress group (β = 0.121, p < 0.05) and the high environmental stress group (β = 0.342, p < 0.05), as shown in Figure 3.

MEDIATING EFFECT ANALYSIS

The fitting indexes of Model 1 were as follows: χ^2/degrees of freedom = 1.860; TLI = 0.934; CFI = 0.939; SRMR = 0.054; and RMSEA = 0.046. All of these indexes met the acceptable standard criteria. Both neuroticism (β = 0.396, p < 0.001) and work-relationship stress (β = 0.380, p < 0.001) had significant positive predictive relationships with anxiety symptoms, while neuroticism also had a significant positive predictive relationship with work-relationship stress (β = 0.384, p < 0.001). As shown in Table 5, the total effect of neuroticism on anxiety symptoms was 0.542, for which the 95% confidence interval [0.456, 0.628] did not contain 0, the mediation effect was 0.146 [0.089, 0.203], and the direct effect was 0.396 [0.298, 0.494], indicating that work-relationship stress had a partial mediating effect on the relationship between neuroticism and anxiety symptoms, and that mediating effect accounted for 26.94% of the total effect. The associated structural equation model is shown in Figure 4.

DISCUSSION

In the present study, we examined the relationship between neuroticism, work stress, and anxiety in a cohort of 397 marine fishermen. Structural equation analysis showed that the relationship between neuroticism and anxiety symptoms could be moderated by work environment stress, and that neuroticism had a direct effect on fishermen's anxiety symptoms and an indirect effect on anxiety through the mediating effect of work-relationship stress.

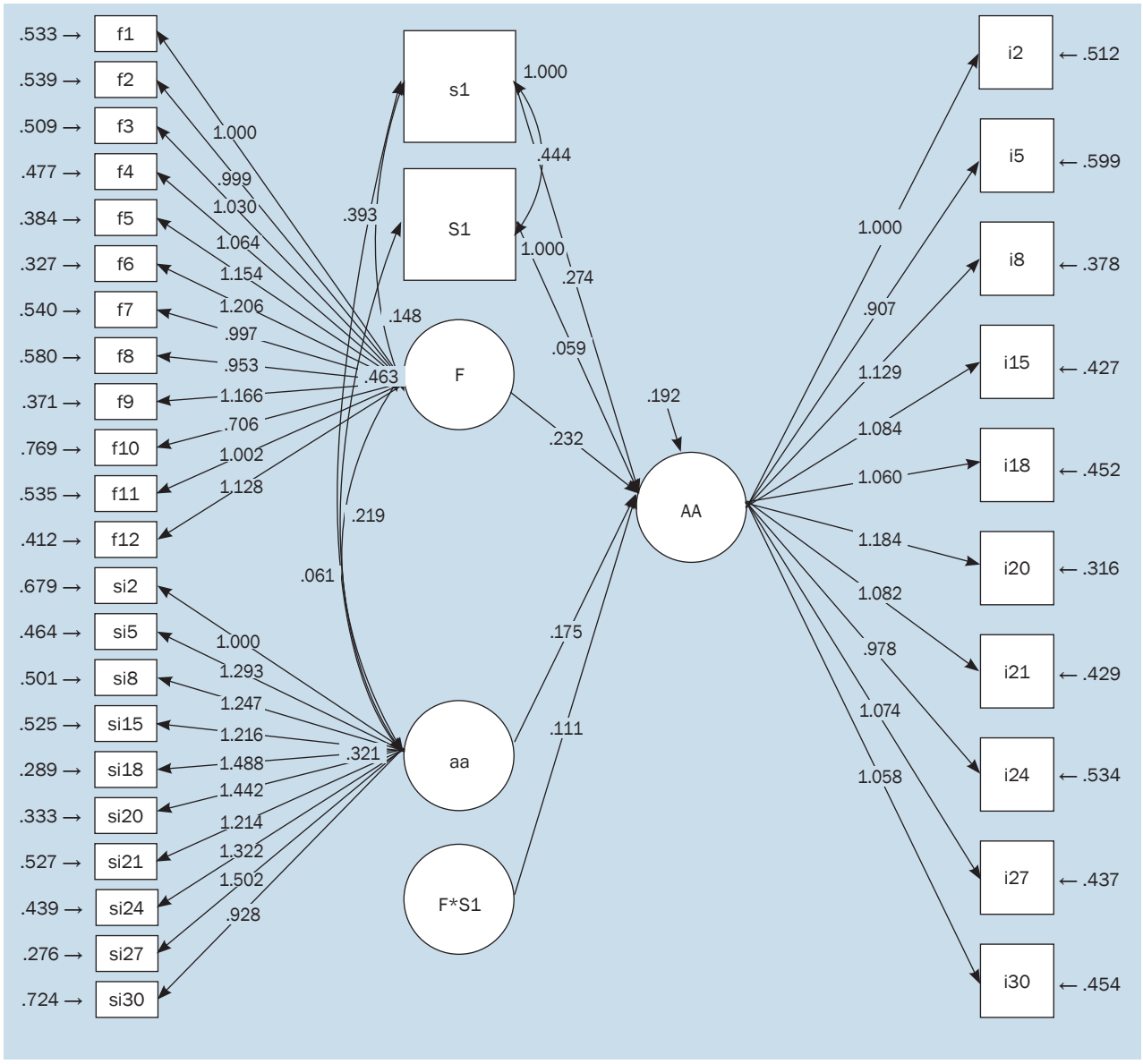

Figure 2. Moderating effect path diagram; F is neuroticism; s1 is baseline of ship environmental stress; S1 is follow-up of ship environmental stress; aa is baseline of anxiety symptom; AA is follow-up of anxiety symptom; F*S1 is the interaction term

ANXIETY SYMPTOMS IN FISHERMEN

Our descriptive analysis results were consistent with prior work indicating that negative emotional reactions, such as anxiety, appear to be connected to neuroticism levels and can lead to emotional disorder pathology [31]. In this context, anxiety symptoms refer to anxiety-specific symptoms, including indices of physical such as an accelerated heartbeat and shortness of breath. Distinguishing anxiety-specific symptoms reduces interference from similar mood disorders. A link between neuroticism level and anxiety vulnerability highlights the potential value of therapeutic strategies that target neuroticism control to prevent the onset of anxiety-specific symptoms, such as physiological hyperarousal.

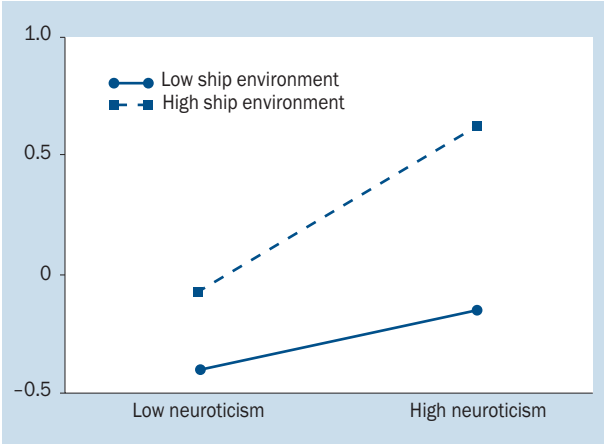

Figure 3. Moderating effect simple slope test results

Table 5. Moderating effect analysis

Path	Effect type	Value	95% Confidence interval	
			Lower limit	Upper limit
Neuroticism → anxiety symptom	Total effect	0.542	0.456	0.628
	Mediating effect	0.146	0.089	0.203
	Direct effect	0.396	0.298	0.494

NEUROTICISM, WORK-ENVIRONMENT STRESS, AND ANXIETY SYMPTOMS

The results of this study support the applicability of the diathesis-stress model in anxiety research. According to the diathesis-stress model, stress interacts with individual susceptibility traits to affect anxiety symptoms. He et al. [32] obtained concordant results in a study that used a tripartite model to examine whether neuroticism may be a predictor of anxiety-specific symptoms. In the hierarchical linear model presented in their study, neuroticism had a significant interaction with stress caused by exposure to increased levels of daily hassles and was found to be a predictor of anxiety-specific symptoms. Partially consistent with He et al.'s [32] results, in a study in which a hierarchical model of neuroticism was developed, Uliaszek et al. [22] found that only some facets of neuroticism were related to anxiety symptoms, although no singular facet of neuroticism had a specific predictive ability for anxiety. Uliaszek et al.'s [22] results, which are not inconsistent with the present results, have led us to hypothesize that perhaps it was only certain facets of neuroticism that interacted with environmental stress in the development of anxiety in our sample of fishermen. Examination of this possibility through the diathesis-stress model in future work may help clarify the pathogenesis of fishermen's anxiety.

Regarding the potential mediating role, fishermen with high neuroticism may be more likely to experience work-relationship stress, further aggravating their anxiety symptoms. High neuroticism favours hyper-focusing on stressful events, including objective stressors, such as a quarrel with a colleague, as well as subjective stressors, wherein one interprets neutral events as stressful [33]. Bolger et al. [34] showed that individuals with a high level of neuroticism were more likely to experience stress from colleagues, work, and other aspects of life, with conflicts and tensions with other people being a major source of daily stress that promotes the emergence of anxiety symptoms. And Song [35] reported recently that, compared to individuals with low neuroticism, highly neurotic individuals were more likely to attend to negative emotional stimuli, to interpret ambiguous information negatively, and to accept negative explanations. These findings suggest that fishermen with high levels of neuroticism may be more likely to interpret ordinary work-relationship phenomena as interpersonal conflicts and tensions due to a negative cognitive bias, thus favouring anxiogenesis. It remains to be examined directly whether cognitive bias may also be a mediator between neuroticism and work-relationship stress.

LIMITATIONS OF THE STUDY

Several limitations of this study should be considered when interpreting the results. Firstly, only 397 subjects participated in this study, and all of the participants were from Hainan Province though China has thousands of fishermen from different regions. Thus the current sample cannot be considered representative of fishermen in general. Our sample size was constrained by the fact that marine fishermen go on multi-month voyages, and it is often difficult to re-establish contact with them for post-voyage surveys upon their return in a timely manner. Enlisting the help of the fishery association and the local government, which receive information on each port-incoming and port-outgoing ship's identification, is crucial to establishing such contacts. In addition, stress level and anxiety symptoms were each evaluated with only a single psychometric scale, which may limit the reliability and validity of this study. In future studies, multiple psychometric scale scores and physiological indicators of stress and anxiety (e.g. hair cortisol and blood catecholamine level) will be examined.

CONCLUSIONS

Neuroticism was found to be a facilitator of the development of anxiety symptoms in fishermen in the context of environmental and social stresses associated with fishing expeditions. The present results provide some reference information for nations' policies regarding marine fishermen. Based on the diathesis-stress model, the present findings suggest that there is a need to improve fishermen's work environments to reduce anxiety, including the improvement of ship conditions by reducing noise exposure and increasing living space tidiness. Moreover, opportunities for fishermen to alleviate boredom on their voyages may be beneficial to the mental and physical health of fishermen.

Fatigue is an important contributory factor to stress in fishermen in different countries [34, 36]. In one study of British fishermen, for example, fishermen reported that

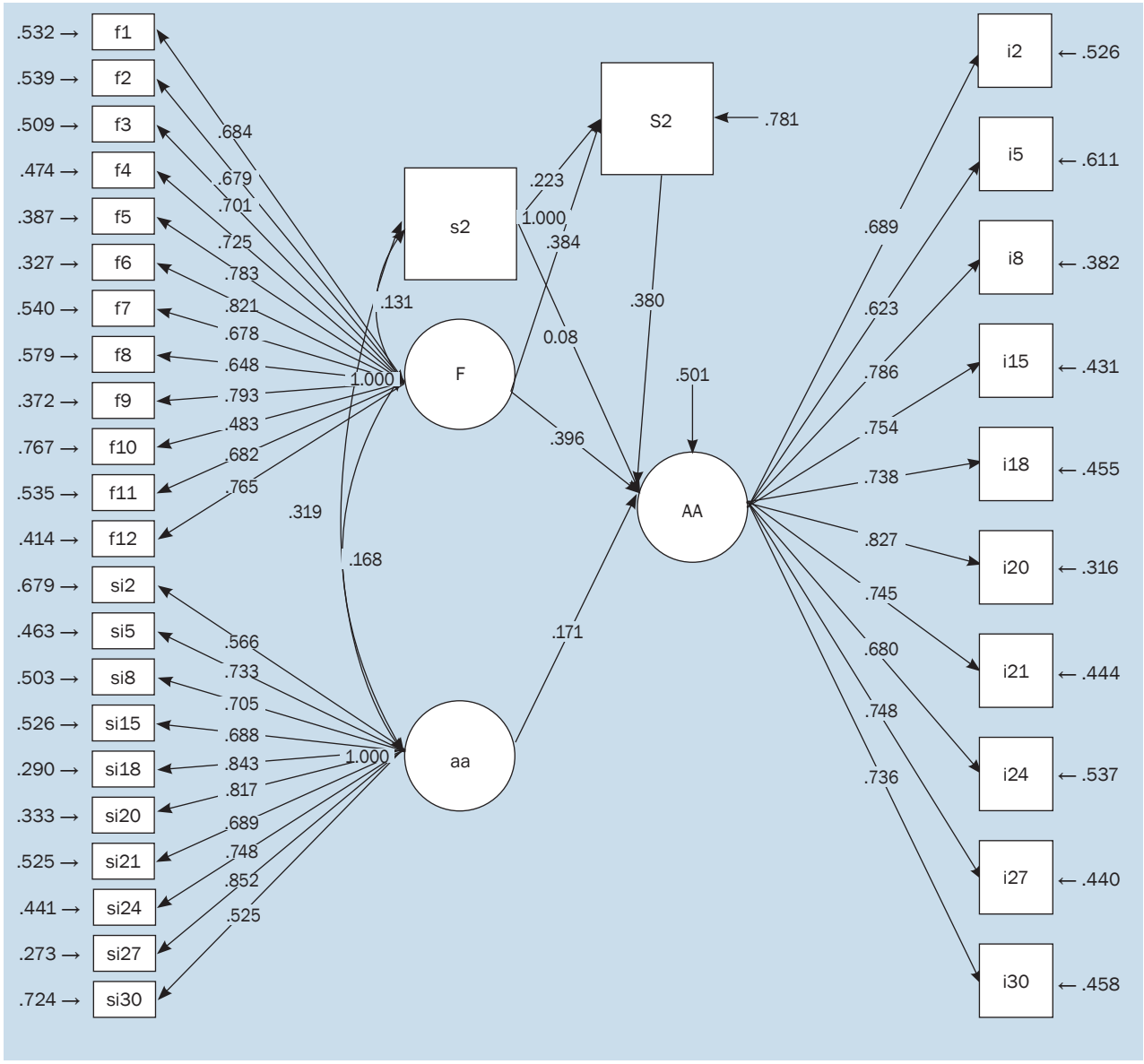

Figure 4. Structural equation modelling intermediary role diagram. F is neuroticism; s2 is baseline of work-relationships stress; S2 is follow-up of work-relationships stress; aa is baseline of anxiety symptom; AA is follow-up of anxiety symptom

fatigue was widespread; 41% of fishermen had fallen asleep at the wheel, and 43% had been so tired that they had slept on the deck or in the gangway [36]. Therefore, in addition to improving the working environment, policies that ensure that fishermen will have enough rest and sleep may enable them to better cope with work-related stressors.

Fishermen experience unexpected events, such as encounters with aquatic life and capsized boats that require strong cooperation among crew members. In the current study, we found that work relationships can be an anxiogenic factor for highly neurotic fishermen. Stress alleviating measures, such as entertainment, may help to improve these interpersonal relationships and thus support the ability of stressed fishermen to cooperate. Therapeutic interventions that target neuroticism directly may also be beneficial in terms of reducing anxiety symptoms. Moreover, a combination of clinical psychology and neuroscience approaches may help to identify behavioural indicators and biomarkers that are directly related to anxiety.

In addition to reducing anxiety symptoms by improving the work conditions of marine fishermen, a more systematic view of the problem is needed. In accordance with Engel's [37] medical model of bio-psycho-society, fishermen have occupationally elevated risks of cardiovascular diseases, skin diseases, and nicotine dependence [1, 38]. Both psychological and biological factors can contribute to psychosomatic

and somatopsychic diseases. Therefore, it is our view that fishermen should receive holistic healthcare that addresses both psychological and physical symptoms. Upon their return, fishermen should be seen by physicians for medical physical examinations as well as by clinical social workers or psychologists for mental health screening. Interactions between physiological and psychological factors should be considered in the treatment planning and clinical follow-up of fishermen exhibiting signs of potential physical disease or mental illness.

COMPLIANCE WITH ETHICAL STANDARDS

All procedures for this study were in accordance with the ethical standards of the institutional research committee and with the 1964 Helsinki Declaration and its later amendments or comparable ethical standards.

FUNDING

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INFORMED CONSENT

Commercial fishermen were recruited from Mandarin Chinese in Tanmen Town, Qionghai, China. Signed consent forms were obtained from fishermen who expressed interest in participating in the study.

Conflict of interest: None declared

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Examining trainees' success in Basic Offshore Safety Induction and Emergency Training (BOSIET) on the basis of their anxiety levels

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ABSTRACT

Background: *A descriptive study was designed to determine the relationship between the anxiety levels of offshore workers participating in the Basic Offshore Safety Induction and Emergency Training (BOSIET) and their success in the training and to examine the potential factors affecting anxiety.*

Materials and methods: *The trainees' state-anxiety values were determined using the State-Trait Anxiety Inventory (STAI) Form TX-1 before and after each exercise, and trait-anxiety values were determined using TX-2 after all exercises had been completed.*

Results: *Among 276 trainees, female (n = 17), non-swimmers (n = 22) and younger trainees (median age: 35 [32–41]) had higher state-anxiety levels. The most anxiety-provoking and the most unsuccessful parts of the training were helicopter escape, the use of Compressed Air Emergency Breathing System (CA-EBS), and sea survival, respectively. After the CA-EBS exercise, where failure was seen for the first time, the anxiety level of those who failed increased.*

Conclusions: *The post-exercise state-anxiety scores of the unsuccessful ones were higher than those of the successful ones.*

(Int Marit Health 2022; 73, 4: 213–222)

Key words: Basic Offshore Safety Induction and Emergency Training (BOSIET), offshore workers, State-Trait Anxiety Inventory, anxiety levels, success rates

INTRODUCTION

The Oil and Gas Industry; employs a large number of employees called "offshore workers" in different roles at offshore assets such as the production platform, drilling rig, and Floating Production Storage and Offloading (FPSO) [1, 2]. Offshore workers face many risks such as fire and explosion [3, 4], toxic gases [5], and chemical hazards [6] due to the handling of dangerous goods every day in their jobs [7–9].

There are several different standard bodies, such as the Canadian Petroleum Manufacturers Association (CAPP), the Norwegian Petroleum Industry Association (OLF), and the most recognized Offshore Petroleum Industry Training Organization (OPITO), which are used to prepare personnel for offshore hazards [10]. In order to improve workforce safety and competence, OPITO has been setting standards for the oil and gas industry since 1991 [11, 12]. OPITO is a non-profit and industry-owned organization serving the needs of the Oil and Gas Industry [13, 14]. In accordance with OPITO standards, offshore workers are required to undertake the OPITO-approved Basic Offshore Safety Induction and Emergency Training (BOSIET) which should be renewed at least once every four years [15, 16].

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The BOSIET course consists of 4 training modules: Module 1: Safety Induction, Module 2: Helicopter Safety and Escape, Module 3: Sea Survival, and Module 4: Firefighting and Self Rescue [17]. Within these modules, the course provides 6 practical exercises to the participants: emergency First Aid (FA), basic knowledge of Fire Fighting and Self-Rescue (FFSR), Totally Enclosed Motor Propelled Survival Craft (TEMPSC) launching, emergency training with using Compressed Air Emergency Breathing System (CA-EBS), practical Helicopter Escape (HE) techniques, and Sea Survival (SS). To be considered successful in a BOSIET course, a trainee must successfully complete all the exercises provided in the course.

In order for practical exercise carried out in a simulated field to serve its purpose, in addition to the physical fidelity of the created area with the real environment [18–21], cognitive fidelity is also an essential requirement during skill acquisition [22]. Cognitive fidelity refers to the level of simulated replicating psychological and cognitive factors such as stress, anxiety, and fear that exist in the real-world system [23]. A high-fidelity training has provided a more confident workforce in dealing with real-world dangers, even though causes more anxiety on trainees [20, 21, 24–26].

In this context, the BOSIET course aims to ensure that the employees are prepared for the difficulties and emergencies that may be encountered by considering the risks and hazards of offshore life [27]. So that, the training activities in its content require practical exercises that may cause anxiety as well as the theoretical part. However, high levels of anxiety can be detrimental to health and may cause trainees to experience a dangerous situation such as falling, burning, injury, drowning, and stress-related panic attacks, which are among the risks involved in the exercises of the BOSIET course [18, 28, 29].

In the courses held in İTÜNOVA Teknoloji A.Ş. (İTÜNOVA), the only institution authorized to provide the OPITO-approved BOSIET course in Turkey, the significant increases in anxiety levels of some participants were observed just prior to the practical exercises, especially immediately before the CA-EBS and HE exercises.

To the best of our knowledge, no study in the literature has measured the anxiety level in an integrated occupational training that includes emergency response exercises as in the BOSIET course. For this reason, given the importance of the need to adjust the anxiety level balance well so that the course reaches its goals and the participants do not experience health problems, the objective of this study; is to examine the difference between trainees' success rates in practical exercises and their anxiety levels as well as to determine the most anxiety-provoking part of training. In addition, it was aimed to determine the difference between the pre-exercise S-anxiety and post-exercise S-anxiety scores of the participants in the study, to compare this difference with the success status, and to investigate the potential factors such as age and swimming, which affect the anxiety level.

It was therefore the intention of the study to be a guide to the trainers of the course and to contribute to the literature, and thus to conduct a comprehensive analysis to evaluate in more detail the effect of anxiety on success status of participants by evaluating the State-Trait Anxiety Inventory (STAI) subscales.

State-Trait Anxiety Inventory is an inventory developed by Spielberger in the 1970s to provide reliable, relatively short, self-report scales for assessing state and trait anxiety [30]. In the study, STAI TX-1 and STAI TX-2 forms were used to determine the state and trait anxiety levels of the trainees with the socio-demographic data form. In the statistical analysis of the data, the SPSS Statistics for Macintosh, Version 27.0 were used [31].

MATERIALS AND METHODS

A descriptive study was designed to determine the relationship between the anxiety levels of offshore workers participating in the BOSIET course and their success in the course and to examine the potential factors affecting anxiety.

The research was initiated after the necessary permissions had been obtained from İTÜNOVA, which hosts the OPITO-approved BOSIET course in Turkey, and the approval of the Galatasaray University Ethics Committee (no: 21/014). Before starting the course, the participants were informed about the purpose of the study, its implementation, voluntary participation, the ability to leave the study at any time, and confidentiality of information. Verbal and written consent was received from the participants who volunteered to participate in the study.

At the time period from April 2021 to August 2021, 276 trainees who received the OPITO-approved BOSIET training in Turkey participated in the study. The research was conducted on a total of 36 training groups. Each group consisted of 8 participants except for two groups that consisted of two participants.

The research data was collected by interviewing the participants face to face and as data collection tools a socio-demographic data form prepared by authors and Spielberg's STAI Form TX-1 and STAI Form TX-2 questionnaires were used.

At the beginning of each course, the voluntary participants completed the 12-question socio and anxiety related demographic data form. With the demographic data form, the participants' identification features were identified such as age, gender as well as their psychiatric and chronic diseases that can be associated with their anxiety levels. The names of the participants were not demanded

Table 1. The programme of the practical exercises in digital Basic Offshore Safety Induction And Emergency Training (BOSIET)

Time interval	Duration [min]	Subject of training	Exercise area	Exercise type
09.00–09.30	30	Knowledge Test	Classroom	Theoretical
09.30–10.20	50	Emergency FA	Classroom	Practical
10.30–12.25	105	FFSR	Firefighting training area	Practical
12.25–12.55	20	Evacuation with TEMPSC	TEMPSC area	Practical
12.55–13.25	30	Launch break	—	—
13.25–14.15	50	Helicopter emergencies	Training pool	Practical (dry)
14.15–14.45	30	Use of CA-EBS	Training pool	Practical (dry)
14.55–16.50	115	Practice with CA-EBS and HE	Training pool	Practical (wet)
16.50–18.10	80	SS techniques	Training pool	Practical (wet)

FA — First Aid; FFSR — Fire Fighting and Self Rescue; TEMPSC — Totally Enclosed Motor Propelled Survival Craft; CA-EBS — Compressed Air Emergency Breathing System; HE — Helicopter Escape; SS — Sea Survival

in the questionnaire to make them feel comfortable when answering the questions. However, in order to make a personal analysis of the participants in the evaluation phase, a personal number was given to each participant, and kept their knowledge confidential.

Each participant completed the STAI Form TX-1 to determine their state-anxiety level before and after each practical exercise and they completed the STAI Form TX-2 after completing all the training to determine trait-anxiety levels. Due to the continuation of the coronavirus disease 2019 (COVID-19) pandemic, the theoretical part of the training was held online, and all practical exercises were carried out face-to-face in a single day. The programme of the practical exercises, which was the subject of our study, is presented in Table 1.

In addition, the success status of the participants was obtained from the trainers. The trainers gave a second try to the trainees who were unsuccessful in the first attempt at any exercise. However, the evaluation of the participants' anxiety levels in these second trials was not made at the request of the trainers in order not to affect their motivation and was not included in the study.

State-Trait Anxiety Inventory is a scale developed by Spielberger in the 1970s to assess state and trait anxiety. It consists of two parts as "STAI Form TX-I" and "STAI Form TX-II", consisting of 20 items each [30, 32]. STAI Form TX-I measures state anxiety (S-anxiety) by asking participants about their feelings at a given time. TX-II aims to measure trait anxiety (T-anxiety) by asking participants about their feelings in general [33–35].

All items in the TX-1 and TX-2 forms are evaluated with 4-point Likert Scale. S-anxiety and T-anxiety are scored individually. There are ten reversed phrases in TX-I and seven in TX-II. The reversed phrases are scored as negative. The anxiety levels are determined by adding a constant value (of 50 for TX-1 and 35 for TX-2) to the score obtained by the TX-1 and TX-2 forms. As a result of this process, a value between 20 and 80 is obtained. Öner and le Compte [36], conducted the Turkish reliability and validity study of the STAI.

STATISTICAL ANALYSIS

In the statistical analysis, SPSS Statistics Version 27.0 for Macintosh was used [31]. The factor analyses and reliability statistics of STAI TX-1 and TX-2 was performed. The Kaiser-Meyer-Olkin Measure of Sampling Adequacy, KMO and Bartlett's test, Total Variance Explained (%), and Cronbach's Alpha values were reviewed and confirmed their suitability for analysis. In determining the normality; the Skewness-Kurtosis values, Kolmogorov-Smirnov test (since the number of evaluated items was greater than 50), histogram and Q-Q plots graphs were examined. The normally distributed variables were presented as the average ± standard deviation, and non-normally distributed variables were presented as median (interquartile range [IQR]: Q1–Q3). The categorical data was expressed as number (%). In the comparison between the two groups, the Mann-Whitney U test was used for non-normally distributed variables, and the Independent Sample T test was used for normally distributed variables. In the comparison among three or more groups, the Kruskal-Wallis H test was used for non-normally distributed variables and to detect the relationship between subgroups in case of significant difference the post-hoc test was used. Since the variances were not homogeneously distributed at this stage, the Games-Howell test was used. The Wilcoxon test was applied in the analysis of two dependent variables. In comparison between non-normally distributed continuous data, the Spearman

Table 2. The difference between the S- and T-anxiety scores and gender, and ability to swim

	Pre-exercise S-anxiety scores	Post-exercise S-anxiety scores	After completing the course T-anxiety scores
Gender			
Female (n = 17)	26.50 (23.00–37.00)	26.00 (22.00–33.00)	38.06+ ± 5.49
Male (n = 259)	23.00 (21.00–35.00)	22.00 (21.00–23.00)	32.91 ± 5.07
P	0.00 < 0.001*	0.00 < 0.001*	0.00 < 0.001**
Able to swim			
Swimmer (n = 254)	23.00 (21.00–30.00)	22.00 (21.00–23.00)	32.63 ± 4.84
Non-swimmer (n = 22)	28.00 (34.00–38.00)	30.00 (25.00–33.00)	40.09 ± 4.76
P	0.00 < 0.001*	0.00 < 0.001*	0.00 < 0.001**

*Mann-Whitney U test for STAI TX-1 (S-anxiety)

**Independent Samples T test for STAI TX-2 (T-anxiety)

S-anxiety scores presented as median (q1–q3); T-anxiety scores presented as mean ± standard deviation. Statistically significant difference was performed at the 0.05 level.

correlation was used and to compare categorical variables chi-square test was used. A p value of < 0.05 was considered to be statistically significant.

RESULTS

Among 276 offshore workers participating in the study, 6.20% (n = 17) were female and 93.8% (n = 259) were male, and the median age was 35 (32–41) years. Ninety two per cent (n = 254) of the participants were swimmers, 8% (n = 22) non-swimmers.

According to the answers given by the participants to the questions in the socio-demographic data form, none of the trainees had a history of psychiatric illness, ongoing psychiatric illness, or phobias such as claustrophobia and aqua-phobia. None of the trainees had ever been in danger of drowning before. Only one trainee stated that he had a chronic disease. Therefore, none of these cases were used in the analysis.

The participants were evaluated in terms of their pre- and post-exercise S-anxiety scores as well as their T-anxiety scores, as shown in Table 2. On the basis of gender, female had higher anxiety levels than male in all categories (p [pre-exercise S-anxiety] = p [post-exercise S-anxiety] = p [T-anxiety] = 0.000), and on the basis of ability to swim, non-swimmers had significantly higher anxiety levels than swimmers in all categories (p [pre-exercise S-anxiety] = p [post-exercise S-anxiety] = p [T-anxiety] = 0.000).

The relationship between the pre- and post-exercise S-anxiety scores of the trainees and their age was analysed with the Spearman correlation. There was a significant, negative, very weak correlation between the pre-exercise S-anxiety scores of the trainees and their age (r = –0.059, p = 0.017). There was also a significant, negative, very weak correlation between the post-exercise S-anxiety scores and age (r = –0.070, p = 0.004). On the other hand, there was no statistically significant relationship between T-anxiety scores and participant age (r = 0.007, p > 0.05).

There was a significant difference between the pre-exercise S-anxiety scores and exercise type as shown in Table 3 (p = 0.000). When this difference was examined, it was seen that the most anxiety-provoking practical exercise on the trainees was HE, followed by CA-EBS, and SS, respectively. The pre-exercise S-anxiety scores of the trainees in TEMPSC, FFSR, and FA exercises were lower than in other exercises. The difference between pre-exercise S-anxiety scores for TEMPSC, FFSR, and FA is quite low, although statistically significant. There was a significant difference between the post-exercise S-anxiety scores and the exercise type (p = 0.001), but the S-anxiety values were close to each other.

When the difference between the pre- and post-exercise S-anxiety scores were examined and success status on the basis of the exercise type as shown in Table 4, there was no significant difference between the pre-exercise S-anxiety score of the trainees and their success for CA-EBS and HE exercises (p [CA-EBS] > 0.05, p [HE] > 0.05). Furthermore, there was no difference between the pre- and post-exercise S-anxiety scores of the trainees and their success for FA, FFSR, and TEMPSC exercises, since everyone is successful in these exercises. On the other hand, for the SS exercises, there was a significant difference between the success of the trainees and their pre-exercises S-anxiety scores (p = 0.042). In addition, for CA-EBS, HE, and SS exercises, significant differences were found between the success status and post-exercise S-anxiety scores (p [CA-EBS] = 0.000, p [HE] = 0.000, p [SS] = 0.032).

According to the course results, 89.5% (n = 247) of the trainees successfully passed all the exercises in

Table 3. Examining the difference between the S-anxiety scores before and after the exercises according to the success level on the basis of exercise type

Exercise groups	N	Pre-exercise	Post-exercise
		S-anxiety scores	S-anxiety scores
FA	276	22.00 (21.00–23.00)	22.00 (21.00–23.50)
FFSR	276	22.00 (21.00–23.00)	22.00 (21.00–23.00)
TEMPSC	276	22.00 (21.00–23.00)	22.00 (21.00–23.00)
CA-EBS	276	34.50 (22.00–38.00)	22.00 (21.00–24.00)
HE	276	40.00 (39.00–41.00)	22.00 (21.00–24.00)
SS	276	23.00 (22.00–25.00)	22.00 (22.00–24.00)
P*		< 0.05 (0.000)	< 0.05 (0.001)

FA — First Aid; FFSR — Fire Fighting and Self Rescue; TEMPSC — Totally Enclosed Motor Propelled Survival Craft; CA-EBS — Compressed Air Emergency Breathing System; HE — Helicopter Escape; SS — Sea Survival

*P was shown as significant difference at the 0.05 level with Kruskal Wallis test.

S-anxiety scores presented as median (q1–q3) due to nonparametric distribution.

Table 4. Examining the difference between the S-anxiety scores before and after the exercises and the success level on the basis of exercise type

Time	Success Status	CA-EBS		HE		SS	
		S-anxiety	P*	S-anxiety	P*	S-anxiety	P*
Pre-exercise	Passed	36.00 (22.00–38.00)	> 0.05	40.00 (39.00–41.00)	> 0.05	23.00 (22.00–24.00)	0.042
	Failed	30.00 (27.50–37.00)		38.50 (23.00–45.00)		31.50 (29.00–34.00)	
Post-exercise	Passed	22.00 (21.00–23.00)	0.000	22.00 (21.00–23.00)	0.000	22.00 (22.00–24.00)	0.032
	Failed	43.50 (42.50–47.50)		31.50 (22.00–44.50)		32.00 (29.00–35.00)	

*P was shown as significant difference at the 0.05 level with Mann-Whitney U test.

S-anxiety scores presented as median (q1–q3) due to nonparametric distribution.

Since everyone is successful from FA, FFSR, and TEMPSC exercises: "The Mann-Whitney Test cannot be performed on empty groups."

Abbreviations — see Table 3.

the course, while 10.5% (n = 29) failed at least one exercise. In order for a trainee to successfully complete the course, it is necessary to pass all the exercises. If the trainee fails even one of the six exercises, he/she is considered unsuccessful in the course. However, the fact that the trainee has failed in one of the exercises does not prevent his/her participation in other exercises. In Table 5, the differences between the pre- and post-exercise S-anxiety scores of successful and unsuccessful individuals for each exercise were given.

A statistically significant difference was found between the pre- and post-exercise S-anxiety scores of the successful ones in FA, FFSR and TEMPSC exercises (p [FA] = 0.008, p [FFSR] = 0.013, p [TEMPSC] = 0.000), but this difference was quite low. There was a significant difference between the pre- and post-exercise S-anxiety scores of the successful ones in CA-EBS, HE and SS exercises (for CA-EBS, HE, and SS, p = 0.000). There was a significant difference between the pre- and post-exercise S-anxiety scores of the unsuccessful ones in CA-EBS exercise (p = 0.012), for HE and SS the difference was not significant (p > 0.05).

DISCUSSION

This study attempted to assess anxiety levels and training success in trainees who participated in the BOSIET emergency response training at ITUNOVA.

In the study, age, gender and swimming knowledge of the trainees stood out as distinctive socio-demographic characteristics. In the gender and anxiety comparison of the trainees, the female's pre- and post-exercise S-anxiety scores and T-anxiety scores were higher. This result showed parallelism with several studies conducted among onshore workers [37–39]. However, although this comparison was statistically significant, only 6.20% (n = 17) of the participants were female. Therefore, this comparison should be re-evaluated by ensuring homogeneity between groups in a larger sample. Nevertheless, it can be said that the current sample reflects the reality due to the gender inequality in

Table 5. Examining the difference between the pre- and post-exercise S-anxiety scores of the successful and unsuccessful ones separately on the basis of the exercise type

Exercise groups	N	Pre-exercise S-anxiety scores	Post-exercise S-anxiety scores	P*
Successful ones				
FA	276	22.00 (21.00–23.00)	22.00 (21.00–23.50)	0.008
FFSR	276	22.00 (21.00–23.00)	22.00 (21.00–23.00)	0.013
TEMPSC	276	22.00 (21.00–23.00)	22.00 (21.00–23.00)	0.000
CA-EBS	268	36.00 (22.00–38.00)	22.00 (21.00–23.00)	0.000
HE	248	40.00 (39.00–41.00)	22.00 (21.00–23.00)	0.000
SS	274	23.00 (22.00–24.00)	22.00 (22.00–24.00)	0.000
Unsuccessful ones				
CA-EBS	8	30.00 (27.50–37.00)	43.50 (42.50–47.50)	0.012
HE	28	38.50 (23.00–45.00)	31.50 (22.00–44.50)	> 0.05
SS	2	31.50 (29.00–34.00)	32.00 (29.00–35.00)	> 0.05

*P was shown as significant difference at the 0.05 level.

Wilcoxon Signed Ranks Test.

Since all trainees were successful in FA, FFSR, and TEMPSC exercises: these exercise groups were not included in the table of unsuccessful ones.

Abbreviations — see Table 3.

the maritime and offshore sector, which is one of the male-dominated occupations today [40–43].

In the comparison between the trainees' ability to swim and their anxiety, the non-swimmers had higher anxiety scores than the swimmers. This was researchers' expectation as well [44, 45]. Because half of the practical exercises took place in the pool environment and this situation naturally caused a fear and higher anxiety in those who could not swim [46, 47].

A significant but very weak correlation was found in the relationship between age and anxiety of the trainees — as the age increased, the pre-exercise S-anxiety score decreased by 5.90% and the post-exercise anxiety score also decreased by 7.00%. This result was compatible with the fact that healthy older individuals can cope with difficulties more calmly with their knowledge and skills gained from their experiences [48–50]. As expected, the T-anxiety score, which reveals the general anxiety states of individuals independent of the exercises, did not have a significant relationship to age [51, 52]. However, these results should be understood taking into consideration the limitations. Although, the sample was a convenient sample and it may not be representative of the complete population. Therefore, the comparison of age and anxiety levels in this sample can't be generalised to alternative samples.

When comparing the pre-exercise S-anxiety scores of the trainees with the exercise types, the most anxiety-provoking part of the training for the trainees was found "Helicopter Escape (HE)" (40.00 [39.00–41.00]). In this exercise carried out in the training pool, trainees are expected to be able to escape the helicopter in case of an emergency landing/ditching in the water. In order for such a serious scenario to be carried out in accordance with its purpose, it was expected that the anxiety levels of the trainees will increase slightly, as the results of this research showed [53]. However, if this increase in the anxiety level of the trainees is not observed carefully by the trainers, it may cause unwanted accidents and injuries [18, 28, 29, 54], even if the necessary precautions are taken in accordance with the OPITO standards in the trainings.

The other exercise that caused the highest increase in the anxiety levels of the trainees after HE was CA-EBS (34.50 [22.00–38.00]). The aim of this exercise, which is carried out in the training pool like HE, is to enable the trainees to move consciously by breathing underwater with CA-EBS. This increase in the anxiety levels of the trainees in CA-EBS exercise was an expected result, since the exercise was carried out most part of it underwater and with an oxygen tube, which people are not used to in general [55, 56].

The next worrisome exercise, though not as much as HE and CA-EBS, was SS, which again took place in the pool and included survival techniques at sea based on individual and group performance (23.00 [22.00–25.00]).

Although the anxiety levels of the trainees in FA, FFSR and TEMPSC exercises were close to each other (22.00 [21.00–23.00]), they were considerably lower than HE and CA-EBS. The result was expected to be this way by the researchers since the trainees had to perform fewer

challenges in these exercise types compared to other exercises in the pool.

Although the trainees who failed one of the exercises in the course were informed by the trainers that they would be deemed "unsuccessful" in the course results, they were free to move on to the next stage and each of the unsuccessful trainees attended the next stage. The rate of the trainees who failed at least one exercise in the course was 10.5% (n = 29). There were 8 (2.9%) trainees who failed in CA-EBS, 28 (10.1%) failed in HE and 2 (0.7%) failed in SS.

When the pre-exercise S-anxiety scores of those who passed the CA-EBS, HE, and SS exercises were compared with those who failed, a statistically significant result was found that only those who failed in the SS exercise had a higher anxiety (p = 0.042). However, since only two trainees failed in the SS, it was decided to ignore this result in the analysis. Therefore, the result was interpreted as that there was no significant difference between the pre-exercise S-anxiety levels of those who passed and failed in the exercise.

In the comparison of the post-exercise S-anxiety levels; the values of those who failed in the CA-EBS, HE and SS exercises were higher than those who passed (p [CA-EBS] = 0.000, p [HE] = 0.000, p [SS] = 0.032).

When the successful and unsuccessful ones on the basis of the exercises were compared separately, a decrease was found in the anxiety scores of the successful ones after the exercise in all types of the exercises. It was expected that the level of anxiety would decrease after the completion of the exercises [53, 57, 58].

However, in the evaluation of the unsuccessful ones, there was a significant difference between the anxiety scores of the trainees before and after the exercise only in CA-EBS, among the three exercises where the trainees were unsuccessful (p = 0.012). Contrary to what was expected, the anxiety level of the unsuccessful ones increased after CA-EBS exercise (pre-exercise S-anxiety score = 30.00 [27.50–37.00], pre-exercise S-anxiety score = 43.50 [42.50–47.50]). This opposite situation of those who failed in CA-EBS exercise was examined. According to the order of the exercises, CA-EBS was the first exercise failed by some trainees. It was believed by the researchers that the reason for this increase in anxiety after the CA-EBS exercise may be the fact that it was the first exercise where failure was seen, and that the trainees had to explain to their companies because they had failed. In addition, the fact that the trainees would re-join this course for the certificate of success they were obliged to receive, created both a time and financial burden for the trainees due to the relatively high cost of the course.

CONCLUSIONS

In our study, the focus was on the comparison of the anxiety levels of the trainees in the BOSIET emergency response training and their success in the course, which, as far as we know, is not included in the literature. The fact that the anxiety levels and success levels of the trainees before and after the exercises are compared in each of the 6 exercises in the course makes the study unique.

The participants' pre-exercise S-anxiety levels and their success status in the practical exercises was compared. Thus, the exercises could be ranked according to the level of anxiety in the trainees. Also, the difference between the success status of the trainees in each exercise and their post-exercise S-anxiety scores were presented. In addition, the difference between the trainees' sociodemographic characteristics and their anxiety levels were examined.

However, various limitations were encountered while carrying out the study: In the socio-demographic data form, all of the trainees answered "no" to the questions asked to learn about the psychiatric history, ongoing psychiatric diseases and phobias, which are among the factors that may affect anxiety. Also, only one of the trainees gave the answer "yes" to the chronic disease condition. For this reason, the comparison of these situations with anxiety could not be examined in the analyses in the study. Due to the uneven distribution of male and female, swimmers and non-swimmers, successful and unsuccessful rates in the sample, although statistically significant results were found in the comparisons, it was seen that a larger and more homogeneous data set was needed to strengthen the analysis. Another limitation was that the trainees who were unsuccessful in the first attempt were given a second chance by the trainers, but upon the request of the trainers, anxiety could not be detected in the second attempts of these trainees. For this reason, only the results of the first trial are included in the study.

The conclusions and recommendations presented according to the results of the study are as follows:

- Among the trainees, female, non-swimmers and younger trainees had higher S-anxiety levels;
- In this sample consisting of 276 people, the failure rate was 10.5%;
- There were only those who failed in the exercises performed in the training pool. All of the trainees were successful in the FA, FFSR and TEMPSC exercises held outside the pool. Failure rates were 2.9% (n = 8) for CA-EBS, 10.1% (n = 28) for HE, and 0.7% (n = 2) for SS;
- The anxiety level of those who successfully passed the exercises decreased significantly after each exercise;
- After the CA-EBS exercise, where failure was seen for the first time, the anxiety level of those who failed increased;
- The post-exercise S-anxiety scores of the unsuccessful ones were higher than the successful ones;

— The most worrying part of the course was the HE. As a matter of fact, the exercise with the highest unsuccessful rate of trainees was also HE. The order of the exercise types according to the anxiety level on the trainees is as follows: HE (40.00 [39.00–41.00]) > CA-EBS (34.50 [22.00–38.00]) > SS (23.00 [22.00–25.00]) > TEMPSC (22.00 [21.00–23.00]) > FFSR (22.00 [21.00–23.00]) > FA (22.00 [21.00–23.00]).

RECOMMENDATIONS FOR THE BOSIET COURSE TRAINERS

— Trainers should be trained on the causes and consequences of anxiety, coping with anxiety and how to help trainees suffering from anxiety.
— "Toolbox Talk" is the conversation in which the trainer gives information to the trainees about what they will encounter in the exercise, the purpose of the exercise and the safety measures taken for the exercise, before starting an exercise. In the "Toolbox Talks" especially held before the HE and CA-EBS exercises, where the anxiety level of the trainees is higher, there should also be speeches that reduce the anxiety level of the trainees and motivate the training.
— Anxiety levels should be reduced to as low as reasonably practicable through a continuous improvement process so that trainees do not experience any accidents and injuries in exercises.
— In this research, it was seen that the trainees were unsuccessful in the exercises that took place in the training pool (CA-EBS, HE and SS). More time should be given to the trainees in the first wet exercise in the pool so that the trainees can become familiar with the environment and equipment.
— In the first wet exercise in the pool, one-to-one training can be given, especially in the use of equipment such as CA-EBS. In this way, trainees with anxiety can gain familiarity with the pool environment and equipment without feeling the pressure of other trainees.
— More time should be given to the trainees during the first exercise in the pool environment where the helicopter simulator and the use of CA-EBS are introduced, where they are still dry. In this way, trainees can better concentrate on the escape points of the helicopter simulator, the push-out window, the seat belt and the CA-EBS equipment on them.

RECOMMENDATIONS FOR THE FUTURE RESEARCHERS

— Expanding the sample and ensuring homogeneity between the groups will contribute to the literature in terms of the comparability of the analysis results of similar studies.
— The analysis of anxiety levels in the second attempts of the trainees who failed in their first attempt, which could not be done in this study, can be done in future studies.
— The fact that all of the trainees answered no to all of the questions examining the psychiatric situation while the pandemic process, in which many people were negatively affected, is still continuing, aroused suspicion in researchers. The reasons behind giving no answers to these questions can be examined in the maritime and/or offshore sector.

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LETTER TO THE EDITOR

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Mental health of seafarers amidst pandemics

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Mental health is a critical problem that affects companies and individuals all over the world yet lurks beneath the shadows. Seafarers are exposed to several physical and psychosocial stressors [1]. The social and recreational options available to seafarers who work and live aboard are constrained. They frequently work 10–12 hour shifts for days without a break and are typically hired for 6–8 months on ships with breaks beyond the initial contract time [1]. Prior to the pandemic, studies on the mental health and wellbeing of seafarers revealed that they experienced higher rates of depression, anxiety, and suicidal ideation than the overall population [1]. Some of the pre-existing problems have gotten worse as a result of the coronavirus disease 2019 (COVID-19) pandemic, and new problems have also emerged for the maritime sector [2].

According to studies, the COVID-19 pandemic's diverse hurdles may compound the high stress levels that maritime workplaces already experienced before the pandemic, creating a conducive atmosphere for mental health issues [2, 3]. For instance, efforts taken to stop the virus' spread, such as travel bans and border closures, have had an impact on crew changes and helped to extend the time sailors spend at sea, often above the legally allowed maximum [1–3]. Numerous sailors were forced to remain on board cruise ships since they were unable to disembark in ports to return to their native countries. Many of these mariners have not received payment [3]. As a result of the growing epidemic, the mental health of many seafarers is already suffering. Approximately 60% of the 400,000 sailors stranded aboard ships throughout the world are concerned that not enough reasonable precautions have been taken to protect their health at work during the epidemic. They are increasingly concerned about the negative consequences of spending so much time on board [4, 5]. The affected seafarers experienced severe anxiety, social isolation, and stress, all of which had an adverse effect on their mental health and, in some cases, resulted in suicide [3]. In several ports, shore leave was further limited or not allowed at all. As a result, it was challenging to perform maintenance and repair work as well as obtain medical aid and supplies. The risk of contracting an infection, uncertainty, employment insecurity, and worries about the safety of friends and relatives back home were additional stressors [2]. Evidence from other industries suggests that the added difficulties posed by the epidemic have a detrimental impact on workers' capacity to cope and are a factor in the rising prevalence of mental health issues including post-traumatic stress disorder (PTSD) [2, 4]. Seafarers are also commonly exposed to PTSD as a result of experiences from piracy, accidents, threats and disasters [4]. Seafaring remains a dangerous and socially isolating occupation where work-related accidents are likely and will be potentially traumatic to mariners [5].

Global stakeholders have pushed for the designation of seafarers as "key workers," in the same rank as medical professionals or other individuals whose job is crucial for the welfare of the entire public, in recognition of the impact of COVID-19 on seafarers and the significant role they play. When traveling to or from their ships, they will be permitted to use "safe corridors" in airports since they have the status of a key worker. This acknowledgment could lessen the mental discomfort that the COVID-19 pandemic is causing among seafarers [1, 3, 5]. There are continuing gaps in mental health research, as well as unmet data demands on many levels, particularly in the marine industry. There is a need for increased research, sustainable initiatives and grants to get a thorough understanding of seafarers' mental health during pandemics and beyond [4, 5].

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Monkeypox virus among seafarers is not to be neglected

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Almost 2 million seafarers must work around the globe to ensure the supply of goods required for daily living [1]. The most international of all industries is the shipping industry, which accounts for 80% of the global trade. Shipping is the most reliable, efficient, and effective mode of transportation, especially for maintaining the supply chains open and delivering cargo and supplies that the world requires on a daily basis [1].

Among the worries that have surfaced throughout the pandemic is leaving seafarers abandoned on their ships. Additionally, infectious illness outbreaks are more likely to occur on ships [1]. Even in the case of a global pandemic, it is inhumane to forbid seafarers from coming ashore for transit, transfer, or crew replacement purposes. Public health concerns may very well be a valid justification for this, but it is not a valid reason to prevent seafarers from taking shore leave [1]. Following the World Health Organization's (WHO) announcement that the monkeypox outbreak is now classified as a public health emergency of international concern, seafarers around the world are preparing for potential future inconveniences from port states [2]. Since May, over 16,000 cases of monkeypox have been reported in 74 countries. This means the outbreak has become an "extraordinary event" that could spread to more countries and calls for a coordinated global response [2].

The conditions under which seafarers have to work in the face of an outbreak are likely to deteriorate, as was the case with the coronavirus disease 2019 (COVID-19) pandemic, when seafarers were left stranded at sea and uncertain of when the next crew change would be permitted. This could just be another repeated scenario of inhumane treatment as was the case with the COVID-19 pandemic [3]. Seafarers will never forget how they were frequently left practically stranded when port officials around the world forbade ships from docking for fear that a super-spreader event would occur [3]. Significant challenges on international shipping include port and border closures for cruise ships and airlines, crew changeover and repatriation for seafarers, licensing and certification of seafarers, resupply, repairs, ship surveys, and certification [1, 3].

On the backdrop of a fading pandemic, the President of the Liner Trade's InterManager Crew Association has emphasized the need for WHO to establish the required standards for responding wisely to situations like the outbreak of monkeypox [3]. He also stated that the legacy from COVID-19 should not be a hasty, inappropriate, or exaggerated response to news of every viral or bacterial outbreak [3]. As the world deals with monkeypox, shipping executives have pleaded with policymakers to refrain from any irrational responses [2]. However, we cannot forget how important is the risk communication, such as displaying posters, movies, and message boards, to alert crew members about monkeypox [4, 5]. Promoting personal safety precautions and risk-reducing behaviour is crucial, especially before visits to the shore [4, 5]. A potential public health crisis must be assessed and prepared for as soon as possible given the disturbingly high number of cases of monkeypox. It is past time to propose various risk-control strategies to deal with the risk's ongoing expansion [5].

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The role of nurses in global maritime health

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The maritime industry is one of the most important contributors to the global economy. Maritime workers or seafarers are essential to the global economy with as many as 1.5 million personnel working to ensure the safe and efficient transportation of more than 90% of the goods that move across the globe [1]. Despite this immense contribution, the health of the seafarers has not been given a deserving attention. While seafarers' treatment has been improved significantly in many countries, particularly developed countries; seafarers are still facing health issues, such as long working hours, insufficient nutrition, lack of recreation and poor mental health [2]. Global maritime health comprises health workers from different disciplines, among which nursing is an integral part; as nurses are involved in health care promotion of seafarers. Nurses play a role in all aspects of the work cycle of seafarers from pre-employment medical examination of the seafarers to their health on board.

Keeping ship crews mentally and physically healthy is a challenge due to the nature of the job [1]. Therefore, the maritime nurses could assist with promoting and maintaining the mental and physical wellbeing of the crews by educating the crew members on activities such as physical exercise, recreational activities and adequate sleep, which can positively impact their physical and mental wellbeing.

Inherent in their work, seafarers have a high rate of occupational accidents [3]. Merchant shipping is an occupation with a high rate of fatal accidents [4]. These accidents especially on the deck result in many injuries that can be fatal to the seafarers. These accidents can result from slip and falls, compressed air accident, chemical exposure, crane and lifting gear accident and electrical accidents [4]. In this regard, nurses could assist the occupational health physician in the provision of accident prevention guidelines and treatments for injuries sustained in the ships. They can educate crews on the health benefits of using personal protective equipment such as goggles, boots, helmets, gloves and proper lifting techniques in their various areas of operations.

With the possibility of significant self-medication practices with medicines, including antibiotics, among seafarers since medications are allowed on board [5], nurses' role in antibiotic stewardship within the maritime industry can be very crucial. They can assist in minimising antimicrobial resistance among the seafarers and aquatic lives by the use of best practice in antibiotic medications.

Nurses' role in global maritime health therefore, can never be overemphasised as they are involved in promoting the health care of seafarers. Integration of maritime nursing curriculum in the various nursing institutions across the globe should therefore, be advocated. More nurses should be trained in maritime health in order to support healthy changes in practice within the maritime industry. They should also be trained in global maritime health research and actively involved in maritime associations such as the International Maritime Health Association. This can help them further understand the health issues and health needs of seafarers and hence, provide evidence-based care for better health promotion among the seafarers.

Conflict of interest: None declared

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Invitation to maritime doctors and maritime schools on research collaboration

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PREVENTION OF PRE-DIABETES, TYPE 2 DIABETES AND HYPERTENSION

We want to invite all the maritime doctors to participate in a pilot study regarding precise diagnosis of pre-diabetes, type 2 diabetes (T2DM) and hypertension in 2023––2024. The International Maritime Health Association (IMHA) and Maritime Health Research and Education-NET (MAHRE-Net) have agreed on a collaboration with early diagnostics and prevention of type 2 diabetes (T2DM) among seafarers. The scientific background is that early stages of T2DM and high blood pressure can be reversed to normal with correct and timely prevention [1]. Thus, there are both financial benefits for shipping and health and job benefits for the seafarers. The initiative will take place over the coming years in a collaboration between maritime doctors, shipping companies, seafarers, researchers, and the authorities [2, 3]. Further, IMHA will coordinate the work on a revision of the International Labour Organization/International Maritime Organization (ILO/IMO) international guidelines for the medical examinations. Please send us an email and we will invite you to a virtual meeting with further information.

INVITATION TO THE MARITIME SCHOOLS ON RESEARCH AND IMPROVEMENT OF STUDY ENVIRONMENT

There is a great need to strengthen the well-being of young people and the maritime schools are invited to participate [4]. The MAHRE-Net has in the last few years investigated the psychosocial factors in the study environment at maritime universities in several countries [5, 6].

The goal is to provide the basis for the UN's Global Sustainability Goals in maritime areas and to strengthen the well-being of young people.

Questionnaires to the students will include mental health, bullying, sexual harassment, use of tobacco and alcohol, and their suggestions for improving the education.

The results can be used by students for their final thesis as well as for teaching about the work environment. Further, the management can, together with the students, use the results to propose and implement improvements to the educational programmes. This will create interest among the students in the maritime industry, and the young people can use this knowledge later as sailors. The same model may be used for sailors on the ships. Please send

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us an email and we will invite you to a virtual meeting with further information in the early 2023.

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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.

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