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First report of the presence of *Vibrio vulnificus* in the Gulf of Gdansk

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ABSTRACT

Background: Vibrio *infections are becoming more frequent in the Baltic Sea region, which is caused by an increase in the sea surface temperature. Climate change creates the conditions for the emergence of new environmental niches that are beneficial for* Vibrio *spp., especially in the summer months.* Vibrio vulnificus*, which causes wound infections and septicaemia, represents a particularly dangerous species of* Vibrio *spp. There are numerous publications on the prevalence of* V. vulnificus *in various regions of the Baltic Sea, but there is a lack of such data for the Polish coast. This prompted us to conduct a pilot study into the prevalence of the bacteria in the Gulf of Gdansk. The study aimed to detect* Vibrio *spp. in the coastal waters and the wet sand at the beaches and bathing areas in the Gulf of Gdansk.*

Materials and methods: *During the period from June 16th to September 23rd 2020, 112 samples of seawater and 105 samples of wet sand were collected at 16 locations along the coast of the Gulf of Gdansk and Hel peninsula. Isolation of* Vibrio *spp. was conducted by filtering method and the isolated bacteria was cultured on CHROM agar Vibrio and TCBS agar. Final genus identification was performed by the MALDI TOF technique.*

Results: *In the present study, 10 isolates of* Vibrio *spp. were obtained from seawater and wet sand samples collected in the Gulf of Gdansk and Hel peninsula coast. Three of the isolates were identified as* V. vulnificus*; the presence of the species was confirmed in the seawater samples which had been collected in Hel (1 isolate), Jastarnia (1 isolate), and Chalupy (1 isolate). One strain of* Vibrio alginolyticus *was isolated from the seawater sample collected in Hel. Moreover, identification was incomplete for 6 of the isolated strains, these were identified as* Vibrio cholerae/mimicus *These strains were collected in Jastarnia (1 isolate), Kuznica (1 isolate), Gdansk-Brzezno (1 isolate), Puck (2 isolates), Chalupy (1 isolate).*

Conclusions: *Our preliminary research study confirmed the presence of potentially pathogenic* V. vulnificus *in the Gulf of Gdansk in the summer months. Therefore, further monitoring of the presence of* Vibrio *spp. in the Baltic coast area is necessary.*

(Int Marit Health 2021; 72, 4: 247–251)

Key words: Gulf of Gdansk, *Vibrio*, seawater, wet sand, marine environment

INTRODUCTION

Vibrio spp. are widespread in the estuaries and coastal areas of warmer climates (South Asia, South America, Africa, and the Mediterranean Sea). The disturbing fact is that the bacteria are more and more frequently found in the Baltic Sea, which may be associated with global warming [1, 2]. Three of the *Vibrio* genus (Gram-negative, curved-rod shape) pathogens are dangerous to humans; these include: *V. cholerae*, *V. parahaemolyticus*, and *V. vulnificus*. Rising water temperatures are a key factor contributing to the creation of new niches for *Vibrio* spp. [3, 4]. Studies carried out by Böer et al. [4] in the waters off the German coast on North Sea

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have shown the temperature as the main factor supporting the prevalence of *V. vulnificus*. Interestingly, these studies also showed that *V. vulnificus* frequently occurs in the Ems and Weser estuary, which suggests that lower salinity may also have an impact on prevalence of these bacteria [5]. Warm (> 18°C) and low salinity (< 2.5% NaCl) waters offer optimal functioning conditions for the growth of these bacteria. As was already mentioned, *Vibrio* spp. may also be used as a climate change warning indicator [6]. It has been suggested that the Baltic Sea may become a more favourable environment for these bacteria, especially in the summer months, near the estuaries and in coastal waters [6]. The mean temperature of the Baltic Sea ranges from –10°C to 17°C, depending on the region. For the last 29 years (1990–2018) the annual mean sea surface temperature of the Baltic Sea was the highest in 2014 and 2018 (9°C). While the lowest annual mean sea surface temperature was recorded in 1996 (6°C). Moreover, the analysis shows that the linear trend of warming was 0.59°C/decade in the analysed period (1990–2018) [7]. It is estimated that global warming may have a significant impact on the prevalence of *Vibrio* spp. in the Baltic Sea region. The Baltic Sea is also characterised as a brackish environment because of its low salinity, which is associated with the presence of estuaries of large rivers (Vistula and Oder) and limited water influx from the oceans [8].

A growing number of infections caused by *Vibrio* present in the waters of the Baltic Sea is worrying [9, 10]. However, it is difficult to estimate the scale of the problem as there is no obligation to report cases caused by *Vibrio* spp. In fact, most European countries do not provide testing for these pathogens [2]. An increasing prevalence of *Vibrio* spp., which is considered a tropical pathogen, has led us to look more closely at the problem and to monitor the spread of *Vibrio* spp. in the Gulf of Gdansk. Our research is a pilot study which is planned as part of a larger research programme conducted by the Department of Immunobiology and Environmental Microbiology, Faculty of Health Sciences, Medical University of Gdansk, Poland [11].

MATERIALS AND METHODS

SAMPLING SITES

Samples were collected at 16 locations along the Gulf of Gdansk (1. Gdansk-Brzezno — gate 52; 2. Gdansk-Jelitkowo — gate 66; 3. Sopot — gate 43; 4. Sopot — gate 19; 5. Gdynia-Orlowo; 6. Gdynia — city beach; 7. Puck; 8. Wladyslawowo — gate 2; 9. Chalupy — Gulfside; 10. Chalupy — gate 18; 11. Kuznica — Gulfside; 12. Kuznica — gate 31; 13. Jastarnia — Gulfside; 14. Jastarnia — gate 48; 15. Hel — Gulfside; 16. Hel — gate 64). The sampling was performed 7 times in the period from June 16th to September 23rd 2020. The sampling sites are presented in Figure 1. The

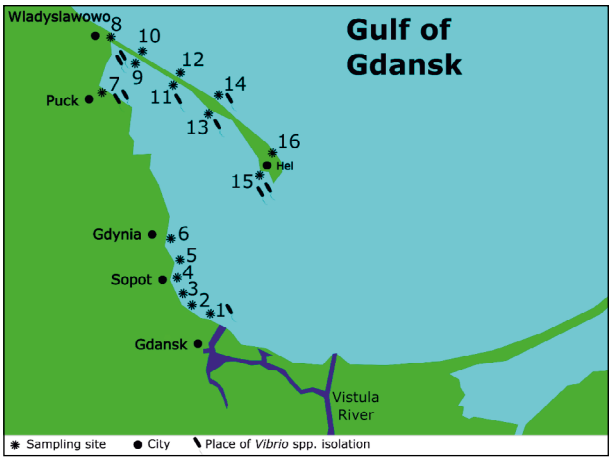

Figure 1. Sampling sites: 1. Gdansk-Brzezno — gate 52; 2. Gdansk-Jelitkowo — gate 66; 3. Sopot — gate 43; 4. Sopot — gate 19; 5. Gdynia-Orlowo; 6. Gdynia — city beach; 7. Puck; 8. Wladyslawowo — gate 2; 9. Chalupy — Gulfside; 10. Chalupy — gate 18; 11. Kuznica — Gulfside; 12. Kuznica — gate 31; 13. Jastarnia — Gulfside; 14. Jastarnia — gate 48; 15. Hel — Gulfside; 16. Hel — gate 64

sampling sites had been chosen to give us the opportunity to assess multiple bathing sites in the Gulf of Gdansk and along the coastal area of the Hel peninsula. Seawater and wet sand samples were taken at 2-week intervals between 5 and 12 a.m. Due to the characteristics of the shoreline, no sand samples were taken at point 9: Chalupy — Gulfside.

WATER SAMPLES

Sampling. A total of 112 seawater samples from the Baltic Sea were tested for the purpose of the present study. The water samples were taken at all 16 sampling sites (Fig. 1); approximately 0.5 L of seawater (taken at 1 m from the coastline and 20–30 cm below the water surface) was collected into aseptic bottles. A similar sampling method was used by researchers from the Department of Environmental Protection and Hygienic Transport [11]. The data on the water temperature at the sampling site was obtained from available online databases, and was established based on the longitude and latitude position of the sampling site. The data were obtained at 8 a.m. local time (e.g. SatBaltyk) [12]

Isolation and identification. All samples were transported directly from the sampling sites to the laboratories. The isolation was performed on the day of collection. Seawater (50 mL) was filtered using 0.22 µm, white, gridded 47 mm filters (Millipore, Merck; Germany). The filters were applied to the CHROM agar *Vibrio* (CHROMagar, France) to pre-differentiate the obtained microorganisms. Chromogenic agar with filters was incubated at 37°C for 18–24 hours (POL-EKO APARATURA, Poland). Bacteria of the genus *Vibrio* that grow on the chromogenic medium exhibit a differentia colony colour (*V. parahaemolyticus* — mauve, *V. cholerae*/

/*V. vulnificus* — turquoise blue). In the next step, the characteristic colonies from the *Vibrio* chromogenic agar were transferred onto chromogenic thiosulfate-citrate-bile salts-sucrose (TCBS) medium (Merck, Germany) and incubated at 37 °C for 18–24 hours (POL-EKO APARATURA, Poland). The characteristic TCBS dark yellow colonies of about 2 mm in diameter (*V. cholerae*) and blue-green colonies (*V. parahaemolyticus*, *V. vulnificus*) were extracted and purified [13, 14]. The isolated strains were stored at –20 °C. The strains were identified by MALDI-TOF using a VITEK MS instrument (bioMérieux, France). Briefly, a portion of a bacterial colony (~1 µL) was transferred onto a MALDI sample plate, overlaid with 1 µL of a saturated solution of α-cyano-4-hydroxycinnamic acid in acetonitrile (28%), and then allowed to dry at room temperature. For each isolate, a mean spectrum was constructed with at least 50 m/z spectra profiles and used for the identification by comparison with the spectra contained in the Saramis database (bioMérieux). Identification was defined as > 99% match to the species-specific m/z profiles in the database. Escherichia coli ATCC 8739 (bioMérieux, Marcy l'Etoile, France) was used as a standard for calibration and quality control.

WET SAND SAMPLES

Sampling. A total of 105 samples of wet sand were tested for the purpose of this study. Samples of wet sand were collected at 15 sample sites (excluding sample site 9: Chalupy — Gulfside) to aseptic plastic containers (200 mL). Wet sand was sampled in the area between the dry sand and the seawater (the intertidal zone). At each site, the sand was collected from the depth of up to 5 cm.

Isolation and identification. All samples of wet sand were transported directly to the laboratory and isolation was performed on the day of collection. Wet sand samples were mixed and shaken with sterile deionised water (100 mL) for 30 minutes at the speed of 200 c.p.m. (laboratory shaker type 358 S, Elpin +) (wet sand washing water). In the next step, the wet sand washing water (50 mL) was filtered using 0.45 µm filters. The filters were applied onto the CHROM agar *Vibrio* (CHROMagar, France) to pre-differentiate the obtained microorganisms. Chromogenic agar with filters were incubated at 37 °C for 18–24 hours (POL-EKO APARATURA, Poland). Bacteria of the genus *Vibrio* that grow on the chromogenic medium have a different colony colour (*V. parahaemolyticus* — mauve, *V. cholerae*/*V. vulnificus* — turquoise blue). Next, the characteristic colonies from the *Vibrio* chromogenic agar were transferred onto the chromogenic TCBS medium and incubated at 37 °C for 18–24 hours (POL-EKO APARATURA, Poland). The characteristic TCBS dark yellow colonies of about 2 mm in diameter (*V. cholerae*) and blue-green colonies (*V. parahaemolyticus*, *V. vulnificus*) were extracted and purified [13, 14]. The strains were identified by MALDI-TOF in the same way as isolates obtained from water samples (described in the Water Samples, Isolation, and Identification section).

RESULTS

The presence of *V. vulnificus* in coastal waters of the Baltic Sea was confirmed in 3 seawater samples collected in: Hel (1 isolate), Jastarnia (1 isolate), and Chalupy (1 isolate). The strain of *Vibrio alginolyticus* was found in a seawater sample collected in Hel. Moreover, the identification was incomplete for 6 of the isolated strains, these were identified as *Vibrio cholerae/mimicus*. The strains which were not completely identified had been collected in Jastarnia (1 isolate), Puck (2 isolates), Chalupy (1 isolate). The metadata associated with the isolates are presented in Table 1.

The presence of *Vibrio* spp. was confirmed in 2 wet sand samples collected in the Gulf of Gdansk, the samples were collected in Kuznica — Gulfside (1 isolate) and Gdansk-Brzezno (1 isolate). The identification of isolates obtained from wet sand samples was incomplete; the strains were identified as *Vibrio cholerae/mimicus.* The metadata associated with the isolates are presented in Table 2.

DISCUSSION

The present research is one of the first concerning the prevalence of *V. vulnificus* in coastal waters and in the wet sand at the beaches and bathing sites in the Gulf of Gdansk. A number of researchers have indicated the correlation between global warming and the prevalence of *Vibrio* spp. in the Baltic Sea. In 2017, Semenza et al. [5] published the results of their analysis concerning the risk of growth and spread of *Vibrio* spp. in the Baltic Sea and its potential for causing infections in humans. For the purpose of the research study, they used the European Centre for Disease Prevention and Control (ECDC) online tool '*Vibrio* map Viewer' (https://e3geoportal.ecdc.europa.eu/SitePages/*Vibrio*%20Map%20Viewer.aspx) and the information on the prevalence of *Vibrio* infections (2006–2014) which is gathered and registered under the Swedish Communicable Diseases Act. *Vibrio* spp. have already been observed many times in the coastal waters of the Baltic Sea, and it is estimated that their presence is influenced by an increase in the temperature in the coastal regions. The presence of *Vibrio* spp. has been confirmed off the coast of Lithuania in 2018 [15]. *V. cholerae* was observed in Sweden (2003, 2004, and 2006) [2, 10]. *V. vulnificus* and *V. parahaemolyticus* were also isolated off the coast of Germany [16]. In Poland, the presence of the *Vibrio* genus has as yet only been detected in the Bug river, and all the strains (n = 22) were identical to *V. cholerae* El Tor 01 Ogawa [17]. The data concerning the prevalence of *Vibrio* spp. in the Baltic Sea is presented in Table 3.

Table 1. *Vibrio* spp. isolates obtained from the coastal waters of the Baltic Sea

Isolate number	Identification	Sampling site	Source of isolation	Date of isolation	Sea surface temperature [°C]*	Longitude and latitude*
W1	*V. vulnificus*	Hel — Gulfside	Water	15.07.2020	19.2	18°47'E 54°36'
W2	*V. vulnificus*	Jastarnia — Gulfside	Water	15.07.2020	18.5	18°39'E 54°41'N
W3	*V. cholerae/ /mimicus*	Puck	Water	27.07.2020	20	18°24' 54°43'
W4	*V. cholerae/ /mimicus*	Jastarnia — gate 48	Water	10.08.2020	20	18°40'E 54°42'N
W5	*V. alginolyticus*	Hel — Gulfside	Water	10.08.2020	21.3	18°47' 54°36'
W6	*V. cholerae/ /mimicus*	Chalupy — Gulfside	Water	27.08.2020	19.6	18°28' 54°46'
W7	*V. vulnificus*	Chalupy — Gulfside	Water	27.08.2020	19.6	18°28' 54°46'
W8	*V. cholerae/ /mimicus*	Puck	Water	27.08.2020	19.7	18°24' 54°43'

*Data on the water temperature at the sampling site was obtained from available online databases (SatBaltyk) [12]

Table 2. *Vibrio* spp. isolates obtained from wet sand samples

Isolate number	Identification	Sampling site	Source of isolation	Date of isolation
S1	*V. cholerae/mimicus*	Kuznica — Gulfside	Wet sand	29.06.2020
S2	*V. cholerae/mimicus*	Gdansk-Brzezno — gate 52	Wet sand	14.07.2020

Table 3. The prevalence of *Vibrio* spp. in the Baltic Sea

Microorganism	Coastline (country)	Year	Reference
Vibrio spp.	Lithuania	2018	[15]
V. cholerae	Sweden	2006	[10]
V. cholerae	Sweden	2003–2004	[2]
V. vulnificus	Germany	2006	[16]
V. parahaemolyticus	Germany	2006	[16]
V. alginolyticus	Germany	2006	[16]

In the last few decades, there has been an increasing number of infections caused by the bacteria of the *Vibrio* genus in the Baltic Sea region. Infections caused by *V. cholerae* (including 2 fatal cases) were recorded in Finland in 2003 [18]. Patients were reported to have been exposed to seawater. In 2006, 3 cases of wound infections by non-agglutinating and non-toxin-producing *V. cholerae* were reported in Sweden. All of these patients had contact with water from the Baltic Sea or the irrigation ponds. Environmental research has confirmed the presence of the above bacteria in 4 Swedish lakes [10].

It has already been mentioned that *V. vulnificus* was isolated from German patients with skin infections and septicaemia. All of the described cases were associated with seawater exposure while bathing in the Baltic Sea [8]. In August 2003, at least 2 cases of *V. vulnificus* infections were reported on the Island of Usedom. The analysis of the seawater in this region showed a high concentration of *V. vulnificus*, which was likely associated with high water temperature (exceeding 20°C) [19]. Both patients had open wounds when they entered the water. It is also important to emphasize that both of them had underlying diseases. Genotypic analysis and virulence characteristics of *V. vulnificus* isolates obtained from the patients and the environment (the German coast) showed that *V. vulnificus* represented two distinct clusters (I and II). There was no clear distinction between clinical and environmental isolates [9].

Two cases of septicaemia caused by *V. cholera* non-01, non-0139 were reported in 2006, in Poland. The first case was seen in a male patient aged 49 years. Epidemiological investigation indicated that the transmission probably occurred while the man was swimming in a lake. Water samples collected from this water reservoir tested positive for *V. cholera* non-01 and non-0139. The second case involved a 79-year-old man. Epidemiological investigation indicated that the probable source of *V. cholerae* was water from an old well [20].

CONCLUSIONS

Our research study confirmed the presence of potentially pathogenic bacteria including *Vibrio vulnificus* in the Gulf of Gdansk in the summer months. *Vibrio* spp. are a group of bacteria characteristic of warm climates (tropical regions). It is estimated that the more frequent occurrence of the *Vibrio* bacteria in the Baltic Sea is caused by an increase in water temperature and low salinity. Climate change and global warming contribute to the creation of favourable environmental conditions for the growth and spread of these microorganisms. The presence of *Vibrio* spp. may become a threat to the elderly and immunosuppressed patients. Therefore, further research into the prevalence of these bacteria along the Baltic coast is necessary.

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Conflict of interest: None declared

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A descriptive epidemiological study of cardiovascular diseases among seafarers

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ABSTRACT

Background: *Cardiovascular diseases (CVD) are the leading cause of morbidity and mortality among seafarers. This study aimed to evaluate CVDs distribution and differences, considering seafarers' rank and worksite groups.*

Materials and methods: *A descriptive epidemiological study was employed, and the analysis was based on the telemedical assistance data of the International Radio Medical Centre (C.I.R.M.) from 2010 to 2018. The age, gender, rank, and worksite variables were considered for the analysis. Chi-square or Fisher test was used to assess differences in CVD distribution between rank and worksite groups.*

Results: *Cardiovascular diseases were the sixth leading cause of medical advice requests to C.I.R.M. Distribution of CVD significantly differed between officers and non-officers [x^2 (5) = 17.308, p = 0.004]. Officers were often diagnosed with hypertensive CVD (46%), whereas non-officers were frequently diagnosed with ischaemic heart diseases (41%). There were no significant differences in the distribution of CVD diagnoses between worksite groups [x^2 (10) = 12.863, p = 0.231].*

Conclusions: *The frequency of CVD is higher among non-officers and older seafarers who have been more often diagnosed with CVD. Specific interventions such as early diagnosis, regular monitoring, and physical training to reduce cardiovascular risk should be considered on board ships. Future studies should take into account the incidence rate of CVD between rank and worksite groups.*

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Key words: cardiovascular diseases, epidemiology, seafarers, hypertensive disease, ischaemic heart disease

INTRODUCTION

Cardiovascular diseases (CVD) are the term defining several pathologies affecting the cardiovascular system. These include coronary heart disease, cerebrovascular disease, peripheral arterial disease, rheumatic and congenital heart diseases, and venous thromboembolism [1]. CVD is the leading cause of death worldwide, with approximately 17.9 million people dying per year and representing 31% of all global deaths. Of these deaths, about 7.4 million and 6.7 million were due to coronary heart disease and stroke, respectively [2]. In 2015, more than 1.6 million seafarers were employed worldwide, of which approximately 775,000 and 875,000 were officers and ratings, respectively [3]. In general, nautical work is broadly grouped by working place on board ships, including deck, engine, and galley [4], based on the differences between professional duties on board. CVD is the number one cause of death among seafarers, and the mortality rates on board are higher than those observed on shore [5–7]. Workers at sea have high mortality, injuries, and illnesses, probably as a consequence that they are working in hazardous environments.

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Different studies revealed that modifiable lifestyles such as tobacco use, harmful use of alcohol, physical inactivity, and unhealthy diet together with other significant risk factors, including increased arterial pressure, blood glucose levels, elevated blood lipids, overweight, and obesity, are the most critical. The above risk factors are causally linked with CVD, which represent the leading causes of deaths and disability in most countries [8–13]. Overweight and obesity represent relevant CVD risk factors for seafarers, and in these workers occur more often than in the general population [14]. A study conducted on the board of Italian flagship (2019) reported that more than 40% and 10% of seafarers were overweight and obese, respectively [15]. Another work on Iranian seafarers revealed that overweight increased from 46.7% to 60.9% over the period of 3 years [16]. These results indicate that in seafarers' CVD risk factors become worse compared to ashore workers. Other risk factors like gender, stress, depression and age are causes of CVD, and the reduction of these risk factors decreases the burden of CVD in all age groups [17]. Mental, psychological, and physical stressors represent other factors influenced by work-related issues [18]. These include isolation from family, long working hours, lack of shore leave, fatigue, exposure to different unhealthy lifestyles, and others [18–23] and make seafarers at a higher risk of CVD than the general population.

Ischaemic heart disease (IHD) and stroke are the principal components of the CVD burden globally and contributed to approximately 15.2 million deaths in 2015 [24, 25]. This accounts for more than 85% of all deaths due to CVD in the same year [24]. IHD and stroke cases increased, from 7.3 to 8.93 million and from 5.29 to 6.17 million deaths, respectively, between 2007 and 2017 [26]. The incidence and mortality rate of IHD has decreased in high-income countries in the last 25 years [25, 27, 28]. In contrast, the prevalence and mortality rate for this pathology is increased remarkably with age in developing countries and Eastern Europe [25, 27]. This suggests that CVD is reversing in developed countries and needs more attention in developing countries [26].

To meet the global health policy goal of reducing CVDs, further analysis of epidemiological data focusing on location, age, and time patterns is important [26]. This is because countering risk factors represents a health target in sustainable development goals for CVD reduction [25, 29]. In addition, the global efforts to reduce the CVD burden should be evidence-based [25] and centred on analysing the prevalence trends of these disorders.

Cardiovascular disease needs attention in commercial maritime operations because a high proportion of CVD death rate was recorded at sea among sailing seafarers [30–33]. Moreover, seafarers are exposed to different work-related stressors and potential complications like the risk of sudden cardiac arrest. In view of this, studies should provide evidence-based information about the CVD burden in the case of seafarers to handle events effectively [6].

The present work has evaluated the CVD distribution and differences between the rank and the seafarers' worksite. The analysis was made based on medical assistance data to seafarers provided by Centro Internazionale Radio Medico (International Radio Medical Centre, C.I.R.M.), the Italian Telemedical Maritime Assistance Service (TMAS).

MATERIALS AND METHODS

A descriptive epidemiological study was used to evaluate the distribution and differences in CVD occurrence between occupational groups and seafarers' worksites from 2010 to 2018.

DATA SOURCE AND COLLECTION PROCEDURES

Data were obtained from the C.I.R.M. database. C.I.R.M. is a non-profit institution established in 1935 which provides worldwide telemedical assistance to sailing seafarers [34]. The Centre was appointed in 2002 as the Italian TMAS and is the type of organization with the largest experience worldwide in terms of the number of patients assisted on board ships. For the last 84 years (from April 1935 to December 2019), the C.I.R.M. assisted more than 101,600 patients' on board ships and received 686,163 calls for medical consultations, with an average of 6 calls per patient. Data of C.I.R.M. assistance are available for each year with their gender, age, country, duties, and the diagnosis was encoded by both World Health Organization (WHO) International Classification of Diseases (ICD) 9th and ICD 10th versions. We used for this study data from 2010 to 2018 because, until 2009, data were encoded by ICD 9th version, but we considered 2010 and onwards data in which diagnoses were classified according to the ICD 10th version. In this version, the cardiovascular disease ICD code is from I00–I99. Diseases affecting seafarers were therefore classified into IHD (I20–I25), hypertensive disease (I10–I15), acute rheumatic fever (I00–I02), chronic rheumatic heart disease (I05–I09), pulmonary heart disease, and diseases of pulmonary circulation (I26–I28). Other forms of heart disease (I30–I52), cerebrovascular disease (I60–I69), diseases of arteries, arterioles, and capillaries (I70–I79), diseases of veins, lymphatic vessels, and lymph nodes, not elsewhere classified (I80–I89) and unspecified disorders of the circulatory system (I95–I99) [35] were also considered.

All recorded medical data are stored in the C.I.R.M. database, which is not accessible for externals. Data extraction, compiling, and coding were then performed. The attributes collected from each diagnosis were age, gender, occupational rank, and worksite. Age was cal-

culated by subtracting the seafarer's date of birth from the date of medical advice provision. Seafarers, the date of birth of which was not available, were excluded from this study.

STATISTICAL ANALYSIS

Descriptive analysis of seafarers' demographic variables, including age, gender, rank, and worksite, was done to evaluate the distribution of CVDs. Quantitative attributes like age and sex were encoded and categorized. For example, the age of seafarers was categorized into five groups: less than or equal to 30 years (age group 1), 31–40 years (age group 2), 41–50 years (age group 3), 51–60 years (age group 4) and older than 60 years (age group 5). Occupational rank was stratified by officers (deck and engine officers) and non-officers (deck and engine ratings, and galley), whereas worksites were categorized into three groups, namely deck, engine, and galley. Chi-square or Fisher's exact test was used to analyse distributional differences in rank and worksite groups. Data analysis was made using the IBM SPSS Statistics software version 26.

RESULTS

DEMOGRAPHIC CHARACTERISTICS

Overall, 1,377 CVD cases were assisted by C.I.R.M. during the 9 years under study. Almost all (98%) seafarers examined with CVD were male, and the average age (± standard deviation) of the patients with CVDs was 48.35 ± 12.71 years. CVD was frequently diagnosed in seafarers aged 51–60 years (31% of all seafarers with CVD). CVD occurred more often in non-officers compared to officers (748 [54.3%] vs. 629 [45.7%]) and was almost 2 and 9 times more frequent in the deck than in the engine and galley workers (Table 1).

Cardiovascular disease was the sixth leading cause for accessing the C.I.R.M. Other cases such as gastrointestinal disease and injury/trauma were the first and second most frequent causes of pathologies assisted among seafarers and accounted for 5,372 (16.60%) and 5,330 (16.40%) of all medical events, respectively, during the study period (Fig. 1).

The frequencies of different CVD diagnoses are shown in Figure 2. The most frequent CVD were hypertensive diseases (n = 551; 40%) and IHD (n = 530; 38.5%). Among hypertensive diseases, arterial hypertension was the most frequently diagnosed (89% of the total hypertensive diseases), whereas other types of hypertensive diseases such as hypertensive heart disease, renal diseases, and secondary hypertension accounted for 11% of the total hypertensive diseases. IHD included unspecified angina pectoris (376 cases), acute myocardial infarction (132 cases), and other forms of angina pectoris (22 cases).

Table 1. Demographic characteristics of seafarers with cardiovascular disease from 2010 to 2018

Variable	Number of cases (n = 1,377)	Frequency (%)
Age group		
≤ 30	133	9.7
31–40	231	16.8
41–50	385	28
51–60	429	31
> 60	199	14.5
Mean (SD)	48.35 ± 12.71	
Gender		
Male	1,345	98
Female	32	2
Rank		
Officer	629	45.7
Non-officer	748	54.3
Worksite		
Deck	807	59
Engine	479	35
Galley	91	6

SD — standard deviation

The other heart disease forms were the third most often diagnosed CVD, accounting for approximately 7% (95) of pathologies of this group. A common diagnosis of other forms of heart disease included cardiac arrest (62 cases), paroxysmal tachycardia (26 cases), and other cardiac arrhythmias (7 cases). Cerebrovascular diseases were also diagnosed in 59 seafarers and accounted for over 4% of total CVD. The most often cerebrovascular diagnosis included stroke, which is responsible for 80% of total cerebrovascular cases. Cerebral infarction accounted for the remaining 20% of cerebrovascular diseases.

Diseases of veins and lymphatic vessels were responsible for nearly 4% (50) of medical advice requests received. 91% of these pathologies included phlebitis and thrombophlebitis. The remaining 9% consisted of portal vein thrombosis and varicose veins of other sites.

DIFFERENCES BETWEEN OFFICERS AND NON-OFFICERS IN CVD DISTRIBUTION

The average age of officers and non-officers with CVD was 48.21 ± 13.08 years and 48.47 ± 12.44 years, respectively. CVD was frequently diagnosed in officers aged 41 to 50 years and in non-officers aged 51 and 60 years during the study period (Fig. 3).

Officers were frequently diagnosed with hypertensive CVDs (46%), whereas non-officers were often diagnosed

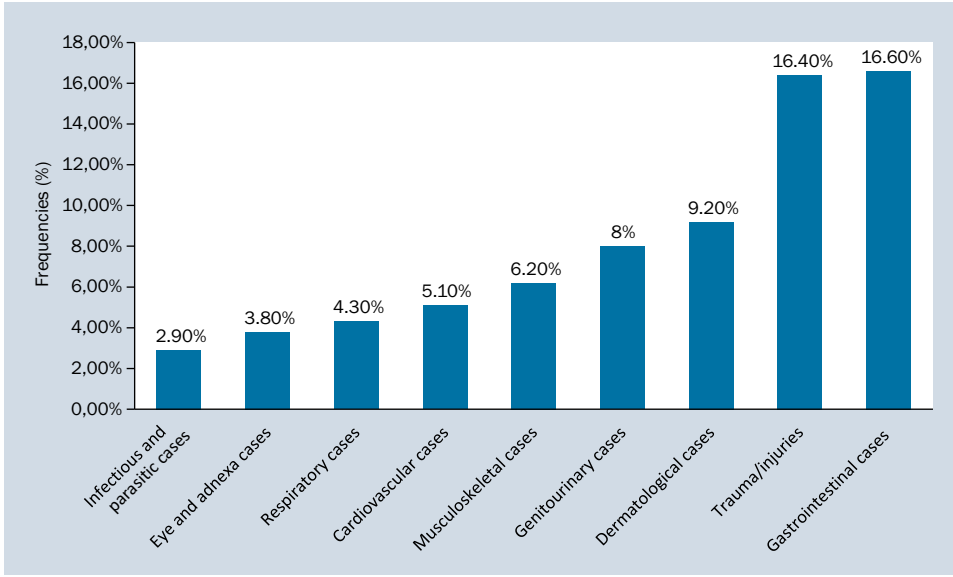

Figure 1. Frequencies (%) of pathologies assisted by Centro Internazionale Radio Medico (International Radio Medical Centre, C.I.R.M.) from 2010 to 2018

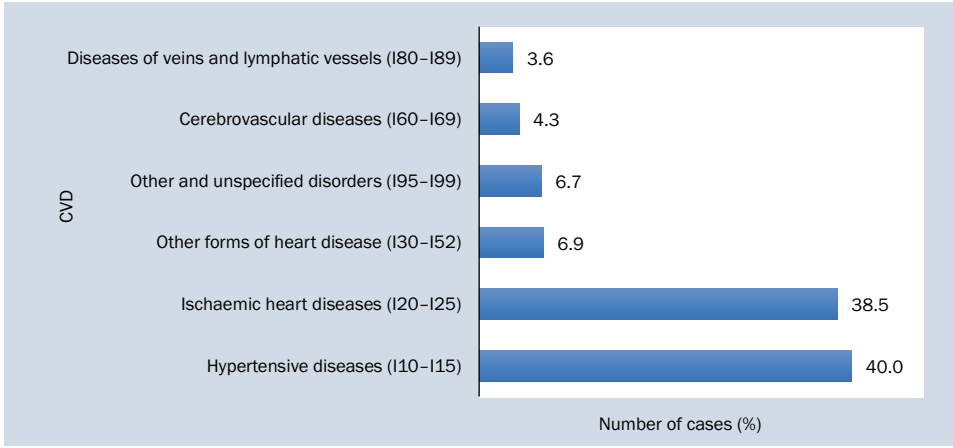

Figure 2. Frequencies (%) of cardiovascular diseases (CVD) diagnosis according to World Health Organization (WHO) International Classification of Diseases (ICD) 10th category from 2010 to 2018 (n = 1,377)

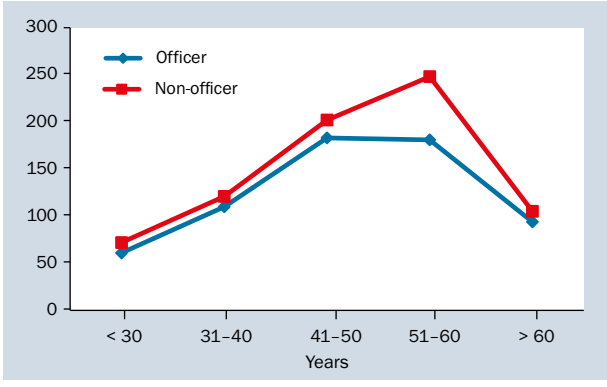

Figure 3. Distribution of cardiovascular diseases by age group between officers and non-officers with cardiovascular cases from 2010 to 2018

with IHDs (41%). The observed frequencies and percentages of each type of CVD diagnosis by seafarer rank are summarised in Table 2. The distribution of CVD diagnosis between officers and non-officers was significantly different [x^2 (5) = 17.308, p = 0.004] (Table 2).

DISTRIBUTIONS OF CVD BETWEEN WORKSITE GROUPS ONBOARD SHIPS

We found that deck workers were often diagnosed with IHD (41.9%), while engine room workers (43.8%) and galley (46.2%) were frequently diagnosed with hypertensive diseases. There was no difference in distribution of CVD diagnosis between worksite groups [x^2 (10) = 12.863, p = 0.231] (Table 3).

Table 2. Distribution of cardiovascular diseases by seafarer rank from 2010 to 2018 (n = 1,377)

Types of cardiovascular diseases	Rank		P-value
	Officer	Non-officer	
Total	629 (100)	748 (100)	0.004
Hypertensive diseases (I10–I15)	288 (46%)	263 (35%)	
Ischaemic heart diseases (I20–I25)	220 (35%)	310 (41%)	
Other forms of heart disease (I30–I52)	39 (6%)	56 (7%)	
Cerebrovascular diseases (I60–I69)	21 (3%)	38 (5%)	
Diseases of veins and lymphatic vessels (I80–I89)	23 (4%)	27 (4%)	
Other and unspecified disorders (I95–I99)	38 (6%)	54 (7%)	

Table 3. Distribution of cardiovascular diseases by seafarer worksites from 2010 to 2018 (n = 1,377)

Types of cardiovascular diseases	Worksites			P-value
	Deck	Engine	Galley	
Total	807 (100%)	479 (100%)	91 (100%)	0.231
Hypertensive diseases (I10–I15)	299 (37%)	210 (43.8%)	42 (46.2%)	
Ischaemic Heart diseases (I20–I25)	338 (41.9%)	162 (33.8%)	30 (32.9%)	
Other forms of heart disease (I30–I52)	54 (6.7%)	35 (7.3%)	6 (6.6%)	
Cerebrovascular diseases (I60–I69)	36 (4.5%)	20 (4.2%)	3 (3.3%)	
Diseases of veins and lymphatic vessels (I80–I89)	32 (3.9%)	15 (3.2%)	3 (3.3%)	
Other and unspecified disorders (I95–I99)	48 (5.9%)	37 (7.7%)	7 (7.7%)	

DISCUSSION

Over 9 years (from 2010 to 2018), there were 1,377 contacts to C.I.R.M due to CVD. Among the medical advice requests, 40% and 38.5% were respectively for hypertensive and IHD. The remaining 21.5% were for other heart disease forms, cerebrovascular diseases, diseases of veins and lymphatic vessels, and unspecified disorders of the circulatory system. In this study, we focused on the distribution and differences of CVD between the rank and the seafarers' worksite groups based on the assistance data of C.I.R.M. This type of analysis was chosen for practical reasons because it is difficult to estimate the incidence of CVD among seafarers without information on the total at-risk seafarer population on board ships.

In this study, we found that CVD was the sixth leading cause of accessing C.I.R.M. medical services. These results are not consistent with a German study [36] but in line with research conducted in the United States merchant vessels [6]. Nevertheless, these diseases are critical and one of the main health problems for seafarers. This is because factors such as exposure to the noise, job strain, and fatigue could increase CVD risk among seafarers. On the other hand, seafarers stay for long times away from their families, and they are experiencing many work-related issues such as physical, mental, and psychological stressors that can exacerbate the risk of developing CVD. Another study conducted on seafarers reported that vessel-specific stress, unhealthy diet, and lack of exercise were the major risk factor for CVD on board. This could be the reason for the not negligible occurrence of CVD among seafarers [38] in spite of the rather frequent cardiovascular pre-employment tests that people working at sea should make every 2 years. A study conducted in the modern maritime industry reported several work-related cardiac risk factors such as time pressure, long working hours, and high-stress factors are present on board [37].

The present study has shown that CVD distribution between officers and non-officers was significantly different [x^2 (5) = 17.308, p = 0.004], with non-officers having more CVD diagnoses than officers. This may be due to differences in stress management, lifestyle risk factors, and high work-related stressors. In addition, a recently conducted study among seafarers revealed that non-officers required a high level of physical effort to carry out their duties, and they had a higher risk of psychological stress than officers because of work-related risk factors [38]. This may explain our findings of different frequencies of CVD diagnoses between officers and non-officers. In contrast,

no significant differences in CVD diagnosis by seafarer's worksite were noticeable.

In this study, hypertensive disease was the most common CVD, accounting for 40% of all cardiovascular cases. Arterial hypertension with 89% of diagnoses was the main CVD affecting seafarers. A Danish study revealed that arterial hypertension was the main health concern of seafarers. The same study reported 44.7% and 41.8% of the prevalence of hypertension and pre-hypertension, respectively, among Danish seafarers [39]. According to different studies, the prevalence of CVD was increased among seafarers because of unhealthy lifestyles such as smoking, a high-fat diet, and inadequate physical activity [36]. This may explain our findings of the elevated frequency of hypertensive disease diagnoses. Ischaemic heart disease was the second most frequent disorder in the present work, accounting for 39% of all cardiovascular diseases. The basic medical assistance level that can be offered to on board ships without doctors or adequately trained paramedics, complicated by the relevant limitations in terms of availability of diagnostic devices on board, makes our analysis rather generic. For instance, situations like unspecified angina pectoris would need additional tests to confirm the condition, but unfortunately, this is not possible in the large majority of merchant ships [6, 40]. Moreover, devices for precise CVD diagnoses such as electrocardiogram, echocardiogram, coronary angiogram, and myocardial imaging to minimise misdiagnosis and prevent treatment delay remain today a dream far becoming a reality. Despite the above limitations, our analysis, based on requests coming from the ship side at the time of occurrence of symptoms requiring medical care, represents a real-life survey of what happens in an isolated environment like a ship in the middle of the sea.

The present study showed that CVD frequently occurred in older seafarers on board, with 31% (429) of all CVD cases affecting people aged between 51 to 60 years. In other words, the distribution of CVD among older seafarers is threefold higher than in younger seafarers (less than or equal to 30 years). Our results are in line with those of a German study reporting that CVD distribution significantly varied between age groups among seafarers [36]. In other words, as expected, increasing age is associated with a higher likelihood of CVD. This observation should consider more deep fitting tests in older seafarers and an effective preventative measure targeting older age seafarers on board.

LIMITATIONS OF THE STUDY

This study has some limitations and strengths. It was a retrospective descriptive study, and in nature, it has its constraints, including variable incomplete. Other limitations are gender disproportion and not considering the nationality variable because these attributes for some seafarers were incomplete in the database. We have also not assessed the incidence rate or cumulative incidence because of the lack of control group data. However, this study has some strengths. This work has shown the case frequency and differences between occupational groups. This can give insights into cardiovascular problems' real occurrence and stimulate future incidence of CVD studies in merchant seafarers.

CONCLUSIONS

Non-officers had a higher frequency of CVD diagnosis compared to officers during the study period. Officers were frequently diagnosed with hypertensive CVDs, whereas non-officers often diagnosed with IHDs. Older seafarers aged 51 to 60 were the age group with a higher frequency of CVD. To prevent CVD distribution and reduce their burden on merchant seafarers, effective prevention measures such as early diagnosis, regular follow-up, and training crewmembers on basic life support and using automatic external defibrillators should be considered. In addition, telemonitoring equipment for cardiovascular diagnosis via telemedicine should be introduced on a large scale on board to guarantee higher quality medical assistance to sailing seafarers. Special attention should also be given to seafarers older than 50 years. Primary prevention focused on increased awareness of CVD risk factors, intensive health education campaigns, and regular medical check-ups on board should be considered with full attention.

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Conflict of interest: None declared

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A survey on relationship between Gendarmerie Coast Guard Academy (GCGA) students' physical activity and COVID-19 infection

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ABSTRACT

Background: *The primary aim of this study was to reveal whether the Gendarmerie Coast Guard Academy (GCGA) students caught and went through the coronavirus disease 2019 (COVID-19) according to their physical activity levels during the COVID-19 pandemic process.*

Materials and methods: *The research group of the study consisted of 332 volunteer male students studying at the GCGA. International Physical Activity Questionnaire-Short Form (IPAQ-SF) and personal information form were used as data collection tools in the study. The data obtained from the questionnaires were analysed in the Jamovi 1.8.2 statistical software programme with a 95% confidence interval and a 5% margin of error. In the analysis of data, non-parametric correlation test was used for pairwise comparisons and Multinomial and Binomial Logistic Regression test was used for comparisons of subcategories.*

Results: *According to students' body mass index scores, 73.49% of the students were of normal weight. The results of the analysis, showed that 29.82% of the GCGA students had COVID-19, and 70.18% of them did not have COVID-19. It was determined that 91.92% of those who had COVID-19 had mild illness and recovered at home. According to the metabolic equivalence classification of students, a negative and significant relationship between students' physical activity levels (inactive < minimally active < very active) and the risk of getting the positive results for COVID-19 (yes < no) and the severity of COVID-19 (in intensive care < in the hospital < mildly at home) was found.*

Conclusions: *It could be said that increasing the physical activity level of students can reduce the possibility of having COVID-19 and also increase the probability of mild illness not requiring hospitalisation in those with positive COVID-19 test result.*

(Int Marit Health 2021; 72, 4: 259–267)

Key words: physical activity, catching COVID-19, overcome COVID-19

INTRODUCTION

The World Health Organization declared coronavirus disease 2019 (COVID-19) as an international public health emergency on January 30, 2020 [1] and a global pandemic on March 11, 2020 [2]. For the prevention of social contact and viral spread, curfews, quarantine practices, social distance rules, closure of educational institutions, reduction of travel, and other preventive methods have been observed to reduce the number of infections and deaths caused by COVID-19 [3]. These public health measures implemented to prevent the spread of the pandemic create significant disruptions of staying physically active [4]. During the period of staying at home, sedentary behaviours around leisure interests and screen activities are exhibited [2]. According

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to the results of the studies (n = 66) included in a systematic review, it was concluded that physical activity (PA) decreased and sedentary behaviours increased during the COVID-19 pandemic [5].

When the causes of death in the world are examined, lack of PA is stated as the fourth risk factor [6]. PA is any body movement produced by skeletal muscles that results in energy expenditure above resting (basal) levels [7, 8]. In general, it includes "exercise, sports and physical activities performed as a part of daily life, occupation, leisure time and active transportation" [9]. Achieving minimum levels of PA (i.e., 150 min of moderate to vigorous PA, 75 min of vigorous PA per week, or a combination of both) and reducing sedentary behaviour during times of social isolation has become a challenge and also a must for everyone [10]. In studies, it has been reported that the total metabolic equivalence (MET)-min/week values of the participants decreased during the pandemic compared with the pre-COVID-19 pandemic [11–17]. Considering the results from an international study, it has been shown that restraint has a negative effect on PA behaviour, with a 33% reduction in active minutes/day and a significant increase in sitting time (from 5 to 8 h per day) [13]. This is seen as a cause for concern, as just a few days of inactivity can lead to muscle loss, neuromuscular damage, insulin resistance, and fat accumulation [18]. Prolonged physical inactivity can cause hypertension, obesity, and heart disease [19]. At the onset of the pandemic, it was emphasized that maintaining one's PA during periods of social restrictions and quarantine is an important strategy for maintaining both physical and mental health [20, 21]. Educational approaches are changing because of the situation related to COVID-19 and perhaps university students who receive hands-on training are more affected by this situation [22]. Accordingly, it is thought that the COVID-19 epidemic caused changes in the PA level of Gendarmerie Coast Guard Academy (GCGA) students. Based on all this, the aim of this study was to investigate the relationship between the PA levels of GCGA students during the COVID-19 pandemic and the status of catching and going through COVID-19. In this context, "relationship between Gendarmerie Coast Guard Academy (GCGA) students' physical activity and COVID-19 infection" constituted the problem statement of the research. In order to answer this problem, answers to the following sub-problems were sought.

MATERIALS AND METHODS

RESEARCH MODEL

The model of this research, which aimed to determine the PA levels of university students during the pandemic process, and their status of catching COVID-19 and having the illness, was the "descriptive, relational screening (survey)" cross-sectional model.

RESEARCH GROUP

Three hundred thirty-two university students studying at GCGA participated in the study voluntarily. The mean age of the students (20.26 ± 5.68 years), the mean weight (74.80 ± 8.09 kg) and the mean height (178.46 ± 9.95 cm) were measured. The total MET averages of the students were 4126.4 ± 4098.1 and the body mass index (BMI) averages were 23.53 ± 1.92.

DATA COLLECTION TOOLS

The data were collected by creating the International Physical Activity Questionnaire-Short Form (IPAQ-SF) questionnaire and the personal information form prepared by the researcher in the virtual environment (google-form). Questionnaires were sent online to the students who volunteered after being asked if they wanted to participate in the study. In addition, the students were asked to mark the phrase 'I voluntarily participate in the study' at the beginning of the questionnaire.

COVID-19 DETECTION

An attempt was made to contain the COVID-19 epidemic thanks to the 'HES' (Life Fits in the House) telephone application developed by the Ministry of Health in Turkey and made mandatory for every individual [23]. With the 'HES' code, the positive or negative polymerase chain reaction (PCR) test result of the individual is reflected in the application, and it is ensured that the person does not go outside during the 15-day quarantine process. In our cross-sectional study, it has been determined whether the students have had COVID-19 according to the PCR test results in the 'HES' code to this day.

INTERNATIONAL PHYSICAL ACTIVITY QUESTIONNAIRE-SHORT FORM (IPAQ-SF)

The PA level of the participants was evaluated by means of the IPAQ-SF. A reliable and valid questionnaire was designed by an Australian researcher, Michael Booth in 1996 to examine the health and PA levels of the population and the relationship between them. The International Physical Activity Assessment Group developed the IPAQ based on this survey; the Turkish validity and reliability study of the scale was conducted by Öztürk in 2005 [24]. IPAQ is designed in two forms, short and long, to detect PA and sedentary lifestyles of adults. The short form consists of seven questions; provides information on time spent walking, moderate-to-vigorous and vigorous activities. It basically includes questions about PA done for at least 10 minutes in the last 7 days. Time spent sitting is considered a separate question. Scoring of the questionnaire includes the total of walking, moderate-intensity and vigorous activity in terms of duration (min) and frequency (days) [25]. It is determined how many

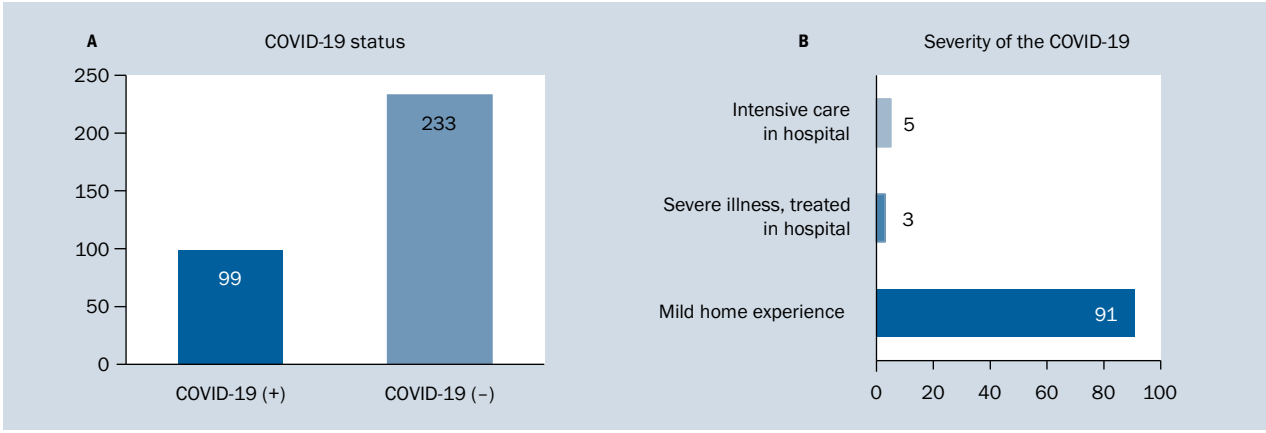

Figure 1. Coronavirus disease 2019 (COVID-19) status (**A**) and disease severity (**B**) in the participants of the study

days in the last week and for how long for each day, heavy physical activities, moderate-intensity physical activities, and walking are done. In the last question, the time spent daily without moving (sitting, lying down, etc.) is determined. As a result of these calculations, the "MET-minute" score is reached. A MET-minute is calculated by multiplying the minute of activity with the MET score.

A person at rest consumes 3.5 mL of oxygen per kg per minute. In IPAQ, it is accepted that AFA = 8.0 MET, OFA = 4.0 MET, Y = 3.3 MET [26].

MET calculation criteria:

- Walking MET-min/week = 3.3 × walking minutes × the number of walking days;
- Moderate intensity MET-min/week = 4.0 × minutes of moderate-intensity activity × the number of days of moderate-intensity activity;
- Vigorous MET-min/week = 8.0 × minutes of vigorous activity × the number of days of vigorous activity;
- Total, MET-min/week = (walking + moderate + vigorous + sitting) MET-min/week;
- Physical activity level is determined in three categories: inactive (< 600 MET-min/week) group, minimal active (> 600–3000 MET-min/week) group and very active (< 3000 MET-min/week) group.

It was obtained from the Scientific Research and Publication Ethics Committee of the Karamanoğlu Mehmetbey University Rectorate on 17.08.2021 (Document no: 26301).

ANALYSIS OF THE DATA

In the study, frequency (n), percentage (%), arithmetic mean (x) and standard deviation (SD) were used for personal information. When assessing the normality of the data distribution, it was determined that the skewness and kurtosis coefficients of the data were not between +1.5 and –1.5. This indicates that the results obtained in the study do not show a normal distribution [27]. From this point of view, non-parametric correlation test was used in relational searches and Binomial and Multinomial Logistic Regression test was used in comparisons of subcategories.

RESULTS

The number of people who became infected with coronavirus and the distribution of patients depending on the severity of the disease are shown in Figure 1.

It was determined that 29.82% (n = 99) of the participants tested positive for COVID-19, and in 70.18% (n = 233) the test for COVID-19 was negative. The vast majority of those with confirmed COVID-19 infection (91.92%; n = 91) had mild symptoms and were treated at home, 3.03% (n = 3) had severe illness requiring hospitalisation, and 5.05% (n = 5) were treated in the intensive care unit Figure 2 shows the number of COVID-19 infected participants according to the MET and BMI categories.

According to Figure 2, 20.2% (n = 67) of the participants who had COVID-19 had normal weight and 9.6% (n = 32) were in the overweight group. Of the participants, 53.3% (n = 177) of those who had not have COVID-19 were at normal weight and 16.9% (n = 56) were in the overweight group. Of the participants, 0.6% (n = 2) of those who had COVID-19 were inactive, 8.4% (n = 28) were minimally active, and 20.8% (n = 69) were in the very active group. Of the participants, 5.1% (n = 17) of those who did not have COVID-19 were inactive, 24.7% (n = 82) were minimally active, and 40.46% (n = 134) were in the very active group. Numbers and percentages of patients with severe or mild COVID-19 according to their PA levels (MET) classification are given in Table 1.

As shown in Table 1, 2.02% of the participants who had a mild home experience with COVID-19 were in the inactive group, 24.24% were in the minimally active group, and 65.66% were in the very active group. It is seen that 3.03% of those who had severe COVID-19 and were treated in the

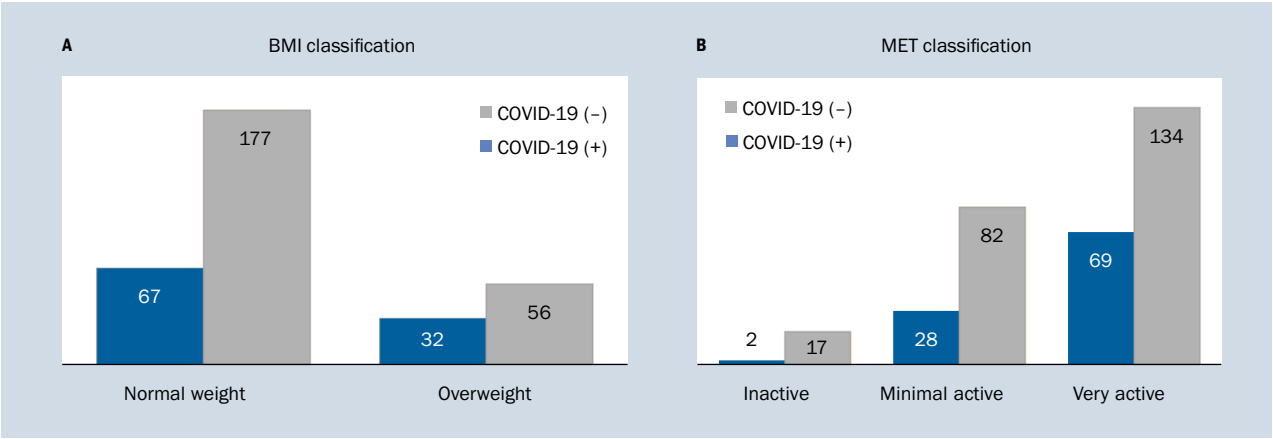

Figure 2. Body mass index (BMI) (**A**) and metabolic equivalent (MET) (**B**) in participants with or without coronavirus disease 2019 (COVID-19)

Table 1. Numbers and percentages of patients with severe or mild coronavirus disease 2019 (COVID-19) according to the metabolic equivalent (MET) classification

Severity of COVID-19		MET classification					
		Inactive		Minimal active		Very active	
	N	F	%	F	%	F	%
Mild home experience	99	2	2.02	24	24.24	65	65.66
Severe illness, treated in hospital	99	0	0	3	3.03	0	0
Intensive care in hospital	99	0	0	1	1.01	4	4.04

Table 2. Correlation test results of contracting coronavirus disease 2019 (COVID-19) and the severity of the disease according to the metabolic equivalence (MET) classification of the participants

MET classification	Contracting COVID-19	Severity of COVID-19
R	–0.125	–0.129
P	0.023*	0.018*

*p < 0.05

hospital, 3.03% were in the minimal active group; 1.01% of those who were treated due to COVID-19 in the intensive care unit were in the minimal active group and 4.04% were in the very active group.

As shown in Table 2, a statistically significant, strong negative correlation was found between the MET classification of the participants and their COVID-19 status ($r = -0.125$, $p < 0.05$). The increase in the PA levels of the participants (inactive < minimally active < very active) and the rate of not getting positive results for COVID-19 (yes < no) are directly proportional. There is a statistically significant, strong negative correlation between the MET classification of the participants and their COVID-19 status ($r = -0.129$, $p < 0.05$). The increase in the PA levels of the participants (inactive < minimally active very active) and the rate of mild COVID-19 treated at home (in the intensive care unit < hospital < mildly at home) are directly proportional. The probability estimation between the MET classification and the categories of contracting COVID-19 is given in Table 3 with the results of the Binomial Logistic Regression test.

As presented in Table 3, the probability of contracting COVID-19 according to the MET classification model is statistically significant, and the MET classification can increase the probability of contracting COVID-19 by 8.5 times ($R^2 = 0.28$, $p < 0.001$). When the independent variables are examined, it is seen that being in the inactive group may increase the probability of having COVID-19 by 0.3 times compared with those in the minimally active group, but this probability is not statistically significant ($p > 0.05$). Being in the active group may increase the probability of having COVID-19 by

Table 3. Binomial Logistic Regression test results of participants' metabolic equivalence (MET) classification and contracting coronavirus disease 2019 (COVID-19)

Predictor	Estimate	SE	CI	OR	P
Intercept	2.14	0.748	1.96–36.79	8.5	0.004*
Minimal active-inactive	–1.07	0.779	0.08–1.59	0.3	0.17
Very active-inactive	–1.48	0.762	0.05–1.02	0.2	0.05
N = 332, R^2 = 0.28 (Negelkerkes), Model = $\chi^2(2)$ = 6.77, p = 0.034					

*p < 0.01; CI — confidence interval; OR — odds ratio; SE — standard error

Table 4. Multinomial Logistic Regression test results of participants' metabolic equivalence (MET) classification and having coronavirus disease 2019 (COVID-19) illness

	Predictor	Estimate	SE	CI	OR	P
COVID-19 (–)/COVID-19 (+)	Intercept	2.141	0.748	1.96–36.82	8.5	0.004*
	Minimal active-inactive	–0.912	0.783	0.08–1.86	0.4	0.24
	Very active-inactive	–1.417	0.763	0.05–1.08	0.2	0.06
N = 332, R^2 = 0.37 (Negelkerkes), Model = $\chi^2(2)$ = 14.9, p = 0.021						

*p < 0.01; CI — confidence interval; OR — odds ratio; SE — standard error

0.2 times compared with those in the very active group, this probability is not statistically significant (p > 0.05). The probability estimate between the MET classification and the subcategories of COVID-19 status and severity is given in Table 4 with the results of the Multinomial Logistic Regression test.

As shown in Table 4, the status model of surviving COVID-19 according to the MET classification is statistically significant, and the MET classification can increase the probability of passing COVID-19 milder by 8.5 times (R^2 = 0.37 p < 0.001). When the independent variables are taken into consideration, it is seen that being in the minimally active group may increase the probability of having mild COVID-19 at home by 0.4 times compared with those in the inactive group, while this probability is not statistically significant (p > 0.05). While it is seen that being in the very active group among the participants may increase the probability of having mild COVID-19 at home by 0.2 times compared with those in the inactive group, this probability is not statistically significant (p > 0.05).

DISCUSSION

The following results were obtained in the study conducted to examine the PA levels of GCGA students and the coronavirus infection rate and the severity of COVID-19. It was determined that 29.82% of the participants tested positive for COVID-19, and in 70.18% the test for COVID-19 was negative. It was determined that 91.92% of the participants had a mild COVID-19 at home, 3.03% had severe illness and were in a hospital, and 5.05% were treated in the intensive care unit. As of May 10, 2020, more than 4 million cases of COVID-19 and 280,000 deaths from COVID-19 have been reported [28]. In China, 59% of 1014 COVID-19 patients had positive mass PCR results and 88% had positive computed tomography scans [29]. In more than 330 laboratory-confirmed adult COVID-19 cases in Shanghai; most patients (> 90%) had mild or moderate symptoms, and more than 90% of them have been cured and discharged [30]. In New York, 10% of individuals aged 18–45 who tested positive for COVID-19 have been reported to require hospitalisation [31]. The mean age of 1590 COVID-19 patients in Wuhan was 48.9 years, and 686 (42.7%) patients were female. It has been reported that 20–51% of patients have at least one comorbidity, with diabetes (10–20%), hypertension (10–15%), and other cardiovascular and cerebrovascular diseases (7–40%) being the most common. It has been reported that 399 (25.1%) of the patients had at least one comorbidity [32–34]. Among cases of COVID-19, patients with any comorbidity had worse clinical outcomes than those without. More comorbidities have also been reported to be associated with worse clinical outcomes [35]. Although patients from all age groups are infected with COVID-19, elderly patients seem to be more susceptible to infection and it is seen that the middle-aged group is the most affected. Although infection rates among children and young adults are very low, an incidence rate of 0.8–4.0% is reported [36]. Many young individuals with COVID-19 infection are said to develop a relatively mild illness and recover almost completely within 5–7 days [37]. It has been reported that generally young people have a mild course of COVID-19 and symptoms improve within a week [38]. In addition, one of the criteria that GCGA students must meet in order to be

admitted to university is the absence of chronic disease, which could also have had an impact on the results. These research results support the results of our study.

It was determined that 71.5% of the students had normal weight, according to their BMI values, and their PA levels were as follows: 51.1% were very active and 41.6% were minimally active. Moreover, 20.8% of students who had COVID-19 and 40.46% of those who had not had COVID-19 were also in the very active group. Ain addition, 20.2% of students who have had COVID-19 and 53.3% of those who have not had COVID-19 were in the normal weight group. To prevent the spread of the COVID-19 epidemic and to reduce the number of cases, curfews were introduced on the days and times specified by the authorities, however the measures taken have contributed positively to the spread of the epidemic as reducing the amount of time spent outdoors caused changes in the daily regular PA and exercise activities of individuals [39]. In a study that included many countries (Asia [36%], Africa [40%], Europe [21%]) and 1047 responses from other continents (3%), COVID-19-related house detention has been reported to have a negative effect on all PA levels (vigorous, moderate, walking, and general) [13]. In this sample of physically active adults in Norway, during the pandemic period, the levels of PA decreased in 177 (13.8) respondents, remained unchanged in 824 (64.3) and increased in 280 (21.9) [40]. The impact of social distancing measures on general PA, an important determinant of health, should be taken into account, especially if long-term social distancing is needed [41]. It can be said that before the pandemic, military students' PA levels and participation in sports activities were generally high [42]. In an experimental study, it was determined that the body weight and BMI of military students within 6 months did not change within or between groups [43]. Gaździńska et al. (2015) [44] stated that 71.3% of the military students had normal body weight, 25.3% were overweight and 3.4% were obese, according to their BMI values. In a study conducted with the students of the Martial University, it was reported that 52% of the students performed sports activities in their spare time and 46% did physical activities besides attending physical exercise classes at school [45]. In another study conducted with military students, it was concluded that students generally had minimally active and very active MET levels [46]. In military students, the content of mainly martial arts, condition, and endurance exercises may enable students to be physically active both in and out of class. These studies support the results of our study.

It was shown that 2.02% of the participants who had a mild home experience with COVID-19 were in the inactive group, 24.24% were in the minimally active group, and 65.66% were in the very active group. It is seen that 3.03% of those who had severe COVID-19 and were treated in the hospital were in the minimal active group; 1.01% of those who were treated due to COVID-19 in the intensive care unit were in the minimal active group and 4.04% were in the very active group. In order to prevent the COVID-19 pandemic, higher education institutions in almost every country closed in the first half of 2020 [47]. In our country, the transition to distance education has been made as of 16.03.2020. These public health measures implemented to prevent the spread of the illness create an obstacle to staying physically active [4]. A decrease in PA may also cause a decrease in immune and cardiorespiratory system functions [48]. Physical activity significantly reduces the risks of common noncontagious diseases, including cardiovascular disease, diabetes, some cancers, and depression [49, 50]. It is said that there is no evidence to suggest that physically active individuals will develop a less severe form of the disease when infected with COVID-19 [51]. In addition, it is reported to reduce the severity of symptoms [52] and the improves immune response to infections, which may affect clinical outcomes in COVID-19 patients [53]. It is well appropriate to exercise at home using a variety of safe, simple, and easily applicable exercises, to prevent the spread of coronavirus outside and to maintain fitness levels [54]. It is recommended that individuals who are in contact with COVID-19 and have a positive diagnosis but are asymptomatic should continue to do moderate-intensity regular PA at home [55]. In the study, the distance education of students during the pandemic may have reduced the rate of COVID-19 transmission by reducing their contact with other people. The students' persistence in exercise and physical activities in the house may have kept their immunity at a certain level, allowing them to have a mild period of COVID-19 at home.

A statistically significant negative high correlation was found between the students' MET levels and the status of contracting and going through COVID-19. It has been determined that the probability of having COVID-19 has increased by 0.3 times in the inactive group compared with those in the minimally active group, and the probability of having COVID-19 in the active group by 0.2 times compared with the students in the very active group, while these probabilities were not statistically significant. Although it was found that the probability of having COVID-19 mildly at home for students in the minimally active group may increase 0.4 times compared with those in the inactive group, and the probability of having COVID-19 at home for the students in the very active group is 0.2 times higher than those in the inactive group, these possibilities are not statistically significant. Prolonged physical inactivity can cause hypertension, obesity, and ischaemic heart disease [19]. For example, a 2-week reduction in daily steps from ~10,000 to ~1,500 steps lead to impaired insulin sensitivity and lipid metabolism, increased visceral fat, reduced

lean mass, and reduced cardiovascular fitness in healthy adults [56]. Regular PA has been shown to be effective in preventing the most common noncontagious pathologies [57] and reducing the risk of death [50, 58]. Regarding contagious diseases, PA improves immune response which can reduce both the risk of SARS-CoV-2 infection and the severity of COVID-19 symptoms [59]. Therefore, it is recommended to increase the immune function with appropriate PA that will boost the body against the virus before the illness [60]. It is recommended to develop a regular exercise habit with approximately 2500 MET weekly PA during the pandemic period [61]. An acute exercise (moderate-vigorous-intensity aerobic exercise, less than 60 min) strengthens the immune response of circulatory and peripheral tissues (e.g. respiratory, and intestinal epithelium) [62]. It is recommended to stay below 80% of the maximum heart rate, as stated in the "Journal of Sports Health" [63]. It has been reported that the biggest obstacle to healthy nutrition and regular exercise in military training is insufficient time [64]. Although the distance lessons or the work carried out continue during the pandemic process, in free time; since we add the hours spent on the road to and from school into the free time period, it can be said that everyone has an increase of approximately 2 hours more [65]. In the study, military students' continuance to exercise and PA during the pandemic, and that the distance courses they take are mainly condition-improving could induce to think that it may have helped the students to have COVID-19 less and to have the illness mildly or at home, even if they got positive results for COVID-19.

LIMITATIONS OF THE STUDY

The limitation of our study is whether the students had COVID-19 according to the results of PCR tests based on the application of 'HES' code only. Our study is a cross-sectional study and the COVID-19 (+) and COVID-19 (–) statuses of individuals were determined during the time period of the study.

CONCLUSIONS

The study showed that GCGA students had a high level of PA during the pandemic and continued to exercise at home. It has been determined that the rate of contracting COVID-19 in students is low and those having COVID-19 experienced a mild illness at home. The high level of PA of the students may suggest the possibility of not contracting COVID-19 and the possibility of mildly having the illness at home. The physical inactivity brought by the pandemic may have affected more, especially the universities that provide applied education. Military students have had to attend applied and sportive classes mainly remotely. However, contrary to expectations, military students tried to do sports and keep their physical activities high in their home environment. The course discipline taken by military students may have been effective in the formation of this situation. In our study, the possibilities of high PA level and contracting COVID-19 in the future were discussed. In further studies on this subject, there is a need for definite results out of possibilities. In addition, further studies can investigate which people are most susceptible to coronavirus infection. Vaccination and dose status of individuals can also be included in the evaluation and inferences can be made.

Conflict of interest: None declared

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Effects of an on-board psychosocial programme on stress, resilience, and job satisfaction amongst a sample of merchant seafarers

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ABSTRACT

Background: *Seafarers are an occupational group amongst those at highest risk for stress, which may adversely affect their mental health. The primary aim of this study was to assess the effects of a psychosocial programme on perceived stress, resilience, and job satisfaction among a sample of merchant seafarers.*

Materials and methods: *Secondary data analysis was conducted using a work questionnaire administered by a large shipping company. The matched subjects technique and multivariate analysis of covariance were conducted using a theoretical model of the programme's effects on job satisfaction, resilience, and perceived stress.*

Results: *A significant interaction between programme participation and weeks on board indicated that the effects of weeks on board on perceived stress differed significantly for the intervention group and matched control group. Weeks on board had a significant effect for perceived stress for the control group ($p = 0.02$), but not for the intervention group ($p = 0.857$).*

Conclusions: *These findings indicate that participation in the programme moderated the effects of weeks on board on perceived stress, suggesting that the programme may have safeguarded participants against the effects of weeks on board on perceived stress. Importantly, however, a work environment that is experienced as supportive, inclusive and just is necessary as a cornerstone for individually-focused psychosocial interventions to be optimally applied.*

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Key words: merchant seafarers, psychosocial intervention, duration on board, stress, resilience, job satisfaction, MANCOVA

INTRODUCTION

STRESS IN THE SEAFARING POPULATION

Maritime transport underpins trade and development, with over 80% of the volume and 70% of the value of global trade transported by sea [1]. In the shipping industry, in 2015, the global supply of seafarers was approximately 1,647,500 seafarers, and the global demand was approximately 1,545,000 seafarers, with a world merchant fleet of approximately 68,723 ships [2]. The largest supply country of seafarers in 2015 was China, followed by the Philippines, Indonesia, Russian Federation, and Ukraine [2].

Occupational hazards experienced by seafarers comprise restricted treatment for cardiovascular diseases, communicable diseases, restricted ability to provide med-

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ical aid on board, and exposure to dangerous substances [3, 4]. Indeed, seafarers experience several substantial psychosocial and physical stressors, including fatigue and sleep deprivation, separation from family, loneliness, social isolation, multinational crew, high workload and long work hours, physical demands, lack of recreation [4–10], and potentially traumatic experiences such as serious injury, death of a colleague, piracy, and shipwrecks [11]. Seafarers' sleep may be adversely affected by continuous exposure to noise, vibration, and movement of the vessel and by the need to work in shifts to ensure the continuous running of the ship [5, 7].

As seafarers are on board for long durations, spending both work and recreation time in the same confined environment, several stressors may be chronic [12]. In addition, many stressors on board may occur simultaneously, creating physical and psychological strain [13]. For example, Jensen et al. [14] conducted a questionnaire study with a sample of 6,461 seafarers across 11 countries. They found that the majority of seafarers worked every day of the week and on average from 67 to 70 hours per week throughout durations of 2.5 to 8.5 months on board.

Significant changes throughout the past half-century have impacted on both the health and safety of seafarers [15]. These changes include the globalisation of the shipping industry; automatisation and mechanisation of work on vessels, with cargo transported in containers; reflagging of vessels, with multicultural seafarers working on vessels operating under flags of convenience; and unstable employment of seafarers on short-term contracts, who frequently originate from low-cost labour supply countries [15]. Further recent changes include faster turnaround schedules in ports, decreased manning, labour intensification, and social isolation, which have significantly altered the seafaring landscape [16–20]. Psychological pressure and social isolation are compounded by a lack of shore leave even when there is adequate time in ports, due to changes in port infrastructures and stricter international security [21, 22]. Furthermore, socialisation on merchant ships varies substantially depending on the vessel's workload and trade, and there is a lack of time or space for recreational activities on many ships [23].

Moreover, as suggested by Carter [24] (p. 62): "Perceived inequity can contribute to distress. Common concerns are: hours worked, length of tour, the link of senior posts to nationality, different pay rates for the same job, age discrimination in recruitment, access to health care during employment and between contracts".

According to the International Transport Workers' Federation (ITF) [25], discrimination according to nationality is prevalent in the shipping sector, with ship-owners cost-saving on seafarers from low- and middle-income countries as a strategy to increase the competitiveness of their companies. Carter [24] (p. 62) further proposes that "inequity may also be seen as a form of neo-colonialism with rich ship owning countries exploiting those with less economic strength". The concept of **sweat ships** signifies similar exploitation of employees [26, 27]. For example, a political spotlight has shone in recent years on labour exploitation and enslavement of maritime workers across numerous Southeast Asian countries; with such human rights violations compounded by factors such as human trafficking organisations, weak legislation, insufficient labour inspections and protections, inadequate access to healthcare, and corruption [28]. Urgent human rights issues are therefore evident in the maritime industry [29].

Accordingly, seafarers are an occupational group amongst those at the highest risk for stress [30], which may adversely affect their mental health [31]. Issues relating to psychological functioning, such as depression, anxiety, suicide, and alcohol or drug dependence, are recognised health problems in the maritime industry [32]. Indeed, minor mental health problems are the most common type of health problem on non-passenger ships [33]. Months or years spent away from home, loneliness, stress and fatigue, harassment or bullying, long work hours without adequate sleep, a lack of shore leave, short turnaround schedules in ports, and risk of piracy, may give rise to anxiety and depression, and for some seafarers, suicide [34]. Suicide comprised an estimated 1.4% of all deaths globally in 2016 [35]. However, suicide amongst seafarers may be considerably more common [36]. As reported by the United Kingdom Protection and Indemnity Club [37], 4.4% of all deaths on board were attributable to suicide from 2014–2015, which escalated to 15.3% for the year 2015–2016. Notably, mental health problems amongst seafarers can be under-reported as a result of social stigma and fear of one's employment being terminated [38]. A review of seafarers' depression and suicide reported that investigations of depression and suicide amongst seafarers indicate improvement, although numerous recent case series suggest that suicide remains problematic [39]. While the importance of seafarers' psychological well-being is being increasingly recognised, there is a call for a change in the culture of shipping to facilitate more openness and less stigma regarding mental health [40].

Stress amongst seafarers has been identified as being associated with resilience. For example, Doyle et al. [41] found that self-reported higher levels of dispositional resilience was significantly associated with lower levels of perceived stress at sea in a sample of merchant seafarers. Similarly, in a related study to identify predictors of stress and job satisfaction in a sample of merchant seafarers using structural equation modelling, McVeigh et al. [42] reported that the study's theoretical model explained

23.8% of variance of perceived stress and the strongest predictive effect was for dispositional resilience. Beyond the seafaring population, research similarly indicates that resilience may protect against the adverse impact of stress [43–46].

RESILIENCE IN THE SEAFARING POPULATION

Resilience is defined by Luthans [47] (p. 702) as the "positive psychological capacity to rebound, to 'bounce back' from adversity, uncertainty, conflict, failure or even positive change, progress and increased responsibility". Resilience may therefore be more adequately conceptualised as adaptability rather than stability, as a process of 'bouncing back' from harm instead of immunity from harm [48]. An individual who is resilient is not therefore immune to experiencing challenges or distress, but rather has the ability to effectively adapt and 'bounce back' when confronted with adversity, trauma, tragedies, or substantial sources of stress [49].

One possible trajectory to resilience is personality hardiness, defined by Bartone [50] (p. S131) as "a characteristic sense that life is meaningful, that we choose our futures, and that change is interesting and valuable". Hardiness is conceptualised as incorporating three components: (1) **challenge**, signifying the belief that stressful changes are an opportunity to grow in knowledge and ability; (2) **commitment**, the view that no matter what difficulties are presented, it is important to stay involved with what is occurring instead of detaching and alienating oneself; and (3) **control**, the belief in turning stress from potential disasters into opportunities for growth [51]. The hardiness hypothesis posits that individuals with high levels of challenge, commitment, and control are more likely to remain healthy under stressful conditions than those with low levels of hardiness [52]. Hardiness is therefore a pattern of attitudes and skills that supports resilience and thriving under stress [53]. Indeed, the resiliency construct of hardiness has been empirically proven to be a significant resource for resistance to stress [54, 55].

While resilience may be dispositional and trait-like, there is evidence that it is also state-like and can be developed [53, 56, 57]. Resilience therefore comprises thoughts, behaviours and actions that can be learnt and strengthened [49]. In relation to hardiness, Bartone [50] (p. S137) suggests that "conceptually, hardiness is a personality dimension that develops early in life and is reasonably stable over time, although amenable to change and probably trainable under certain conditions". Hardiness is therefore both a trait and state, whereby individuals demonstrate consistency in their levels of hardiness across time and situations, but hardiness attitudes and behaviours may also be affected by different social and environmental factors [58].

Resilience has been explored in the maritime context. Turan et al. [59] argue that system resilience is needed for operational procedures on board to effectively deal with safety-critical operations and challenging environments, requiring resilience at the levels of the individual, team, multi-party team, and organisation. In one study, with a sample of 413 Filipino seafarers, Hystad and Bye [60] reported that personal values and hardiness explained a significant amount of variance in self-reported safety behaviour. The researchers recommended a focus on hardiness and personal values regarding the training of maritime workers and when planning interventions to support safety in maritime organisations [60]. Correspondingly, Carter [24] asserts that research needs to focus on the resilience, coping strategies and motivations of seafarers, and the organisation of work, with interventions aiming to modify these factors. It is proposed that psychological resilience training and education in the shipping industry could support safety and strengthen employee well-being [61]. As suggested by Leppin et al. [62], training programmes that strengthen resilience may increase health, well-being and quality of life.

JOB SATISFACTION IN THE SEAFARING POPULATION

Job satisfaction of merchant seafarers is associated with financial security, free time spent at home, the nature and dynamics of the work [63], as well as promotion, salary and benefits, the working environment, feeling of status, and satisfaction with management [64]. Job satisfaction [65–68] may be an imperative factor in maritime organisations [69]. For example, an association is empirically supported between job satisfaction and turnover intentions/retention of seafarers. For instance, Kim and Lee [70] found that a higher level of satisfaction in relation to working conditions and wages was associated with a lower level of turnover intention amongst a sample of Korean seafarers. Correspondingly, Nielsen et al. [71], with a sample of 541 seafarers from two Norwegian shipping companies, found a relatively strong negative association between intention to leave and job satisfaction. Caesar et al. [72] conducted a systematic review exploring retention issues for seafarers in global shipping and found that retention factors primarily pertained to satisfaction with job and employer, opportunities for career advancement, and good working conditions.

Empirical studies indicate that job satisfaction may also be an associate of safety in the maritime industry. For instance, in Nielsen et al.'s study [71] with a sample of 541 seafarers, job satisfaction was positively associated with individual intention and motivation to follow safety procedures, and negatively associated with management prioritising production over safety. Correspondingly, with a sample of 986 Norwegian offshore workers, Nielsen et

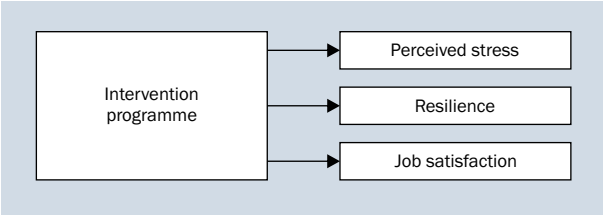

Figure 1. Theoretical model of the effects of the psychosocial programme on perceived stress, resilience, and job satisfaction amongst merchant seafarers

al. [73] found that workers who perceived high levels of risk reported lower job satisfaction levels, while this effect decreased when workers perceived their safety climate as positive. Bergheim et al. [69] conducted a study on the relationship of psychological capital (efficacy, optimism, hope and resiliency) to perceptions of safety climate and job satisfaction with a sample of 594 maritime workers from Norwegian shipping companies. They found that for European participants, a high level of psychological capital resulted in higher job satisfaction, which resulted in positive perceptions of the safety climate; although this mediation through job satisfaction was not found for Filipino participants.

Importantly, job satisfaction amongst seafarers is also associated with resilience [69]. Beyond the seafaring population, job satisfaction has similarly been identified as being associated with resilience [74–78].

RESEARCH AIM

There is a call for more research investigating the psychosocial health and stress of seafarers [4, 9, 19, 24, 79, 80]. For example, Carter and Karlshoej [81] suggest that health promotion interventions for seafarers are limited in scope and their efficacy is uncertain. As suggested by Jagosh et al. [82] (p. 27), "the unique features of the work and lives of seafarers, in addition to the changes within the field in the past ten years, require a clear understanding of the psychosocial impact on seafarers and the kinds of interventions that can improve psychological resiliency".

Accordingly, the primary aim of this study was to assess the effects of a psychosocial programme on perceived stress, resilience, and job satisfaction among a sample of merchant seafarers. Based on a review of the literature above, Figure 1 schematically presents the study's simplified theoretical model of the effects of the psychosocial programme on stress, resilience, and job satisfaction in the sample of merchant seafarers.

We hypothesised that there would be differences between the intervention group and a matched control group on perceived stress, resilience, and job satisfaction. The programme was designed by the company to address stress, resilience, and job satisfaction; and the relevance of these dependent variables is supported by a review of the literature.

Table 1. Psychosocial programme modules

1. Introduction: What is resilience?
2. Take care of yourself
3. Make connections
4. Avoid seeing crises as insurmountable problems
5. Accept that change is a part of living
6. Move towards your goals
7. Take decisive actions
8. Look for opportunities for self-discovery
9. Being grateful can accomplish more
10. Nurture a positive view of yourself
11. Keep things in perspective
12. Maintain a hopeful outlook

MATERIALS AND METHODS

THE ON-BOARD PILOT PSYCHOSOCIAL PROGRAMME

The Shell Health psychosocial programme or 'resilience programme' is a resilience-training programme aiming to support the thriving of employees both on- and off-shore [83, 84]. The programme was developed by Shell Health professionals, based on the American Psychological Association's concept of resilience [49]. Launched onshore in 2009, the programme was subsequently adapted and launched as a pilot programme at sea between April and December 2014. The programme at sea was piloted with an intervention group of 21 vessels (half of the company's fleet). The programme is a voluntary intervention, based on positive psychology, cognitive behavioural therapy, neuro-linguistic programming, and research on leadership. The programme comprises 12 modules, which are 40–60 minutes in duration. Each of the modules focuses on a specific aspect in relation to resilience, outlined in Table 1.

Officers, who acted as lay facilitators of the modules, administered the programme to teams on board. A small number of officers were trained as facilitators throughout a one-hour training session at an annual officers' conference onshore. Officers, rather than non-officer ranks, were chosen to facilitate the programme as officers usually deliver routine training on board and were therefore considered to be more confident with delivering training. The choice of officers was limited to those attending the particular conference at the beginning of the study. The selection was not completely random as four events took place in the

United Kingdom, one in India and one in Croatia, so officers would likely have self-selected depending on their country of origin. However, participation was independent of the facilitator training, as officers would not have known prior to registration. Representation of each ship in the intervention group was a determining factor, and the organisation aimed to have a minimum of two trained officers for each ship. All officers of the intervention group ships who attended the conference participated in the facilitator training. Each ship's officer could determine how to share or lead the roll-out on the ship.

During this training session, a brief conceptual background was given, alongside a summary of the experience of the company with the programme. The introductory presentation first discussed resilience in terms of experiences in the military sector and disaster response, organisations that were embracing resilience, and the planned piloting of the programme. Participants were also given the opportunity to share their own views of resilience through structured group discussion. Guided group discussion took place over a 15-minute duration, guided by questions including 'What is your definition of resilience?', 'Why is resilience important nowadays?', and 'What well-known or personal examples of resilience do you recall?'.

Using a peer-to-peer training scheme, officers trained other officers on board so that the programme could continue when a trained facilitator disembarked or transferred between ships. Joint preparation and facilitation of the modules by more than one facilitator was encouraged. Although facilitators guided the activities and discussions, the modules were highly interactive and drew substantially on the experiences of participants.

Adopting the programme at sea presented challenges due to circumstances specific to life on board. An adequate number of facilitators needed to be trained as each vessel needed their own facilitator. However, the ships were in remote locations most of the time, restricting the availability of seafarers for training as facilitators. The working pattern required seafarers to be on board for numerous months, followed by a similar duration of shore leave, meaning that an adequate number of facilitators needed to be available on each ship to allow continuity of the programme. The staggered changeover of crew on each ship led to team members participating in a different number and combination of modules. Moreover, online information and additional programme materials to support facilitators were not routinely accessible on board.

To overcome some of these challenges, the programme was adapted and piloted with an intervention group of 21 ships. The modules themselves were not adapted for the programme at sea, but rather the delivery was adapted to take into account staggered crew and changes of facilitators. Materials for the modules and supporting information were tailored to the needs of the seafarers and prepared for offline use. Each ship in the pilot study was provided with all of the required programme materials.

Innovative examples of programme facilitation were shared by participants. For example, some seafarers created presentations for facilitating the programme, shared their personal experiences, and reframed the content of the modules into their own words, translating the programme into their cultural and occupational context. On one ship, everybody participated in the preparation and facilitation of the modules. This ship also chose to complete all of the modules on a single training day, instead of extending the implementation of the programme over months.

PARTICIPANTS AND PROCEDURES

Secondary data analysis was conducted, using work questionnaires administered at two time points to seafarers within the shipping organisation. The organisation did not select or exclude any individual or vessel when administering the questionnaires. Fleet information messages were sent by the organisation to ship captains, requesting them to inform seafarers on board of the questionnaires and upload them onto the vessels' web-based servers. Respondents completed the anonymous online-based questionnaires, on a voluntary basis, while at sea. Data were not available in relation to the number of seafarers on each ship who were informed of the study and asked to complete the work questionnaire. Therefore, it was not possible to specify a response rate.

Time 0 (T0) baseline questionnaires were completed between January and July 2014 across 51 of a possible 53 tanker vessels (n = 575). After implementation of the pilot resilience programme, a follow-up questionnaire (T1) was then completed between November 2014 and March 2015 across 41 of a possible 52 vessels (n = 329). Of the total sample of questionnaire respondents at T1, 61 respondents reported participating in the programme.

Participants were merchant seafarers, both officers and ratings/crew, working in the company's fleet on liquefied natural gas carriers, product oil tankers and crude oil tankers, operating globally. The categorisation of departments on merchant ships can be primarily classified as: (1) deck department, responsible for managing the navigation of the ship and handling cargo operations and berthing instruments on the ship deck; (2) engine department, tasked with the operation and maintenance of the machinery of the ship; and (3) catering department, responsible for meal preparation and general housekeeping on board [85]. Merchant seafarers are categorised as officers and ratings, and these groups are further divided by rank, ranging from captain to third officer, chief engineer to fourth engineer,

and bosun to ordinary seaman [23]. Demographic characteristics of questionnaire respondents at T0 and T1 are reported elsewhere [42].

Ethical approval for this study was granted by the School of Psychology Ethics Committee, Trinity College Dublin, Ireland. Data collection was conducted using Survey Monkey, which is a third-party online survey software and not linked to any systems of the shipping organisation from which the study sample originated. Due to requirements within the company to protect the confidentiality and anonymity of respondents, questionnaire data were not collected on respondents' names, email addresses or phone numbers. Moreover, demographic data were collected on age ranges rather than specific ages. Respondents were also asked to provide their race/ethnicity rather than nationality for the purpose of making respondents less identifiable. Such procedures safeguarded the anonymity of respondents. Consent of participants was implicitly provided by virtue of questionnaire completion. Both the baseline and follow-up questionnaire outlined that information would be treated confidentially, that respondents' identification could not be known, that participation was on a voluntary basis, and the freedom to withdraw from the study at any time without providing a reason. Employees of the shipping company participated in the planning and coordination of the study and in jointly reviewing with the primary researcher the study design, analyses, findings and interpretations. Although the company collected the questionnaire data, the primary researcher independently conducted secondary analyses of the questionnaire data, independently interpreted and discussed the findings, and independently wrote the original draft of this manuscript and chose to publish.

STUDY MATERIALS

Both the T0 and T1 work questionnaires comprised demographic items; items from the organisation's Employees Survey; the Dispositional Resilience Scale-15; and the Perceived Stress Scale-4, which are each described in more detail below. The T0 questionnaire contained 48 items. The T1 questionnaire comprised 64 items, which included additional items on resilience and the programme. As English has been the lingua franca of the maritime industry for approximately the last century [86], questionnaires were administered in English.

Employees Survey. The company's Employees Survey is an annual and anonymous employee survey of work experiences and attitudes. Sixteen items from the Employees Survey were completed at T0, and seventeen items were completed at T1. Previous exploratory factor analysis with a subsample of respondents at T0 [41] indicated that five items reflected the dimension of 'job satisfaction'.

All items of the Job Satisfaction Scale (JS Scale) were measured on a five-point Likert scale, including scales ranging from 'very satisfied' to 'very dissatisfied', and 'strongly agree' to 'strongly disagree'. Total scores for job satisfaction were calculated by averaging scores ranging from 1 to 5. Higher scores reflect higher levels of job satisfaction. The five items comprised in the JS Scale were: 'Considering everything, how satisfied are you with your job?', 'I am proud to work for Shell', 'I would recommend Shell as a good employer', 'The level of work pressure I experience is acceptable', and 'I am able to balance my work and my personal life'. The reliability estimates for the JS Scale were satisfactory: Cronbach's alpha = 0.79 at T0 and 0.80 at T1. Confirmatory factor analysis of the JS Scale is reported elsewhere [42].

Dispositional Resilience Scale-15. The Dispositional Resilience Scale-15 (DRS-15) was used to measure hardiness [50, 54, 87]. The decision to use the DRS-15 was based on its established validity, acceptable internal consistency, and acceptable test-retest reliability, as well as its brevity [87, 88]. While the DRS-15 is a measure of hardiness, the scale was used by the organisation as it was considered that hardiness and resilience were closely associated. The DRS-15 uses both positively and negatively keyed items and comprises three facets of hardiness: commitment, control and challenge [50], each measured by five items scored on a four-point scale ranging from 'not at all true' to 'completely true'. Example items are: 'Most of my life gets spent doing things that are meaningful' (commitment), 'By working hard, you can nearly always achieve your goals' (control), and 'Changes in routine are interesting to me' (challenge) [89, 90]. When the six negatively keyed items are reversed, a total score for resilience can be calculated by summing scores for all items [91]. For the present study, as several respondents were missing scores for particular items of the DRS-15, a total score for each respondent was calculated by averaging rather than summing scores.

Bartone [88] reports internal consistency for the total scale (alpha = 0.83) and three subscales of commitment, control and challenge (alpha ranging from 0.70 to 0.77), which equal or exceed the acceptable alpha threshold of 0.70 [92]. In another study conducted by Bartone [87], the 3-week test-retest reliability coefficient for the DRS-15 was 0.78, exceeding the recommended threshold of above 0.70 [93]. However, the test-retest coefficients for the three subscales were 0.75 for Commitment, 0.58 for Control, and 0.81 for Challenge, indicating a test-retest coefficient for Control that was below the recommended threshold [87]. While Doyle et al. [41] reported the internal consistency for the total DRS-15 score as 0.72, the internal consistency was 0.65 for Commitment, 0.57 for Control, and 0.57 for Challenge, which were below the acceptable alpha value of 0.70. Total resilience scores were therefore used in the

present study. The internal consistency for the DRS-15 was 0.70 at T0 and 0.73 at T1.

Perceived Stress Scale-4. The Perceived Stress Scale-4 (PSS-4) was used to measure perceived stress. The PSS-4 is a four-item version of the Perceived Stress Scale developed by Cohen et al. [94], which measures an individual's assessment of stressful situations in the last month. The decision to use the PSS-4 was based on its validity, acceptable internal consistency, and brevity [94–96]. The PSS-4 comprises two positively stated and two negatively stated items, with a response set ranging from 0 (never) to 4 (very often) [97]. An example item is: 'In the last month, how often have you felt that you were unable to control the important things in your life?'. Positively stated items are reverse coded prior to summing the items, and higher scores indicate higher perceived stress [97]. For the present study, as several respondents were missing scores for particular items of the PSS-4, total scores were calculated using average instead of summed scores.

Cohen et al. [94] reported the internal consistency for the PSS-4 as 0.72, exceeding the acceptable alpha threshold of 0.70 [92]. In the same study, Cohen et al. [94] reported the test-retest reliability over a 2-month interval as 0.55, below the recommended threshold of above 0.70 [93]. In another study comprising a probability sample of the United States (n = 2,387), Cohen and Williamson [95] reported the internal reliability for the PSS-4 (alpha = 0.60) as less than that of the 10-item version (alpha = 0.78) and 14-item version (alpha = 0.75). While the PSS-4 indicates a moderate loss in internal reliability relative to the 14-item scale, the brevity of this scale is advantageous when time for assessment is limited [96]. For the present study, the internal consistency for the PSS-4 was 0.55 at both T0 and T1.

DATA ANALYSIS

Of the 575 questionnaires returned at T0, 55 respondents provided only demographic information and were therefore excluded from analyses. Moreover, 4 respondents who reported their job description as office-based and 4 extreme outliers were excluded from analyses, resulting in a total of 512 respondents at T0. Of the 329 questionnaires returned at T1, 50 respondents provided only demographic information and were consequently excluded from analyses. Furthermore, 3 extreme outliers were removed, resulting in a total of 276 respondents at T1.

Matched subjects procedure. The T0 and T1 samples could not be matched due to several reasons. The company's data privacy rules would have required a cumbersome process if any identifiable information was collected (such as using a unique identifier code); any traceable information may have reduced participation; and the same seafarers may not have been 'on tour' on the ships at both T0 and T1. A comparative analysis could therefore not be conducted of respondents' scores at T0 and T1. Accordingly, this study evaluated the intervention by a comparison of dependent variables at T1 only, using the intervention group and a matched control group.

The matched subjects technique comprises the matching of each individual in one sample to an individual in a second sample, so that the two individuals correspond with regards to specific variables that the researcher aims to control [98]. When selecting variables on which to match, a high correlation between the variables used for matching and the dependent variables is recommended [99, 100]. By matching on variables that are expected to strongly affect the dependent variable(s), these potential sources of confounding can be removed [101]. Accordingly, to reduce potential confounding bias caused by differences between participants in the intervention and control groups, these groups were matched according to characteristics likely to influence the dependent variables.

To select variables on which to match, a MANCOVA was conducted using T0 data, with perceived stress, resilience, and job satisfaction as dependent variables. MANCOVA comprises an analysis of the effects of one or more independent variables on more than one dependent variable, while controlling for the effect of one or more covariates on dependent variables [102, 103]. MANCOVA is comparable to multivariate analysis of variance (MANOVA) with the exception of the addition of covariates, which act as control variables to decrease the error in the model and produce the best fit [104, 105].

Analysis was conducted using IBM SPSS Statistics 23. Preliminary MANCOVA was conducted to test the assumption of homogeneity of regression slopes, by testing for interactions between the factors (independent variables) and covariate (weeks on board) [104]. Categorical predictors were entered as fixed factors, and continuous predictors were entered as covariates [106]. Categorical predictors comprised age, race/ethnicity, job, seafaring experience, and vessel location; while weeks on board was entered as a continuous predictor. Factors or covariates with significant effects on dependent variables in this analysis were considered potential confounders in the evaluation of the intervention effect, and hence were subsequently used to manually match participants of the programme (n = 61) with non-participants of the programme (n = 61) at T1. Table 2 presents demographic characteristics of programme participants and the matched control group.

Differences between the Intervention Group and Control Group. A second MANCOVA was then conducted using T1 data to assess differences between the intervention group (n = 61) and matched control group (n = 61) on the dependent variables of perceived stress, resilience, and job

Table 2. Demographic characteristics of programme participants and matched control group

Variables	Participants n (valid %)	Matched n (valid %)
Gender		
Male	61 (100)	61 (100)
Female	0 (0)	0 (0)
Ethnicity		
South Asian	22 (36.1)	22 (36.1)
East Asian	21 (34.4)	21 (34.4)
Other	8 (13.1)	8 (13.1)
Latino/Hispanic		
Middle Eastern		
Mixed		
African	5 (8.2)	5 (8.2)
Caucasian	5 (8.2)	5 (8.2)
Job		
Officer, Engineer	31 (50.8)	35 (57.4)
Rating, Crew	19 (31.1)	19 (31.1)
Catering	11 (18.0)	7 (11.5)
Age [years]		
18–29	9 (14.8)	11 (18.0)
30–39	28 (45.9)	23 (37.7)
40–64	24 (39.3)	27 (44.3)
65+	0 (0)	0 (0)
Seafaring experience [years]		
0–1	11 (18.0)	8 (13.1)
1–5		
5–10	14 (23.0)	16 (26.2)
10–20	26 (42.6)	27 (44.3)
> 20	10 (16.4)	10 (16.4)
Weeks since last shore leave		
0	0 (0)	0 (0)
1–5	32 (52.5)	31 (50.8)
6–10	13 (21.3)	21 (34.4)
11–15	9 (14.8)	3 (4.9)
16–20	3 (4.9)	5 (8.2)
21–25	3 (4.9)	1 (1.6)
26 or more	1 (1.6)	0 (0)
Current location		
On passage	50 (82.0)	53 (86.9)
Approaching port	11 (18.0)	8 (13.1)
Loading/discharging		

Note: The variables of ethnicity and job (emboldened) were used to match programme participants with non-participants. The ethnicity group of 'Other Combined' (Latino/Hispanic, Middle Eastern, and Mixed) was combined with the ethnicity group of 'Other' as the former had fewer than 10 cases. The seafaring experience group of '0–1 year' was combined with the group of '1–5 years' as the former had less than 10 cases. Similarly, the location group of 'Loading/ /Discharging' was combined with the location group of 'Approaching port' as the former had fewer than 10 cases.

satisfaction, while controlling for age, race/ethnicity, job, seafaring experience, location, and weeks on board. While this final MANCOVA for assessing the programme effects was conducted using T1 data, the initial MANCOVA for selecting matching variables was conducted using T0 data to avoid biasing the main analysis. This approach, comprising matching subjects and MANCOVA, was developed in consultation with two statisticians in two different universities, who independently agreed on this method for assessing the effects of the programme.

MANOVA is robust to violations of multivariate normality when the sample size is sufficiently large, namely, an overall sample size of 40 with 10 participants or more per group of the independent variable [107, 108]. Therefore, tests of normality were not relevant.

Dose-response relationships. An analysis was also conducted of dose-response relationships to assess a potential effect on the dependent variables of participating in a different number of programme modules. Programme participants were categorised into three groups of approximately equal size: 1–5 modules (n = 16), 6–11 modules (n = 23), and 12 modules (n = 22). MANCOVA was conducted to measure differences between these three groups for the dependent variables of perceived stress, resilience, and job satisfaction, while controlling for age, race/ethnicity, job, seafaring experience, location, and weeks on board. Categorical predictors comprised the three participant groups (categorised according to number of participated modules), age, race/ethnicity, job, seafaring experience, and vessel location; while the continuous predictor was weeks on board.

RESULTS

MATCHED SUBJECTS PROCEDURE

Descriptive statistics of variables at T0 and T1 are presented elsewhere [42]. For the preliminary MANCOVA conducted to test the assumption of homogeneity of regression slopes, a custom model was specified comprising all 2-way interactions between each factor and weeks on board, and main effects. Box's test of equality of covariance matrices indicated validity of the assumption of homogeneity of variance-covariance matrices. Levene's test of equality of error variances indicated equal variances between groups for each of the dependent variables. The interaction between weeks on board and location was significant, Wilks'^ = 0.963, $F(6, 882) = 2.77$, p = 0.011, multivariate $\eta^2 = 0.019$. This significant interaction term was therefore included in the final MANCOVA for selecting matching variables.

Final MANCOVA was conducted to select variables on which to match, with perceived stress, resilience, and job satisfaction as dependent variables. A custom model was specified comprising the weeks on board X location in-

teraction, and main effects. MANCOVA results indicated significant differences among categories of race/ethnicity on the dependent variables overall, Wilks'^ = 0.904, $F(15, 1253.695) = 3.108$, $p < 0.001$, multivariate $\eta^2 = 0.033$. Significant differences were also found among job categories on the dependent variables overall, Wilks'^ = 0.937, $F(6, 908) = 4.98$, $p < 0.001$, multivariate $\eta^2 = 0.032$. A significant interaction was found for weeks on board and location, Wilks'^ = 0.970, $F(6, 908) = 2.33$, $p = 0.031$, multivariate $\eta^2 = 0.015$.

As significant differences were found among race/ethnicity categories and among job categories on the dependent variables overall, the variables of race/ethnicity and job category were used to match control and intervention groups. Although a significant interaction between weeks on board and location was found, the variables of weeks on board and location were not used as matching variables, as the use of more than two variables was impractical. At any rate, the variables of weeks on board and location were subsequently controlled for in the MANCOVA conducted with T1 data to assess the effects of the programme.

Using T1 data, participants of the programme (n = 61) were matched with non-participants of the programme (n = 61) in relation to the variables of race/ethnicity and job category. As a match on both race/ethnicity and job category could not be identified for four programme participants, these participants were matched only on race/ethnicity.

DIFFERENCES BETWEEN THE INTERVENTION GROUP AND CONTROL GROUP

The data set comprising the intervention group and matched control group at T1 (n = 122) was again screened prior to conducting MANCOVA to measure differences between the intervention group and matched control group. Two intervention group participants had missing data on predictor variables, and these missing values were therefore replaced with the most common value for the respective variable, i.e. a missing value for location was replaced with 'on passage', and a missing value for job category was replaced with 'officer, engineer'. The ethnicity group of 'Other Combined' (Latino/Hispanic, Middle Eastern, and Mixed) was combined with the ethnicity group of 'Other' as the former had fewer than 10 cases. The seafaring experience group of '0–1 year' was combined with the group of '1–5 years' as the former had less than 10 cases. Similarly, the location group of 'Loading/Discharging' was combined with the location group of 'Approaching Port' as the former had fewer than 10 cases.

Categorical predictors comprised the intervention group/matched control group, age, seafaring experience, and location; while the continuous predictor was weeks on board. Race/ethnicity and job category were not included as these variables were previously controlled for through the matched subjects procedure.

For the preliminary MANCOVA conducted to test the assumption of homogeneity of regression slopes, a custom model was specified comprising all 2-way interactions between each factor and weeks on board, and main effects. Box's test of equality of covariance matrices indicated validity of the assumption of homogeneity of variance-covariance matrices. Levene's test of equality of error variances indicated equal variances between groups for each of the dependent variables. The interaction between weeks on board and intervention group/matched control group was significant, Wilks'^ = 0.885, $F(3, 104) = 4.52$, $p = 0.005$, multivariate $\eta^2 = 0.115$. Furthermore, the interaction between weeks on board and seafaring experience was significant, Wilks'^ = 0.823, $F(9, 253.259) = 2.35$, $p = 0.015$, multivariate $\eta^2 = 0.063$. These significant interaction terms were therefore included in the final MANCOVA.

Final MANCOVA was conducted to measure differences between the intervention group and matched control group for the dependent variables of perceived stress, resilience, and job satisfaction. A custom model was specified comprising the weeks on board X intervention group/matched control group interaction, the weeks on board X seafaring experience interaction, all 2-way interactions between matched groups and each predictor, and main effects.

MANCOVA results indicated a significant difference between the intervention group and matched control group on the dependent variables overall, Wilks'^ = 0.923, $F(3, 101) = 2.79$, $p = 0.044$, multivariate $\eta^2 = 0.077$. The covariate weeks on board also significantly influenced the dependent variables overall, Wilks'^ = 0.853, $F(3, 101) = 5.82$, $p = 0.001$, multivariate $\eta^2 = 0.147$. A significant interaction was found for weeks on board and intervention group/matched control group, Wilks'^ = 0.912, $F(3, 101) = 3.23$, $p = 0.025$, multivariate $\eta^2 = 0.088$. Moreover, a significant interaction was found for weeks on board and seafaring experience, Wilks'^ = 0.795, $F(9, 245.958) = 2.69$, $p = 0.005$, multivariate $\eta^2 = 0.073$.

Univariate ANOVA results indicated a significant difference between the intervention group and matched control group for perceived stress, $F(1, 103) = 7.44$, $p = 0.008$, partial $\eta^2 = 0.067$; but not for job satisfaction, $F(1, 103) = 0.55$, $p = 0.46$, partial $\eta^2 = 0.005$; or for resilience, $F(1, 103) = 0.27$, $p = 0.603$, partial $\eta^2 = 0.003$. Furthermore, differences for weeks on board were significant for perceived stress, $F(1, 103) = 15.46$, $p < 0.001$, partial $\eta^2 = 0.131$; but not for job satisfaction, $F(1, 103) = 0.29$, $p = 0.59$, partial $\eta^2 = 0.003$; or for resilience, $F(1, 103) = 1.42$, $p = 0.23$, partial $\eta^2 = 0.014$.

A significant effect was found for the intervention group/matched control group X weeks on board interaction on perceived stress, $F(1, 103) = 4.90$, $p = 0.029$,

partial $\eta^2 = 0.045$. A significant effect was also found for the seafaring experience X weeks on board interaction on perceived stress, $F(3, 103) = 3.95$, $p = 0.01$, partial $\eta^2 = 0.103$, and on job satisfaction, $F(3, 103) = 3.80$, $p = 0.012$, partial $\eta^2 = 0.100$. Weeks on board had a significant effect for perceived stress for the control group ($p = 0.02$); but not for the intervention group ($p = 0.857$).

DOSE-RESPONSE RELATIONSHIPS

For the preliminary MANCOVA conducted to test the assumption of homogeneity of regression slopes, a custom model was specified comprising all 2-way interactions between each factor and weeks on board, and main effects. Box's test of equality of covariance matrices could not be computed as there were fewer than two nonsingular cell covariance matrices. Levene's test of equality of error variances indicated equal variances between groups for each of the dependent variables. Pillai's Trace is used, rather than Wilks' Lambda, when homogeneity of variance-covariance (Box's test) is in question [104]. Factor-covariate interactions were not significant.

Final MANCOVA was conducted to assess dose-response relationships. A custom model was specified comprising all 2-way interactions between the three participant groups (categorised according to number of participated modules) and each predictor, and main effects. MANCOVA results indicated no significant difference between the three groups on the dependent variables overall, Pillai's Trace = 0.211, $F(6, 38) = 0.747$, $p = 0.616$, multivariate $\eta^2 = 0.105$, and no significant interactions between participant groups and each predictor. Accordingly, no significant dose-response relationships were identified.

DISCUSSION

The primary aim of this study was to assess the effects of a psychosocial programme on perceived stress, resilience, and job satisfaction among a sample of merchant seafarers. The discussion presented below examines some of the issues emerging from the findings in relation to a review of the literature.

EFFECTS OF THE PILOT PSYCHOSOCIAL PROGRAMME

We hypothesised that there would be differences between the intervention group and a matched control group on perceived stress, resilience, and job satisfaction. Findings indicated a significant difference between the intervention group and matched control group for perceived stress, although a significant difference was not found between these groups for job satisfaction or resilience. A significant effect was found for the intervention group/matched control group X weeks on board interaction on perceived stress. The significant interaction between participation in the programme and weeks on board indicated that the effect of weeks on board on perceived stress differed significantly for the intervention group and matched control group. Weeks on board had a significant effect for perceived stress for the control group ($p = 0.02$); but not for the intervention group ($p = 0.857$). These results suggest that participation in the programme moderated the effect of weeks on board on perceived stress.

Accordingly, the analyses suggested that the programme may have safeguarded participants against the effects of weeks on board on perceived stress. While only a limited evidence base exists on the success of health promotion interventions for seafarers [81], this study's findings suggest beneficial effects of an on-board pilot psychosocial programme on the psychosocial well-being of a sample of merchant seafarers. This finding lends support to the contention that psychological resilience training in the shipping industry could support employee well-being [61]. Research may therefore need to focus on the resilience and coping strategies of seafarers, with interventions aiming to modify these factors [24]. This study has aimed to address a critical gap in research investigating the psychosocial health and stress of seafarers [4, 9, 19, 24, 79, 80]. Such research is crucial to examine interventions that can increase psychological resilience amongst seafarers [82].

This study found that the programme impacted on participants' levels of perceived stress, but not on their levels of hardiness. The programme may have impacted on other factors not measured by the study; this is very likely considering the programme's basis in several fields including positive psychology, cognitive behavioural therapy, neuro-linguistic programming, and research on leadership. Indeed, the programme may have strengthened participants' resilience, but other aspects or types of resilience beyond hardiness. The measurement of resilience with a single self-report scale is questionable, as resilience is multi-dimensional and needs to be measured while considering several different factors. While the DRS-15 is a measure of hardiness, the scale was used by the organisation as it was considered that hardiness and resilience were closely associated. While there is some conflation between hardiness and resilience as concepts, these concepts were used synonymously within Shell. This reflects the importance of conceptual distinctions and of psychometric measures that address distinct theoretical constructs. The challenges of this study, however, also illustrate the practicalities of designing, rolling out, and administering an intervention in an organisational context in a timely manner, the inherent difficulties of implementing interventions outside of a controlled experimental setting, and of conducting real-world "messy research" (p. 227) [109].

This study provides a quantitative analysis of the effects of the programme. A related qualitative study of this programme [110] found that participants reported positive perceptions of the programme, but also communicated criticisms, many of which were underpinned by the need to adapt the programme to the unique context on board. Specifically, a number of participants reported that the personal nature of the programme was an uncomfortable experience on board; a lack of time for the programme; and the need for trained facilitators. Moreover, the need to tailor the programme was highlighted with regards to addressing its concurrent delivery across different nationalities and ranks, the importance of simpler English, and of shipping-specific examples. Notably, change of crew on board was also reported as a barrier to programme continuity and to assessing the impact of the programme. Notably, many of these concerns raised by these programme participants may be addressed through the use of computer-based psychosocial interventions on board, which could be completed in the individual's own time, privacy, and even language. Online or computer-based psychosocial interventions and training lend themselves to the isolated and dispersed context of seafaring [110]. Numerous Internet-based interventions have been tested for common psychological disorders, and research indicates that they frequently lead to similar outcomes as face-to-face psychotherapy, alongside being cost-effective [111].

LIMITATIONS OF THE STUDY

Matched subjects procedure. It is a limitation of this study that pre-treatment (T0) and post-treatment (T1) questionnaires were not matched and that the sample of participants at T0 was not the same sample at T1. We can therefore suggest that differences in perceived stress between the intervention and matched control groups may be explained by the intervention itself. However, we are unable to assert with certainty that differences are a result of the intervention, due to potential confounding factors.

Extrapolation of findings. This research has focused on a single company engaged in bulk hydrocarbon transport. The distances travelled in such ships, the routines over long passages, the multinational nature of the company, along with its high public profile, all constitute a specific combination of attributes that create a work and social environment not necessarily shared by other shipping companies or cohorts of seafarers. It is important to caution against extrapolation from one study across an industry that has a great variety of employers, flags, States, ship types, types of contracts, and different recruitment and remuneration practices. Elsewhere we have argued for the importance of considering context in developing relevant policy initiatives [112], and this certainly also applies in the maritime sector.

Response rate. Data were not available in relation to the number of seafarers on each ship who were informed of the study and asked to complete the work questionnaire. Therefore, it was not possible to specify a response rate. Without this information, it is possible that a sampling bias may have been present. For example, those who responded to the questionnaire may have been particularly resilient.

Work questionnaire. The item in the questionnaire assessing seafaring experience contained overlapping response categories, i.e. 0–1 year, 1–5 years, 5–10 years, 10–20 years, and > 20 years. Accordingly, for example, respondents with 1 year of experience may have responded as having '0–1 year' or '1–5 years' of experience. These overlapping response categories were therefore not mutually exclusive [113, 114].

Perceived Stress Scale-4. The internal reliability for the PSS-4 was 0.55 at both T0 and T1, below the acceptable alpha threshold of 0.70 cited in the literature [92]. The internal reliability for the PSS-4 was marginally lower than that reported by Cohen and Williamson [95] with a probability sample of the United States (n = 2,387), whereby the internal reliability for the PSS-4 (alpha = 0.60) was reported as less than that of the 10-item version (alpha = 0.78) and 14-item version (alpha = 0.75). This may be due to fewer items in the PSS-4 than the PSS-10 or PSS-14, as Cronbach's α may increase relative to the number of items in a scale [92, 115]. While the decision to use the PSS-4 for the present study was based on its brevity, validity, and acceptable internal consistency as reported in the literature [94–96], one of the limitations of this study was the less than satisfactory internal reliability of the PSS-4.

CONCLUSIONS

The findings of this study suggest that the on-board psychosocial programme may have provided a psychological buffer against the impact of duration on board on perceived stress. Importantly, however, a work environment that is experienced as supportive, inclusive and just is necessary as a cornerstone for individually-focused psychosocial interventions to be optimally applied [116]. As MacLachlan [26] suggests, "no matter what sort of clever individual psychological interventions maritime psychologists can develop, implementing these in a fundamentally unfair and exploitative working environment can be counterproductive, individualising a systems problem" (p. 7). Although depression, suicide, and other forms of psychological distress may be experienced at the individual level, their origins are manifold and cannot be effectively addressed by focusing only at the level of individual functioning. Rather, factors that affect well-being and performance in the maritime industry are embedded at different levels of work, including the team, organisation, and industry [32].

The maritime industry at large prioritises 'rationalisation' of work practices and 'optimisation' of budgets, which may result in the infringement of rights and working standards for seafarers [117]. To be competitive in the industry, maritime companies may be compelled to rationalise in ways that compromise the well-being, dignity, performance, and safety of seafarers; therefore, incentives and strategies at the industry level are also needed to support seafarers' well-being [117]. At a period of excessive cost-saving in the maritime sector, occurring alongside psychosocial problems amongst seafarers, now is the time for the well-being of seafarers to be prioritised and incentivised by maritime companies and the maritime sector at large.

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Marine creatures dangerous for divers in tropical waters

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ABSTRACT

Diving has been gaining in popularity in recent years with spectacular dive sites in tropical waters. Before anyone goes diving, they should learn about the risk factors associated with the exposure to hyperbaric conditions and also the risks from exposure to marine life. Apart from amazing views of the coral reefs, divers may be astonished by the magnitude of marine species diversity in local waters, ranging from predators (sharks, barracuda, moray eels) to venomous or stinging fish (jellyfish, anemones) and sea snakes. If travelers are unprepared and know little about the existing risk factors, a diving trip that was much looked forward to may turn out to have some very unpleasant consequences. The article describes the most common marine species which divers can come across in tropical waters. It also discusses the management of injuries caused by dangerous marine creatures.

(Int Marit Health 2021; 72, 4: 283–292)

Key words: marine fauna, divers, danger, injuries

INTRODUCTION

No matter how careful and vigilant a person is, the risk of being bitten, stung or poisoned by a dangerous marine creatures will always be there [1]. The risk is obviously higher if a diver is careless and less watchful, for example when a person continues diving despite being tired. Divers should also be aware of the fact that eating local specialties, including seafood, may cause gastrointestinal disorders or fish toxin poisoning [2, 3]. While staying underwater, divers must be particularly careful about contact with marine fauna. Most problems and incidents can be avoided if divers follow the basic safety principle: You can watch, but do not touch! (Table 1).

PREDATORS

SHARKS (*SELACHIMORPHA*)

Researchers have identified approximately 350 shark species, of which only about 20 are considered to be dangerous to humans. The smallest shark (*Sqaliolus laticaudus*) is only 15 cm long, while the biggest one — the whale shark — can reach the length of up to 20 m and the weight of 12 tons. Sharks can be found in all seas and oceans around the world but are generally most prevalent in tropical waters. Many shark species are able to reach estuaries and are often spotted in shallow coastal waters. Sharks were found to have the largest brains of all fish. Apart from the senses of sight, smell, hearing, taste and touch they also have two other species-specific senses; these are the sense of electrical currents and the sense of pressure changes, the first one mediated by special electroreceptors and the other by the lateral line. In dark waters, sharks can see 10 times better than humans [1]. Sharks are widely believed to be one of the most dangerous animal species in the world, which is partly the effect of the film series "Jaws" by Stephen Spielberg. In fact, only 27 of all the living shark species have been known to attack people or boats, of which no more than 10 species are considered dangerous to humans. The risk of a shark attack is much higher in shallow waters — the

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Table 1. Marine creatures dangerous for divers in tropical waters [1]

Marine fauna	Species/Family
Predators	Sharks (*Selachimorpha*) Barracudas (*Sphyraenidae*) Moray eels (*Muraenidae*) Triggerfishes (*Balistidae*) The serranid fish (*Serranidae*) The surgeonfishes (*Acanthuridae*)
Venomous fish	Rays (*Batoidea*) The scorpionfishes (*Scorpaenidae*) The stonefishes (*Synanceiidae*) The weevers (*Trachinidae*) The stargazers (*Uranoscopidae*) The rabbitfishes (*Siganidae*) The electric rays (*Torpedinidae*)
Cnidarians	Jellyfishes (*Scyphozoa*) Sea anemones (*Actiniaria*) Corals (*Anthozoa*)
Molluscs and echinoderms	Gastropods (*Gastropoda*) Octopuses (*Octopoda*) Sea urchins (*Echinoidea*)
Sea snakes	The beaked sea snake *(Enhydrina schistosa)* The annulated sea snake (*Hydrophis cyanocinctus)* The blue-ringed sea krait *(Liticauda laticaudata)* The yellow-lipped sea krait *(Laticauda colubrina)* The yellow-bellied sea snake *(Pelamis platurus)* The olive-brown sea snake *(Aipysurus laevis)*

animals most often attack swimmers, surfers, snorkelers and spearfishers. At deep depths (> 20 m) the risk is much lower [4]. A total of 150–200 shark attacks on humans are recorded each year, but less than 6% of the attacks are fatal. An analysis of the shark attack rate from 1960–2015 for 14 countries demonstrated the rate of merely one shark attack per one million people, but found that around 10% of the attacks involved scuba divers. Sharks have a poor sense of sight and are more attracted to the smell of blood or vibrations rather than the mere presence of a human in the water. In fact, their excellent sense of smell compensates for their poor eyesight and enables them to sense their victims from long distances. Sharks are able to detect electrical signals produced by the living creatures. If they are injured or scared they tend to be aggressive [5]. Shark attacks can be either provoked by the behavior of a scuba diver, when a shark tries to defend itself, or unprovoked, when a shark attack is unexpected and occurs for no clear reason. In general, a shark attack is more likely to occur under the following conditions: when the water temperature is > 20°C, when there is blood in the water and in areas where the number of prey is limited [6].

In order to minimize the risk of getting attacked by a shark, swimmers and divers are recommended to follow a few simple rules. You should avoid swimming or diving at night or dusk as it is the time when sharks are most active and usually go hunting. You must not get into the water if you have an open bleeding wound (this also applies to menstruating women). Avoid waters which are fished and where fishing nets are emptied. If you see a shark approaching you, remain calm and be careful. Try not to make quick movements or escape as it might provoke an attack. You should rather try to withdraw calmly without losing the sight of the shark. Never try to feed sharks as it may also provoke an attack. Be careful not to come into contact with the rough skin of a shark, it may cause an injury, and the bleeding may in turn provoke an attack. In order to minimize the risk of a potential attack stay calm and try not to move, perhaps the shark will swim away. However, if you are attacked, you should hit the shark hard in the nose, eyes or the gills — this may scare it away. Another effective method of scaring the shark off is to direct a stream of air bubbles from the regulator towards the shark or to swim directly towards the approaching animal — this usually makes the shark turn away making it possible to avoid a direct contact with the shark [1, 4]. Shark bite injuries are usually quite severe and result in massive tissue loss — a shark tears off pieces of flesh from the victim with its sharp teeth. Massive bleeding that follows a shark attack can attract other predators. In case of a shark attack, the victim should be removed from the water as quickly as possible; the bleeding must be controlled, the wound dressed, and the victim should be taken to hospital immediately. A vast majority of shark attacks casualties die of a hemorrhagic shock [7].

BARRACUDAS (*SPHYRAENIDAE*)

There are about 20 known species of the barracuda. All of the barracuda species are predators but some are so small that they are not dangerous to humans. Interestingly, people living in the West Indies fear barracudas even more than they fear sharks and in some parts of the world it is the barracuda, and not the shark, which is called the 'the king of the coral reef'. The fish is considered to be one the most dangerous marine predators. Barracuda resemble a large eel. Their average length is 1–1.5 m, but some species can grow up to 2.5 m. Barracudas have long sharp teeth with which they can inflict major injuries and in some cases even bite off a person's fingers or the hand. Barracuda normally reside near the coral reefs and in rock crevices. They usually attack to defend their territory rather than satisfy their hunger. They are known to form schools, which are dangerous to other marine animals. They show no fear of humans and are often seen to stay close to scuba divers. Unprovoked barracuda attacks are rare. An interesting fact is that the fish is attracted by bright colors and glittering objects such as scuba gear. For this reason, a barracuda may, for exam-

ple, mistake a glittering watch for pray and attack a diver causing severe injuries. Barracuda bites take a long time to heal and they usually require in-patient treatment [8, 9].

MORAY EELS (*MURAENIDAE*)

There are approximately 20 genera of the moray eel. Some may reach the length of up to 3 m, the width of over 30 cm, and the weight of up to 30 kg. They have a long, eel-shaped, slightly flattened body and very wide and strong jaws. They can be found in the coral reefs where they normally reside under the rocks or in crevices.

Moray eels rarely attack humans. The attacks are usually provoked by people, e.g., if a diver comes too close and puts their hand inside a crevice where a moray eel is hiding, the fish is very likely to attack in order to defend its territory. You should not feed, touch or approach moray eels as this can scare the fish and provoke an attack. Moray eels often look out for their prey in shallow waters and therefore it is possible to come across the fish while wading in the sea close to the rocks or the reefs [10, 11].

TRIGGERFISH (*BALISTIDAE*)

Scientists have identified more than 25 different species of the triggerfish. The fish can be found in all tropical waters. It is considered to be the most aggressive fish inhabiting the coral reef. Triggerfish is a solitary species. It has large and sharp teeth adapted for crushing corals and therefore its bite can cause a severe injury. The green giant triggerfish is the largest species of the triggerfish genus, and can reach the length of up to 90 cm. The animals show no fear of scuba divers and can attack them if they approach their nest. The triggerfish is found at the depth of up to 50 m [1, 12].

THE SERRANID FISH (*SERRANIDAE*)

This extremely large fish can be found in the tropical waters of the Indo-Pacific Ocean and the Caribbean Sea. There are approximately 400 different species of the serranid fish belonging to 67 genera. Some species are small, while others can be very large, e.g., the giant grouper. *Epinephelinae* are the largest of the *Serranidae* family, their average length is 1.5–2.5 m, but some can grow up to 3.5 m and weigh as much as 300 kg. The serranid fish should be treated as potentially dangerous to humans because of its large size, wide jaws and sharp teeth. They show no fear of scuba divers. They must not be fed as they can bite a diver on the hand [13].

THE SURGEONFISHES (*ACANTHURIDAE*)

These brightly colored fishes are commonly found in tropical waters of the coral reefs. The size of the different species of the surgeonfish ranges from 15 cm to more than 1 m, but their average length is around 50 cm. There are around 80 species belonging to the surgeonfish family. They form schools and can be found at the depth of up to 100 m. The surgeonfish is a territorial species which tends to be aggressive towards other fish of their own species. Although they are not predatory, they may potentially be dangerous to scuba divers because of their extremely sharp spines on each side of their tail that can cause a severe injury to anyone who tries to touch or hold the fish in a careless manner. If it is scared and cannot retreat, the fish can attack a human using its scalpel-like spines. The fish can inflict deep lacerated wounds by moving its tail [1, 14].

FIRST AID AFTER AN ATTACK BY A MARINE PREDATOR

If you are attacked and injured by a marine predator or a dangerous fish, the wound must be cleaned, washed with water and disinfected (e.g., using iodine solution) as quickly as possible. The wound should be then covered with a sterile dressing. The treatment normally involves the administration of painkillers, anti-tetanus and anti-shock medications and antibiotic therapy. In case of deep or extensive wounds, surgical treatment will usually be necessary [15].

VENOMOUS FISH

A vast majority of venomous fish produce and use their toxins for self-defense. The venomous spines or barbs, at the base of which venom glands are located, can reach the length of up to 30 cm in some species. The greater weever, for example, which can be found along the coastline of the Mediterranean Sea and east coasts of the Atlantic Ocean have their venomous spines located on each of their gill covers and their dorsal fin. The fish can inflict extremely painful puncture wounds. Most species of the venomous fish are known to lead a sedentary lifestyle and are usually found in shallow coastline waters. When a person is wading in the shallow waters, they may accidentally step on a venomous marine creature and sustain a puncture wound on the sole of their foot. For this reason, it is not safe to walk barefoot on the beach or in the waters rich in marine life. Instead, swimmers are recommended to wear specially designed water shoes to prevent possible injuries [16–18].

RAYS (*BATOIDEA*)

Rays belong to one of the largest groups of marine animals. There are seven recognized families of *Batoidea*, of which two possess venomous spines — these are *Dasyatidae*, commonly known as stingrays, and *Myliobatidae* including eagle and manta rays. Rays inhabit calm and shallow waters such as lagoons and can be found on the sandy seabed of the coral reefs. The most common rays include: the common stingray (*Dasyatis pastinaca*), which lives in the Mediterranean Sea and the Black Sea, the south-

ern stingray (*Hypanus americanus*) inhabiting the Gulf of Mexico and the Caribbean Sea, and the spotted eagle ray (*Aetobatus narinari*) which can be found across all tropical seas and oceans. Stingrays spend most of their time partly buried in the sand on the ocean floor, with only their eyes and a part of their tail sticking out. Stingrays will usually only attack to defend themselves when they are disturbed or accidentally stepped on. They attack by whipping their tail which is equipped with a venom spine at its end. The stingrays usually sting people in their feet and the lower extremities less commonly on other parts of the body. The pain starts immediately or within 10 min of the sting. It is sharp, excruciating or throbbing. The wound itself is either a laceration or a puncture wound. The removal of the stingray spine causes further tissue damage. The sting site becomes swollen and the surrounding skin turns white, then blue and eventually red. A person stung by a stingray may experience signs and symptoms which are indicative of poisoning, such as blood-tinged sputum, vomiting, diarrhea, sweating, tachycardia, muscle paralysis. A sting by a stingray may be fatal [1, 19].

THE SCORPIONFISHES (*SCORPAENIDAE*)

The family of the *Scorpaenidae* is large and includes around 100 species which inhabit both tropical and temperate seas and oceans. The *Scorpaenidae* includes one of the world's most venomous fishes, which can normally be found close to coral reefs. The largest of the species grow up to 1 m long. Most of the fish have camouflage coloration. Because of the differences in the structure of their venom glands they are divided into the lionfish (*Pterois*) and the scorpionfish (*Scorpaena*). They can be found in shallow waters, close to the coral reefs, the ocean bed and sandy beaches. They show no fear of people. Their venomous spines are hidden beneath their elongated fins. Because of their camouflage coloration the scorpionfish are difficult to spot, especially in shallow waters, where they normally reside. When disturbed they take a defensive position and prepare for an attack by erecting their dorsal spines and spreading their other fins. Both the lionfish and the scorpionfish have up to 20 sharp spines with venom glands located at their bases. The lionfish spines are long and straight while the scorpionfish have shorter and thicker spines. When a person gets stung by either of the two species, they will immediately feel acute throbbing pain which radiates from the sting site all through the affected limb and lasts for up to several hours. The injured site turns white and then blue and an inflammatory response occurs. The symptoms which are associated with a sting by a scorpionfish or a lionfish include vomiting, diarrhea, arthralgia, delirium, convulsions, shortness of breath, arrhythmia, hypotonia and in extreme cases cardiac arrest [20].

THE STONEFISHES (*SYNANCEIIDAE*)

The fish belonging to the *Synanceiidae* family, commonly known as the stonefish, lives in shallow waters of the coral reefs; they can be found inside cracks, caves and crevices or buried in the sand on the ocean floor. They are considered to be one of the most venomous and therefore dangerous marine animals. They grow up to 40 cm long, on average. They are found in the Red Sea, the Indian Ocean and the Pacific as well as in the coastal regions of Australia. They have 13 short but thick dorsal fin spines at the base of which their multiple venom glands are located. People usually get stung as they accidentally step on the fish which is lying motionless on the ocean floor often partially buried in the sand. The injuries caused by the stonefish are much more serious than those inflicted by the scorpionfish. The pain can last for many days and it can be so excruciating that it may result in a loss of consciousness. A swelling and an inflammatory response usually occurs at the sting site; in some cases muscular paralysis may ensue. Other signs and symptoms of a sting by a stonefish include: lymphadenopathy, arthralgia, vomiting, delirium, convulsions, shortness of breath, arrhythmia and eventually death in some cases. A victim must immediately leave the water and seek medical attention as quickly as possible. The treatment is long and can take several months, but even if it is successful, the poisoning can cause permanent health damage [21].

THE WEEVERS (*TRACHINIDAE*)

The fish belonging to the *Trachinidae* family are one of the most venomous marine creatures inhabiting the temperate seas and oceans. The species is distributed in warm waters along the east coast of the Atlantic Ocean, i.e., along the coasts of Norway, the British Isles as well as along the coasts of the Mediterranean Sea and the Black Sea. The fish inhabits the muddy ocean floor where it often buries itself in the sand. It can be found both in deep and shallow waters (at the depth of only 1 m) and therefore it might be dangerous for swimmers or those wading in the water along the coast as well as for scuba divers. Its venom apparatus consists of a venomous spine above the eye, long spines on each of their gill covers, 5–7 dorsal fin spines and 2 anal fin spines all connected with venom glands located at their bases. Its venom shows both neurotoxic and chemotoxic properties. The sting causes excruciating pain which radiates all through the affected limb; the pain is most intense after 30 min of the sting. Sometimes the pain is so severe that a victim of a sting can lose consciousness. Redness and swelling occur around the sting site, which persist for around 10 days. An infection of the affected site may lead to tissue necrosis. The common signs and symptoms of a weever sting include: excitement, tremors, sweating,

vomiting, arthralgia and in more severe cases: shortness of breath and cyanosis, arrhythmia, delirium, disturbance of consciousness and convulsions. A sting by the weever fish can cause death in extreme cases. The treatment and the convalescence are long and can take up to several months [1, 22].

THE STARGAZERS (*URANOSCOPIDAE*)

The stargazer is a relatively small fish, reaching the length of 40 cm. The species inhabit the east coastline of the Atlantic Ocean (from Portugal to the Republic of South Africa), the Mediterranean Sea and the Black Sea; it resides on the ocean floor and spends its time buried in the sand. The stargazers are active during daytime. Some species have a worm-shaped lure, which they use to attract the prey's attention. The venomous apparatus of a stargazer consists of two large venom spines located on their gill covers above their pectoral fins. A sting by the stargazer causes a painful injury and swelling of the affected site. In some cases the pain is so intense that it may lead to a loss of consciousness. The common signs and symptoms associated with the stargazer sting include: shivers, sweating, dizziness, arthralgia, shortness of breath, arrhythmia, convulsions and a loss of consciousness. A sting inflicted by the Atlantic stargazer (*Uranoscopus scaber*) can cause death [1, 23].

THE RABBITFISHES (*SIGANIDAE*)

The rabbitfish, also known as the spinefoot, are a small species (their average length is 35 cm long) commonly found in the Red Sea, the Indo-Pacific and Polynesia. They resemble the surgeonfish. The venomous apparatus of the rabbitfish consists of 24 spines connected with venom glands located at their bases. The signs and symptoms which occur after getting stung by the rabbitfish are similar to those associated with a sting by the scorpionfish and usually include: acute excruciating pain, cyanosis, arthralgia, shortness of breath, arrhythmia and convulsions. Although quite serious, the signs and symptoms are not life-threatening [24]. Other species of venomous fish which are distributed in warm waters include: catfish, gafftopsail catfish, chimarea, toadfish, dragonets (e.g., spotted dragonet), snake eels (e.g., *Ophichths semicinctus*). The wounds inflicted by these species are usually quite painful and cause local signs and symptoms including redness, swelling, infection at the sting site, occasionally tissue necrosis and hard-to-heal wounds.

THE ELECTRIC RAYS (*TORPEDINIDAE*)

Torpedinidae is a family of electric rays. They are not particularly dangerous to scuba divers; however, a close encounter with the fish can be very unpleasant. The fish is equipped with electric organs and is capable of generating electricity which they either use for self-defense or to capture their prey. They are primarily found along the coastline of the Mediterranean Sea, the Indian Ocean, the Pacific and the Atlantic Ocean as well. The best known species of the electric rays include: the leopard torpedo (*Torpedo panther*), the common torpedo (*Torpedo maculata*), the Atlantic torpedo (*Torpedo nobiliana*) and the Brazilian electric ray (*Narcine brasiliensis*). Electric rays have flat, disc-shaped body. They are usually brightly colored with darker spots on the top of their body; they have small retracted eyes, two dorsal fins and a well-developed caudal fin. They have two electric organs which are placed on both sides of their head; the largest species are capable of generating an electric shock of up to 300 volt. The electric rays differ in size; the smallest species are no more than 20 cm long, while the largest ones can grow up to the length of 180 cm and can weigh a few dozen kilograms. They are solitary bottom dwellers which spend most of their time buried in the sand or mud. Approaching or touching the animal may provoke an electric discharge, which can be very unpleasant and may even immobilize a diver for a short period. The recovery is swift and the electric shock from the ray causes no long-term complications [1].

FIRST AID AFTER BEING STUNG BY A VENOMOUS FISH

If you get stung by a venomous fish, the first aid will normally aim at relieving the pain, minimizing the toxic effects of the venom and preventing infection. Rays and catfish inflict lacerated wounds, which must be disinfected as quickly as possible. A sting by a venomous fish is often quite small and therefore difficult to clean of the venom. In some cases it might be necessary to make an incision at the sting site in order to bleed the wound or clean it. After it has been cleaned, the wound should be left to heal naturally through the growth of the granulation tissue. If you get stung by a venomous fish, it is recommended to immerse the affected limb in hot water (45°C or more) for 30–90 min or for as long as you can stand without getting burnt. If you get stung on the torso, you can use hot compresses to neutralize the effects of the neurotoxin. Doctors are divided on whether or not a tourniquet should be used. If you do apply a tourniquet, you will need to loosen it periodically, at least every 20 min in order to restore the normal blood flow. Larger wounds should be cleaned with warm water and disinfected using povidone iodine solution, the necrotic tissue and any foreign bodies should be removed and then the edges of the wound should be brought close together, a surgical drain should be inserted and left for 1–2 days, finally an antiseptic and a sterile dressing should be applied on the wound. The wound must not be stitched or stapled. A broad-spectrum antibiotic and post-exposure tetanus prophylaxis (if a patient has not been

vaccinated in the last 10 years) are recommended. Severe pain can be treated with non-steroidal anti-inflammatory drugs, and if they do not help, narcotic analgesics can be used. If a person manifests any generalized respiratory of circulatory signs and symptoms, the standard treatment should be applied to maintain their functions. If possible, antivenom should be administered (it is only available for stings by the stonefish) [16, 18].

CNIDARIANS

Cnidarians encompass a broad category of marine species which belong to the group of *Coelenterata* and include jellyfishes (*Scyphozoa*), sea anemones (*Actiniaria*) and corals (*Anthozoa*).

JELLYFISHES (*SCYPHOZOA*)

They are potentially dangerous to swimmers and scuba divers because of their venomous properties. Their venom apparatus consists of numerous nematocysts which are small elongated venom-filled capsules. When attacking their prey or trying to defend themselves they discharge thread-like spines from the nematocysts and inject the venom into the body of their prey or an attacker. Some jellyfish have tentacles of more than 15 m long. For this reason, if a diver sees anything which might potentially be a jellyfish, they should stay away. Even beached and dead jellyfish can inflict severe stings. In most cases, a sting by a jellyfish, corals or sea anemones causes an inflammatory response — with redness or a burn occurring locally. Some jellyfish (e.g., *Dactylometra*, *Chyropsalmus* or *Carybdea*) are particularly venomous; their sting can cause generalized signs and symptoms as well as severe skin lesions including tissue necrosis. Such stings are hard to heal [25, 26].

The Portuguese man-of-war (*Physalia physalis*) can be potentially dangerous to scuba divers who go diving in the Indian Ocean or the Atlantic Ocean. Although it is often mistaken for jellyfish, it is in fact a colonial hydrozoan which lives on the surface of the ocean. The Portuguese man-of-war has purple-blue pneumatophore and extremely venomous tentacles which are up to several meters long. The stings inflicted by the tentacles are painful and extremely dangerous as they can cause a severe poisoning, and in extreme cases even lead to death of an affected person [27].

The sea wasps (*Chironex fleckeri*) are known to have caused around 60 deaths in the Great Barrier Reef off the coast of Australia. The sea wasp is considered to be one of the most venomous jellyfish in the world. Its bell is relatively small, around 20 cm in diameter, but has several dozen long transparent tentacles. Its venom is so potent that it can kill a person within minutes [28]. Another dangerous jellyfish that can be found in tropical waters along the coasts of Australia is the Irukandji jellyfish (*Carukia barnesi*), a small species of the jellyfish which is the size of a human finger. Its sting can result in the Irukandji syndrome associated with catecholamine release [29, 30]. A sting from cnidarian species can cause a variety of signs and symptoms, including the anaphylactic shock [31].

When swimming or diving in waters where cnidarians are distributed, you should always be wearing a diving suit that protects your skin from jellyfish stings. The recommended first aid for a jellyfish sting (urticaria or contact dermatitis) is to rinse the affected area with vinegar. On some tropical beaches, you will even find bottles of vinegar to be used as first aid to treat stings. Obviously, not all jellyfish stings can be treated with vinegar only. If you are stung by the Portuguese man-of-war, vinegar should not be used as it can cause nematocysts to activate and trigger a stronger inflammatory response. In severe cases, when the sting is life-threatening, the only treatment option will be to give the victim cardiopulmonary resuscitation; cardiopulmonary resuscitation should be performed by qualified medics. Administration of antivenom is an effective treatment option; however, it is only available for stings by a limited number of sea stingers, e.g., the sea wasp [32, 33].

SEA ANEMONES (*ACTINIARIA*)

Sea anemones are either sedentary or semi-sedentary species in the class of Hexacorallia. The latter species are capable of moving slowly on their pedal disc with which they attach to hard surfaces. They live singly and are known for their vivid colors which they owe to carotenoid pigments. Some species live in symbiosis with other animals, e.g., small fish. Sea anemones are well adapted to a wide range of habitats and can be found throughout the world across all seas and oceans and at various depths. Yet, a vast majority of the species inhabit tropical waters. Sea anemones have cylindrical body which varies in size from a few millimeters to as much as 1.5 m in diameter. Anemones have a ring of tentacles growing around its central mouth and multiple stinging cells which they use in self-defense and to hunt prey. Sea anemones are predators, they use venom to paralyze their prey and next their tentacles to move the prey into the mouth. The tentacles are also used for catching the passing plankton [34].

CORALS (*ANTHOZOA*)

Corals are marine invertebrates which belong to the class of *Cnidaria*. The species have a structure of a polyp. Polyps form colonies which usually grow in shallow waters along the coast but some species can be found as deep as 6000 m. Attached to the ocean floor, they inhabit tropical or sub-tropical waters that are well-oxygenated and rich in sunlight. There are more than seven thousand different species of corals that can be classified into two broad subclasses:

Hexacorallia and *Octocorallia*. Singly living species vary in size from several millimeters to more than 10 cm, but the largest ones can grow up to 1.5 m in diameter. Coral polyps produce limestone which forms the structure of the ecosystem commonly known as the coral reef. Most species are sessile creatures (they lack the ability of self-locomotion) but some may be surprisingly mobile. Most corals feed on zooplankton, but bigger species are capable of catching bigger prey, such as crustaceans, mollusks and small fish. They paralyze and catch the prey using stinging cells which are located on their tentacles. Many species of crustaceans, starfish and fish feed on corals [34].

MOLLUSCS AND ECHINODERMS

Both swimmers and divers are at risk of exposure to venomous mollusks, snails and cephalopods (which are equipped with a venom-producing apparatus) and sea urchins.

GASTROPODS (*GASTROPODA*)

Marine species of gastropods have colorful and beautifully sculptured spiral shells which are desired by shell collectors. Many tropical snails, however, produce toxic venom, which can cause a severe poisoning or in extreme cases even death. Cone snails and terebra snails have a harpoon-like tooth loaded with venom which they fire into the prey. Once the prey has been stung, the venom is injected into its body under high pressure. Although murex snails and Aplysia species are not equipped with a venom apparatus, they are capable of producing toxic secretions in their salivary glands to overpower their prey [1]. Both cone and terebra snails inflict puncture wounds. If you are stung, the sting site turns white at first and then cyanosis, itching, numbness, intense pain and a burning sensation follow. The localized symptoms may soon progress into generalized ones including muscle paralysis, difficulty breathing and arrhythmia, and in extreme cases death. Gastropod stings should be managed in the same way as stings by venomous fish [35]. The most venomous species of marine gastropods include the textile cone (*Conus textile*), the geography cone (*Conus geographus*) and terebra (*Terebra maculata*). The species are widely distributed in the Red Sea, the Indian Ocean and the Pacific Ocean [36]. *Murex haustellum*, the species classified in the family of murrex snails, which is capable of producing toxic salivary secretions is primarily found in the Mediterranean Sea and the Black Sea [1].

OCTOPUSES (*OCTOPODA*)

All octopuses are equipped with venom apparatus that is capable of producing highly toxic secretions that enter the victim's body through a puncture wound inflicted by the animal's horn beak. The wound is usually quite small, but it may bleed heavily and be associated with a burning or itching sensation spreading all through the affected limb. The octopus bite causes redness, swelling and a rise in body temperature. In severe cases signs and symptoms of a poisoning may ensue, including a headache, vomiting, difficulty breathing and arrhythmia, the last two symptoms can be potentially life-threatening. Injuries inflicted by octopuses as well as a poisoning by an octopus should be managed in the same way as stings by venomous fish. The blue-ringed octopus, a small species with an arm span of only up to 20 cm, is considered one of the most dangerous marine animals; its toxin can be deadly to humans. When disturbed, it can become aggressive and attack an intruder. It is known to attack and kill animals which are much bigger and stronger. The blue-ringed octopus is found in the Pacific Ocean, especially along the northern costs of Australia. Each year, several people are reported to die from a sting by this marine creature [37]. *Octopus vulgaris*, the giant Pacific octopus with an arm span of more than 6 m, is venomous both to marine animals as well as to humans. It mainly inhabits tropical waters but some species can be found in the Black Sea, the Mediterranean Sea or the Caribbean Sea [38].

SEA URCHINS (*ECHINOIDEA*)

Sea urchins are one of the most common species of echinoderms. Sea urchins are found in both tropical and temperate climates. The long-spined urchins are considered the most dangerous because their sharp venomous spines can easily puncture the human skin and break off inside the body. Sea urchins are venomous and their sting can cause both localized and systemic poisoning. A sting by a sea urchin is painful and the pain can radiate all through the affected limb. In extreme cases a person who has been stung by a sea urchin may experience difficulty breathing, fits or seizures, face muscles paralysis, partial paralysis of other body parts or a loss of consciousness. The severity of signs and symptoms will depend on the species of the sea urchin and the number of stings. Deaths from sea urchin stings are extremely rare. The stings are managed in the same way as stings by other venomous fish. The removal of broken spines may be difficult and may require a surgical procedure. The black long spine urchin (*Diadema setosum*) is a typical long-spined sea urchin with the body of 10 cm in diameter and extremely long and sharp spines that can reach the length of more than 30 cm. The species can be found throughout the Indo-Pacific and in the Red Sea [39].

SEA SNAKES

Marine snakes belong to the *Elapidae* family and include approximately 50 different species. Although they are marine animals, some can be found near estuaries. Sea snakes are

primarily found in tropical waters of the Indo-Pacific Ocean. They are adapted to a variety of habitats, the yellow-bellied sea snake, for example, is known to be drifting deep sea, moving extremely long distances with the ocean currents but some species are found in shallow coastline waters. The beaked sea snake, the yellow-lipped sea krait and the annulated sea snake also known as the blue-banded sea snake (*Hydrophis cyanocinctus*) are typical representatives of marine snakes [40].

THE BEAKED SEA SNAKE (*ENHYDRINA SCHISTOSA*)

This highly venomous sea snake is considered to be the most dangerous of all marine snake species. The species is known to be aggressive and is responsible for the majority of deaths from sea snakes bites in humans. It grows up to the length of around 2 m and is found all throughout the Indian Ocean including in the Persian Gulf, the warm waters of the Malay Archipelago, the northern coasts of Australia and the coasts of New Guinea [41].

THE ANNULATED SEA SNAKE (*HYDROPHIS CYANOCINCTUS*)

Although it is generally less dangerous than the beaked sea snake, its bite may also be potentially life-threatening to scuba divers. Its maximum length is approximately 130 cm; the largest animals can grow up to 150 cm. It is often found in shallow coastline waters overgrown with mangrows. During the wet season the species travel inland — sometimes they can be spotted a few kilometers away from the shore. It is commonly distributed in the Indian Ocean, from the Persian Gulf to Japan and Australia [42].

THE BLUE-RINGED SEA KRAIT (*LITICAUDA LATICAUDATA*)

The colorful blue-ringed sea krait is one of the most common sea snakes. It has a black head with characteristic yellowish patches. Its average length is around 1 m. Although the species is not aggressive towards humans and its bites are rarely reported, the snakes can be dangerous as they have very potent toxic venom. The species can be found in the waters of the Indian Ocean — along the coasts of India, the Malay Archipelago, northern coasts of Australia and New Guinea, the Philippines and the Salomon Islands [43].

THE YELLOW-LIPPED SEA KRAIT (*LATICAUDA COLUBRINA*)

The yellow-lipped sea krait, also known as the banded sea krait or the colubrine sea krait, is one of the most common species of the sea snakes inhabiting the coral reefs of the Indo-Pacific. It has characteristic black rings all throughout the length of its body and vertically flattened paddle-like tail which is adapted for swimming. The upper surface of the snake's body has a grayish color, while the belly is *yellowish*. The black rings narrow or are interrupted at the bottom part of the snake's body. The yellow-lipped sea krait is one the few sea snakes which regularly comes ashore, especially at dusk and during the night. On average, it grows up to 140 cm long. The yellow-lipped sea krait has extremely potent toxic venom, which they use to paralyze their prey. Fortunately, the snake is not aggressive towards humans. Nevertheless, you must remain extremely cautious whenever getting close to the species [44].

THE YELLOW-BELLIED SEA SNAKE (*PELAMIS PLATURUS*)

The yellow-bellied sea snake is yet another marine snake which can potentially be dangerous to humans. It is the only pelagic sea snake and as such it spends its entire life away from the shallow waters of the coastline. It can be found in tropical waters across the Indian Ocean and the Pacific. The snake is bicolored — black on the upper surface of its body and yellow at the belly with the two colors sharply demarcating from each other. Its length rarely exceeds 1 m. Bites in humans are extremely rare, but the snake's venom is particularly potent and highly toxic [45].

THE OLIVE-BROWN SEA SNAKE (*AIPYSURUS LAEVIS*)

The olive-brown sea snake is commonly found along the coasts of New Guinea, Indonesia, New Caledonia and the northern coasts of Australia. Their body is thick and massive, the largest adults can exceed 1.8 m long. It has a flattened, paddle-like tail with slightly frayed edges. The snake is not aggressive and will not attack until provoked, but its bite can be dangerous to humans as its venom is highly toxic [46]. Marine snakes are one of the most venomous animals in the world. Some sea snakes have venom which is several times more potent than that of the Indian Cobra. The mortality from a sea snake bite has been estimated at 15–30%. Fortunately, a majority of marine snakes have an underdeveloped venom apparatus and are generally not aggressive towards people, and tend to stay away from swimmers and scuba divers. Still, a direct contact with the animals should be avoided as their bite may be life-threatening. Most species are colorful and do not exceed the length of 1 m, but the largest sea snakes can grow up to around 2 m. Marine snakes are most dangerous to fishermen; a bite can occur when fishers are emptying the fishing nets or while they are wading in shallow waters. The signs and symptoms of sea snake envenomation develop quite slowly. In some cases, no signs or symptoms will occur, and a person may not even know that they had been bitten. However, after a bite by a more venomous snake, signs and symptoms usually begin within 30 to 90 min. Sea

snake venom contains a neurotoxin affecting the nervous system. The initial symptoms of envenomation might include excitement and agitation in some cases or anxiety and restlessness in other cases; the victim can feel mild pain at the bite site. Hemolysis, rhabdomyolysis and a respiratory failure will often ensue. Tongue stiffness, muscle numbness weakness and pain can also occur. Muscle paresis and paralysis gradually spreads upwards from the lower extremities towards the torso and then the head. This results in trismus, facial and eye muscles paralysis. Eventually complete muscle paralysis and kidney damage occur followed by bradycardia, difficulty breathing, cyanosis, convulsions, vomiting, loss of consciousness and eventually death which is due to the paralysis of the respiratory muscles. In most cases, a bite by a sea snake will leave no visible marks on the skin of the victim but it will cause certain systemic signs and symptoms resulting from the neurotoxic effects of venom. A bite by a sea snake is a medical emergency, the victims will need to get prompt medical assistance and will generally require in-hospital treatment (dialysis, mechanical ventilation, maintaining fluid and electrolyte balance) [47, 48].

FIRST AID AFTER BEING BITTEN BY A VENOMOUS SEA SNAKE

A bite by a marine snake should always be considered an emergency. The victim should lie still and try to avoid any effort or movement as it may facilitate the spread of the neurotoxin. A tourniquet should be applied above the bite site and antivenom should be administered, if available. Whenever possible, the snake that had bitten the victim should be caught and brought to the nearest medical facility for identification [46–48].

CONCLUSIONS

The diversity of marine animal species is enormous. The underwater world attracts many people with its beauty, but at the same time, it may pose a serious threat to human health or life. Admiring marine creatures is usually perfectly safe for divers' health. However, in some situations direct contact with aquatic animal species may result in the occurrence of pathological lesions of varying severity such as superficial injuries of the epidermis, dermatitis, major injuries inflicted by marine predators that can lead to disability or death of a person, or life-threatening envenomation or intoxication caused by contact with venomous creatures. Every year, tens of thousands of diving enthusiasts go on a holiday to tropical destinations. If they are planning to go diving during their holiday, they should not only learn how to deal with hyperbaric conditions, but also how to give first aid and effectively manage injuries, intoxication or envenomation caused by marine creatures.

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Travelers with thyroid disorders

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ABSTRACT

Thyroid disorders account for a majority of endocrine diseases. The most frequent among them are Hashimoto's thyroiditis, thyroid nodules and cancer with hyperthyroidism or hypothyroidism. Many thyroid patients travel a lot and therefore require appropriate guidance from their doctor. The aim of the review article is to discuss various aspects of travel in order to determine the optimal travel conditions for thyroid patients. Thyroid travelers must be well prepared for their journey. They should put particular emphasis on the choice of destination, the season and iodine resources at the planned place of stay. Before going on a journey, they are advised to check their health insurance, buy enough medications, prepare a copy of prescriptions and all other necessary documents. Depending on the means of transport, a few precautions should be taken to avoid infections or worsening of thyroid symptoms during travel. To deal with unpredictable events which might occur at the place of stay, travelers are recommended to take a first-aid kit containing basic medications. It needs to be stressed that many drugs are responsible for thyroid function disruptions and should only be used after consultation with a healthcare professional. Avoiding stress, maintaining good night's rest, as well as following a healthy diet, are all of great importance in managing thyroid diseases. Observing a few simple rules can minimize the frequency of flare-ups and the occurrence of the life-threatening thyroid storm. Traveling is an inseparable element of life for many people. Therefore, ensuring that patients are well informed about how to travel safely may prevent unwanted health events during travel.

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Key words: travelers, thyroid disorders, epidemiology

INTRODUCTION

Thyroid gland is a vital organ situated anteriorly in the lower neck and laterally to the thyroid cartilage. It consists of two lateral lobes connected by isthmus. Thyroid is one of the biggest endocrine glands and it is a richly vascular organ [1]. In up to 44.6% of the general population a third thyroid lobe exists, also known as the pyramidal lobe, which is a persistent embryonic remnant of the thyroglossal duct [2–4]. Along its path functional accessory thyroid glands may also be found [2]. Thyroid gland is built up of lobules, which are divided into thyroid follicles, the structural and functional units of the thyroid gland. Each follicle is filled with fluid containing thyroglobulin, which is the matrix for the synthesis of thyroid hormones occurring by tyrosine iodination. As a result, triiodothyronine (T3) and tetraiodothyronine (T4) are produced. Thyroid is the only endocrine gland which is capable of storing enough of its hormones to cover a 10-month demand of the body [5]. Hence any disruptive factors or pharmacologic actions require time to result in the change of the thyroid gland function. Furthermore, it enables adaptation to iodine nutritional undersupply [6, 7]. T4:T3 secreting ratio is approximately 14:1 on average. Tetraiodothyronine is often considered as a 'prohormone', as 80% of T4 is converted peripherally into the T3 and reverse T3 (rT3). T3 is the active form of thyroid hormones with 20–30 times higher affinity to

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TRs than that of T4, having main effect on target cells [8]. Thyroid hormones exert their biological effect by binding to nuclear receptors. Their actions are necessary for normal metabolism of all the cells in the body, considering their permissive effect upon growth hormone and their cooperation with glucocorticoids and especially, catecholamines, by raising the sensitivity of the beta-adrenergic receptor, effecting heart rate and its contraction. They have a particularly strong effect on the central nervous system and the basal metabolic rate, by regulating carbohydrate metabolism. Moreover, thyroid hormones have a great impact on a person's mood and behavior, which is why thyroid gland disorders manifest in such a distinguishing manner [9, 10].

EPIDEMIOLOGY

Thyroid disorders are the most prevalent endocrine problems; many of them have an autoimmune basis; the statistics clearly show that the incidence of such disorders is remarkably higher in female patients [11]. Thyroid abnormalities may be classified into the following categories: thyroid disorders — hyperthyroidism, hypothyroidism and diseases of the gland — thyroid nodules, goiter and cancer. **Hyperthyroidism** is the most common form of thyrotoxicosis, affecting 0.5–2% of women. Its common cause is the **Graves' disease** or toxinodular goiter. Graves' disease is of autoimmune origin. Symptoms result from increased metabolic rate and enhanced sympathetic activity, mainly manifesting as tachycardia, arrhythmia, increased perspiration and weight loss. The characteristic signs and symptoms of the Graves' disease also include ophthalmopathy and pretibial myxedema. Subclinical hyperthyroidism is also quite common in the general population, with the prevalence of 3% in people over 65 years [12]. **Hypothyroidism** is a condition of insufficient production of the thyroid hormones, which may be a result of thyroidectomy or autoimmune destruction of the gland. The annual incidence of spontaneous hypothyroidism was estimated at 3.5 cases per 1000 women and 0.6 cases per 1000 men. In low iodine areas the incidence rises to 1–2%. Subclinical form of the disease was found to affect about 8% of women and 3% of men in the general population. Clinically, hypothyroidism manifests with myxedema coma with low blood pressure, fatigue, exercise intolerance, apathy, poor concentration; the symptoms may mimic depression [13]. **Hashimoto's thyroiditis** is another autoimmune disorder which is caused by gradual destruction of the gland. The incidence is considered to be 3.5 cases per 1000 women and 0.8 cases per 1000 men annually [13]. Transient thyrotoxicosis may occur during the initial stage of the disease (hashitoxicosis). The main signs and symptoms of Hashimoto's disease include painless enlargement of the gland, problems getting pregnant or any other symptoms specific for hypothyroidism [14]. **Thyroid nodules** are found in 6.4% of women and 1.5% of men over 60 years [12]. The most clinically relevant are the autonomous ones, which may be a part of multinodular toxic goiter. Initially they may be inactive because of insufficient iodine supply; however, their presence may be unmasked after uptake of iodine under various circumstances. Given the fact that elderly persons are generally more likely to have nodular goiter, they are at a much higher risk of developing thyrotoxicosis induced by iodization. Although **thyroid cancer** accounts for > 90% of all endocrine cancers, it is a rare malignancy. It accounts for < 1% of all malignancies in the United Kingdom [12]. The annual incidence in this country is 3.5 cases per 100,000 women and 1.3 cases per 100,000 men. Thyroid cancer manifests as a painless solitary thyroid nodule or goiter [7]. It seldom causes disruption in thyroid function, but it frequently results in compression or even displacement of the adjacent neck structures [7].

RISK FACTORS RELATING TO THYROID DISORDERS

Different thyroid disorders are relatively frequent in travelers, especially in certain age groups. Functionally they may be normo-, hypo- or hyperthyroid causing a large variety of pathological conditions resulting from multiple trigger factors. Thus, the risk for such travelers may vary from relatively low to critical. The role of healthcare professionals is not only to provide treatment to their patients but also to ensure their patients' wellbeing. For many people travel is an important element of their life. To fulfil this responsibility patients with thyroid conditions have to be informed about the necessary precautions they will need to take in order to minimize the risk of potential health problems. Careful planning helps anticipate potential risk factors which may occur during travel.

Climatic conditions. Temperature, climate and altitude were found to have a significant impact on the thyroid gland function: thyroid-stimulating hormone (TSH) and FT3 values increase in the winter but drop during the hot seasons. Patients with hyperthyroidism are recommended to avoid destinations with hot and humid weather; instead, because of their heat intolerance, they are advised to travel during colder seasons. Humid weather may be unbearable for hyperthyroid patients, as they already experience increased perspiration. In contrast, hypothyroid patients are advised not to travel to extremely cold destinations, as an underactive thyroid gland is incapable of maintaining proper thermoregulation. Travel to tropical countries is only possible when thyroid function is well controlled and a patient's condition is stabilized. Moreover, adequate precautions should be taken when going to places characterized by extremely dry climate, as it may aggravate mucosal dryness and lead to nasal bleeding. Another important risk factor with respect

to climate is staying at the altitudes of over 5,400 m above sea level, where hypoxia occurs and thus the levels of thyroid hormones along with TSH are likely to increase. Hypoxic conditions may be challenging for thyroid patients, and therefore additional oxygen may be recommended. If thyroid patients undertake such an expedition, they should undergo gradual acclimatization to high-altitude conditions [15].

Low iodine-areas. The Earth's environment is rich in iodine, although its resources are not evenly distributed; the highest iodine concentration is in coastal regions, whereas soils of inlands, mountainous areas, grounds that are recurrently flooded or even some of the coasts are low in iodine. The areas which are low in iodine include: the mountainous parts of Europe (Germany, Austria, Switzerland), the Songkhala valley and the mountain regions in China, the northern parts of India and the Ganges Valley, the Irrawaddy Valley in Burma, the Andes in South America and some parts of Africa to a lesser extent [16]. Despite intensive efforts to restore iodine in affected countries by universal salt iodization, which is by now the most cost-effective strategy, some areas are still at high risk of iodine deficiency [17]. The daily dose of iodine recommended by the World Health Organization (WHO) is 150 µg. If a traveler is staying in a low-iodine area for a longer period, they should regularly undergo thyroid function tests in order to check whether the iodine supply is sufficient or if iodine supplementation should be commenced. Unfortunately, due to lack of data it is difficult to estimate how long a traveler can stay in low-iodine place, without developing symptoms of deficiency, because it is highly individual and depends on many factors. For blood testing purpose patients may send a serum sample in brown monovette tube to the institution making the examination in their country. Blood work arrangements should be made prior to a journey to make sure patients have got all the equipment needed for collecting and sending blood sample [11].

TRAVEL

Before travel, it is essential for patients to check their health insurance to ensure it provides enough coverage in the country of destination. Bearing in mind that unexpected situations may occur, such as delays, damage to the baggage or losing the medications, it will be reasonable to take excess amount of medication. It is not recommended to buy medications at the destination as there may be differences in the quality of the drugs. In case of a stay longer than a few months, a doctor may give a patient a prescription for an extra supply of medicines they take on a regular basis. For easier access, taking a photo of the prescription medications and saving it on an electrical device is always an option. If travel is associated with crossing multiple time zones it is recommended to talk to a physician about adjusting the medication schedule. With regard to transport, especially air transport, thyroid patients are recommended to rebook their flight if they have an ear, nose or sinus infection. Flying with the abovementioned conditions can cause severe pain, bleeding and increases the risk of an eardrum rupture even if decongestants are used. Many airlines do not charge passengers for rescheduling or cancelling their booking on condition that they provide a certificate from their doctor explaining the need for rescheduling the flight. Travel first-aid kit should also contain medications for sunburn or insect bites. To avoid sunburns, sunscreen should be used whenever going outdoors. Photosensitivity can be caused by radiotherapy, chemotherapy or certain medications, including the most common tetracycline, doxycycline, voriconazole, amiodarone, hydrochlorothiazide, naproxen, piroxicam, chlorpromazine and thioridazine.

Travel by plane. Planes are a popular means of transport; however, high altitude exposure carries a degree of risk for thyroid patients. A pre-travel consultation with a physician is strongly advised especially to patients after a surgery, including eye and dental procedures, those with pulmonary and cardiac diseases, or cancer patients as these patients are at a higher risk of complications. The conditions inside an aircraft cabin are unfavorable to human health. Aircrafts are flying at the altitudes of up to 12,000 m above sea level (39,000 ft). A cabin is pressurized to an equivalent of the atmospheric pressure at an altitude of 1,500–2,400 m above sea level (5,000–8,000 ft) to maintain partial pressure of oxygen. Nevertheless, Humphreys et al. [18] found that both short and long-haul flights decrease oxygen saturation (SpO_2) from 97% at the ground level to 93% at cruising altitude in both healthy patients and those with comorbidities. Values of SpO_2 below 94% are an indication for applying supplementary oxygen [18]. It needs to be stressed that patients suffering from chronic hypoxia may experience an even greater reduction in SpO_2 when exposed to high altitudes. It is a meaningful discovery when it comes to thyroid patients; those with hyperthyroidism, for instance, have increased demand for oxygen. Moreover, hypoxemia activates the sympathetic nervous system, which causes increased heart rate and may increase the risk of angina and dysrhythmias. These effects are especially unwanted for patients with hyperthyroidism, as they already experience similar symptoms [18]. Anemia is another indication for the administration of additional oxygen. Long-haul flights are associated with immobility and dehydration. These factors reduce blood flow in lower extremities, which may lead to local hypoxia resulting in vasodilation and increased capillary permeability. This is how limb edema starts to develop [18]. To minimize the risk of its occurrence, passengers are advised to wear loose-fitting clothes and footwear which can be easily taken off. Another tip is to leave a seat and

walk around every hour or two and stretch the legs, neck and shoulders every 30 min. Passengers must remember to stand up slowly to avoid vertigo. Walking and stretching the muscles will help to relieve muscle and joint pain, which often affects thyroid patients. It may also prevent the formation of blood clots, as the blood that pooled in the extremities while a person was immobilized is forced to circulate [11]. Deep vein thrombosis (DVT) is a well-known complication of long-haul flights; hence passengers are advised to wear antiembolic stockings. Sometimes taking aspirin or low molecular weight heparin is recommended. Individuals susceptible to edema should avoid wearing rings or wristwatches during a flight. According to the available data, humidity in an aircraft cabin is below 20%, while at the ground level it is significantly above 30%. Low humidity conditions cause dehydration, so drinking fluids (250 mL every hour) throughout the flight is recommended, preferably bottled water as a safety precaution against infectious diseases. Alcohol consumption should be reduced 24 hours before a flight. Other dehydrating factors including coffee, soda and salty snacks should be avoided. Staying hydrated is essential to maintain proper peristalsis. Constipation is common in people with hypothyroidism, and steatorrhea is prevalent among hyperthyroid patients. Low humidity aggravates dry skin, dryness of nasal mucosa and eyes; the conditions can be easily managed by the use of moisturizers, saline nasal spray, eye drops and by choosing to wear glasses instead of contact lenses [11]. Staying on board with other passengers during long-haul flights carries a high risk of contracting an infectious disease. To reduce the risk of becoming ill it is important to order bottled or canned beverages only and to avoid drinking airline-provided coffee and tea, as the United States Environmental Protection Agency proved that airline water could be contaminated by bacteria [19]. Multiple in-flight food-borne outbreaks have been reported over the years, among which the most common were those caused by Salmonella, Staphylococcus, viral-induced enteritis and Norwalk-like agent, what was associated with mortality [20]. Thyroid patients already experience abnormal peristalsis, hence additional disruption in the intestines function may lead to serious complications, e.g., dehydration. Hashimoto's thyroiditis and Graves' disease can both be caused by infectious agents and make patients more susceptible to infections. Thyroid patients, in particular those with symptoms of hypothyroidism, suffer from cold intolerance, which may be inconvenient during travel. Patients need to stay cautious and not use blankets provided by the airline, because even if they are sealed they are infrequently disinfected. For those who are more sensitive to cold temperatures, dressing in layers is a good idea [11]. It is also recommended to wear a protective antimicrobial face mask in case there are sick passengers on board. Using disinfectant wipes to clean seatbelts, armrests and especially tray tables, which are considered to be a prime source of bacteria on a plane is always an option. Although, they are not legally required, most aircrafts are equipped with high efficiency particulate air filters (HEPA). They effectively filter air from dust, vapors, bacteria, fungi and viruses. Unfortunately, it seems not to be enough as there are at least several studies that reported of the spread of airborne infections such as tuberculosis, SARS, influenza and meningococcal disease aboard a plane. Novel pathogens can potentially cause outbreaks, as was the case in 2002 when acute respiratory syndrome was rapidly spread during air travel. The risk of developing an infection is not only limited to the aircraft cabin itself but it also exists at the airports, i.e., before and after a flight. The best example of an airport disease is the so-called airport malaria that occurs in and around airports all over the world. There is evidence that mosquitoes which are able to transmit malaria can be imported to non-endemic regions aboard planes. Out of 87 reported cases of airport malaria, 75 occurred in Europe. Dengue and yellow fever were also reported in European countries [20]. Hence, thyroid patients are advised to maintain good hand hygiene and wear a face mask while traveling by plane, as becoming ill during a journey may aggravate their underlying condition. Furthermore, many medications, such as antimalarial drugs have been reported to interfere with thyroid medications, thus potentially placing thyroid patients in a life-threatening situation while abroad [21]. Stress and fatigue are the main contributors to becoming ill, so travelers should remember that a good night rest and staying hydrated are crucial for sustaining immunity.

Patients with chronic diseases must not forget to take their medications when going on a journey; they should be kept in carry-on baggage. Furthermore, medicines should be kept in original packaging in case of a security check. Liquid medications are not always required to be put in a zip-top bag, but travelers are accountable for informing security about it so the medication can be screened separately [11].

Travel by boat. Before a boat or a ship journey it is a good idea to ask a physician for anticholinergic prescription drugs, e.g., scopolamine patches, to treat sea sickness. Hyperthyroidism itself can cause nausea and vomiting. **Scopolamine**, also known as hyoscine, works for up to 3 days, but should be administered 6 to 8 hours before travel. Another medication used to prevent motion sickness is **dimenhydrinate**, with administration time 0.5 to 1 hour before the start of the journey. Its combination with **cinnarizine** was reported to have a response rate of 78%, although their effect lasts for 4–8 hours and their use should be limited to acute cases only. Alternatively, **Sea-Band** wristbands may be applied as a preventive measure. They work by stimulating the P6 acupressure point located on the anterior surface of the forearm

and are believed to affect serotonin transmission. Although Sea-Bands' effectiveness is debatable, taking into consideration that they are a non-invasive and inexpensive form of preventing sea sickness it is worth giving them a chance, as they have proved to be effective in alleviating nausea and vomiting in pregnancy and after chemotherapy [22]. Natural supplements containing **gingers** are often used by patients as an unconventional antiemetic. High doses of vitamin C are also reported to be effective. Non-pharmacological interventions include **transcutaneous electrical nerve stimulation** and stress managing techniques, e.g., relaxing music or odors. Another point worth mentioning is the fact that travelers should avoid **food** and drinks, whose process of production is based on fermentation or require the use of microorganisms, such as tuna, cheese, salami, sauerkraut and red wine. These products are rich in histamine and eliminating them during the sea travel is a known preventive measure [23]. The antiemetic medications that are contradicted in treating motion sickness include metoclopramide, because it is known to cause extrapyramidal symptoms and QT prolongation, ondansetron and aprepitant, which cause headache and constipation.

Radioactive iodine. Both air travel and sea travel require security check. Patients who have recently undergone radioactive treatment may activate radiation detector. It is difficult to decide how long such an inconvenience may last, as it will depend on the rate of renal clearance of radioiodine [24]. It is speculated that patients may trigger airport radiation detectors for up to 95 days after the therapy. Therefore, patients are recommended to carry a certificate confirming they have had radioactive iodine treatment, in case they activate radiation detector and need to explain the situation to the airport staff [11].

STRESS AND SLEEP

Traveling is associated with a number of stressors. Therefore, travel should be planned in details in order to avoid stressful situations. Travelers are advised to arrive at airports in good time, book their hotel rooms well in advance and carefully plan their itinerary. It is crucial to bear in mind that stress may be both emotional or physical tension. Long journeys, lack of sleep, strenuous exercise and permanent tension also put strain on the body.

While it is challenging to maintain regular sleep hours on a journey, the best advice for thyroid patients is to prepare a realistic plan of the journey and make sure there is enough time for rest and meals. Sleep deprivation affects the immune system and increases the risk of autoimmune diseases [25]. The endocrine system is extremely vulnerable to circadian rhythm disruptions. The thyroid gland is driven by TSH changes, affected by sleep alterations. It was reported that acute, extreme sleep deprivation elevates TSH secretion, while long-term but moderate lack of sleep decrease its release. There are studies which indicate that less than 7 hours of sleep or more than 9–10 hours of sleep are associated with a higher risk of subclinical thyroid dysfunctions. Hence, 7–8 hours are considered as normal sleep duration, which is associated with the lowest risk of TSH secretion alterations [26]. Maintaining the above mentioned sleep schedule may be challenging given the fact of changing time zones. For some patients it may be beneficial to try melatonin. It facilitates the adjustment of the internal body clock to the local time zone. The general advice is to take it about 30–60 minutes before going to bed [27]. When traveling east it is also advised to take it for 2 consecutive days prior to travel when the time at the destination is 11 p.m., because it takes longer to reset the circadian rhythm when traveling eastward. To reduce the risk of jet lag, travelers are recommended to stay awake during the flight when traveling east, and to try to have a rest while flying west. Stress increases secretion of glucocorticoids as well as catecholamines, resulting in tachycardia, tachypnea and elevated blood pressure. Hyperthyroidism often manifests with similar symptoms, which are normally treated with beta-blockers. Every stressful situation may aggravate a patient's condition by exacerbating the symptoms. Any kind of stress is associated with the risk of flare-ups of autoimmune disease and with thyroid disorders there is no difference. Despite crediting stress a suppressive function, its main influence on homeostasis is by shifting T helper cells from Th1 toward a Th2, thus suppressing cellular immunity and enhancing humoral immunity. Bearing in mind that Graves' disease is characterized by lymphocytic infiltration of CD4+ Th2 cells, there is strong evidence that stress influences clinical expression of Graves' disease, increasing relapse rate, thus elevating anti-TSH antibodies. Moreover, during stress corticotrophin-releasing hormone is secreted in peripheral tissues, which results in the release of histamine — a well-known trigger of acute inflammation. These destructive features of stress are reversible after stress withdrawal or palliated by glutathione intake, because of its ability to bring back antioxidant storage. It is widely used by patients with autoimmune thyroid disease, such as Graves' disease or Hashimoto's thyroiditis [28].

DIET

Autoimmune diseases, especially Hashimoto's thyroiditis, require self-care, as even minor triggers may be debilitating and result in flare-ups. Factors like menstruation, hormonal imbalance, viral or bacterial infections, excessive physical strain and nutritional deficiencies have considerable impact on the already impaired immune system. Avoiding the abovementioned risk factors and taking care of a physical and mental health are a priority.

First of all, travelers should carefully plan when and where they are going to have their meals. Before going on a vacation they could search online for restaurants that offer healthy food. If possible, they might take their own kitchen equipment and food products to prepare their own meals. It's worth checking if there is a refrigerator at the accommodation — this will enable patients to keep the food fresh. When traveler is spending the whole day outdoors, and have no possibility of ordering a meal, it is a good idea to take along some packed snacks like crackers, energy bars or previously prepared meals, including, for example olives, sardines, celery or beef jerky [11].

The general recommendation for Hashimoto's disease patients is to eat 4–5 well balanced meals a day. Daily protein consumption should be up to 15–20% or even 25% of daily calorie intake. Sugar-free diet should be followed, particularly by patients with coexisting insulin resistance or diabetes. Increased blood glucose leads to an inflammatory response, which disrupts many bodily processes. Whole grains should be the main source of carbohydrates, as these are rich in dietary fiber, which is essential in maintaining balance in intestinal microbiota and bowel movements (the disorder of which is a common issue in hypothyroid patients). The minimum intake of fiber should be 25 g per day. To nourish the immune system, patients are recommended to eat sufficient amounts of fruit and vegetables and reduce the intake of processed food like sweets and chilled beverages. The use of pre-, pro- or synbiotics is also beneficial in thyroid patients. Intake of saturated fatty acids should be reduced, in favor of food containing omega-3 acids, in the amount of 1–2 g/day. Olive oil, avocado oil and walnut oil are excellent sources of fats [29]. Diet of patients with autoimmune thyroid disease, should be rich in iodine, iron, zinc, copper, magnesium, potassium, vitamins, A, C, D and B group, as these elements were found to be in deficiency among these patients. Iron is profusely found in meat, animal offal and cocoa and plays an important role in the production of thyroid hormones. Magnesium and zinc, both found in pumpkin seeds, nuts and cocoa are responsible for decreasing antibody titers. Additionally, magnesium has anti-inflammatory properties, by reducing C-reactive protein. Vitamin D3, often overlooked, is responsible for maintaining the physiological functions of the immune system by activating or suppressing about 200–500 genes. This is why a number of studies presented clinical improvement in patients with autoimmune disease, when supplementation was introduced [29]. According to Mansournia et al. [30], an increase in vitamin D3 intake by 5 ng/mL reduces the risk of developing Hashimoto's disease by 19%. Selenium is another essential mineral; it is a potent antioxidant and plays a protective role on the thyroid gland, when iodine is given in excess. Moreover, it suppresses secretion of inflammatory cytokines by T lymphocytes. A diverse diet is required for maintaining proper amount of vitamins, micro- and macroelements; hence supplementation in the form of capsules is needed only when nutritional changes do not bring a positive effect, as in the case of selenium deficiency, where studies showed that eating habits had no significant impact on selenium level in the blood [29]. The need of supplementation should be assessed based on symptoms of a particular element deficit, e.g., hair loss in zinc deficiency or upon blood test results, e.g., vitamin D3 and selenium, as excess of microelements are also harmful.

As many as 75.9% of patients with Hashimoto's thyroiditis suffer from lactose intolerance; hence products containing lactose should be eliminated from their diet, after positive diagnostic tests. It's essential information as not observing the restrictions, while having lactose intolerance, causes a decrease in the bioavailability of levothyroxine, and thus patients will require higher doses of the medication [29, 31, 32]. Similarly, gluten-free diet should be observed, when there is coexistence of celiac disease or non-celiac gluten intolerance, which are significantly more prevalent in Hashimoto's disease. The reason for treating co-existing celiac disease is because of cross-reactions between gliadin and thyroid antigens and the possibility of immune system attacking the body's tissues. Screening for celiac disease should be considered among patients, who have difficulty achieving sufficient nutrition and regulating the concentration of thyroid hormones [29]. According to 1 study, patients without the clinical symptoms of celiac disease, but with the presence of anti-tissue transglutaminase antibodies, achieved better results after they had gone on an elimination diet, than control group. A significant reduction in the level of antibodies against thyroid peroxidase and thyroglobulin was reported [33]. Avoiding food containing gluten before initiating diagnostic process may result in false test results [29]. Diet should be introduced only after positive diagnostic tests, according to the Expert Committee of the Section of Medical Dietetics of the Polish Society for Parental, Enteral Nutrition and Metabolism (POLSPEN) [34]. There is a lack of studies proving benefits of introducing gluten-free diet in patients without co-occurring celiac disease or another form of gluten intolerance. Furthermore, if patients put themselves on elimination diet without medical indications, they increase the risk of harmful health consequences, such as an increased cardiovascular risk or nutritional deficiencies. Whole grains and unprocessed cereals contain more fiber and vitamins. That is why after introducing gluten-free diet, patient should stay under a care of a dietician to avoid iron, folate, vitamin B12, D3, magnesium and selenium deficiency, all significant in maintaining the proper functions of the immune system and the thyroid [29].

Hyperthyroid patients should also bear in mind, that diet supports their health and can alleviate many symptoms. Because of increased metabolic rate it is recommended that calorie intake should be upped by 15–25% or even by up to 50–80%, depending on how severely thyroid gland is overactive. Protein supply should be maintained at about 110–130 g per day. Products containing fats and processed food should be avoided, as well as caffeine, which causes insomnia and restlessness, exacerbating symptoms patient with hyperthyroidism already face. In case of gastrointestinal issues, e.g., diarrhea, easily digestible diet should be introduced [35].

ALLERGIES

Allergic rhinitis has been found to be more prevalent among patients with Hashimoto's thyroiditis and Graves' disease. Hence, avoidance of allergens is critical so as not to stimulate the immune system. Environmental antigens not only induce local allergic reactions, but also aggravate autoimmune conditions [36–38]. Dust, feather pillows, synthetic scents are among the common triggers. Allergy sufferers may be advised to track pollen counts and stay indoors as much as possible during times when pollen counts reach high levels. Cetirizine, fexofenadine, levocetirizine, loratadine which are widely available in supermarkets are highly effective for allergic rhinitis. Travelers with allergies are recommended to book hotels which offer allergy-friendly rooms with air purifiers, fragrance-free cosmetics and windows that can be opened to ventilate the room. Choosing hypoallergenic products is recommended. Many allergies are manifested by skin redness and in some cases hives. The food which a patient is sensitive to should also be eliminated from his/her diet [11].

DRUG INTERACTIONS

Levothyroxine should be taken orally on an empty stomach as food and many other medications, e.g., calcium, iron and aluminum-containing supplements, bisphosphonates inhibiting bone resorption, sulfonylurea derivatives used in the treatment of diabetes and proton pump inhibitors (antacids), sucralfate to treat stomach conditions and also drugs lowering the level of cholesterol; e.g., resin binders affect the absorption of thyroid hormones. Cholesterol lowering statins, dopamine agonists, estrogens, androgens and tamoxifen, all influence thyroid function tests. Ipodate, iopanoic acid and tyropanoate and contrast media inhibit conversion of T4 to T3, causing transient rise in TSH level. Antiepileptic drugs like carbamazepine or phenytoin enhance levothyroxine clearance, similarly to sertraline. Lithium carbonate, a normotymic drug, causes subclinical hypothyroidism as the compound concentrates in the gland and disrupts hormone synthesis at the same time increasing the risk of the rise in the levels of antibodies, particularly in female patients.

Amiodarone, a drug used to manage atrial fibrillation and congestive heart failure, is known for its great impact on thyroid function. Up to 24% of patients taking this medication suffer from amiodarone-induced thyroid disorder. Hypothyroidism is more common than hyperthyroidism and is recognized with difficulty, as bradycardia and constipation are both listed among the possible side effect of amiodarone. Overactive thyroid gland may present as Graves' disease-like hyperthyroidism with the presence of antibodies or subacute thyroiditis with no antithyroid antibodies detected. Treatment is undeniably needed, even after amiodarone discontinuation, because of drug's accumulation in adipose tissue.

Glucocorticoids are widely used in numerous dermatological, ophthalmological and allergic conditions as well as suppressive therapy. Their impact is mainly by decreasing TSH level, and in large doses reducing T3 level, to prevent thyroid storm in hyperthyroidism.

Furosemide, first-line therapy in lowering acute surge in blood pressure, salicylates and non-steroidal anti-inflammatory drugs (NSAIDs), such as diclofenac or naproxen, transiently increase free T4. During prolonged use of NSAIDs hormones return to normal.

Beta-blockers, including propranolol, atenolol, metoprolol, used to maintain normal heart rate, suppresses peripheral conversion of T4 to T3.

Rifampicin is an antibiotic used to prevent infections caused by meningococci and Haemophilus influenzae type b. It is used for treating tuberculosis and leprosy. It enhances T4 metabolism by inducing hepatic enzymes. Hence, maintenance of euthyroidism will require higher doses of thyroxine.

Interferon alpha, used as a long-term treatment for hepatitis C, has also been proved to cause hypothyroidism, as well as hyperthyroidism. The onset may be as early as 6–8 weeks of the therapy course, albeit these conditions are transient and treatment is only symptomatic [39].

Antimalarial chloroquine and proguanil were reported to stimulate TSH level in hypothyroid female patient receiving thyroxine sodium. The effect on thyroid gland was observed after 4 weeks of starting medication. It is contentious whether any of these drugs directly affect hypothalamus. It is much more likely that antimalarial drugs enhance thyroxine clearance by activating liver enzymes [21].

Metoclopramide should not be used by thyroid patients to suppress nausea and vomiting as it slightly elevates TSH level in function tests. Also, it is not advised to be taken to prevent motion sickness.

Iodides, prevalent in numerous medications such as povidone iodine, iodinated glycerol, tablets containing seaweed, herbal preparations and dietary supplements, expose patients to an iodine load which can lead to thyroid dysfunction. Jod-Basedow disease is iodide-induced hyperthyroidism, which occurs exclusively in patients with endemic

goiter, Graves' disease, toxic multinodular goiter and thyroid adenomas. It usually develops within 3–8 weeks of increased exposure and cannot be suppressed by radioactive iodine, because iodine loading prevents the Wolff-Chaikoff block. Beta-blockers and thioamides are often required to be taken for several months. Iodide-induced hypothyroidism also occurs when the gland is not able to overcome the Wolff-Chaikoff block. Thyroxine therapy should then be commenced [39]. It is crucial for patients to be aware of the iodine contents in the products they use. At present, cough or expectorant preparations do not contain iodine. Among newer medications only Waterbury's Compound was found to contain sodium iodide [40]. Thyroid patients are strongly recommended to check the iodine contents in all the medications they are using as thyroid malfunction was even reported after the use of povidone iodine locally for vaginal irritation [39].

IODIZATION OF WATER

The matter of water quality is extremely important for those traveling to parts of the world where the available water supplies are non-potable. Iodine is a widely accessible, effective and low-cost method of water disinfection. Albeit, its use entails the risk of thyroid function disruption, because of excess iodine load. There are several types of iodine solutions e.g. tincture, povidone, Lugol's and saturated aqueous solutions with iodine crystals. Tablets and iodine resins are also a popular option among travelers. The latter may be considered as the most convenient form, as the residual iodine concentration is significantly lower, the solution is much more stable and the equipment provides two additional methods of eliminating microorganisms — microfiltration of Cryptosporidium oocysts and granular activated charcoal, with the aim of filtering the residual iodine in water. Iodine-induced hypothyroidism is much more common and may develop in patients with or without underlying thyroid disease. Iodine-induced hyperthyroidism also occurs, particularly in thyroid patients or persons with previous iodine deficiency. These patients exhibit a higher rate of multi nodular goiter with autonomous nodules, which in case of an increased iodine load are no longer suppressed by iodine deficiency. Because a safe daily dose of iodine has not been unambiguously determined, WHO only recommends short-term and emergency use of iodine or chlorine-based products in water treatment. Furthermore, thyroid function tests should be conducted before and during water treatment [41].

VACCINATIONS

The crucial part of travel planning is to consider if there is an indication for pre-travel vaccination. The need of immunization is based upon country of destination, a patient's health history and behaviors related to travel, e.g., type of accommodation, food and spending time outdoors. It is recommended that travelers get fully vaccinated in their homeland before travel, as patients may encounter difficulties in completing their course abroad because of uncertain vaccine quality as well the risk of as using unsafe (infected) needles. Details about an exact trip itinerary and dosing should always be discussed individually with a physician. In this review, only the most prevalent vaccines will be discussed.

Vaccine against tetanus-diphtheria-acellular pertussis should be administered in every adult patient who did not receive a booster. Traveling to the remote countries is a strong indication for getting boosters at 10-year intervals.

Vaccine against varicella is recommended for adult patients without the evidence of immunity against this disease (2 doses at least 6 weeks apart).

As respiratory diseases are easy to catch during travel, all healthy travelers above 65 years should be immunized with a **pneumococcal** vaccine (1 dose; 13 serotypes of *Streptococcus pneumoniae*).

Adults should receive a lifetime total of at least 2 doses of vaccine against **measles-mumps-rubella** or be able to present a written confirmation that they have recorded from diseases and acquired natural immunity.

Vaccination against **hepatitis B** is indicated for all non-vaccinated patients. It is particularly important for adventure travelers (3 doses: 0, 1, 6 month).

Vaccine against **influenza** is especially important when staying on cruise ships or going to mass-gathering events. It is strongly advised for those visiting the tropics, regardless a time of the year and temperate countries where is currently winter. Due to high mutation rate of the influenza viruses, travelers are required to take the latest available vaccine. Its efficacy lasts for about 6–12 months. After that time revaccination should be considered. It is worth to stress that even if the immunization will not prevent a patient from falling ill, it will certainly protect against influenza complications.

Quadrivalent **meningococcal** vaccine is recommended for those going to the "meningitis belt" in Sub-Saharan Africa, during the dry season, lasting from December to June. One dose of the quadrivalent vaccine A,C,W-135,Y provides lifetime immunity. Meningococcal B vaccine is indicated for travelers with comorbid conditions, e.g., asplenia or complement deficiency.

Adults who received complete primary vaccine series against **poliomyelitis** in childhood and are traveling to risk countries (polio-endemic or reported cases of vaccine-derived polio) should be administered with one-time single dose of inactivated vaccine as a booster (every 10 years).

Vaccine against **hepatitis A** is indicated for every non-immune traveler going to countries other than United

States, Canada, Japan, Australia, New Zealand, and developed countries in Europe. Two doses given 6–12 months apart provides long-term protection. Patients with a history of hepatitis or those who have lived in an endemic country may be tested for antibodies. When the patient cannot be vaccinated they will benefit from intramuscular immunoglobulin dosing. Non-immune travelers who experienced hepatitis A exposure are given a single dose of vaccine or immunoglobulin, if available, for immunocompromised patients.

Vaccine against **typhoid fever** is indicated when going to the Indian subcontinent or to endemic areas in Africa. However, food and water precautions should still be taken, as vaccine is only 53–72% protective.

Indication for vaccine against **yellow fever** is limited to the individuals at risk, as serious vaccine-associated adverse effects were reported. The decision about vaccination should be based upon the risk of transmission in this area and country entry requirements. That is why up-to-date maps and national laws should be checked by traveler.

Vaccine against **rabies** is recommended when long-staying in endemic areas of Latin America, Asia or Africa. Receiving it does not eliminate the need for vaccination after an exposure but it simplifies the procedure. Immunocompromised patients should get advice from specialized travel clinic before a journey. Live vaccine administration should be delayed 1 month after immunosuppressive corticosteroids are withdrawn. For chemotherapy and radiation therapy the waiting period is 3 months. Pneumococcal as well as hepatitis B vaccine high-dose regimen is recommended for all immunocompromised travelers. Moreover, titers should be evaluated after vaccination to determine the antibody response [42].

ADVICE FOR PATIENTS WITH THYROID CANCER

Recently, traveling has become easier and more available to cancer patients, which is due to better quality of their life. Although travel is not impossible for such patients, there are precautions that should be taken before they decide to travel. Cancer patients are recommended to take a written summary of their medical history, as well as contact details of their attending physician. The documents are advised to be translated into the language of the country the patient is going to visit. Travel first-aid kit should contain enough amount of oral cancer medications, as well as other drugs alleviating the common cancer symptoms, such as antiemetics, antidiarrheals and analgesics. In terms of transporting the medication, a patient should check the current regulations regarding the transport of medications in the country of destination, to know exactly which medication and in what quantity can be brought into a given country. Some countries may have strict restrictions on the transport of opioid medications. Cancer patients should never forget about the sunscreen, as they often experience photosensitivity after systemic treatment. Vaccinations should be discussed with a physician well in advance; travel destination and current treatment plan of the patient should be taken into account when considering if there is a need for vaccination. Vaccines should be avoided in cases of considerable exogenous immunosuppression, because patients undergoing immunosupressive treatment are less responsive to vaccinations. That is the reason why it is recommended to start all vaccinations 2–3 months before a journey, it will ensure enough time to perform serologic evaluation, confirming protective level of antibodies. Particular emphasis should be put on preventing infections. Observing simple rules of hygiene may not be enough and patients are strongly advised to avoid traveling during peak time of neutropenia while receiving chemotherapy.

Generally, patients should be clinically stable to be allowed to go on a journey. Moreover, undergoing radiation or systemic treatment is a strong contradiction against commercial air travel. Oxygen deficiency may lead to complications. That is why cancer patients are referred to perform hypoxic challenge test to determine the need for oxygen supplementation during a flight. In general, airlines recommend hemoglobin level above 8.5 g/dL. There were also reports of acute mountain sickness and high-altitude cerebral edema after head and neck surgery or radiation therapy.

Patients with active cancer are at a higher risk for venous thromboembolism. Before a flight, prophylaxis may be considered. Low molecular weight heparin is the usual drug of choice in such cases. Compression stockings are also advised on flights lasting longer than 5 hours. Other tips for decreasing the risk of blood clotting is maintaining hydration and doing some light exercises during the flight. Guidelines for patients with the history of DVT or pulmonary embolism include medical clearance within 21 days of the medical event. Patients should remain stable while taking anticoagulants. A history of DVT is an absolute contraindication to flying for 4 weeks after the event. Air travel is allowed after DVT is treated and if pre-exercise or postexercise desaturation does not occur. Postoperative or postirradiation lymphedema may origin or be exacerbated by pressure changes inside a plane cabin. It is contentious how much air travel increases the risk of it; nevertheless, it is recommended to wear loose-fitting clothes, shoes that can be easily taken of and avoid wearing rings and watches. As cancer patients have diminished physical performance, lymphedema may additionally make carrying heavy luggage difficult. To minimize the physical strain, airports offer assistance. Arrangements should be made early enough before travel [43].

THYROID STORM

Thyrotoxic crisis, also known as thyroid storm, develops in the course of hyperthyroidism. One hypothesis states that it occurs due to excessive secretion of thyroid hormones. This, however, is debatable and as yet the condition is of uncertain etiology. The condition may be caused by a number of factors, including the discontinuation of antithyroid medication, a trauma, a diabetic ketoacidosis, recent use of iodinated contrast medium or a medication interfering with thyroid function like amiodarone or salicylates. Acute infections also account for thyroid storm. Clinically, the condition is expressed by fever, tachycardia, arrhythmia, nausea, vomiting, diarrhea and central nervous system symptoms including agitation, delirium, anxiety, psychosis or coma. It is crucial that the condition is diagnosed at an early stage, as the mortality despite treatment achieves a rate of up to 25%. Thyroid patients should be aware that the condition is life-threatening and its treatment requires professional care. Patients must be admitted to the intensive care unit where their heart function can be monitored. Along with supportive measures like IV fluids and oxygen, patients receive beta-blockers, thioamides, glucocorticoids, iodine solution and others. Patients should be informed how serious thyroid storm is and that in case of suspected thyroid storm visiting an emergency department should not be delayed [44].

CONCLUSIONS

Thyroid diseases are not a contraindication to travel. Thyroid patients can safely travel if they observe certain basic precautions. It is important to choose the destination and the season for traveling carefully, depending on the condition a patient suffers from. Climate has a significant impact on thyroid gland function. Hyperthyroid patients, for example, experience increased perspiration and have heat intolerance, whereas hypothyroid patients are extremely sensitive to cold temperatures. Humidity level and altitude should also be considered. Before travel, thyroid patients are advised to check if their health insurance provides medical coverage at their destination. Patients are recommended to consult with a physician which vaccinations they should receive before a journey. Travelers need to make sure they have an adequate supply of all the necessary medications in case their luggage is delayed, lost or damaged. The means of transport should also be chosen carefully, as travel, especially air travel, may aggravate certain underlying conditions. When traveling by plane, the administration of supplementary oxygen should be considered in patients suffering from chronic hypoxia. To prevent dehydration caused by low humidity on board a plane, travelers are advised to drink plenty of non-alcoholic beverages and use moisturizers. It is recommended to leave a seat and walk around every hour to restore the circulation of the blood and minimize the risk of blood clots formation. As staying on board with many other passengers carries a high risk of catching an infection, it is important to observe good hygiene practices and wear an antimicrobial face mask during the flight. Sea travel entails the risk of sea sickness, therefore, it is a good idea to ask a physician for anticholinergic prescription drugs prior to a journey. Thyroid patients must not forget to maintain a healthy lifestyle when they travel, this means avoiding stress, having a regular sleep schedule and following a balanced diet. A journey should be planned in details; it is important to arrive at an airport in good time, book a hotel room well in advance and choose the dining facilities carefully. Patients with thyroid cancer should also bear in mind adjusting their travel plan to their health condition and wellbeing. Thyroid patients can safely travel if only they follow some simple rules. Informing a patient about the standard precautionary measures and the steps which need to be taken in case of a medical emergency is a key to preventing life-threatening situations during travel and getting a thyroid patient enjoy their journey.

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COVID-19 vaccinations for seafarers on ocean-going vessels

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We would like to share ideas on the publication "Procedural aspects of COVID-19 vaccinations for seafarers on ocean-going vessels [1]." Schlaich et al. [1] mentioned that "As a port medical clinic, we will share our practical vaccination experience on board of merchant vessels in (...) published by the International Chamber of Shipping (www.ics-shipping.org) [1]." We recognise importance of vaccination for seafarers and a good procedure is very important. However, there are many practical issues for consideration. First, the flexibility of vaccine schedule is an important query. Seafarers might have to wander around and it might not possible to get a booster dose of vaccine on the appointed date and the same vaccine as the first dose might not be available in the new setting. Second, the pre-administration quality control of COVID-19 is important. How to deliver the vaccine to the site has to be specifically planned. In a large medical centre where there are plenty of facilities to promote cold chain delivery, the poor quality of the vaccine due to poor pre-administration keeping and delivery is still possible [2].

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Addressing sea safety in Cyprus

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Cyprus is an island that is surrounded by water from the Mediterranean Sea [1]. The definition of the word "island", which is a land smaller than a continent and surrounded by water, induces how important and beneficial the sea is to Cyprus for achieving their annual revenue and goals in the sectors of marine trading, tourism, swimming, and transportation. As a result, we would like to address the topic of "sea safety in Cyprus", not only to identify the gaps of it, but also enhance it with new preventative ideas.

Sea safety involves the enforcement of desirable conditions of human activity at sea, to eliminate any form of danger to human life, property, and the marine environment [2]. Accidents may occur in the seas of Cyprus. These accidents occur mainly by boat wrecks or drowning from swimming. A famous shipwreck accident in Cyprus is the Edro III Shipwreck, which started its journey at Sierra, Leone, then had a stop at Limassol's port with its final destination being Rhodes. The ship was carrying 9 sailors when a rough storm severely damaged it in the Chloraka area of Paphos, but luckily all these sailors were saved by a helicopter of the British military. This incident, since 2011, has been famous for tourists, because the shipwreck can be seen from the shore [3].

The most recent drowning occurred on the 18th of September 2021 at Latchi, where a man was found dead in the sea [4]. In certain areas of Cyprus, especially in Paphos, the seas are coded as red dangerous areas. This indicates possible water currents or big waves, but most people are not aware of these codes and what they mean in the sea of Cyprus. As a result, I would like to make some recommendations that could help increase safety in the seas of Cyprus. Safety is crucial; it is a basic principle for conducting any activity within or around the sea. Important factors such as effective technology for communication such as satellites must be prioritised [5]. The legislation needs to address matters relating to seafarers' health, decision-making, exchange of information, and safety culture.

Drowning occurs more often to people that do not have the necessary swimming skills; as a result, the government should contribute to developing the necessary skills of swimming for every person capable of learning. This will help to reduce the number of deaths caused by drowning. To supplement swimming, more efforts should be placed on search and rescue; this can include the recruitment of rescue staff and training of members of the public on the basic rescue techniques with a focus on drowning.

The Ministry of Health and Education should mandate all people taking courses on sea safety or even these courses could be offered free, to all citizens above 18 years old.

Concluding, our call to action to the government of Cyprus is to apply the above thoughts in their policy strategy to increase the sea safety of Cyprus.

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Occupational health of seamen: what can *Laborem Exercens* say to us 40 years later?

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Forty years ago, Pope John Paul II published a social encyclical about work, *Laborem Exercens* (On Human Work, 1981) [1]. While the "sea" is only mentioned twice, as a natural resource, and the term "seamen" does not appear, can the encyclical reveal something to us about maritime health or work health of seamen today without there being any question of Catholic spirituality [2]?

The encyclical was written in a particular historical context. The Polish Pope knew about the social movements in his home country. The magisterium of the Church was increasingly aware of globalisation. If we look at *Laborem Exercens*, John Paul II develops a new vision of work, honouring the dignity of work itself. He distinguishes between objective work, namely the technical part of the tasks, and subjective work. Work is then seen as a focal point for the development of the person as such. For seamen, we can take the example of Peplińska et al. [3] who have shown that seafarers with good marital relations have a lower level of stress. The perception of his role for the good of society, in this case his family, gives meaning to work. Subjective work according to John Paul II is a means of developing human capacities for oneself and for society.

But the encyclical also spoke of another dimension of work. Alongside the direct employer, namely the person with whom you sign a contract, there are one or more indirect employers: company, law, states etc. The problem of the indirect employer is particularly acute for the health of seafarers. The majority of these are employed in countries other than their own; they sail under foreign flags. The sailors, who connect the land by the seas, crystallise the divergent logics of labour rights, trade law, and human rights according to their country of birth, their flag country and their navigation countries.

The health of seafarers has always been a global issue. Their internationality is an integral part of their profession which calls them to go beyond borders. In the 21st century, maritime law and international law allow a dialogue and a step back on these questions [4]. John Paul II shed light on the human stake of respect for the dignity of each person, allowing them to work for the common good, in particular that of those close to them. The encyclical of John Paul II reminds us here of a major issue for the occupational health; that we can extrapolate for seamen. Far from their relatives, often in crews of multiple nationalities, some can feel alone, no longer perceiving the meaning of their work, as Sekhon and Srivastrava showed [5].

However, seamen transport 90% of world trade [6]. They thus cooperate for the common good and for the development of society and international cooperation. And one can imagine that with the fight against global warming, maritime trade is developing even more [7]. How then to promote, for the years to come, a work organization of seafarers that promotes the subjective meaning of work, attachment to others and awareness of their role in the development of common good?

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Potential effect of ocean pollution on human health, marine species, and health of the planet: adopting a planetary approach to a planetary problem

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Over the years, ocean pollution — which can be described as a complex combination of pollutants including plastics, toxic metals, oil spills and petroleum wastes, pharmaceutical wastes, agricultural run-off, urban and industrial wastes, and microbial wastes — has become an increasingly growing global threat due to its devastating impact on human health and marine species by causing the death of millions of people and thousands of marine species per annum across the world [1, 2]. This threat has been on the rise since the beginning of the Agricultural Revolution and Industrial Revolution that brought about increased release of agricultural run-off containing fertilizers, animal wastes (that contains antibiotics residue) as well as industrial wastes such as toxic metals and chlorinated petrochemicals into the ocean by anthropogenic activities, thus, posing a threat to marine species, the human health, and planetary health — as a result of collapsed of fishing ground and reduced livelihood of populations in the coastal areas. The rising detrimental effect of ocean pollution on the health of humans, marine species, and the health of the planet can best be addressed effectively from a planetary health perspective.

Human activities including overfishing and environmental disruptions are important factors causing changes in climatic conditions such as the drastic increase in global ocean temperatures, increased occurrence of extreme weather events such as heatwave that could result in melting of the glacier, and ocean acidification from increased absorption of CO_2 emission by the ocean [3]. Changes in climatic conditions could also drive pathogenic microorganisms, particularly bacteria into the water body causing a significant threat to human health due to the spread of infectious diseases such as cholera during contact with water contaminated by *Vibrio cholerae* [4]. Increased ocean pollution has been revealed to occur from land-based sources, evidently, an estimated 80% of ocean pollution originated from land-based sources while the remaining 20% has been linked with discharge and wastes from the offshore industry, marine shipping, and unregulated wastes (solid and liquid) disposed at the sea [5]. However, this global threat of ocean pollution can hinder the attainment of Sustainable Development Goals (SDGs) like SDG 14 which seek to reduce marine pollution from land-based sources and other sources towards protecting the lives below water (marine species), SDG 6 which aims to ensure clean water and sanitation by minimising the release of toxic chemicals in the water body, and SDG 3 which advocate for the improvement of human health and well-being by mitigating the threat occurring in their environment.

Pollution of the ocean by plastics is on the rise and about 4.8–12.7 million metric tons of plastic are dumped into the ocean per annum [2]. The accumulation of undigested macroplastic wastes including bottle caps and small bottles in the gastrointestinal tract of marine species such as fishes and seabirds result in increased mortality in these animals. Microplastics (< 5 mm in diameter) can cause damages to the tissues and cells of marine species while nanoplastics (< 1 μm in diameter) can penetrate the gut lining, bloodstream, and organs of marine species when ingested, leading to organs damage and death [6]. Human consumption of seafood contaminated with plastic residues could lead to various health threats such as the threat of non-communicable diseases like cancer; however, there are fewer studies on this aspect. Chemical additives such as plasticizers and other organic chemicals that could be absorbed by plastics can pose a considerable threat to marine species and human health — through the food chain [7].

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Another important source of ocean pollution is the unregulated disposal of pharmaceutical wastes such as antibiotics from sewage effluent, aquaculture, and animal husbandry. These wastes enormously find their way into the aquatic environment where they can undergo biotic and abiotic transformation into suspended particulate matter and sediment. In most cases, the suspended particulate matter is accumulated in the tissue of marine species which when consumed by humans can result in antibiotic-resistant infections [8]. In their study, Rose et al. [9] revealed the increased spread of antibiotic resistance in fishes, marine mammals, and seabirds in coastal water in North Eastern United States.

General shipping and industrial activities have led to increased pollution of the marine environment by petroleum wastes and oil spills containing toxic hydrocarbons that have a detrimental effect on human health and marine species. It has been reported that the toxicity of hydrocarbons increases when ingested by marine species due to the activation of the polycyclic aromatic hydrocarbons in their liver causing carcinogenic effects and a significant mortality level [10]. Consequently, inhalation of hydrocarbons by these marine species can result in respiratory tract irritation and narcosis due to the high volatility of the compounds, the hydrocarbon compounds, when inhaled, have also been reported to pose a long-term health effect to humans [11]. Runoff containing spilled mercury from the metal mining industry is one of the most common toxic metals with a high accumulation rate by marine species, the consumption of fishes and marine animals contaminated with mercury can lead to cardiovascular threats and brain damages in man [12].

Microbial pollution in the marine environment usually occurs when toxin-producing algal species dominate the ocean, thus, leading to the formation of algal blooms. These algal blooms tend to limit inorganic nutrients and dissolved oxygen available to marine animals and this could lead to their deaths. Through the consumption of seafood contaminated with an algal bloom, humans become exposed to the toxin produced by algal species causing diseases and death [13].

In conclusion, the increased ocean pollution being demonstrated to have a devastating effect on the human health, marine species, and the health of the planet as a result of interdependency that exists, can best be addressed from a holistic view like planetary health. It is important to note that there is a paucity of research on this aspect and we recommend more research to be conducted in the spectrum of planetary health, and through the multisectoral and interdisciplinary collaboration amongst researchers (ecologists, climate scientists, microbiologists, marine biologists, and public health scientists) evidenced-based result targeting at fostering law and policies that limit ocean pollution can be implemented towards protecting the health of humans, animals, and the planet.

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LETTER TO THE EDITOR

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Could seafarers serve as medium of transmission of resistant bacteria?

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Antibiotic resistance remains a major threat to public health amid quest for alternative solutions to treat and curb the effects of resistant bacteria. Bacteria develop the ability to resist antibiotics by genetic mutation. This can be triggered by misuse and overuse of antibiotics in some cases. The ability to resist antibiotics can also be acquired by transfer of resistant genes between bacteria as wells as between bacteria and bacteriophages. The resistant bacteria can in turn infect humans via transmission between humans or via zoonotic transmission. This article describes the possible role of seafarers in transmission of resistant bacteria to various locations.

The significant role seafarers play in ensuring safe and efficient transportation of cargos and vessel implies that they have to move from one location to another [1]. Seafaring labour is needed because of the demand for shipping services, which in turn is derived from the demand for the products being shipped [1]. Seafarers usually consume seafood, interact with sea water and occasionally come in contact with their colleagues that are aboard. More so, they interact with people in the aquaculture business space. From a survey, both seafarers and aboard personnel eat uncooked or raw food that is not sufficiently washed and are therefore prone to the risk of communicable diseases [2].

Researches have shown that significant amount of resistant bacteria is found in seas and oceans [3]. One of the contributing factors to this is the massive use of antibiotics in treating sea animals by those involved in aquaculture business [4, 5]. Moreover, this has become alarming because this triggers antibiotic resistance mutation in the pathogenic bacteria which can be evenly transmitted to water bodies. Consequently, the resistant bacteria in the water bodies can transfer the resistant genes acquired to other bacteria that can subsequently proceed to infect sea animals and seafarers.

Furthermore, seafarers as mediators of transmitting resistant bacteria can acquire them via the following ways: consuming raw or improperly cooked seafood housing resistant bacteria, direct contact with sea animals harbouring resistant bacteria, drinking water contaminated by resistant bacteria found in water bodies, contact with seafood handlers especially those in the aquaculture business, contact with aboard personnel. Seafarers harbouring the resistant bacteria then proceed to mediate their global transmission, starting from seaports and beyond, therefore resulting in difficult-to-treat or resistant infections.

Seafarers as a medium of transmission of resistance microbes poses a public health challenge with tackling antimicrobial resistance. There is evidence that the outcome of globalisation, human migration and urban trade contribute significantly to the spread of drug-resistant pathogens between countries [6, 7]. This calls for urgent epidemiological surveillance of resistant microbes between countries, increasing awareness of antimicrobial resistance among seafarers and promotion of antimicrobial stewardship across sections in order to curtail the possible effect of transmission of resistant microbes through seafarers.

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Deep-sea antibiotics exploitation: PROs and CONs

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Antimicrobial resistance is an incubating pandemic that needs urgent alleviation as most known antibiotics are currently ineffective against a wide group of bacteria following the misuse of antibiotics. The increasing rate of resistivity of bacteria to known antibiotics is continuously destroying the effort made by scientists towards the discovering of antibiotics in past decades. Pharmaceutical industries have abandoned natural metabolite research from microorganism due to the lack of rediscovery and low metabolite production in known microbes around the environment [1]. Also, microorganisms that produce these important secondary metabolites cannot grow on culture media plates in the laboratory [1]. Following the constant demand for several drugs, scientist have been inspired to seek for solutions in untapped habitats like the sea and this has recorded positive discovery of novel *Actinomycetes* and *Streptomyces* species used to combat infectious disease.

Deep-sea is the furthermost ecosystem with much untapped natural biodiversity; its sediment contains important microbial diversity whose secondary metabolite can be utilised by man [2]. Irrespective of our limited knowledge of this ecosystem, they play a pivotal role in ecological balance and serve as one of the nurseries of life on earth [3]. Deep-sea peregrination has moved from geological to ecological to biological to physiological and currently, bioprospecting [3]. The exploitation of the sea is not a novel practice, but this has gained more scientific interest due to resource scarcity, improved technology [4] and partnership between governments, industries, and scientific researchers [3]. A noticeable alteration of the natural state of the deep-sea will directly influence other factors unifying the environment.

The quest for pure forms of organism that produces bioactive natural products has been the latest focus of scientific research as they harness these products and promote its application to combat antimicrobial resistance and other infections. It is no doubt that recent microbial discoveries in these untapped environments have led to novel compounds with hopeful bioactivities [1]. However, there is a need to clearly define what bioprospecting stands for and develop guidelines and criteria in adjudicating the consequence of scientific research on the natural biota in the sea [3]. It is very essential that the rate of exploitation and technology used during the process needs to be regulated to limit the pressure exerted on the lives below water. Bioprospecting needs adherence to technological, legal, economic, societal, and environmental policy to ensure its sustainability [4]. If these policies are not fully adopted by sea exploiters, there will be little or no resources to harness/utilise bringing us to our current era of over-exploitation of terrestrial microbe [1]. The current and future consequence of these exploitation need to be emphasised because pressure on any of the factors sustaining the earth disrupts the state of equilibrium of others.

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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.

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

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

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

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

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

REFERENCES

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

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

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