



Centro Internazionale Radio Medico (C.I.R.M.)

Research hand in the improvement of the environmental, medical, and informational sciences of seafarers

2021

Foreword

It is said that Maritime Jobs are one of the highest paid jobs in the career market and they come along with several other perks. This is the main reason that keeps pulling in many new aspirants who want to establish a successful career in the merchant navy or other marine fields. The Maritime industry can be said to be reborn in the last decade due to the introduction of several security, safety and environmental protection measures adopted by the global shipping industry.

The maritime business is of strategic importance to all Europeans since, in economic terms, 90% of the EU's external trade and 40% of internal trade is transported by sea. Most of the world's shipping is owned by Europeans, and European turnover in the maritime transport sector is more than 137 billion euros. Europe is now benefiting from a world boom in the global shipping market. As a consequence, some European shipbuilders can now successfully concentrate on high-value orders within the current market for the construction of the world's most advanced ships. As we all know this is a cyclic industry. To maintain success, the investment must continue against the background of increasingly sophisticated and expanding global competition.

On other hand, marine medical solutions are your provider for management, consulting and education for medical care in the maritime sector. Globally, several maritime companies trying to understand each year for training and imparting medical knowledge to shipping authorities. This research centre at Centro Internazionale Radio Medico (C.I.R.M.) aims to understand some of the areas wherein shipping companies need to put more effort into research. It must be relevant and be directed by maritime industrial needs. Research must form the building block for improved prosperity and sustainable development. EU level support can only be a relatively small part of research investment and must be complemented by sufficient commitment and investment at the national level and from the private sector. With the changes in the need of economical, social and environmental scenarios of the world with the growth of the shipping industry, today's maritime institutes have to adopt some more research methods apart from technical and conventional knowledge. Therefore, in this booklet, we present the set of the research works done by the C.I.R.M. foundation in the last year 2021 to improve the quality of seafarers health.

List of the works

1. Sagaro GG, Battineni G, Di Canio M, Amenta F. Self-Reported Modifiable Risk Factors of Cardiovascular Disease among Seafarers: A Cross-Sectional Study of Prevalence and Clustering. *J Pers Med*. 2021 Jun 4;11(6):512. doi:10.3390/jpm11060512.
2. Battineni G, Kumar S, Mittal M, Amenta F. COVID-19 vaccine onboard ships: current and future implications of seafarers. *Int Marit Health*.2021;72(1):76-77. doi: 10.5603/IMH.2021.0010.
3. Battineni G, Nittari G, Sirignano A, Amenta F. Are telemedicine systems effective healthcare solutions during the COVID-19 pandemic? *J Taibah Univ Med Sci*. 2021 Jun;16(3):305-306. doi: 10.1016/j.jtumed.2021.02.009.
4. Sagaro GG, Di Canio M, Talevi E, Amenta F. Telemedicine for Pre-Employment Medical Examinations and Follow-Up Visits on Board Ships: A Narrative Review on the Feasibility. *Healthcare (Basel)*. 2021 Jan 13;9(1):69. doi: 10.3390/healthcare9010069.
5. Chintalapudi N, Battineni G, Canio MD, Sagaro GG, Amenta F. Text mining with sentiment analysis on seafarers' medical documents, *Inter Jour of Info Manage Data Insights*, 1(1), 2021,100005,https://doi.org/10.1016/j.jjime.2020.100005.
6. Sagaro GG, Dicanio M, Battineni G, Samad MA, Amenta F. Incidence of occupational injuries and diseases among seafarers: a descriptive epidemiological study based on contacts from onboard ships to the Italian Telemedical Maritime Assistance Service in Rome, Italy. *BMJ Open*. 2021 Mar 16;11(3):e044633. doi: 10.1136/bmjopen-2020-044633.

Article

Self-Reported Modifiable Risk Factors of Cardiovascular Disease among Seafarers: A Cross-Sectional Study of Prevalence and Clustering

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Abstract: Background: Cardiovascular diseases (CVD) are the major cause of work-related mortality from diseases onboard ships in seafarers. CVD burden derives mainly from modifiable risk factors. To reduce the risk factors and the burden of CVD onboard ships in seafarers, it is important to understand the up-to-date prevalence of modifiable risk factors. The primary purpose of this study was to assess the prevalence and clustering of self-reported modifiable CVD risk factors among seafarers. We have also explored the association between socio-demographic and occupational characteristics and reported modifiable CVD risk factor clustering. Materials and methods: A cross-sectional study was conducted among seafarers from November to December 2020 on board ships. In total, 8125 seafarers aged 18 to 70 were selected from 400 ships. Data were collected using a standardized and anonymous self-reported questionnaire. The prevalence value for categorical variables and mean differences for continuous variables were compared using chi-square and independent sample t-tests. Multinomial logistic regression models were performed to identify independent predictors for modifiable CVD risk factor clustering. Results: Out of a total of 8125 seafarers aged ≥ 18 years on selected vessels, 4648 seafarers volunteered to participate in the survey, with a response rate of 57.2%. Out of 4318 participants included in analysis, 44.7% and 55.3% were officers and non-officers, respectively. The prevalence of reported hypertension, diabetes, current smoking and overweight or obesity were 20.8%, 8.5%, 32.5%, and 44.7%, respectively. Overall, 40%, 20.9%, 6% and 1.3% of the study participants respectively had one, two, three and four modifiable CVD risk factors. Older age (51+ years) (odds ratio (OR): 3.92, 95% confidence interval (CI): 2.44–6.29), being non-officers (OR: 1.36, 95% CI: 1.09–1.70), job duration (10–20 years) (OR: 2.73, 95% CI: 2.09–3.57), job duration (21+ years) (OR: 2.60, 95% CI: 1.79–3.78), working 57–70 h per week (OR: 2.03, 95% CI: 1.65–2.49) and working 71+ h per week (OR: 3.08, 95% CI: 2.42–3.92) were independent predictors for at least two self-reported modifiable CVD risk factor clustering. Conclusion: The results of our study demonstrate that more than four in six (68.5%) seafarers aged between 19 and 70 years have at least one of the modifiable CVD risk factors. Therefore, CVD prevention and modifiable risk factors reduction strategies targeting high-risk groups should be designed and implemented on board ships.

Keywords: seafarers; hypertension; cardiovascular disease; occupation; diabetes; body mass index; cigarette smoking; modifiable risk factors



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1. Introduction

Globally, cardiovascular diseases (CVD) are the leading causes of mortality and disability [1]. The prevalence of overall CVD increased from 271 million in 1990 to 523 million in 2019, and mortality due to CVD also increased from 12.1 million to 18.6 million respectively from 1990 to 2019 worldwide [1]. CVD are responsible for approximately 31% (17.9

million) of all death worldwide, and four out of five (80%) deaths from these diseases were due to heart attacks and strokes [2].

CVDs are also the major cause of work-related mortality from diseases among seafarers' onboard ships. A study conducted on British merchant shipping reported that 4601 (19.8%) of 23,291 work-related deaths from 1919 to 2005 were due to CVD [3]. Another study found that 147 (38.4%) out of the 384 documented deaths at sea were from CVDs [4]. Various studies have reported that a high percentage of deaths among seafarers was due to CVDs in Polish vessels (62 (19%) of 324 deaths) [5], on Danish merchant ships (35 (66%) of 53 deaths) [6], on Singapore ships (45 (65%) of 69 deaths) [7], and in Isle of Man shipping (16 (80%) of 20 deaths) [8]. In terms of morbidity, CVDs are among the top five (gastrointestinal, CV, musculoskeletal, dermatological and respiratory disorders) major cause of illness from diseases at sea among seafarers [9–12].

CVD burden attributable to modifiable risk factors, namely hypertension, diabetes, overweight or obesity, high low-density lipoprotein cholesterol, and cigarette smoking, was increased worldwide [1]. For instance, globally, 5.02 million death and 160 million disability-adjusted life years (DALYs) were attributed to high BMI in 2019. Further, the number of deaths caused by diabetes and high blood pressure increased respectively from 2.91 million and 6.79 million in 1990 to 6.50 million and 10.8 million in 2019 [1]. Different studies conducted in the general population [13–15] and seafarers [16–20] were reported that modifiable CVD risk factors included cigarette smoking, overweight or obesity, hypertension, and diabetes, can be reduced or eliminated by modifying lifestyle behaviors. Studies found that the prevalence of CVD risk factors included overweight or obesity and cigarette smoking to be higher among seafarers when compared to the general population [21,22]. There are different reasons that seafarers might have more modifiable CVD risk factors compared to the general population. Their work is both physically and psychologically stressful, working long hours and short average sleep time, prolonged time away from their family. It has been also demonstrated that work-related stress is a main contributor to CVD risk factors [21,23].

To mitigate the risk factors and the burden of CVD onboard ships among seafarers, it is important to understand the up-to-date prevalence of modifiable risk factors. Analysis of which modifiable risk factors frequently occur simultaneously is relevant for identifying a high-risk group. Understanding how clustering of CVD risk factors is associated with socio-demographic and occupational characteristics could help for developing effective CVD prevention and control strategies.

The present study has investigated the prevalence of reported modifiable CVD risk factors and their distribution by socio-demographic and occupational characteristics among seafarers. We have also investigated the association between socio-demographic and occupational variables and reported modifiable CVD risk factor clustering among seafarers. This study is probably the first investigation involving a large representative sample of seafarers, and no study has been conducted so far on reported modifiable CVD risk factors and clustering among seafarers. The present work could therefore provide up-to-date, evidence-based information on the prevalence and clustering of modifiable CVD risk factors in seafarers.

2. Materials and Methods

2.1. Study Design and Setting

In the present study, we conducted a cross-sectional epidemiological study to assess the prevalence and clustering of reported modifiable CVD risk factors among seafarers. This study was conducted from November to December 2020 onboard ships. Currently, nearly 65,000 deep-sea merchant ships operate, carrying an average of 1.3 million seafarers worldwide [24]. The workforce onboard ship is classified into three broad categories: deck, engine, and galley/support personnel. In 2015, the number of seafarers actively employed at sea, 774,000 officers, and 873,500 ratings (non-officers) [24].

2.2. Study Participants and Procedures

The study participants were recruited through International Radio Medical Center (C.I.R.M.). C.I.R.M. is an Italian Telemedical Maritime Assistance Service (TMAS) Center and is the organization with the largest experience worldwide in terms of the number of patients assisted onboard ships. C.I.R.M. provides teleconsultations and medical advice to seafarers and passengers regardless of their nationality and flag of the vessels 24 h a day, seven days a week, and 365/366 days a year. C.I.R.M. has more than 5000 ship contacts. Of these, 400 ships were selected randomly from the ships' list by applying a simple random sampling strategy. In the second step, the research team presented the study's purpose and protocol to all captains of selected vessels to obtain permission to submit a self-reported anonymous questionnaire and requested the list of seafarers per ship. The captains of 400 ships agreed to participate in the study and provided the active seafarers' (seafarers on duty) lists per vessel. A list of a total of 8125 seafarers with indication of their names, age and ranking was obtained in a sample of 400 ships. Inclusion criteria were seafarers over the age of 18 and signing the informed consent form. In the subsequent step, a simple random sampling method to select the potential participants from the list based on our eligibility criteria was used.

All crew members were eligible for this study because they are greater than 18 years old. According to the International Labor Organization (ILO), seafarers' recruitment policy limits seafarers' age, and anyone who is recruited as a seafarer must be over 18 years of age [25]. As for the data collection, the research team collaborated with the C.I.R.M. doctors and provided one-day training via videoconferencing for the telemedicine case manager and one crew member per ship on survey administration and how to measure the body weight and height of the participating crew members. Telemedicine Case Managers (TCMs) are already trained medical first responders and have experience working with seafarers' aboard ships and TMAS doctors or other health professionals. As a result, the questionnaire was sent to telemedicine case managers via their email address by the C.I.R.M., enclosing the invitation letter and informed consent forms. The survey was then administered by trained telemedicine case managers per vessel. The invitation letter contains a brief introduction to the study purpose, procedures, declaration of participant anonymity, and voluntary participation. Besides, the participants were assured of the privacy and confidentiality of the response. The participant who chose to participate provided their signed informed consent before participation in the study.

2.3. Data Collection

Data were collected using a standardized and anonymous questionnaire, and the tool has four core parts. The first part of the questionnaire contains the socio-demographic information included age, gender, educational status, nationality, and marital status. The second section of the questionnaire was occupational characteristics, including rank, work-site, job duration at sea, working hours per week. The third part of the questionnaire contains a history of high blood pressure (hypertension), history of diabetes, physical measurement (weight and height), alcohol consumption, and cigarette smoking status. As for the measured high blood pressure (hypertension) was ascertained with the following questions. Has a doctor or other health professional ever told you that you have high blood pressure (hypertension)? The question has only two options, "Yes" and "No". Among those who answered "Yes" to the above question, they were further asked, "Are you currently receiving medicine for your high blood pressure (Hypertension)?" This question also has two choices, "Yes" and "No". Participants who answered "yes" to the above medicine question were also asked to show any antihypertensive medication they were currently taking. Regarding self-reported hypertension (HTN), in this study, it was defined as having a past hypertensive diagnosis and currently using medication due to hypertension. As for the diabetes mellitus, the self-reported diabetic Mellitus was assessed by asking, "Have you ever been told by a doctor or other health worker that you have raised blood sugar levels or diabetes?" The question has two options "Yes" and "No" and the subjects who answered

yes to the above question were further asked, "Are you currently taking medicine for high blood sugar level?" The subjects who were taking medicine for high blood sugar levels were further asked to show any drug currently they were receiving due to diabetic Mellitus. In this study, self-reported diabetic mellitus (DM) was defined as having a past diabetic mellitus diagnosis and a current diabetic mellitus treatment. The current smoking was assessed by asking, "Do you currently smoke any tobacco products?" The question has two choices "Yes," "No". The participants who answered "Yes" for the above question were further asked, "do you currently smoked tobacco products daily?" Again, the participants who answered the above question "Yes" further assessed how many years they smoked cigarettes without stopping.

In this study, the current smoking was defined as the participants who smoked cigarettes regularly for a year and had not stopped smoking tobacco products at least six months. According to the World Health Organization (WHO) guideline [26], the study subjects' body weight and height were measured. We then calculated body mass index as weight in kilograms (kg) divided by height in meter (m) squared (Weight (kg)/height (m)²). BMI was also classified into underweight (<18.5 kg/m²), normal body weight (18.5–24.99 kg/m²), overweight (25–29.99 kg/m²) and obesity (≥30 kg/m²). The questionnaire was designed for the Google survey tool (Google Forms) and the link shared to the C.I.R.M.

2.4. Statistical Analysis

Descriptive statistics included frequency and percentages, were determined for categorical variables to understand the distribution of socio-demographic and occupational characteristics by seafarer's rank. We used the chi-square test to determine whether the socio-demographic and occupational characteristics were distributed homogeneously by rank group and to evaluate their association with the prevalence and clustering of modifiable cardiovascular disease risk factors. The independent-sample t-test was used to examine the mean differences of continuous variables between officers and non-officers. The prevalence and clustering of the modifiable CVD risk factors were determined by Socio-demographic (age, marital status, educational level, and nationality) and occupational (rank, worksite, job duration at sea, and working hours per week) characteristics. The educational level of the participants was grouped into three categories, namely, high (completed college or university), middle (completed high school and technical school), and low (secondary and lower school). Moreover, the rank was categorized into officers (captain, deck, and engine officers) and non-officer (deck crew, engine crew, galley, and others).

The multinomial logistic regression model was performed to identify independent predictors for the cardiovascular disease risk factor clustering. Socio-demographic and occupational variables with *p*-values less than 0.25 in the univariate analysis were selected and entered multinomial logistic regression model. The clustering of modifiable CVD risk factors (dependent variable) was formed from the four modifiable risk factors: hypertension, diabetic mellitus, current smoking, and overweight or obesity. The categories were: (1) no risk factors, (2) one risk factor, and (3) two or three or four risk factors. Finally, having (1) one risk factor and (≥2) two and more than two risk factors versus (0) no risk factors (reference group) were analyzed in the model. Finally, adjusted Odds Ratio (OR) and 95% of confidence interval (95%CI) were reported.

Statistical analyses were performed using R-software [27], version 4.0.2 (R Foundation for Statistical Computing, Vienna, Austria). R-package 'dplyr' was used for data manipulation [28], and R-package 'summarytools' was used for frequencies tables, cross-tabulation, and other descriptive statistics [29]. R-package 'tidystats' was used for *chisq.test()* function and R-package 'nnet' was used for running the multinomial logistic regression model [30,31]. A two-tailed *p*-value less than 0.05 was considered statistically significant.

3. Results

3.1. Socio-Demographic and Occupational Characteristics

Out of a total of 8125 seafarers aged ≥ 18 years on selected vessels, 4648 seafarers volunteered to participate in the survey, with a response rate of 57.2%. We then excluded 330 participants due to missing data. Hence, a total of 4318 subjects were included in the analysis. As presented in Table 1, out of 4318 participants, 44.7% and 55.3% were officers and non-officers, respectively. The mean age of the participants was 37.94 ± 10.32 (range: 19–70 years). Almost all (99.4%) participants were male, and more than seventy percent were from non-EU countries. Of the 3069 participants from non-EU countries, 58.7% and 36.7% were Filipino and Indian, respectively. More than three-fifths (69.8%) of study subjects were married, and 55.55% were deck workers. The average working hours per week was 65.96 ± 10.96 . 35.5% and 7.9% of officers and 38.7% and 8.6% of non-officers were overweight and obese, respectively. Some 71.5% officers and 53.3% of non-officers respectively had a high and middle level of education. Besides, 45.6% of the study subjects had 10 to 20 years job duration at sea (Table 1).

Table 1. Distribution of socio-demographic, occupational, and other relevant characteristics of participants by the rank group.

Variables	Total (%)	Rank		p-Value
		Officer, n (%)	Non-Officer n (%)	
Number, n (%)	4318 (100.0)	1929 (44.7)	2389 (55.3)	
Age (in years), mean (SD)	37.94 ± 10.32	38.39 ± 9.89	37.58 ± 10.60	0.011
Gender (male)	4290 (99.4)	1925 (99.8)	2365 (98.9)	-
Nationality				
EU-countries	1222 (28.3)	782 (40.5)	440 (18.4)	<0.001
Non-EU countries	3096 (71.7)	1147 (59.5)	1949 (81.6)	
Marital status				
Single	1303 (30.2)	526 (27.3)	777 (32.5)	0.001
Married	3015 (69.8)	1403 (72.7)	1612 (67.5)	
Educational level				
Higher	1741 (40.3)	1375 (71.3)	366 (15.3)	<0.001
Middle	1803 (41.7)	530 (27.5)	1273 (53.3)	
Low	774 (18)	24 (1.2)	750 (31.4)	
Worksite				
Deck	2396 (55.5)	1167 (60.5)	1229 (51.4)	<0.001
Engine	1468 (34)	762 (39.5)	706 (29.6)	
Galley	454 (10.5)	0 (0)	454 (19)	
Job duration at sea				
<10 years	1551 (35.9)	481 (24.9)	1070 (44.8)	<0.001
10–20 years	1967 (45.6)	1000 (40.4)	967 (40.5)	
21+ years	800 (18.5)	448 (14.7)	352 (14.7)	
Working hours per week, mean (SD)	65.96 ± 10.98	65.67 ± 10.4	66.19 ± 11.4	0.122
Body mass index (BMI)				
Underweight	34 (0.8%)	8 (0.4%)	26 (1.0%)	<0.001
Normal	2355 (54.5%)	1123 (58.2%)	1232 (51.6%)	
Overweight	1571 (36.4%)	646 (33.5%)	925 (38.7%)	
Obesity	358 (8.3%)	152 (7.9%)	206 (8.6%)	

3.2. Prevalence of Modifiable CVD Risk Factors

3.2.1. Self-Reported Hypertension

The prevalence of reported hypertension was 20.8% (95% CI: 19.6% to 22.1%). 18.5% and 27.7% of officers and non-officers respectively had reported hypertension and the

prevalence of reported hypertension was significantly higher among non-officers than officers (22.7% vs. 18.5%). The prevalence of reported hypertension was high in study subjects who had married, older age groups, had a lower education level, had long job duration at sea and in deck workers regardless of rank (Table 2). Irrespective of rank, the prevalence of hypertension increased with working hours per week, from 14.1% in participants working <56 h per week to 32.2% in those working >71 h per week.

Table 2. Prevalence (95% CI) of modifiable risk factors of cardiovascular disease and its distribution by socio-demographic and occupational characteristics among seafarers.

	Self-Reported Hypertension	Self-Reported Diabetes	Self-Reported Current Smoking	Overweight or Obesity
Total	20.8 (19.6–22.1)	8.5 (7.7–9.4)	32.5 (31.2–33.9)	44.7 (43.2–46.2)
Age group (in years)				
19–30	3.6 (2.7–4.9)	0.3 (0.10–0.89)	36.3 (33.6–39.0)	33.8 (31.2–36.6)
31–40	16.6 (14.7–18.7)	5.2 (4.3–6.9)	32.9 (30.5–35.5)	43.5 (40.9–46.2)
41–50	35 (32.2–37.8)	13.4 (11.5–15.5)	25.7 (23.2–28.3)	50.4 (47.4–53.3)
51+	41.6 (37.3–47.9)	25.9 (22.3–29.9)	37.9 (33.7–42.3)	60.9 (56.6–65.2)
<i>p</i> -value	<0.001	<0.001	<0.001	<0.001
Nationality				
EU-countries	22.6 (20.3–25.0)	9.2 (7.7–11.0)	41.5 (38.7–44.3)	45.8 (43–48.6)
Non-EU countries	20.2 (18.8–21.6)	8.2 (7.2–9.2)	29.2 (27.4–30.6)	44.2 (42.5–45.9)
<i>p</i> -value	0.084	0.279	<0.001	0.356
Marital status				
Single	9.8 (8.2–11.5)	2.3 (1.6–3.3)	34.3 (31.7–36.9)	33.7 (31.2–36.3)
Married	25.6 (24.1–27.2)	11.2 (10–12.3)	31.8 (30.2–33.5)	49.9 (47.6–51.2)
<i>p</i> -value	<0.001	<0.001	0.111	<0.001
Educational level				
Higher	15.2 (13.4–16.8)	7.4 (6.2–8.8)	28.7 (26.6–30.9)	37.5 (35.2–39.8)
Middle	23.7 (21.8–25.8)	8.7 (7.4–10.0)	36.7 (34.4–38.9)	47.1 (44.8–49.4)
Low	27.2 (24–30.4)	10.5 (8.4–12.9)	31.5 (28.3–34.9)	55.3 (51.7–58.8)
<i>p</i> -value	<0.001	0.037	<0.001	<0.001
Rank				
Officer	18.5 (16.8–20.3)	7.7 (6.5–8.9)	30.2 (28.2–32.3)	41.4 (39.2–43.6)
Non-officer	22.7 (21–24.5)	9.2 (8.0–10.4)	34.5 (32.5–36.4)	47.3 (45.3–49.4)
<i>p</i> -value	<0.001	0.099	0.003	<0.001
Worksite				
Deck	23.5 (21.8–25.2)	8.1 (7.1–9.3)	33.5 (31.6–34.4)	43.7 (41.7–45.7)
Engine	18.5 (16.6–20.6)	9.7 (8.3–11.4)	31.5 (29.1–33.9)	44.5 (41.9–47.1)
Galley	14.5 (11.5–18.2)	6.2 (4.2–8.9)	31 (26.9–35.6)	50.2 (45.6–54.9)
<i>p</i> -value	<0.001	0.038	0.338	0.038
Job duration at sea				
<10 years	6.6 (5.5–8.0)	1.4 (0.9–2.1)	34.4 (32.2–36.8)	32.2 (29.7–34.5)
10–20 years	26.5 (24.6–28.5)	9.9 (8.7–11.4)	31.6 (29.6–33.7)	49.5 (47.2–51.7)
21+ years	34.5 (31.2–37.9)	18.6 (16–21.5)	31.3 (28.1–34.6)	57.4 (53.9–60.8)
<i>p</i> -value	<0.001	<0.001	0.156	<0.001
Working hours per week				
≤56 h				
57–70 h	14.1 (12.2–16.3)	5.4 (4.1–6.9)	25.7 (23.2–28.4)	38.0 (35.2–40.9)
71+ h	19.2 (17.6–20.9)	9.1 (7.9–10.4)	32.2 (30.3–34.2)	46.5 (44.4–48.6)
<i>p</i> -value	32.2 (29.3–35.2)	10.6 (8.8–12.8)	40.9 (37.9–44.2)	48.3 (45–51.5)
	<0.001	<0.001	<0.001	<0.001

3.2.2. Self-Reported Diabetes

Out of the total, 366 (8.5%) participants had reported diabetic mellitus. The prevalence of reported diabetic mellitus was higher in study participants who had married (11.2% (10.0% to 12.3%)) compared with single (2.3% (1.6% to 3.3%)). The prevalence of diabetes mellitus (DM) increased significantly with age, from 0.3% in the age group 19–30 years to 25.9% in the age ≥ 51 years. This risk factor's prevalence was higher among the participants who had 21 years and above job duration at sea, working 71 h and more per week. The proportion of DM was increased with the decreasing level of education regardless of rank. As for the worksites, the engine workers had a high prevalence of DM irrespective of rank. Variables included rank and nationality, were not significantly associated with the prevalence of self-reported DM (Table 2).

3.2.3. Self-Reported Current Smoking

Reported current smoking was observed in 32.5% (95% CI: 31.2% to 33.9%) of the total participants. As shown in Table 2, age groups, nationality, educational level, rank, and working hours per week were significantly associated with the prevalence of reported current smoking. In contrast, variables included marital status, worksites, and job duration at sea were not associated with current smoking. Current smoking varied significantly with age groups and was higher in non-officers than officers (34.5% vs. 30.2%). The prevalence of reported current smoking was increased with working hours per week, from 25.7% in participants who had worked ≤ 56 h to 40.9% in those working 71 h or more per week.

3.2.4. Overweight or Obesity

Some 44.7% (95% CI: 43.2% to 46.2%) of the total participants were overweight or obese. As presented in Table 2, except nationality all socio-demographic and occupational variables were significantly associated with prevalence of the overweight or obese. The prevalence of the overweight or obese was increased with the increasing the age, working hours per week and job duration at sea regardless of rank. In contrast, this risk factor was increased with the decreasing levels of education. It was observed relatively high in non-officers compared to officers (47.3% vs. 41.4%). Besides, the prevalence of overweight or obese was found to be high in participants who had married than single (49.9% vs. 33.7%) (Table 2).

As shown in Table 3, the prevalence of CVD risk factors, except self-reported current smoking increased with age both in officers and non-officers. Reported hypertension and diabetes prevalence increased with the decreasing the level of education in non-officers, but not in officers.

Among non-officers, the prevalence of modifiable CVD risk factors increased with working hours per week. In contrast, CVD risk factors prevalence, except reported hypertension varied significantly with working hours per week among officers. The proportion of overweight or obesity and reported diabetes increased with the length of work at sea both in officers and non-officers. Educational levels and nationality were not associated with reported hypertension and diabetes among officers. In addition, working hours per week was not associated with hypertension in officers (Table 3).

Table 3. Prevalence (95% CI) of modifiable CVD risk factors by socio-demographic and occupational characteristics stratified by rank.

Rank Group	Self-Reported Hypertension	Self-Reported Diabetes	Self-Reported Current Smoking	Overweight or Obesity
Officer				
Overall	18.5 (16.8–20.3)	7.7 (6.5–8.9)	30.2 (28.1–32.3)	41.4 (39.2–43.6)
Age group (in years)				
19–30	5.1 (3.4–7.6)	0.2 (0.01–1.4)	36.2 (31.9–40.7)	30.9 (26.7–35.3)
31–40	14.8 (12.3–17.6)	1.5 (0.8–2.8)	32.7 (29.3–36.3)	39.0 (35.4–42.7)
41–50	26.3 (22.6–30.4)	15.4 (12.4–18.9)	18.5 (15.3–22.2)	43.5 (39.2–47.9)
51+	40.4 (33.9–47.1)	25.0 (19.6–31.2)	36.0 (29.8–42.6)	65.8 (59.2–71.8)
<i>p</i> -value	<0.001	<0.001	<0.001	<0.001
Nationality				
EU-countries	19.7 (16.9–22.7)	7.9 (6.2–10.1)	38.9 (35.5–42.4)	44.1 (40.6–47.7)
Non-EU countries	17.7 (15.6–20.1)	7.5 (6.1–9.2)	24.2 (21.8–26.8)	39.5 (36.7–42.4)
<i>p</i> -value	0.295	0.794	<0.001	0.058
Marital status				
Single	12.9 (10.2–16.2)	4.0 (2.6–6.1)	33.7 (29.7–37.9)	28.9 (25.1–33.0)
Married	20.6 (18.5–22.8)	9.1 (7.6–10.7)	28.9 (26.5–31.3)	46.0 (43.4–48.7)
<i>p</i> -value	<0.001	<0.001	0.047	<0.001
Educational level				
Higher	17.5 (15.6–19.7)	8.4 (6.9–9.9)	28.2 (25.9–30.7)	37.6 (35.0–40.2)
Middle	21.5 (18.1–25.3)	6.2 (4.4–8.7)	33.0 (29.1–37.2)	49.2 (44.9–53.6)
Low	8.3 (1.5–2.8)	0.0	79.2 (57.2–92.1)	83.3 (61.8–94.5)
<i>p</i> -value	0.058	0.106	<0.001	<0.001
Worksite				
Deck	18.8 (16.6–21.2)	6.2 (4.9–7.7)	31.1 (28.5–33.9)	42.9 (40.1–45.8)
Engine	18.1 (15.1–21.1)	10.0 (7.9–12.4)	28.7 (25.6–32.1)	39.0 (35.5–42.5)
Galley	—	—	—	—
<i>p</i> -value	N/A	N/A	N/A	N/A
Job duration at sea				
<10 years	6.0 (4.1–8.6)	0.4 (0.07–1.7)	33.5 (29.3–37.9)	26.0 (22.2–30.2)
10–20 years	16.6 (14.4–19.1)	5.8 (4.5–7.5)	30.8 (27.9–33.9)	41.6 (38.5–44.7)
21+ years	36.2 (31.7–40.8)	19.6 (16.1–23.7)	25.2 (21.3–29.6)	57.4 (52.6–61.9)
<i>p</i> -value	<0.001	<0.001	0.019	<0.001
Working hours per week				
≤56 h	21.3 (17.9–25.2)	5.7 (3.9–8.2)	25.4 (21.7–29.5)	37.9 (33.7–42.3)
57–70 h	16.8 (14.6–19.3)	10.6 (8.8–12.7)	32.5 (29.6–35.5)	45.2 (42.1–48.3)
71+ h	19.1 (15.5–23.3)	2.9 (1.6–5.2)	30.3 (25.9–34.9)	36.3 (31.7–41.2)
<i>p</i> -value	0.102	<0.001	0.018	0.002
Non-officer				
Overall	22.7 (21.1–24.5)	9.2 (8.0–10.4)	34.5 (32.5–36.4)	47.3 (45.3–49.4)
Age group (in years)				
19–30	2.7 (1.7–4.2)	1.8 (1.0–3.1)	36.3 (32.9–39.9)	35.7 (32.3–39.2)
31–40	18.6 (15.8–21.7)	9.2 (7.2–11.6)	33.1 (29.7–36.8)	48.3 (44.5–52.1)
41–50	41.9 (38.1–45.8)	11.1 (8.9–13.9)	31.4 (27.8–35.1)	55.8 (51.9–59.7)
51+	42.6 (36.8–48.5)	23.9 (19.2–29.3)	39.4 (33.8–45.4)	57.1 (51.2–62.8)
<i>p</i> -value	<0.001	<0.001	<0.055	<0.001
Nationality				
EU-countries	27.7 (23.6–32.2)	9.3 (6.8–12.5)	46.1 (41.4–50.9)	48.9 (44.1–53.6)
Non-EU countries	21.6 (19.8–23.5)	9.0 (7.9–10.5)	31.8 (29.7–33.9)	47.0 (44.8–49.2)
<i>p</i> -value	0.007	0.949	<0.001	0.513

Table 3. Cont.

Rank Group	Self-Reported Hypertension	Self-Reported Diabetes	Self-Reported Current Smoking	Overweight or Obesity
Marital status				
Single	7.6 (5.9–9.7)	2.2 (1.3–3.6)	34.7 (31.4–38.2)	36.9 (33.6–40.5)
Married	30.0 (27.8–32.3)	12.5 (10.9–14.5)	34.3 (31.9–36.7)	52.4 (49.9–54.8)
<i>p</i> -value	<0.001	<0.001	0.343	<0.001
Educational level				
Higher	5.7 (3.7–8.8)	3.8 (2.2–6.5)	30.6 (25.9–35.6)	36.9 (31.9–42.1)
Middle	24.7 (22.3–27.1)	9.7 (8.1–11.5)	38.2 (35.5–40.9)	46.2 (43.4–48.9)
Low	27.7 (24.6–31.1)	10.8 (8.7–13.3)	30.0 (26.8–33.4)	54.4 (50.7–57.9)
<i>p</i> -value	<0.001	<0.001	<0.001	<0.001
Worksite				
Deck	27.9 (25.4–30.5)	10.0 (8.4–11.9)	35.7 (33.0–38.5)	44.5 (41.7–47.3)
Engine	19.0 (16.2–22.1)	9.5 (7.5–11.9)	34.4 (30.9–38.1)	50.4 (46.7–54.2)
Galley	14.5 (11.5–18.2)	6.2 (4.2–8.9)	31.1 (26.9–35.6)	50.2 (45.5–54.9)
<i>p</i> -value	<0.001	0.048	0.203	0.015
Job duration at sea				
<10 years	6.9 (5.5–8.6)	1.8 (1.1–2.8)	34.8 (31.9–37.7)	34.8 (31.9–37.7)
10–20 years	36.7 (33.7–39.8)	14.3 (12.1–16.7)	32.5 (29.5–35.5)	57.4 (54.4–60.7)
21+ years	32.4 (27.6–37.6)	17.3 (13.6–21.8)	38.9 (33.8–44.3)	57.6 (52.0–62.6)
<i>p</i> -value	<0.001	<0.001	0.089	<0.001
Working hours per week				
≤56 h	8.1 (6.2–10.7)	5.0 (3.5–7.2)	25.9 (22.5–29.6)	38.1 (34.3–42.1)
57–70 h	21.2 (18.9–23.6)	7.8 (6.4–9.5)	32.0 (29.4–34.7)	47.5 (44.6–50.4)
71+ h	41.5 (37.5–45.7)	16.2 (13.3–19.5)	48.7 (44.5–52.9)	56.9 (52.7–60.9)
<i>p</i> -value	<0.001	<0.001	<0.001	<0.001

3.3. Clustering of Modifiable CVD Risk Factors

The clustering of modifiable CVD risk factors was categorized into three classes. The classes were no risk factors, having one risk factor and clustering two and more than two risk factors (Table 4). In general, 68.5% (95% CI: 67.2% to 69.9%) and 28.3% (26.9% to 29.7%) of the study subjects respectively, had at least one and at least two modifiable CVD risk factors. Overall, 31.4 % (30.0% to 32.8%), 40.3 (38.8% to 41.8%), 20.9 % (19.7% to 22.2%), 6% (5.4% to 6.8%) and 1.3% (1.0% to 1.7%) of the study participants respectively had zero, one, two, three and four modifiable CVD risk factors. As for the rank, 33.4 % of officers and 29.8% of non-officers had no CVD risk factors.

In contrast, 43.5% and 23.1% of officers and 37.7% and 32.5% of non-officers had one and at least two modifiable risk factors, respectively. The prevalence of having at least two risk factors increased significantly among non-officers compared with officers. The prevalence of having at least two risk factors increased significantly with age, from 13.3% in the age group 19–30 years to 51.3% in age ≥51 years. On the other hand, the prevalence of at least two risk factors of CVD increasing with the decreasing the level of education. However, the proportion of having at least two risk factors significantly increased with increasing the job duration at sea and working hours per week regardless of rank (Table 3).

As for the combination of the CVD risk factors, self-reported current smoking/ overweight or obesity (30.9% (28.9% to 32.9%)), overweight or obesity/self-reported hypertension (27.5% (25.6% to 29.5%)), and self-reported current smoking/self-reported hypertension (17.5% (15.9% to 19.2%)) were the three most common of all two modifiable CVD risk factor clustering. Besides, the combination of overweight or obesity/self-reported hypertension/self-reported current smoking (70.0% (64.0% to 75.3%)) were the most often clustering of three modifiable CVD risk factors. Among the participants with only one risk factors, 49.2% were overweight or obesity, 35.3% were current smokers, 10.9% had hypertension and 4.6% had diabetes.

Table 4. Prevalence (95% CI) of modifiable CVD risk factor clustering based on socio-demographic and occupational characteristics among seafarers.

Category	None	One	Clustering (≥ 2)	p-Value
Total	31.4 (30.0–32.8)	40.3 (38.8–41.8)	28.3 (26.9–29.7)	
Age group (in years)				
19–30	39.3 (36.5–42.1)	47.5 (44.6–50.2)	13.3 (11.5–15.3)	<0.001
31–40	33.5 (31.0–36.0)	41.3 (38.7–43.9)	25.2 (22.9–27.5)	
41–50	28.9 (26.4–31.7)	33.2 (30.5–35.9)	37.8 (35.0–40.7)	
51+	12.6 (9.9–15.8)	36.2 (32.1–40.5)	51.3 (46.9–55.6)	
Nationality				
EU-countries	24.9 (22.5–27.4)	42.8 (40–45.6)	32.3 (29.7–35.0)	<0.001
Non-EU countries	34.0 (32.4–35.7)	39.3 (37.6–41)	26.7 (25.2–28.3)	
Marital status				
Single	39.9 (37.3–42.7)	45.2 (42.3–47.8)	14.9 (13.0–17.0)	<0.001
Married	27.7 (26.2–29.4)	38.2 (36.5–39.9)	34.1 (32.4–35.8)	
Educational level				
Higher	38.5 (36.2–40.8)	41.6 (39.3–43.9)	19.9 (18.1–21.9)	<0.001
Middle	26.2 (24.2–28.3)	42.2 (39.9–44.5)	31.7 (29.5–33.9)	
Low	27.8 (24.7–31.0)	32.9 (29.7–34.4)	39.3 (35.8–42.8)	
Rank				
Officer	33.4 (31.3–35.6)	43.5 (41.3–45.7)	23.1 (22.3–25.1)	<0.001
Non-officer	29.8 (28.0–31.7)	37.7 (35.7–39.7)	32.5 (30.6–34.4)	
Worksite				
Deck	31.9 (30.0–33.8)	37.8 (35.8–39.7)	30.3 (28.5–32.2)	<0.001
Engine	29.2 (26.9–31.6)	45.8 (43.3–48.4)	25.0 (22.8–27.3)	
Galley	36.3 (31.9–40.9)	35.5 (30.0–40.0)	28.2 (24.1–32.6)	
Job duration at sea				
<10 years	42.8 (40.4–45.3)	42.0 (39.6–44.5)	15.2 (13.4–17.1)	<0.001
10–20 years	26.8 (24.9–28.8)	40.0 (37.8–42.2)	33.2 (31.1–35.3)	
21+ years	20.8 (18.0–23.8)	37.5 (34.2–40.9)	41.8 (38.3–45.3)	
Working hours per week				
≤ 56 h	43.7 (40.8–46.7)	36.0 (33.2–38.9)	20.3 (17.9–22.7)	<0.001
57–70 h	28.5 (26.6–30.4)	43.2 (41.1–45.3)	28.3 (26.5–30.3)	
71+ h	24.0 (21.5–26.9)	38.6 (35.5–41.7)	37.3 (34.3–40.5)	

The prevalence of modifiable CVD risk factor clustering by socio-demographic and occupational characteristics stratified by rank is presented in Table 5. Consequently, the prevalence of having at least two modifiable CVD risk factors was higher in older ages, in both officers and non-officers. The prevalence of having two or more CVD risk factors increased with working hours per week among non-officers, but not in officers. However, the prevalence of at least two CVD risk factors differed significantly with the working hours per week among officers. The proportion of having ≥ 2 risk factors increased with the working hours per week in non-officers and with the job duration at sea among officers. The clustering of two and more than two CVD risk factors found to be more favorable in both officers and non-officers who had married than single and the differences was also statistically significant.

As summarized in Table 6, multinomial logistic regression analysis showed that study subjects aged 51 years and above 3.92 times more likely to have at least two CVD risk factors compared to those aged from 19–30 years. Non-officers (OR: 1.36, 95% CI:1.09–1.70) were more likely to have at least two CVD risk factors when compared to officers. Participants from EU countries were 1.38 and 1.60 more likely to have one and at least two CVD risk factors than those from non-EU countries. Study subjects working 71 h and above per week and had 21 and above job duration at sea were more likely to have both one, and at least two risk factors compared with those who were working less than

or equal to 56 h, and had less ten years work experiences, respectively. Besides, study individuals who had lower level of education were more likely to have at least two CVD risk factors when compared to high level of education. Variables included educational level (middle vs. higher), nationality, job duration at sea and working hours per week were independent predictors for both having one and at least two modifiable CVD risk factors. On the other hand, age, marital status, and rank were important predictors for having at least two modifiable CVD risk factors (Table 6).

Table 5. Prevalence (95% CI) of modifiable CVD risk factor clustering among seafarers stratified by rank.

Rank Group	None	One	Clustering (≥ 2)	p-Value
Officer				
Overall	33.4 (31.3–35.6)	43.5 (41.3–45.7)	23.1 (22.3–25.1)	
Age group (in years)				
19–30	39.8 (35.4–44.4)	48.3 (43.7–52.9)	11.9 (9.2–15.3)	<0.001
31–40	37.6 (34.1–42.3)	42.2 (38.6–45.9)	20.2 (17.4–23.4)	
41–50	30.8 (26.9–35.0)	43.7 (39.3–48.1)	25.5 (21.8–29.6)	
51+	12.7 (8.8–17.9)	37.3 (31.0–43.9)	50.0 (43.6–56.4)	
Nationality				
EU-countries	28.9 (25.8–32.2)	42.2 (38.7–45.8)	28.9 (25.8–32.2)	<0.001
Non-EU countries	36.4 (33.6–39.3)	44.4 (41.5–47.3)	19.2 (16.9–21.6)	
Marital status				
Single	44.3 (40.0–48.7)	41.4 (37.2–45.8)	14.3 (11.4–17.6)	<0.001
Married	29.3 (26.9–31.8)	44.3 (41.6–46.9)	26.4 (24.2–28.8)	
Educational level				
Higher	36.6 (34.0–39.2)	43.2 (40.6–45.9)	20.2 (18.1–22.5)	<0.001
Middle	26.2 (22.6–30.2)	45.5 (41.2–49.8)	28.3 (24.5–32.4)	
Low	8.3 (1.5–28.5)	16.7 (5.5–38.2)	75.0 (52.9–89.4)	
Worksite				
Deck	32.8 (30.1–35.6)	43.2 (40.3–46.1)	24.0 (21.6–26.6)	N/A
Engine	34.3 (30.9–37.8)	44.0 (40.4–47.6)	21.8 (18.9–24.9)	
Galley	—	—	—	
Job duration at sea				
<10 years	47.6 (43.1–52.2)	40.7 (36.3–45.3)	11.6 (8.9–14.9)	<0.001
10–20 years	32.8 (29.9–35.8)	45.9 (42.8–49.0)	21.3 (18.8–23.9)	
21+ years	19.4 (15.9–23.5)	41.1 (36.5–45.8)	39.5 (34.9–44.2)	
Working hours per week				
≤ 56 h	40.2 (35.9–44.7)	37.9 (33.7–42.3)	21.9 (18.4–25.8)	<0.001
57–70 h	28.9 (26.2–31.9)	45.3 (42.5–48.7)	25.5 (22.8–28.3)	
71+ h	35.8 (31.2–40.7)	45.6 (40.4–50.2)	18.8 (15.3–23.1)	
Non-officer				
Overall	29.8 (28.0–31.7)	37.7 (35.7–39.7)	32.5 (30.6–34.4)	
Age group (in years)				
19–30	39.0 (35.5–42.5)	46.9 (43.4–50.5)	14.1 (11.8–16.8)	<0.001
31–40	29.2 (25.9–32.8)	40.4 (36.7–44.2)	30.4 (26.9–33.9)	
41–50	27.5 (24.1–31.2)	24.9 (21.6–28.4)	47.6 (43.7–51.5)	
51+	12.5 (8.9–16.9)	35.3 (29.8–41.1)	52.2 (46.3–58.1)	
Nationality				
EU-countries	17.7 (14.3–21.7)	43.9 (39.2–48.6)	38.4 (33.9–43.2)	<0.001
Non-EU countries	32.6 (30.5–34.7)	36.3 (34.1–38.5)	31.1 (29.1–33.3)	
Marital status				
Single	37.1 (33.7–40.6)	47.5 (43.9–51.1)	15.4 (13.1–18.2)	<0.001
Married	26.4 (24.2–28.6)	32.9 (30.7–35.3)	40.7 (38.3–43.1)	

Table 5. *Cont.*

Rank Group	None	One	Clustering (≥ 2)	<i>p</i> -Value
Educational level				
Higher	45.6 (40.5–50.9)	35.5 (30.7–40.7)	18.9 (15.1–23.3)	<0.001
Middle	26.2 (23.8–28.7)	40.8 (38.1–43.5)	33.1 (30.5–35.7)	
Low	28.4 (25.2–31.8)	33.5 (30.1–36.9)	38.1 (34.7–41.7)	
Worksite				
Deck	31.0 (28.4–33.7)	32.6 (30.0–35.3)	36.4 (33.7–39.1)	<0.001
Engine	23.7 (20.6–27.0)	47.9 (44.0–51.6)	28.5 (25.2–31.9)	
Galley	36.3 (31.9–40.9)	35.5 (31.1–40.1)	28.2 (24.1–32.6)	
Job duration at sea				
<10 years	40.7 (37.7–43.7)	42.6 (39.6–45.6)	16.7 (14.5–19.1)	<0.001
10–20 years	20.6 (18.1–23.3)	33.0 (30.9–37.0)	45.5 (42.3–48.7)	
21+ years	22.4 (18.3–27.2)	33.9 (28.1–38.2)	44.6 (39.4–49.9)	
Working hours per week				
≤ 56 h	46.6 (42.6–50.6)	34.5 (30.8–38.5)	18.9 (15.9–22.3)	<0.001
57–70 h	28.1 (25.6–30.7)	41.2 (38.4–44.0)	30.8 (28.2–33.5)	
71+ h	15.7 (12.8–18.9)	33.7 (29.9–37.8)	50.6 (46.5–54.8)	

Table 6. Multinomial logistic regression analysis of modifiable cardiovascular disease risk factor clustering among seafarers (n = 4318).

Category	One		Clustering (≥ 2)	
	OR (95% CI)	<i>p</i> -Value	OR (95% CI)	<i>p</i> -Value
Age group (in years)				
19–30	1	-	1	-
31–40	0.85 (0.78–1.10)	0.219	1.02 (0.74–1.39)	0.913
41–50	0.92 (0.86–1.23)	0.068	1.27 (0.89–1.83)	0.193
51+	1.04 (0.67–1.61)	0.871	3.92 (2.44–6.29)	<0.001
Marital status				
Single	1		1	
Married	1.18 (0.97–1.43)	0.114	1.59 (1.24–2.03)	<0.001
Educational level				
Higher	1		1	
Middle	1.56 (1.30–1.88)	<0.001	2.21 (1.78–2.75)	<0.001
Low	1.25 (0.97–1.62)	0.084	2.48 (1.87–3.30)	<0.001
Nationality				
Non-EU countries	1		1	
EU-countries	1.38 (1.16–1.64)	<0.001	1.60 (1.31–1.95)	<0.001
Rank				
Officer	1		1	
Non-officer	1.07 (0.88–1.31)	0.485	1.36 (1.09–1.70)	0.007
Job duration at sea				
<10 years	1		1	
10–20 years	2.22 (1.77–2.79)	<0.001	2.73 (2.09–3.57)	<0.001
21+ years	2.37 (1.68–3.35)	<0.001	2.60 (1.79–3.78)	<0.001
Working hours per week				
≤ 56 h	1		1	
57–70 h	1.73 (1.46–2.05)	<0.001	2.03 (1.65–2.49)	<0.001
71+ h	1.88 (1.52–2.33)	<0.001	3.08 (2.42–3.92)	<0.001

4. Discussion

This cross-sectional epidemiological study has assessed the prevalence and clustering of reported modifiable CVD risk factors among seafarers. This study is the first study to

evaluate the prevalence and clustering of reported modifiable CVD risk factors among seafarers with a large representative sample. As a result, the prevalence of reported hypertension, diabetes, current smoking, and overweight or obesity was 20.8%, 8.5%, 32.5%, and 44.7%, respectively. The most important modifiable CVD risk factor in both officers and non-officers was overweight or obesity. Compared with the previous studies [16,20,21], the prevalence of hypertension among seafarers was less in our study. There are several reasons why the prevalence of hypertension might have less in our study than in previous studies among seafarers. First, we evaluated self-reported hypertension and did not consider participants who were not taking antihypertensive treatment, although they have high blood pressure levels. These could be the reasons that underestimate the proportion of this risk factor in the present study. However, our finding was almost in line with the study conducted among Iranian seafarers and greater than the study conducted on Italian flag vessels regardless of the difference in methods [17,18].

Regardless of the difference in methods, we found a higher prevalence of both self-reported current smoking and diabetes than the previous studies carried out in seafarers [19,21]. This study documented that 36.4% and 8.3% of the participants were overweight and obese, respectively. Our result was inconsistent with studies conducted among Danish seafarers [32,33], which reported 70.8% and 76.6% overweight and 30.9% obesity. The differences might be due to differences in the methods and data sources. As for the rank, the prevalence of self-reported modifiable CVD risk factors, except diabetes was significantly higher among non-officers compared with officers. This might be due to work-related stress because, as different studies reported that non-officers work is characterized by long working hours, night shift work, short average sleep time, suffer from frequent sleep interruption, irregular working times, and more physically demanding [9,17,34,35].

Life on board is another environmental stressor for seafarers, especially for non-officers because non-officers stay on board for more extended periods than officers (8.3 months vs. 4.8 months) [35]. Due to night shift work, lack of sleep, and intense activity, seafarers, especially non-officers, experiencing various coping strategies, including smoking cigarettes, and drinking alcohol during at work. Hence, these physical and Psychosocial stressors and high levels of work-related fatigue, lack of leisure time, and physical inactivity lead to high BMI and other modifiable CVD risk factors. Besides, Work-related stressors can affect the body by activating the neuroendocrine stress pathway, and unhealthy individual lifestyle behaviors (unhealthy diet, smoking, heavy alcohol consumption, and physical inactivity) can indirectly affect the body. Several studies in general population [36–40] and seafarers [34,41–43] have reported that work-related stress contributes significantly to modifiable CVD risk factors. A study in the general population reported that work-related stress, characterized by the effort-reward imbalance model, was significantly associated with a high BMI [44]. In another general population study, also work-related stress, described by the effort-reward imbalance model, was associated with metabolic syndromes [45].

The present study reports that more than four in six (68.5%) seafarers aged 19 to 70 have at least one of the following modifiable CVD risk factors: reported hypertension, diabetes, current smoking, and overweight or obesity. Besides, the clustering of two or more two CVD risk factors was noted in 28.5% of study participants. We found that significantly higher prevalence of two or more CVD risk factors among non-officers compared with officers. It is suggested that the non-officer work accompanied with the exposure to different work-related stressors may have unfavorable effects on cardiovascular health conditions in non-officers. Our finding was inconsistent with the study conducted on German-flagged ships, which reported a higher prevalence of coronary heart disease (CHD) risk factor clustering (>3 risk factors) among officers than non-officers (crew ranks) [16]. These differences could be due to differences in methods and CVD risk factor profiles in the study. For example, we did not consider biochemical parameters such as LDL cholesterol, HDL cholesterol, and triglycerides in the present study. Our study documented that the clustering of reported current smoking/overweight or obesity and overweight or

obesity/reported hypertension/current smoking was the most among the combination of two and three modifiable CVD risk factors.

We found that 33.4%, 43.5%, and 23.1% of officers and 29.8%, 37.7%, and 32.5% of non-officers respectively had zero, one, and two and more than two CVD risk factors. Another study conducted among seafarers reported that clustering of more than three CHD risk factors was observed in 56.2% of the galley staff, 43.6% of the engine officers, 32.2% of the deck officers, 24.6% of the deck crew, and 17.0% of the engine crew [16]. In the present study, modifiable CVD risk factors were observed more often in study subjects from EU countries with a prevalence between 9.2% and 45.8%. The significantly higher prevalence of both one and at least two modifiable CVD risk factors in participants from EU-countries compared to non-EU-countries might be due to their older age. Participants from EU countries were relatively older than those from non-EU countries. Besides, multinomial logistic regression analysis reported that participants from EU-countries 1.60 times more likely to have two and more than two CVD risk factors than those from non-EU countries. Our result was consistent with the study carried out among seafarers regardless of the differences in method, which revealed that European seafarers were 2.4 times more likely to have more than three CHD risk factors than non-European seafarers [16]. Another study reported that the proportion of high blood sugar (30%) was observed in the Croatian sailor [46].

Non-officers in the older age strata (i.e., age of 41 to 50, and age of >51) exhibited a higher prevalence of two and more CVD risk factors compared with the officers. Participants aged 51 and older were approximately four times more likely to have at least two CVD risk factors (OR: 3.92 (95% CI: 2.44–6.29)) than those aged between 19 and 30 years old, while controlling for marital status, rank, educational level, nationality, length of work at sea and working hours per week. This could be due to work-related stressors causing a negative effect on cardiovascular health after a long latency. Older workers may face more work-related stressors, are inactive in physical activity, and more able to complain about the psychological demands of work than younger age groups. Besides, older age is associated with an increased risk of various pathological changes, making older workers more exposed to different physical and psychological stressors than younger workers. A study in seafarers reported increased health problems and fatigue in older workers [47]. The same study found that the interaction between job demands, and age significantly impacted overall mental health and perceived stress [47]. Our study showed that non-officers (OR: 1.36 (95% CI: 1.09–1.70)) were more likely than the officers to have two and more than two modifiable CVD risk factors, while controlling for marital status, age, educational level, nationality, job duration at sea and working hours per week. Our result was not in line with the other previous study carried out in seafarers regardless of the difference in methods [16,48].

In general, this study revealed that non-officers, older age, married, low level of education, working hours per week, EU nationality, and job duration at sea were positively associated with modifiable CVD risk factor clustering, compared to their counterparts. Hence, the present findings may help to develop modifiable CVD risk factors prevention and control strategies onboard ships. As for intervention, for example, non-officers, those who are married, older seafarers (≥ 51 years), who work long hours per week, those with a low level of education, who have a long duration of work at sea, and seafarers from EU-countries could be screened for modifiable CVD risk factors, in particular for clustering of CVD risk factors. Additionally, these groups should be targeted for early prevention programs to reduce risk factors and prevent cardiovascular diseases, as they are more likely to have a modifiable CVD risk factor clustering.

Telemedicine approach prevention program can be more appropriate for screening the high-risk groups and follow-up visits at sea because Seafarers are hundreds of miles away from the nearest aid point regarding healthcare. Studies have reported that telemedicine has proven effective by providing advice, diagnosis, and treatment to seafarers during emergencies at sea [49]. Besides, it is possible to follow up visits and regular medical exam-

inations onboard ships through telemedicine using new technologies, such as high-speed internet and video conferencing [50,51]. Promoting a healthy lifestyle or behavioral modification efforts is most important to reducing CVD risk factors. Hence, the International Maritime Organization (IMO), together with other responsible bodies and stakeholders, should take into account strategies related to cigarette smoking reduction, including smoking restrictions on board ships. In 2006, the International Labor Organization (ILO) [25] adopted the Maritime Labor Convention (MLC) 2006, and it entered into force on 20 August 2013. In chapter five (title two), the 2006 Convention deals with the timetable working hours and rest hours for seafarers and clearly stated that seafarers' working hours are eight per day with one day of rest per week. However, our study reported that 51.2% and 22.9% of the participants worked 57–70 h and 71+ h per week, respectively. Therefore, the Convention 2006 has not yet been fully applied related to working hours of seafarers on board ships. Hence, the ILO and other responsible bodies should pay attention to its enforcement related to working hours according to the guideline because long working hours per week was one of the independent predictors for modifiable CVD risk factor clustering. As for physical activity, the working conditions of seafarers does not motivate them to carry out daily physical training as on land because there are sudden climate changes, accidents, and physical and psychological stress. However, planned health education regarding physical activity through telemedicine and the provision of simple and easy-to-use mobile applications [52] could encourage the seafarers to practice daily physical exercises to be physically active and reduce the chance of being overweight or obese.

Limitation of this study: this study was a cross-sectional study, and the study design prevents us from determining the causality or temporal relationship between modifiable CVD risk factor clustering and CVD. In the present study, we assessed self-reported modifiable CVD risk factors, except overweight or obesity. We did not include participants who were not on treatment despite having high blood pressure or high blood sugar. Therefore, these could underestimate the prevalence of hypertension or diabetes. Current smoking may be subject to reporting bias as it depends only on the participants' responses. Besides, those who did not smoke regularly were excluded. Hence, the prevalence of current smoking may be underestimated.

5. Conclusions

The results of our study demonstrate that a high prevalence of reported modifiable CVD risk factors was observed in non-officers. This study reported that the clustering of reported current smoking/overweight or obesity and overweight or obesity/reported hypertension/ reported current smoking were the most among the combination of two and three modifiable CVD risk factors; the prevalence was 30.9% and 70.0%, respectively. The present study indicates that non-officers, older workers, European seafarers, participants with a low level of education, who work long hours a week, are married, and have a long job duration at sea are susceptible to modifiable CVD risk factor clustering. Hence, a specific intervention targeting the high-risk groups should be designed and implemented onboard ships. In the present study, we did not consider cholesterol profiles, so a prospective study should be considered in the future to evaluate clustering and predict modifiable CVD risk factors, including cholesterol profiles among seafarers, for further preventive measures.

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Institutional Review Board Statement: The study was conducted according to the guidelines of the Declaration of Helsinki and approved by the C.I.R.M. ethics, scientific, and medical committee.

Informed Consent Statement: Informed consent was obtained from all subjects involved in the study.

Data Availability Statement: The data presented in this study are available on request from the corresponding author.

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COVID-19 vaccine on board ships: current and future implications of seafarers

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The impact and effect of novel coronavirus disease 2019 (COVID-19) are expanding all over the world without boundaries. When it began in China in late 2019, it was seen to be not as scary and devastating as it has become today. However, the hope for overcoming the pandemic lies in finding an effective treatment and inventing a vaccine. If we look at the history of the spread of this contagion, within a short span of seven months it has spread all over the world. Statistics are saying that more than 104 million individuals got infected and 2.2 million deaths were currently occurred [1].

In the last few months, there has been a massive revelation in the medical domain regarding the outbreak of COVID-19 and its vaccination [2]. It has been truly amazing to see scientists and doctors come together across all over the world to share their expertise to develop vaccination in the past few months. Thanks to the collaboration between researchers and scientists are always way ahead to take up challenges and bear the torch of a bright and prosperous future as far as the COVID-19 struggle is concerned. To channelise their potential and encourage them to develop solutions by joining hand together in this pandemic time, the government has also been supportive of various initiatives and funding. Medical doctors sharing their experiences and the patients who have recovered from this near-fatal disease largely help in vaccine development. This brought a whole new perspective on how to handle the current situation the world is facing with the COVID-19 pandemic.

Seafarers are unsung heroes of this pandemic because shipping plays an important role in this serious outbreak. Unfortunately, because of the global emergency that happened in the last year, seafarers went through the depressive symptoms and faced various neuropsychological and psycho-affec-

tive alterations [3]. To slow down the rate of onboard infection, various shipping companies provided some serious guidelines such as social distancing at working places, self-hygiene, and room quarantine for any suspicious cases. For some seafarers, this situation is unbearable. Because of the novel pandemic, tens of thousands of sailors were stuck on board for more than a year now. Despite the fact of crew changes have been made conceivable in certain nations, the implementation stays exceptionally challenging. These situations demand immediate access to the vaccine for seafarers.

The speakers in the CrewConnect Global Virtual Event 2020 highlighted that, with some vaccine trials now showing promising results, sailors need to be treated as fundamental workers and be among the first to get vaccine [4]. “I think all the work we’ve done in lobbying governments now needs to be even more concerted effort about the point that seafarers are essential workers... we need to find a way to find a way to access vaccines” said Mr Stephen Cotton, general secretary of International Transport Workers Federation [4].

Some countries, such as Singapore, already started vaccination for seafarers and it becomes one of the first nations to give importance for COVID-19 vaccine to frontline workers of maritime. According to the Maritime and Port Authority of Singapore, seafarers need to undergo fewer testing before getting vaccinated. It is scheduled that at least 10,000 seafarers can be vaccinated by the end of January 2021 under air vaccination exercise [5].

COVID-19 is considered a type of pneumonia which can be effectively treated by vaccination. All national bodies have to step forward and take Singapore as an example in the provision of vaccine for frontline workers such as seafarers. On other hand, the International Maritime Or-

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ganization also urges that maritime workers and seafarers have to obtain COVID-19 vaccination on a priority basis to allow them to work freely and sustain dynamic global supply chain.

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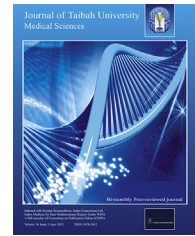
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Editorial Article

Are telemedicine systems effective healthcare solutions during the COVID-19 pandemic?



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Dear Editor,

On 9 January 2020, China's Centres for Disease Control and Prevention (CDC) reported that a novel coronavirus causing a severe acute respiratory syndrome (SARS-CoV-2) had been identified as the causative agent of an aggressive respiratory disease, later referred to as coronavirus disease 2019 (COVID-19).¹ As of 18 January 2021, there have been over 90 million reported cases of COVID-19 and the virus has been responsible for nearly 2.5 million deaths.² The COVID-19 emergency has required continued contingency plans, making it necessary to both rethink the current approach to healthcare as well as how to adapt to the emerging needs of healthcare in the context of a pandemic. We have learned how to mitigate the spread of the virus by implementing social distancing measures, enforcing proper mask compliance, and reducing face-to-face contact in a health setting unless absolutely necessary. Community spread from the virus must be prevented to minimise the risks of infection for health professionals. In this respect, essential telemedicine services may help safeguard public health in significant ways.³

The term 'telemedicine' was introduced in the 1970s by Thomas Bird, an American who used it to refer to the

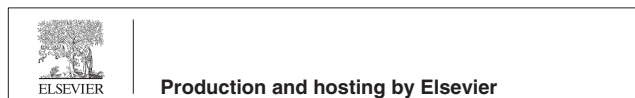
delivery of medical assistance via telecommunication devices without a physical meeting between doctors and patients.⁴ In simple words, telemedicine can be defined as the provision of healthcare for people in remote areas when the providers and receivers of assistance are not in the same place. There is a substantial body of scientific literature that specifically discusses the potential of telemedicine. Notably, telemedicine encompasses the use of video consultations, electronic prescriptions, and remote management and monitoring of symptoms and vital parameters. This can become an indispensable response, especially in disasters like COVID-19 and other high-risk situations involving public health.

No telemedicine programme can be created and activated overnight; however, the health systems of countries like the United States, United Kingdom, Germany, and Canada have already invested in telemedicine, thereby ensuring that COVID-19 patients will receive the treatment and assistance they need.⁵ In Italy, the use of telemedicine in the pandemic context has become a topic of interest, as evidenced by the documents provided by the National Institute of Health (NIH) (Istituto Superiore di Sanità, ISS).⁶ There have been national guidelines on the use of telemedicine since 2012, but there are still several obstacles to implementation such as service costs and the lack of regulations.⁷ This hinders the effective use of these tools throughout the national territory. All activities involving a citizen's personal and health data, which are essential for the provision of telemedicine services, are subject to the secure processing of sensitive data carried out through electronic tools. Thus, the fundamental methods and solutions have to ensure data confidentiality, integrity and availability; therefore, in any case, telemedicine has to be adopted as per the government rules.

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It is important to ensure the responsible use of telemedicine systems, and this can only be possible when the systems are used with better care and in the interest of public safety. The implementation of telemedicine should focus on monitoring patients with mild or asymptomatic cases, which then reduces hospital overcrowding. Accordingly, the possibility that crowding will be lessened also reduces virus spread, not only for patients but also for healthcare personnel.⁸ The usefulness of telemedicine solutions during the COVID-19 pandemic has already been confirmed in the case of remote areas in China, where the mortality rates and the virus spread were significantly higher than in cities with good healthcare systems.

New pandemic events created unique challenges in the provision of healthcare services. Although telemedicine does not present a solution to all problems, it is an important healthcare resource for people who are highly stressed. This includes citizens living in areas where medical services are difficult to access for geographic or other reasons, along with seafarers, who, when at sea, are essentially remote individuals.⁹ The provision of telemedicine should also comply with the ethical and legal standards attached to the medical profession, although relevant gaps still exist between the potentialities of technology and legislation/regulations.¹⁰ In terms of user responsibilities, it is important to highlight ethical issues concerning telemedicine.

With good reason, the current COVID-19 emergency is a call to action. The political responses of governments should include clear provisions on different fronts to evaluate their telemedicine measures as well as their interconnected implications. Subsequently, after the emergency phase, it will also be important to determine if these new approaches can help establish best practices in medicine that respect both the patients and organisations. Once telemedicine has been introduced to the Italian environment, if it is uniformly well-regulated throughout the national territory, it can play a significant role in responding to the current pandemic as well as any future such crises. Telemedicine also presents a solution to the anticipated future lack of healthcare personnel and to the vulnerability of the National Health Service (NHS) as exposed by the COVID-19 pandemic. It will then become necessary to think about and outline specific catalytic experiences—which are understood as contexts of dialogue and discussion, of education and learning as well as of regulations—to try to transform the challenges posed by the emergency into opportunities for improvement.

Telemedicine has consistently become more important over the past few decades; the COVID-19 new pandemic has only underscored the importance of its immediate adoption. Furthermore, reports indicate that between February 2020 to June 2020, telemedicine consultations sharply increased from 36 million to 200 million and are soon projected to reach 1 billion by end of 2020.¹¹ With telemedicine's present direction and widespread adoption, it can disrupt current well-being frameworks, as well as manage costs and care delivery, thus creating a stage for vastly unique medical services in the future.

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Conflict of interest

The authors have no conflict of interest to declare

Ethical approval

The authors confirm that this editorial had been prepared in accordance with COPE roles and regulations. Given the nature of the editorial, the IRB review was not required.

Authors' contributions

GB and GN conducted research, provided research materials, and collected and organised data. GB, AS and FA wrote the initial and final draft of the article. All authors have critically reviewed and approved the final draft and are responsible for the content and similarity index of the manuscript.



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Review

Telemedicine for Pre-Employment Medical Examinations and Follow-Up Visits on Board Ships: A Narrative Review on the Feasibility

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Abstract: Background: Telemedicine has already been applied to various medical specialties for diagnosis, treatment, and follow-up visits for the general population. Telemedicine has also proven effective by providing advice, diagnosis, and treatment to seafarers during emergency medical events onboard ships. However, it has not yet been applied for pre-employment medical examinations and follow-up visits on board ships. Objective: This review aimed to assess the possibility of using telemedicine during periodic visits between one pre-employment medical examination and others on board ships, and to recommend necessary medical examination tests with screening intervals for seafarers. Methods: Various databases including PubMed, EMBASE, Scopus, CINAHL, and Cochrane Library were explored using different keywords, titles, and abstracts. Studies published between 1999 and 2019, in English, in peer-reviewed journal articles, and that are conference proceedings were considered. Finally, the studies included in this review were chosen on the basis of the eligibility criteria. Results: Out of a total of 168 studies, 85 studies were kept for further analysis after removing the duplicates. A further independent screening based on the inclusion and exclusion criteria resulted in the withdrawal of 51 studies that were not further considered for our analysis. Finally, 32 studies were left, which were critically reviewed. Out of 32 accepted studies, 10 studies demonstrated the effectiveness of the electrocardiogram (ECG) in monitoring and managing remote patients with heart failure, early diagnosis, and postoperative screening. In 15 studies, telespirometry was found to be effective in diagnosing and ruling out diseases, detecting lung abnormalities, and managing patients with chronic obstructive pulmonary disease (COPD) and asthma. Seven studies reported that telenephrology was effective, precise, accurate, and usable by non-medical personnel and that it reduced sample analysis times and procedures in laboratories. Conclusion: using new technologies such as high-speed internet, video conferencing, and digital examination, personnel are able to make the necessary tests and perform virtual medical examination on board ships with necessary training.

Keywords: telemedicine; seafarers; cardiology; healthcare; technology



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1. Introduction

Telemedicine is the delivery of medical services over distance through information and communication technologies [1]. Telemedicine applications include disease prevention and control, healthcare, health promotion, education, training, and research for health [1]. Telemedicine can be traced back to the end of the 19th century to the mid-20th century with the use of radiotelegraphy to provide medical advice to patients onboard ships [2]. The evolution versus modern telemedicine began in the 1960s, mainly spurred on by the military and space technologies, as well as by some people using readily available commercial equipment [3,4]. More recently, the applications of telemedicine are manifold

and involve both developed and developing countries, rural areas, islands, and in all situations where distance could limit or make difficult the provision of medical care [5].

Merchant ships represent one of these potential scenarios as they spend long periods on the high seas. Most of the time, merchant ships do not carry a doctor or other health professional on board, and the healthcare is in the hands of the captain or his delegate when seafarers are injured or ill [2,6]. Seafaring is a hazardous profession when compared to land workers [7]. This is probably due to the intrinsic nature of the work rich in psychophysical stressors, including isolation from the family, the multiculturalism of the crews, limited recreational opportunities, and long work shifts [8]. Seafarers exhibit high mortality and morbidity when compared with workers onshore for both the deck and machine sectors [9]. They are also prone to unhealthy lifestyles, such as smoking and unhealthy diets [10]. These risk factors, combined with chemical exposure, make seafarers one of the categories with the highest rate of certain cancer and cardiovascular diseases (CVD) [8]. The most frequent causes of death are attributable to shipboard accidents, work-related accidents, CVD, and poisonings [11,12].

Occupational medicine is an internationally recognized branch of preventive medicine with a large diffusion in all EU countries with the broad spectrum of its influence. One of the main objectives of occupational medicine is the assessment of suitability or unsuitability for a given work, temporary or permanent. Moreover, occupational medicine has the task of assessing the risks associated with the workplace to protect and promote people's health by preventing diseases and accidents that could occur in the workplace [13]. In terms of telemedicine applications to occupational medicine, more than 50% of hospitals in the USA are using telemedicine to treat their patients and over 74% of companies offer telemedicine services to their employees as a part of their healthcare programs [14,15]. Moreover, in the UK, telemedicine is widely used and booming [16]. Telemedicine is often used in postoperative clinical programs and in the follow-up of patients with chronic diseases such as diabetes [17]. Telemedicine is widely demonstrated in the literature in many medical specialties such as pediatrics, neurology, cardiology, diabetology, psychiatry, postoperative orthopedic care, primary care, and emergency medicine in cognitive disorders [18–25]. However, only a few studies have focused on the use of telemedicine in maritime occupational medicine, especially virtual medical examination/test application during emergency on board ships.

The World Labour Organization (WLO) and the International Maritime Organization (IMO), in the report "Guidelines on the medical examination of seafarers", published recommendations concerning pre-employment medical examinations (PEME). The purpose of the PEME is to reduce the risk of illnesses or injuries to the seafarer on board. These visits are carried out every two years and involve certain tests proposed by the WLO and the IMO [26]. Protocols for pre-employment medical examination developed by national maritime authorities or other insurers, agents, or private companies may change screening intervals of less than the expected two years, some of which are carried out directly on board ships [10].

In Italy, the regulations in force provide that a competent doctor, appointed by the shipowner, within the framework of a health protocol, adequately monitors the health conditions of seafarers by carrying out periodic visits. Different medical tests are taken into account during each visit (health check at the time of recruitment/first visit and periodic check-ups), and medical examinations are considered, such as blood chemistry tests, electrocardiogram (ECG), visual function examination, audiometry, and other tests on doctor's recommendation, particularly during periodic visits. The legislation requires the competent doctor to collaborate with the employer/shipowner and/or the captain and with his prevention and protection service in order to carry out preventive and periodic health checks, expressing suitability for the specific task. The competent (occupational) doctor is also called upon to establish the health records of the individual worker, communicating any aptitude in writing to the employer/owner and to the worker [27–29]. However, there are lengthy processes for a medical check-up before boarding services; shipowners' requests

are addressed to the SASN (Servizi Assistenza Sanitaria Naviganti)-Health Assistance Services for Navigation, Maritime and Civil Aviation Personnel, reference USMAF-SASN for the territory or to an authorized medical officer [30]. After approval, depending on the appointment, periodic medical check-ups are to be carried out, with most medical examinations being performed onboard ships by a doctor or other health professionals. Hence, telemedicine for periodic medical check-ups can reduce unnecessary travel, skip/shorten some process steps, reduce transport costs for regular check-ups, avoid waiting lists, and increase the quality of services by offering specialty doctors the opportunity to participate in virtual examinations.

Telemedicine has proven effective by providing advice, diagnosis, and treatment to seafarers during emergency on board ships [31]. It has already been applied to various medical specialties for diagnosis, treatment, and follow-up visits for the general population and has made it possible to overcome various constraints such as geography and the resources to provide healthcare to remote populations [32]. However, it has not yet been used for pre-employment medical examinations and follow-up visits onboard ships. The purpose of the present review was to assess the possibility of using telemedicine during periodic visits between the pre-employment medical examination and others and to propose necessary medical tests with screening intervals to be included in PEME protocols.

2. Materials and Methods

The review was conducted by searching the different published scientific literature, indexed in various databases, including PubMed, EMBASE, Scopus, CINAHL, and Cochrane Library. We included studies in areas of 4 medical specialties reporting medical exams/tests frequently used in telemedicine, namely, electrocardiogram (ECG), spirometry, blood glucose monitoring, and urinalysis. Different key terms for search, including “telecardiology”, “tele diabetology”, “telespirometry”, “telenephrology”, “teleconsultation”, “telemedicine”, and “telehealth” were used. Inclusion criteria for selected studies included studies published between 1999 and 2019, studies published in English, peer-reviewed journal articles, conference proceedings, and full-text paper. Studies published with only abstracts and not in English were excluded.

In total, 168 potentially relevant studies were selected from the above databases. Out of a total of 168 relevant studies, 85 studies remained after the duplicates were removed. A further 51 studies were excluded upon reviewing the abstract, title, and assessment of full-text as not consistent with our research questions. Finally, 32 studies were selected after a thorough review and included in this review (Figure 1). The review analysis involved 3 independent reviewers and an expert in the event of disagreement.

The summary of results for the application of telemedicine in various medical examinations/tests of occupational medicine interest is summarized in Table 1 (Table 1).

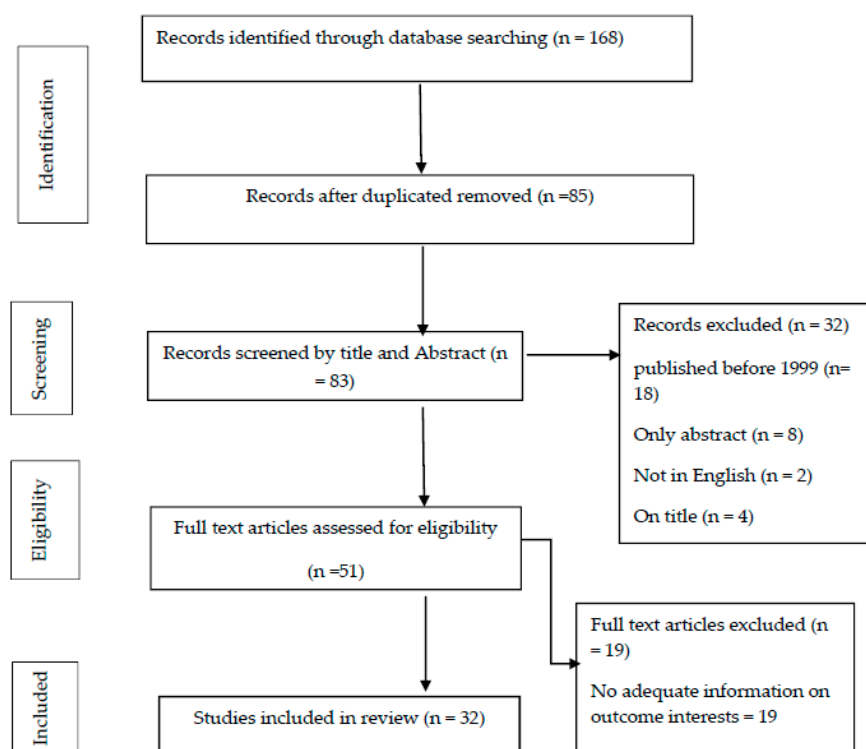


Figure 1. Literature search flowchart with eligibility criteria.

Table 1. Summary of results for the application of telemedicine in different medical examinations/tests.

Area of Application	Medical Examination/Test	Purpose of Application	Outcome	Reference(s)
Telecardiology	Electrocardiogram (ECG)	<ul style="list-style-type: none"> For tele-transmission and teleconsultation in the management of remote patients with heart failure 	<ul style="list-style-type: none"> ✓ Reduction of costs for diagnosis; ✓ Accurate in detecting an episode of atrial fibrillation (93%) and examination (94%). 	<ul style="list-style-type: none"> Molinari G. et al. [33] Inglis S.C. et al. [34] Lin C.T. et al. [35] Ong M.K. et al. [36] Herrin J. et al. [37] Majumder S. et al. [38] Sohn S. et al. [39] De Lazzari C. et al. [40] De Lazzari C. et al. [41] Lupi, L. et al. [42]
		<ul style="list-style-type: none"> Telemonitoring and postoperative screening of patients with cardiovascular cases 	<ul style="list-style-type: none"> ✓ Effective remote patient monitoring, including early diagnosis and postoperative screening. 	
		<ul style="list-style-type: none"> Prevention screening 		
Telespirometry	Spirometric test	<ul style="list-style-type: none"> Respiratory function test 	<ul style="list-style-type: none"> ✓ Effective by diagnosing and rule out pathologies, detecting pulmonary abnormalities. 	<ul style="list-style-type: none"> Kim et al. [43] Zealand N. [44] Molina-bastos C.G. et al. [45] Averame G. et al. [46] Toledo P.D. et al. [47] Owens M. et al. [48] Jouneau S. et al. [49] Vitacca M. et al. [50] Ohberg F. et al. [51] Kupczyk M. et al. [52] Redlich C.A. et al. [53] Stout J.W. et al. [54] Fung A.G. et al. [55]
		<ul style="list-style-type: none"> For early diagnosis and management of patients with COPD, asthma 	<ul style="list-style-type: none"> ✓ Successful self-management of clinical parameters of patients at home. 	
			<ul style="list-style-type: none"> ✓ Effective in managing patients with COPD and asthma (97.32% diagnosing accuracy). 	

Table 1. Cont.

Area of Application	Medical Examination/Test	Purpose of Application	Outcome	Reference(s)
Tele-diabetology	Blood glucose monitoring	<ul style="list-style-type: none"> ✚ Remote glyceimic self-monitoring. ✚ Telenursing, personal medical records, and tele-transmission. 	<ul style="list-style-type: none"> ✓ Effective in diagnosis, treatment, self-glycemic monitoring, and follow up. 	<ul style="list-style-type: none"> Bruttomesso D. et al. [56] Rodriguez-Gutierrez R. et al. [57]
Telenephrology	Urinalysis	<ul style="list-style-type: none"> ✚ Diagnosis and monitoring of the subject's nephrological and urological conditions. ✚ Prevention screening. 	<ul style="list-style-type: none"> ✓ Reduction of time of sample analysis and procedures in laboratories. ✓ Effective, precise, accurate, and usable by non-medical personnel. ✓ Successful in analyzing various tests, including glucose, proteins, bilirubin, ketones, nitrites, pH, specific gravity, erythrocytes, and leukocytes. ✓ The device is efficient and inexpensive. 	<ul style="list-style-type: none"> Hannemann-Pohl K. et al. [58] Langlois M.R. et al. [59] Mohammadi S. et al. [60] Ginardi R.V.H. et al. [61] Lee D.S. et al. [62] Soldat D.J. et al. [63] Montangero M [64]

3. Telemedicine in Different Medical Examinations/Tests

3.1. Electrocardiogram (ECG)

Telemedicine is not a separate medical modality but includes a growing variety of applications and services that use telephone lines, videos, e-mails, smartphones, wireless tools, and other forms of telecommunication technology. Among the wide range of medical specialties in which telemedicine has been successfully applied, cardiology has been found to be one of the most common fields of application. Through the transmission of clinical data and the electrocardiogram (ECG), telecardiology allows access to a real-time assessment (teleconsultation) without the need to travel for both the patient and the cardiologist. Telecardiology has proven to be useful in the clinical management of remote patients with real or suspected heart disease in different clinical settings. Over 20 years, several attempts have been made to try to introduce and expand telecardiology in the hospital setting, especially for the diagnosis and treatment of patients in remote locations [33]. Positive impacts of telecardiology have been demonstrated in the literature on patients with heart failure. In these patients, remote monitoring compared to traditional monitoring procedures decreased the risk of recurrence of the event [34].

A study conducted in 2010 demonstrated that the accuracy of an ECG performed remotely via wireless procedures in detecting an episode of atrial fibrillation was 93%, and the accuracy of this examination was 94% [35]. A study by Ong et al. (2016) focused on the effectiveness of remote patient monitoring (RPM) for the transition of care in adult patients with heart failure, finding no significant difference in patient readmissions for 180 days. Those who received the remote monitoring intervention had readmission rates of 50.8%, while those who did not receive the intervention had readmission rates of 49.2% [36]. Another study compared hospital readmission rates and death rates for two groups of heart failure patients, followed by telemonitoring and conventional monitoring. The types of post-treatment screening were comparable in that no statistically significant difference was found. Readmission rates were 49.3% for remote monitoring and 47.4% for routine

care, while the mortality rate for remote monitoring was 11.1%, and in routine care it was 11.4% [37].

The use of portable, non-invasive tele-cardiologic screening equipment was found to be less costly for hospitals and more comfortable for patients, allowing them to remain in domestic environments [38]. According to Sohn, costs would be around 25% lower in patients with mild symptoms [39]. In addition, to diagnosis and postoperative screening, telecardiology can also be used in prevention. In 2010, an Italian project was launched aimed at using a telecardiology device to perform early diagnosis of 13,016 students aged 16 to 19 [40]. In 2016, the same author collected the results showing that 24% of the suspects had altered signals in the electrocardiogram. The conclusion was that the use of telecardiology procedures in mass screening has many advantages such as lower costs, the possibility of use in environments far from hospitals, and not requiring qualified personnel [41]. Another study evaluated the effectiveness of remote monitoring through the use of various devices, including the electrocardiogram (ECG) in healthy clients, in patients at risk for cardiovascular diseases such as those with diabetes and hypertension, and in patients with a previous cardiovascular event. The healthy clients were monitored by a 12-lead ECG installed in pharmacies and connected to a telemedicine platform manned by a cardiologist 24 h a day. Between 1 January 2015 and 31 December 2017, the study involved a total of 79,898 women (mean age 52 ± 12 years) and 68,458 men (mean age 49 ± 11 years). Of all ECGs performed, approximately 8% showed electrocardiographic abnormalities inconsistent with the patient's medical history. The authors confirm that tele-cardiological screening systems can be used successfully in the prevention of cardiovascular diseases with a consequent positive impact on public health [42].

3.2. Spirometry

Spirometry, also defined as spirometric test or simply respiratory function test, is a diagnostic test that is performed using a spirometer, a computerized instrument, connected to a mouthpiece. It is a very simple, painless, and non-invasive examination. Spirometry plays an important role in the diagnosis and monitoring of chronic obstructive respiratory disease. It should be noted that relevant clinical guidelines indicate the need for widespread use of spirometry in primary care for the early diagnosis and appropriate management of chronic asthma and chronic obstructive bronchopulmonary disease (COPD). Hence, this test is of relevant importance in the health surveillance in preventive medicine for seafarers who, for working reasons, often need to face long journeys [43,44]. The possibility of remote use of spirometry through telemedicine equipment has been investigated by several authors both as a prevention and monitoring tool in patients suffering from respiratory syndrome [45]. Telespirometry is used in clinical practice to monitor asthma patients and patients with COPD living at a distance from the hospital [46,47]. These integrated systems, in patients with respiratory diseases and frequent exacerbations, can reduce both emergency room visits and the number of hospitalizations [48].

In 2009, Bonavia published an article reporting an Italian project investigating the possibility of using telespirometry in general medicine. As a part of the project, 937 family physicians exchanged data via telespirometry equipment with 56 specialist centers, visiting their patients with risk factors, persistent respiratory symptoms, or a previous diagnosis of asthma or chronic obstructive pulmonary disease for two years. About 90% of the spirometry tests (20,757 spirometry tests performed in total) met the criteria and made it possible to make a diagnosis or rule out pathologies. 40% of the spirometries made it possible to detect pulmonary abnormalities. The authors consider telespirometry to be a reliable and useful alternative in the management by general practitioners of chronic respiratory diseases. The quality of the spirometric examination is highly dependent on the skills of the technician administering the test. The pulmonology company's guidelines indicate the skills and training to be acquired to manage this exam [49]. An interesting perspective, which involves several studies, is given by the possibility of remote monitoring at home. This technology enables the self-measurement of clinical parameters/symptoms

of patients at home and allows the communication between healthcare professionals and remote patients [50,51].

A study investigated the possibility of carrying out the spirometric test directly at home in total autonomy. The study involved four patients with previous chronic obstructive bronchopathy who were provided with telespirometry equipment equipped with tablets capable of supporting the patient in the examination. This system was used for 12 weeks in which patients performed several daily spirometries without any medical assistance. As a result, the large part of the spirometry (94.5%) was considered acceptable and usable by qualified personnel [52]. Another study investigated the possibility of self-administration of the spirometric examination in asthmatic patients [53]. The author equipped 86 asthmatic patients with a portable instrument for spirometric measurements at home without medical supervision, evaluating their acceptability according to the American Thoracic Society and European Respiratory Society (ATS/ERS) criteria. The author set the primary endpoint with the following criteria: correct use of the device three or more times within 7 days (± 1 day) in one of the 3 weeks of the study. Of 78 patients, 67 (86%) reached the primary endpoint. Seventy-five (96%) participants used the device correctly one or more times, and 10 (13%) patients managed to use the tool every day during the 3 weeks. The authors showed that remote self-assessment using spirometry equipment is a feasible practice [53].

Adequate training in performing the spirometric examination of technicians or operators onboard the vessel capable of ensuring high-quality standards in spirometry could be fundamental to generate reliable results that the occupational physician could then assess from another clinic suitable for the examination, obviously using portable technological spirometers. The quality of spirometry tests strongly depends on adherence to international recommendations [53,54]. There are different tools today, such as those that use Android micro-control technology to measure lung function. For example, this latest technology has reported excellent results on patients who have been analyzed both with an examination performed with the traditional spirometer and with the new micro-control technology providing very similar final values, with an accuracy of high measurement and for forced expiratory volume in 1 s (FEV1) and forced vital capacity (FVC) indicating that this device, for example, could be usefully used in telemedicine and health surveillance. Furthermore, there is a remote assistance technology that uses a simple spirometer with a Bluetooth module, an ES application based on MATLAB, and a mobile app based on Android. In this case, the portable spirometer used in this study can be connected to a mobile phone via Bluetooth. This technology has been used to evaluate the chronic course of diseases such as COPD and asthma. During 6 months, 780 patients were assessed and diagnosed with an accuracy of 97.32% [55].

3.3. Blood Glucose Monitoring

Telemedicine interventions for diabetes can vary from simple reminder systems via text messages over complex web interfaces. Patients can upload their glucose levels measured with a home meter and other relevant data such as medications, eating habits, level of activity, and anamnesis. The measurement of blood glucose concentration represents an essential step in the management of diabetic disease—glycemic self-monitoring, in fact, is widely used by patients with type 1 and type 2 diabetes to verify metabolic compensation, to identify and treat episodes of hyper- and hypoglycemia and to adapt the hypoglycemic therapy to the conditions of life (nutrition, physical activity, stress, intercurrent diseases) [56]. In the field of diabetes, telemedicine is used in its various forms: remote glycemic monitoring, teleconsultation, personal medical records, telenursing, and call centers. Several studies have shown that real-time transmission of blood glucose data is achievable with evidence demonstrating improvements in terms of glycemic control [57].

3.4. Urine Analysis

Urinalysis is an important diagnostic screening test useful for diagnosing and monitoring nephrological and urological conditions. This test is also often used in general

preventive screening [58]. Information technology has significantly reduced the analysis times following the collection of urine and often performed in specialized laboratories. Nowadays, many portable electronic readers are available that can analyze in real-time the urine collected on particular test strips [59]. To be effective, these devices must be economical, portable, precise, reliable, robust, powered by batteries, and usable by non-medical personnel as well [59].

A recent development consists of the use of smartphones to read and interpret the results of the test strips where urine is collected [60]. These smartphones are often combined with electronic pocket readers and reagent strips [61]. Dae-Sik Lee proposed in 2011 a mobile health platform by combining a pocket colorimetric reader with a smartphone and paper strips for urinalysis capable of analyzing glucose, proteins, bilirubin, ketones, nitrites, pH, specific gravity, erythrocytes, and leukocytes. Various tests carried out show that the device is efficient, inexpensive, and accurate [62]. The urine test strip is a device made up of strips on different distinct reactive zones allowing for the determination of specific gravity, pH, proteins, glucose, ketones, bilirubin, blood, nitrites, urobilinogen, and leukocytes in the urine. Often, the results have to be interpreted, and, in order to avoid human error, some digital scanners are able to interpret the results independently via the smartphone camera [63,64].

4. Legal Implications of Telemedicine

Telemedicine has significant repercussions in the delicate ethical sphere, as this different way of managing the interaction and communication between the patient and the doctor (or in general, the health workers involved) impacts a particular situation for who is in need of health care. On the other hand, on establishing the patient–doctor relationship, the safeguard of the dignity of the patient should be always safeguarded.

The legal problems related to telemedicine have not yet found standard solutions at the international level. Any request for telemedicine is considered a medical act. Hence, although many teleconsultation procedures are unique, the traditional principles of traditional doctor–patient relationships are also valid in telemedicine. Three concerns can be involved in legal performance issues [65,66]. As a result, in terms of the person who transmits the data, “informed consent must govern the relationship between the patient and other interested parties.” This should include the patient’s awareness of the technical aspects; the potential risks; the precautions required; and, at the same time, and the guarantee of the confidentiality of information [66]. The person who receives the data is the medical service user. Regarding the service provider, confidentiality, as well as the quality of the transmitted and received data, must be guaranteed by the service provider [66].

5. Recommendations

Telemedicine can be used successfully for pre-employment medical examinations and follow-up visits on board ships. This study used a narrative review to evaluate the possibility of telemedicine for periodically pre-employment medical exams and follow-up visits for workers needing to be followed aboard ships. We considered four major medical exams/tests for telemedicine applications in this review, namely, electrocardiogram (ECG), spirometry test, blood glucose monitoring, and urinalysis. As a result of telemedicine, we proposed the necessary medical examinations/tests with screening intervals to be included in the pre-employment medical examination (PEME) protocols (see Table 2). Table 2 summarizes features, medical tests, suggested periodicity, telemedicine modality, and equipment to be used for telemedicine practice in occupational medicine. Possible applications of telemedicine in the PEME, follow-up, and future visits are detailed below:

1. PEME: ECG, spirometry, measurement of vital signs (blood pressure, heart rate, and temperature), oxygen saturation assessed by a pulse oximeter, blood glucose measurement by glucometer, and urinalysis are tests that can be monitored remotely in some cases even without medical assistance. These tests are currently used for the general population in different medical specialties. We thus suggest using them both

- for PEME visits and/or for periodic checks of seafarers aboard ships, provided that on board there is the necessary technological resource training.
2. Follow-up visits: Telemedical Maritime Assistance Services (TMAS) doctors can make multiple medical visits a single patient, guaranteeing appropriate evaluation standards. They can also follow the same patient for the necessary time by monitoring over time without the need for large displacements and without the need to visit inside the ships in person. The technological equipment should provide a secure and high-speed internet connection; a clinical telemedicine software that acts as a hub capable of sending the patient's vital parameters to the doctor; devices capable of monitoring the patient's body parameters; and, finally, an ad hoc training program with periodic simulations. If fitted onboard, these systems could also help a TMAS doctor make a correct diagnosis and plan adequate treatment.
 3. Future activities: the possibility of carrying out preventive medicine tests using telemedicine technologies could be considered in the future as a fundamental element for remote maritime preventive medicine practice. Specific experimental studies of devices integrated into platforms, protocols, and patient satisfaction should be conducted, possibly using targeted comparisons with traditional systems.

Table 2. The proposed general medical examinations and tests for seafarers on board ships using telemedicine technologies.

Features	Medical Examination	Periodicity	Telemedicine Modality	Equipment
General well-being	Medical history	Annual basis	Video, e-mail	Telemedicine devices
Noise	Audiometry test	Annual basis	Audio, video	Telemedical devices
General well-being Stress-related	Electrocardiogram (ECG), spirometry, urinalysis	Every six months	Still image Video	Telemedical devices
Vibrations	Postural evaluation: manual handling of loads	Annual basis	Video	Telemedicine devices
Exposure to toxic substances	Blood chemistry tests aimed at checking cardiovascular and renal function (blood count, blood sugar, liver and kidney function, lipid structure); leukocyte formula, urinalysis, determination of urinary hydroxypyrene.	Annual basis	E-mail, audio, video	Telemedicine devices
	Pulse oximetry, blood pressure	Every month	Video, e-mail	Telemedical devices
Postural workload	Body mass index evaluation; postural evaluation	Annual basis	Video	Telemedical devices
Fatigue and stress assessment	Electrocardiogram and saturimetry for fatigue; stress assessment, see the appropriate section of this protocol	Annual basis	Video, e-mail	Telemedical devices

6. Conclusions

This narrative review has highlighted how telemedicine and devices for the detection of body parameters in the medical field are extensively practiced in many specialties of modern medicine. This review evaluated telemedicine's feasibility for pre-employment medical examinations (PEMEs) and follow-up visits aboard ships. It recommended the necessary medical examinations/tests such as ECG, spirometry test, blood glucose monitoring, and urinalysis with screening intervals for seafarers' onboard ships be considered in the PEME protocol. Moreover, recommendations were provided to responsible bodies, stakeholders, and researchers to implement telemedicine during the PEME and study

its effectiveness. However, in many countries around the world, telemedicine is not an integral part of the health system, and thus it is legitimate to assume that the full potential of telemedicine has not yet been exploited. This review shows that with the advent of new technologies such as high-speed internet, video conferencing, and digital examinations, it is possible to report the necessary tests and perform virtual medical exams on board vessels. Telemedicine can be a fundamental element for the prevention and treatment required in health surveillance, particularly for the conditions in which reaching the patient is difficult and expensive, such as onboard ships.

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BMJ Open Incidence of occupational injuries and diseases among seafarers: a descriptive epidemiological study based on contacts from onboard ships to the Italian Telemedical Maritime Assistance Service in Rome, Italy

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ABSTRACT

Objectives Workers at sea have high mortality, injuries and illnesses and work in a hazardous environment compared to ashore workers. The present study was designed to measure the incidence of occupational injuries and diseases among seafarers and quantify the contribution of differences in rank and job onboard on seafarers' diseases and injuries rates.

Design Descriptive epidemiological study.

Setting and participants This study's data were based on contacts (n=423) for medical requests from Compagnie Maritime d'Affrètement/Compagnie Générale Maritime (CMA-CGM) container ships to the Italian Telemedical Maritime Assistance Service in Rome from 2016 to 2019, supplemented by data on the estimated total at-risk seafarer population on container ships (n=13475) over the study period.

Outcome measures Distribution of injuries by anatomic location and types of diseases across seafarers' ranks and worksites. We determined the incidence rate and incidence rate ratio (IRR) with a 95% CI.

Results The total disease rate was 25 per 1000 seafarer-years, and the overall injury rate was 6.31 per 1000 seafarer-years over the 4 years study period. Non-officers were more likely than officers to have reported gastrointestinal (IRR 2.12, 95% CI 1.13 to 4.26), dermatological (IRR 3.66, 95% CI 1.27 to 14.42) and musculoskeletal (IRR 2.25, 95% CI 1.11 to 5.05) disorders onboard container ships. Deck workers were more likely than engine workers to be injured in the wrist and hand (IRR 3.25, 95% CI 1.19 to 10.23).

Conclusions Rates of reported injury and disease were significantly higher among non-officers than officers; thus, this study suggests the need for rank-specific preventative measures. Future studies should consider risk factors for injury and disease among seafarers in order to propose further preventive measures.

INTRODUCTION

In 2015, more than 1.6 million seafarers served worldwide, of which 774 000 and 873 500 were officers and ratings, respectively.¹ It is estimated that nearly 65 000 deep-sea merchant

Strengths and limitations of this study

- The first study to measure the contribution of differences in rank and job to the rates of injury and disease of seafarer's onboard container ships.
- This study measured the incidence rates and incidence rate ratios of injury and disease by rank and worksite of seafarers based on contacts from onboard container ships to Telemedical Maritime Assistance Service.
- The estimated at-risk seafarer population was used in the analysis due to the lack of information on the actual at-risk seafarer population.

ships operate worldwide, carrying more than 1.6 million sailing seafarers.^{1,2}

In general, work onboard ships are broadly grouped by working areas, including the deck, engine and galley.³ Shipping is one of the most widespread transportation systems, and more than 88% of the world's trade use it.^{4,5} Workers at sea have high mortality, injuries and diseases rate compared with ashore workers.⁵ Sailing seafarers have a one in eleven chance of being injured on duty on board,⁶ and sometimes physical injuries can be acute and a primary cause of disability. Different studies have reported higher mortality and morbidity rates onboard merchant ships when compared with the land occupation. For instance, a study conducted on the British merchant fleet reported that between 2003 and 2012, the fatal accident rate in shipping was 21 times higher than that in the general British workforce, 4.7 times higher than that in the construction industry and 13 times higher than in manufacturing.⁷ Fatal occupational accidents in Danish seafarers

onboard ships were 11.5 times higher than Danish male workers ashore.⁸ Moreover, seafarers working on board of British merchant ships had 23.9 times higher risk of mortality due to accidents at work than all workers in Great Britain.⁹ The risk of death is 25 times higher for maritime transport than for air transport, according to the death accounts for every 100 km.¹⁰

Identifying the potential area of incidents and assessing the probability of the occurrence of occupational medical events may assure the availability of treatment and the development of prevention strategies to reduce the rate of diseases and/or injuries among seafarers and to improve health outcomes.^{11–13} Unfortunately, due to the scarcity of evidence-based information on the incidence of occupational diseases and injuries onboard ships, preventive measures in the maritime environment received less attention than other working activities.¹⁴ On the other hand, determinants of onboard merchant ship illnesses, injuries, disability and fatalities, remain not adequately studied due to the not easy access of seafarer's medical data.^{3,13,15} Previous studies have reported that non-officers have a higher risk for diseases and injuries compared with officers,^{3,15–18} but most of these studies considered only occupational groups.

The exposure to the work-related risk of officers and non-officers working in different ship areas such as deck, engine and galley is not similar because they attend different duties in different working hours.¹⁹ For instance, workers in the engine room are exposed to work-related risks such as noise, vibration and heat or pollutants during their working hours.^{19,20} In contrast, people working in the deck, as well as in the galley, are potentially exposed to different work-related risks.¹⁹ Because of the different areas of activity and associated burdens, the likelihood of illnesses and the occurrence of injuries can differ. Hence, the study on the incidence rates (IR) of injury and disease by rank and worksite of seafarers would provide information for prevention strategies such as resource allocation, prioritising training areas, improving the medicine chests on board, and access to telemedicine consultation to reduce injury and disease at the workplace.

The present study aimed to analyse the IR of reported occupational diseases and injuries among seafarers by worksite and rank groups. This work provides factual information on the rate of diseases and injuries between the worksite group as well as the rank. The results obtained can be used to prioritise occupational health risks and guide the development of preventative measures onboard container ships.

MATERIALS AND METHODS

Study design, data source and collection procedure

We employed a descriptive epidemiological study and received data from the Centro Internazionale Radio Medico (International Radio Medical Centre, C.I.R.M.) database. C.I.R.M. is the Italian Telemedical Maritime Assistance Service (TMAS) and represents one of the

oldest and best known TMAS worldwide. C.I.R.M. operates since 1935 and has assisted more than 100 000 seafarers onboard ships.²¹ Compagnie Maritime d'Affrètement/Compagnie Générale Maritime (CMA-CGM) is a French container transport and shipping company. It is a leading shipping group globally, using 200 shipping routes between 420 ports in 150 different countries. In this particular study, the data source we used was reported diseases and injuries from onboard CMA CGM container ships to TMAS, in Rome. CMA-CGM made a contractual agreement with C.I.R.M. Spin-off CIRM SERVIZI. In view of this agreement, data provided for medical assistance on the company's board ships are more detailed and, therefore, can be used for a basic epidemiological analysis.

Work-related diseases are diseases predominantly due to physical, chemical, and biological factors associated with merchant seafaring occupations, and they are recorded in the C.I.R.M. database according to the WHO International Classification of Disease 10th revised version (ICD 10). An occupational injury is defined as a sudden, unexpected and unwanted forceful event due to an external cause's onboard ships. In the C.I.R.M. database, injuries also are recorded according to the WHO ICD 10th revised version (chapter XIX, S00-S99 and T00-T98).

The classification of both diseases and occupational injuries was made according to the prompt diagnosis and recorded medical datasets in the C.I.R.M. database. The injury and disease rates measured were based on the contacts from onboard container ships to the Italian TMAS in Rome. Any contact for medical requests from ships to the C.I.R.M. with injuries or cases of illness with important patient data, including age, sex, job, rank, the nationality of the patient, ship flag, ship name, date of medical event that occurred, anatomic location of the injury, diagnosis, treatment provided, the patient follow-up schedule and other relevant information are registered in the database. Hence, we got access to occupational injuries and diseases with seafarers' rank and job from the TMAS database for this particular study.

An estimated total number of at-risk seafarer population was calculated by multiplying the number of vessels during the study period by the average number of crew members per vessel. As a result, large ships, including general cargo, tankers and bulk carriers, have an average size of 20 crew members per ship.³ The CMA CGM shipping company handles only container ships, with an average of 25 crew members per ship. Regarding rank distribution per ship, nine officers and sixteen non-officers serve onboard. In respect of worksite, 10 deck workers, thirteen engine workers and two galleys (catering) workers are in service per vessel. The average number of the crew size, their rank as well as worksite distribution per large vessel based on the knowledge of industry norm were calculated.

The number of CMA CGM container ships contracted over 4 years, from January 2016 to 31 December 2019, was 539. In other words, 539 vessels represented the total number of active ships onboard in 4 years (January

2016 to 31 December 2019), and due to this, we determined the cumulative IR. An estimated number of the total at-risk seafarer population for worksite and rank was determined by multiplying the total number of vessels over 4 years by occupation and rank distribution per ship. The total number of seafarers at risk was adjusted proportionally to the number of seafarers in the dataset for whom information on occupation and rank was available.

Statistical analysis

Descriptive statistics such as mean and SD of age, frequency and percentage of injuries by anatomic location and types of diseases were done to evaluate the distribution of reported occupational injuries and diseases in seafarers with injuries and diseases. Rank was stratified by officers (deck and engine officers) and non-officers (deck and engine ratings, and galley). The worksite was also categorised into three groups, including the deck, engine and galley. Then, worksite and rank-specific IR were calculated by dividing the number of cases by the total at-risk seafarer population for each worksite and rank over 4 years. IR ratio (IRR) and 95% CI were calculated to compare the injuries and diseases rates by seafarer's rank and worksite. The outcome of rates was expressed as per 1000 seafarer-years. Seafarer-year is defined as the number of crew members per ship multiplied by the number of vessels each year. The χ^2 or Fisher's exact test

was used to determine distributional differences in rank and worksite groups. A two-tailed $p < 0.05$ was considered statistically significant. The STATA software V.15 was used for data analysis.

Patient and public involvement

Patients and public were not involved in the study.

RESULTS

Overall, 423 patients were assisted by the C.I.R.M. aboard container ships during the 4-year study period. Of these, 338 (80%) and 85 (20%) were diseases and injuries, respectively. However, 11% (37) of the total number of patients with the disease and 8% (7) of the injured patients were unknown as to rank and worksite. The mean age (SD) of seafarers with diseases and injuries was 40.37+12.52 years and 38.39+12.88 years, respectively. Non-officers were more likely than officers to be injured (IRR=1.75) and to have reported the disease (IRR=1.45). Deck workers are almost two times more likely than engine workers to be injured ($p < 0.004$) (table 1).

The most frequent causes of illnesses onboard ships were gastrointestinal disorders ($n=71$, 21%), followed by musculoskeletal ($n=52$, 15%) and cardiovascular diseases ($n=51$, 15%) (figure 1). In general, out of the 85 injuries, 29% were wrist and hand injuries, 21% were knee/lower

Table 1 Number of cases, seafarer-years, incidence rates and incidence rate ratios (IRR) of injury and disease by rank and worksite of seafarers from 2016 to 2019

Variable	Injury (n=78)	Seafarer-years	Injury incidence rate (95% CI)	IRR* (95% CI)	P value
Total	78	12 365	6.31 (4.98 to 7.86)	N/A	
Rank					
Officer	19	4451	4.27 (2.57 to 6.66)	1	
Non-officer	59	7914	7.45 (5.68 to 9.61)	1.75 (1.02 to 3.10)	0.029
Worksite					
Deck	43	4946	8.69 (6.29 to 11.69)	1.99 (1.21 to 3.34)	0.004
Engine	28	6430	4.35 (2.89 to 6.29)	1	
Galley	7	989	7.07 (2.85 to 14.53)		
	Disease (n=301)	Seafarer-years	Disease incidence rate (95% CI)	IRR* (95% CI)	
Total	301	12 000	25.00 (22.36 to 28.04)	N/A	
Rank					
Officer	84	4320	19.44 (15.54 to 24.02)	1	
Non-officer	217	7680	28.25 (24.66 to 32.21)	1.45 (1.12 to 1.89)	0.003
Worksite					
Deck	171	4800	35.63 (30.56 to 41.26)	2.12 (1.65 to 2.72)	0.001
Engine	105	6240	16.83 (13.78 to 20.33)	1	
Galley	25	960	26.00 (16.92 to 38.20)		

*IRR only reported the result with a significant comparison at $p < 0.05$ for non-officer versus officer, deck versus engine, deck versus galley and engine versus galley.
N/A, not applicable.

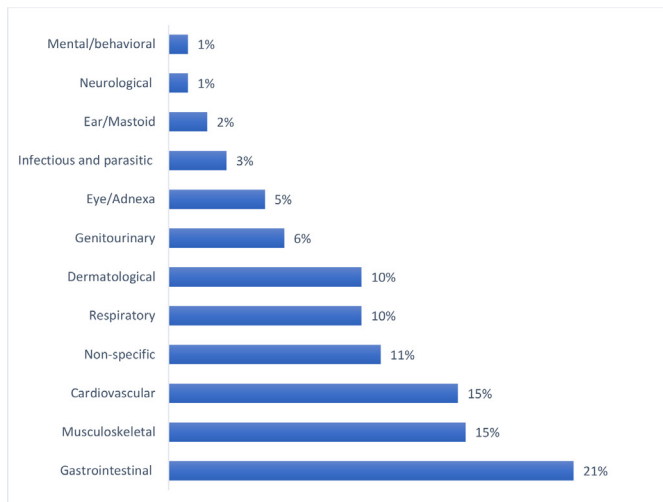


Figure 1 Diagnosis of seafarers according to WHO ICD 10th category from 2016 to 2019 (n=338). ICD-10, International Classification of Disease 10th revised version.

leg injuries, 13% were head/eye injuries, 12% were lower back/lumbar spine injuries, 8% were thorax/neck injuries (figure 2).

Rank-specific IR of occupational injuries and diseases

Gastrointestinal diseases were the most common disorders for officers (IR=3.07 per 1000 seafarer-years) and non-officers (IR=6.51 per 1000 seafarer-years), as presented in table 2. The most common injuries for non-officer was wrist/hand (1.93 per 1000 seafarer-years) and knee/lower leg (1.84 per 1000 seafarer-years). The IRR for non-officers' versus officers was determined and reported in table 2. As a result, non-officers were more likely than officers to have gastrointestinal (IRR=2.12), musculoskeletal (IRR=2.25), and dermatological (IRR=3.66) disorders. Concerning injuries, non-officers were more likely than officers to be injured in the knee or lower leg (IRR=4.21) (table 2).

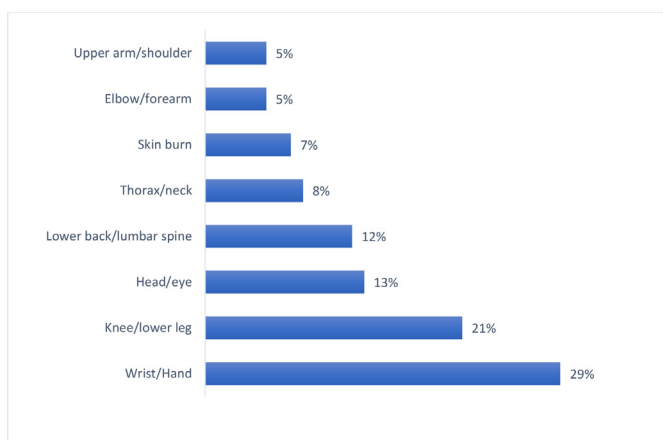


Figure 2 Distribution of injured body parts of seafarers with injuries from 2016 to 2019 (n=85).

Worksite-specific IR of diseases and occupational injuries

Table 3 summarises the rates of diseases and injuries per seafarer worksite groups. Consequently, gastrointestinal (IR=7.01), cardiovascular (IR=6.06) and musculoskeletal (IR=5.40) diseases were the most common disorders for deck workers. Musculoskeletal disorders (IR=2.52) were the second most common diseases for engine workers. Wrist/hand injuries (IR=2.89) were the most common injury for both deck and galley workers, while knee/lower leg injuries (IR=1.06) were for engine workers (table 3).

The IRRs for deck workers vs engine workers', deck workers vs galley workers', and engine workers versus galley workers were calculated and presented in table 4. As a result, deck workers were more likely than engine workers to have reported gastrointestinal (IRR=1.86), cardiovascular (IRR=3.26), dermatological (IRR=4.35), respiratory (IRR=2.62) and musculoskeletal (IRR=2.14) disorders. Also, deck workers were more likely than engine workers to be injured in the wrist and hand (IRR=3.25) (table 4).

DISCUSSION

This descriptive epidemiological study was mainly designed to quantify the IR of reported injuries and diseases among seafarers by worksite and rank groups. We have found that the rates of overall reported diseases were four times higher than the corresponding total reported injuries rates across all worksites. A similar finding was reported from a study conducted in the USA,¹⁵ which reported 2–3 times total illnesses higher in the worksites than overall injuries. The overall reported disease rate was 25 per 1000 seafarer-year during the study period. The disease rate for non-officers and officers were significantly differed (IRR 1.45, 95% CI 1.12 to 1.89). This study reported that the most common causes of illnesses on board were gastrointestinal (21%), musculoskeletal (15%) and cardiovascular disorders (15%). Similar findings were reported in a Japanese study,²² which has shown that gastrointestinal (35.5%), musculoskeletal (19.6%) and cardiovascular diseases (11.6%) were the diseases more often occurring onboard ships. Our findings are not consistent with the study conducted in the USA,³ which reported that dental (26%), respiratory (19%), and dermatological (14%) disorders were in the order the illnesses occurring most often among sailing seafarers.

The majority of gastrointestinal (63%) cases were gastro-oesophageal reflux, oesophagitis, ulcers, gastritis, hernia and appendicitis. Our work has demonstrated that non-officers were more likely than officers to have gastrointestinal (IRR=2.12), musculoskeletal (IRR=2.25) and dermatological (IRR=3.66) disorders. This study also revealed that deck workers were more likely than engine workers to have gastrointestinal (IRR=1.86), dermatological (IRR=4.35), respiratory (IRR=2.62) and musculoskeletal (IRR=2.14) disorders. These might be due to work-related stress because maritime officers, including the captain, have high-level responsibilities

Table 2 Incidence rate of diseases and occupational injuries by the seafarer rank from 2016 to 2019 (n=379)

Medical events	Officer			Non-officer			IRR*	95% CI	P value
	No	Rate	95% CI	No	Rate	95% CI			
Disease types									
Gastrointestinal	13	3.07	1.64 to 5.24	49	6.51	4.82 to 8.59	2.12	1.13 to 4.26	0.011†
Musculoskeletal	10	2.14	1.03 to 3.94	40	4.82	3.45 to 6.56	2.25	1.11 to 5.05	0.016†
Cardiovascular	10	2.69	1.29 to 4.95	29	4.39	2.95 to 6.31	1.63	0.77 to 3.75	0.179
Non-specific	12	2.86	1.47 to 4.99	20	2.68	1.64 to 4.14	0.94	0.44 to 2.10	0.849
Respiratory	11	2.59	1.29 to 4.63	17	2.25	1.31 to 3.60	0.87	0.38 to 2.05	0.711
Dermatological	4	0.88	0.24 to 2.25	26	3.22	2.10 to 4.71	3.66	1.27 to 14.42	0.007†
Genitourinary	10	2.06	0.99 to 3.78	11	1.27	0.64 to 2.28	0.62	0.24 to 1.63	0.280
Eye/adnexa	6	1.31	0.48 to 2.86	10	1.23	0.59 to 2.27	0.94	0.31 to 3.14	0.887
Infectious and parasitic	5	1.26	0.40 to 2.94	4	0.57	0.15 to 1.45	0.45	0.09 to 2.09	0.250
Ear/Mastoid	2	0.41	0.05 to 1.49	4	0.46	0.13 to 1.19	1.13	0.16 to 12.44	0.927
Neurological‡	—	—	—	4	0.46	0.13 to 1.19	—	—	N/A
Mental/behavioural	1	0.21	0.005 to 1.14	3	0.35	0.07 to 1.02	1.69	0.14 to 88.59	0.713
Injury location									
Wrist/hand	8	1.72	0.74 to 3.38	16	1.93	1.11 to 3.14	1.13	0.45 to 3.03	0.801
Knee/lower leg	2	0.44	0.05 to 1.57	15	1.84	1.03 to 3.03	4.20	1.01 to 38.01	0.032†
Head/eye	3	0.76	0.16 to 2.21	6	0.85	0.31 to 1.85	1.13	0.24 to 6.95	0.898
Lower back/lumbar spine	3	0.77	0.16 to 2.25	5	0.73	0.24 to 1.69	0.94	0.18 to 6.07	0.911
Thorax/neck	1	0.21	0.005 to 1.14	6	0.69	0.25 to 1.51	3.37	0.41 to 155	0.261
Skin burns	1	0.21	0.005 to 1.14	5	0.58	0.19 to 1.35	2.81	0.31 to 133	0.369
Upper arm/shoulder	1	0.27	0.006 to 1.53	3	0.46	0.09 to 1.35	1.69	0.14 to 88.6	0.710
Elbow/forearm‡	—	—	—	4	0.46	0.13 to 1.18	—	—	N/A

*IRR calculated as the rate of non-officer/rate of officer.

†Significant at *p<0.05.

‡Dashes indicate no case or the rate or the comparison that was not performed.

IRR, incidence rate ratio; N/A, not applicable.

such as navigation, planning, organisation of loading and unloading operations and ship controls.^{19 23} Non-officers are involved in other tasks occurring during a voyage and their work is physically more demanding and stressful than officers. In general, seafarers have high work-related stressors when compared with ashore workers²⁰ because their work is characterised by long working hours, often time-pressure, prolonged isolation from family and hectic activity. Various studies have reported that work-related stress has long been considered a contributing factor in the development of musculoskeletal problems²⁴ and gastrointestinal disorders.²⁵ Similarly, as for dermatological disorders, it might result in skin exposure to risk factors in the workplace. Seafaring is a risky activity characterised by exposure to different skin risk factors such as seawater, humidity, solar radiation and others.^{26 27} Deck crews are frequently engaged in maintenance, repair, loading, painting activities and exposure to chemicals, UV radiation and other skin risk factors.^{28 29} This study also reported the same rate of dermatological disorders for the deck (IR=3.96) and galley (IR=3.96) workers. However, this could be due to the small number of cases

among galley workers, and even the estimated non-cases of galley workers are not comparable in number to deck workers' non-cases. Consequently, 95% of the CI was wider for the case rate among the galley workers. The IRR results in the comparison made between the workers on deck and in the galley were also not statistically significant (p=1.044) on this matter. Further studies are needed to measure the effect of differences in the workplace of deck and galley workers on dermatological disease rates.

Angina pectoris (39% of all CVD diagnoses) was the most frequently reported cardiovascular disorders in this study. As for cardiovascular disorders, it could be related to lifestyle, especially a high-fat diet, drinking, smoking and physical inactivity. A study conducted on the board of Italian flagship (2019) reported that more than 40% and 10% of seafarers were overweight and obese, respectively.³⁰ This finding suggests that in seafarer's CVD risk factors are higher compared with ashore workers. We found that cardiovascular (IR=6.06) disorders were the second most common diseases for deck workers and deck workers were also more likely than engine worker to have reported cardiovascular diseases (IRR=3.26). This might

Table 3 Incidence rates of diseases and occupational injuries by seafarer's worksite from 2016 to 2019 (n=379)

Medical events	Deck			Engine			Galley		
	No	Rate	95% CI	No	Rate	95% CI	No	Rate	95% CI
Disease types									
Gastrointestinal	33	7.01	4.83 to 9.83	23	3.76	2.38 to 5.63	6	6.37	2.34 to 13.83
Musculoskeletal	28	5.40	3.59 to 7.79	17	2.52	1.47 to 4.04	5	4.82	1.56 to 11.22
Cardiovascular	25	6.06	3.93 to 8.94	10	1.86	0.89 to 3.43	4	4.85	1.32 to 12.38
Non-specific	18	3.86	2.29 to 6.09	13	2.15	1.14 to 3.66	1	1.07	0.03 to 5.96
Respiratory	18	3.82	2.26 to 6.02	9	1.46	0.67 to 2.78	1	1.06	0.03 to 5.89
Dermatological	20	3.96	2.42 to 6.11	6	0.91	0.34 to 1.98	4	3.96	1.08 to 10.09
Genitourinary	11	2.04	1.02 to 3.65	9	1.28	0.59 to 2.43	1	0.93	0.02 to 5.16
Eye/Adnexa	7	1.38	0.56 to 2.84	8	1.21	0.52 to 2.39	1	0.98	0.03 to 5.48
Infectious and parasitic*	5	1.13	0.37 to 2.64	4	0.69	0.19 to 1.79	—	—	—
Ear/Mastoid	1	0.19	0.004 to 1.03	4	0.57	0.16 to 1.46	1	10.93	0.02 to 5.16
Neurological	2	0.37	0.05 to 1.34	1	0.14	0.003 to 0.79	1	0.93	0.02 to 5.16
Mental/behavioral*	3	0.56	0.12 to 1.62	1	0.14	0.003 to 0.79	—	—	—
Injury location									
Wrist/Hand	15	2.89	1.62 to 4.77	6	0.89	0.33 to 1.94	3	2.89	0.59 to 8.45
Knee/lower leg*	10	1.96	0.94 to 3.61	7	1.06	0.43 to 2.18	—	—	—
Head/eye	6	1.36	0.49 to 2.96	2	0.35	0.04 to 1.26	1	1.13	0.03 to 6.30
Lower back/lumbar spine	4	0.93	0.25 to 2.37	3	0.54	0.11 to 1.56	1	1.16	0.03 to 6.44
Thorax/neck*	3	0.56	0.11 to 1.63	4	0.57	0.16 to 1.46	—	—	—
Skin burns	1	0.19	0.004 to 1.03	4	0.57	0.16 to 1.46	1	0.93	0.02 to 5.16
Upper arm/shoulder*	1	0.25	0.006 to 1.38	2	0.38	0.05 to 1.37	—	—	—
Elbow/forearm*	3	0.56	0.11 to 1.63	—	—	—	1	0.93	0.02 to 5.16

*Dashes indicate no case or the rate that was not performed.

be due to work-related stress because deck workers have high work-related stress due to sleep interruption, high job demands, night shift work and intense activity than engine workers. A study reported that work related stress was a risk factor for cardiovascular diseases.³¹ Long working hours are contributing factors to work-related stress, and it is logical to expect an association between long hours and cardiovascular disorders.^{32 33} Studies have also shown that night shift work had adverse effects on health and risk factors for the development of chronic diseases such as cardiovascular diseases.^{19 34 35} The relationship between stress and coronary heart disease are considered to be linked to multiple and protracted increases in heart rate and blood pressure resulting from neuroendocrine activation.^{36–39} Other studies have reported that work-related stress can increase the cardiovascular risk of workers.^{40–42} On the other hand, cardiovascular diseases and metabolic disorders are stress-related diseases.⁴³

The total reported injury rate was 6.31 per 1000 seafarer-year over 4years study period. The injury rate for non-officers and officers were significantly differed (IRR 1.75, 95% CI 1.02 to 3.10). Nearly 30% of injuries occurred in the wrist and hand, followed by the knee and lower leg (21%). Our results agree with the study conducted

in the Danish-flagged merchant fleet,¹⁸ which reported 36% and 18% of upper and lower limb injuries, respectively. Moreover, this study revealed that non-officers were more likely than officers to be injured (IRR=1.75). This finding was in agreement with the previous studies.^{3 17 44} Non-officer work is characterised by mooring, cleaning the ship, repairing broken cables and ropes, operating machinery such as cranes and drilling towers, and steering the ship at sea.^{20 23} The non-officer work is also physically challenging^{19 20 23} and must be carried out regardless of weather conditions. This could explain why non-officers have a higher rate of injuries than officers.

The present study has shown that the deck workers had higher rates of overall reported injuries (IR=8.69) compared with the engine (IR=4.35) workers. These results are consistent with those of the study conducted in the USA.¹⁵ We also found the injury rate for deck workers and engine workers were significantly differed (IRR 1.99, 95% CI 1.21 to 3.34). Similarly, deck workers were more likely than engine workers to be injured in the wrist and hand (IRR=3.25), as shown in table 4. A study conducted in Danish Fleet seafarers⁴⁴ reported that deck workers had a relatively low risk for injuries compared with machine (engine) workers. The difference could be due to

Table 4 Incidence rate ratios (IRR) and 95% CI of diseases and occupational injuries stratified by seafarers' worksite from 2016 to 2019 (n=379)

Medical events	Deck versus engine			Deck versus galley			Engine versus galley		
	IRR	95% CI	P value	IRR	95% CI	P value	IRR	95% CI	P value
Disease types									
Gastrointestinal	1.86	1.06 to 3.33	0.021*	1.09	0.45 to 3.21	0.869	0.59	0.23 to 1.77	0.263
Musculoskeletal	2.14	1.13 to 4.17	0.013*	1.12	0.43 to 3.72	0.857	0.52	0.19 to 1.81	0.224
Cardiovascular	3.26	1.51 to 7.58	0.001*	1.25	0.43 to 4.94	0.721	0.39	0.11 to 1.68	0.135
Non-specific	1.80	0.83 to 3.99	0.108	3.59	0.57 to 149	0.182	1.99	0.30 to 84.9	0.561
Respiratory	2.62	1.11 to 6.57	0.017*	3.59	0.56 to 149	0.182	1.38	0.19 to 60.7	0.846
Dermatological	4.35	1.68 to 13.18	0.001*	1.00	0.34 to 4.03	1.044	0.23	0.05 to 1.11	0.053
Genitourinary	1.59	0.59 to 4.34	0.311	2.20	0.31 to 94	0.494	1.38	0.19 to 60.68	0.846
Eye/adnexa	1.14	0.35 to 3.59	0.803	1.40	0.18 to 63	0.837	1.23	0.17 to 55	0.933
Infectious and parasitic†	1.63	0.35 to 8.19	0.486	—	—	N/A	—	—	N/A
Ear/mastoid	0.32	0.006 to 3.28	0.337	0.20	0.002 to 15.6	0.333	0.61	0.06 to 30.30	0.646
Neurological	2.60	0.14 to 153	0.485	0.40	0.02 to 23.5	0.495	0.15	0.001 to 12	0.267
Mental/behavioral†	3.90	0.31 to 204	0.257	—	—	N/A	—	—	N/A
Injury Location									
Wrist/hand	3.25	1.19 to 10.23	0.012*	1.00	0.28 to 5.39	1.050	0.31	0.06 to 1.90	0.130
Knee/lower leg†	1.86	0.64 to 5.75	0.216	—	—	N/A	—	—	N/A
Head/eye	3.90	0.69 to 39.50	0.089	1.20	0.15 to 55	0.949	0.31	0.02 to 18	0.398
Lower back/lumbar spine	1.73	0.29 to 11.80	0.494	0.80	0.08 to 39.7	0.794	0.46	0.04 to 24	0.524
Thorax/neck†	0.98	0.14 to 5.76	0.987	—	—	N/A	—	—	N/A
Skin burns	0.33	0.01 to 3.28	0.337	0.20	0.003 to 15.7	0.333	0.62	0.06 to 30.30	0.646
Upper arm/shoulder†	0.65	0.01 to 12.50	0.778	—	—	N/A	—	—	N/A
Elbow/forearm†	—	—	N/A	0.60	0.05 to 31.5	0.649	—	—	N/A

*Significant at $p < 0.05$.

†Dashes indicate the comparison that was not performed.

N/A, not applicable.

methodological differences. The study on seafarers in the Danish fleet was a questionnaire-based survey. Furthermore, denominators, used to determine IR and IRR in the Danish fleet, were not consistent with our study. Deck workers, particularly deck ratings, perform physical works such as mooring and unmooring the ship, loading, and unloading cargo.²³ Moreover, deck workers have a shorter sleeping time and sleep interruptions more often than engine workers because they are engaged in the surveillance system with frequent irregular operations. These include monitoring the bridge or gangway, acting as lookouts on the bridge, or carrying out repairs and maintenance work in the deck area.^{19 20 23} Hence, night shift work, long working hours, short average sleep time and physical stress are important factors contributing to the high rates of injuries/accidents at sea.^{10 19 45 46}

Strengths and limitations

This study measured the IR of reported injury and disease to TMAS for container ships. Most of the previous studies on diseases and injuries among seafarers were focused on the number of cases. As far as we know, this study is the first study to measure the contribution of differences in

rank and job to the rates of injury and disease of seafarers onboard container ships. Limitations of this study are: (1) We used an estimated average number of seafarers per ship in the analysis, although we took into account different assumptions, including the number of vessels, ships active at sea, number of crew members per ship and the length of stay of seafarers on board for the accuracy of the estimate. Consequently, the IR may be underestimated or overestimated. (2) Data from patients with injuries and cases of disease contained descriptions such as age and gender, but we had no descriptions of these data on the total at-risk seafarer population. Hence, we have not determined the rates and IRR of the diseases and injuries by seafarers' age and sex. (3) Patient data on both injury and diagnosis were compiled according to the revised WHO ICD10 codes and the injury's anatomic location in the database, but not on mechanisms of injury or potential physical hazards related to injured cases. As a result, we have not stratified injuries by mechanisms of injury or occupational hazards to highlight priority areas and recommend preventative measures. (4) We did not have descriptions of data types such as socio-demographic



variables and another exposure status of the total seafarer population at risk. In this respect, we have not determined the risk factors for injury and disease to propose further prevention strategies. Furthermore, this study is a retrospective study and limited to the variables available in the dataset. Finally, our study is limited to container ships and does not represent other types of ships at sea. Hence, the results do not reflect seafarers working on other types of ships.

CONCLUSION

The results of this study were based on the medical events (diseases and occupational injuries) of seafarers while working on board container ships. Non-officers had significantly higher rates of reported gastrointestinal, musculoskeletal and dermatological disorders compared with officers. Also, non-officers were more likely than officers to be injured in the knee and lower leg. Deck workers had significantly higher rates for dermatological, cardiovascular, musculoskeletal, respiratory and gastrointestinal disorders when compared with engine workers. Deck workers were more likely than engine workers to be injured in the wrist and hand. In general, the total reported injury and disease rates for non-officers were significantly higher compared with officers. The same is true for deck workers compared with engine workers. Hence, this study suggests the need for rank and work site-specific prevention strategies to reduce injury and disease rates at the workplace. Future studies should consider the risk factors for injury and disease among seafarers in order to propose further preventive measures.

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Contributors GGS: conceived and designed the study, performed analysis, methodology, interpreted the data and results, and drafted the initial manuscript. MD: extracted data and assisted with the preparation of the manuscript. GB: contributed to the data collection. MAS: interpreted the data and involved in the preparation of the manuscript. FA: guided, edited, reviewed and approved the study. All authors approved the final version of the manuscript.

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Competing interests None declared.

Patient consent for publication Not required.

Ethics approval The study has been reviewed and approved by the Scientific/Ethics Committee of the C.I.R.M. Foundation.

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Data availability statement No data are available.

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Letter to the Editor

Telemedicine framework to mitigate the impact of the COVID-19 pandemic

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Dear Editor,

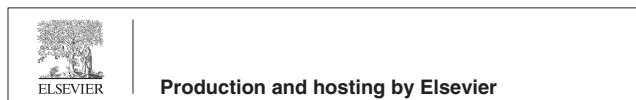
With more than 92 million infected cases, including about 2 million deaths, globally the novel coronavirus (COVID-19)¹ pandemic has shattered the health systems of most nations worldwide. Moreover, many of these systems are unprepared due to a lack of infrastructure and methods in place to guarantee complete health coverage. In view of the high pressure on health systems by the pandemic, reliable medical care is needed. This can be obtained via comprehensive digital techniques, especially in treatment and decision making during a severe pandemic such as COVID-19. The COVID-19 pandemic has triggered all healthcare authorities in one direction to promote the use of digital technologies. Despite some legal and ethical issues, most medical experts argue that telemedicine is a potential source of health care during global epidemics. The implementation of telemedicine systems with the objective of monitoring mild or asymptomatic cases would reduce the high volume of incoming patients. It could limit the cluster of cases and avoid the risk of infection for both patients and health professionals.

Telemedicine and telemonitoring solutions can treat patients in an emergency without physical presence at a hospital. With video conferencing, telemedicine systems enable direct communication with patients by smartphone or PC.

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The entire system should be managed by specially designed software to guarantee stable connections, information flow, and data security.² These systems are a mixture of medical devices, which will automatically record symptomatic information and assess the severity of a medical problem. Numerous efforts are required by all countries to ensure that epidemics such as the COVID-19 pandemic can be managed effectively. From this perspective, if telemedicine is fully integrated into a national health system, it could prove a valid instrument on its own to guarantee continuity of care and reduce the risk of contagion, especially among health professionals. It would also translate into reduced overcrowding of health facilities and result in only a minor depletion of doctors and nurses. However, we also observed unintended problems for doctors, patients, and society at large. In particular, in the U.S. population during COVID-19, disparities for telemedicine access were found in ethnic and racial minorities, the elderly, and those on a low income, among others.

Western healthcare systems are based on the model of in-person interactions between patients and their clinicians.³ This method of assistance contributes to the spread of virus not only to patients but also to health professionals who are carrying out the patient monitoring. A digitised care strategy should be applied in situations of isolation, lockdown, and limitation of movement, especially in those areas where healthcare facilities are not in close vicinity, or for those patients whose mobility is reduced. The validity and reliability of telemedicine systems have been confirmed by the example of some remote areas of China.⁴ For instance, infected patients in home isolation are able to record body temperatures or other metrics with simple devices like a thermometer through video conference with their personal doctor to avoid the risk of either being infected.^{4,5}

Telemedicine has already been proven as an effective solution in past pandemics, such as the Severe Acute

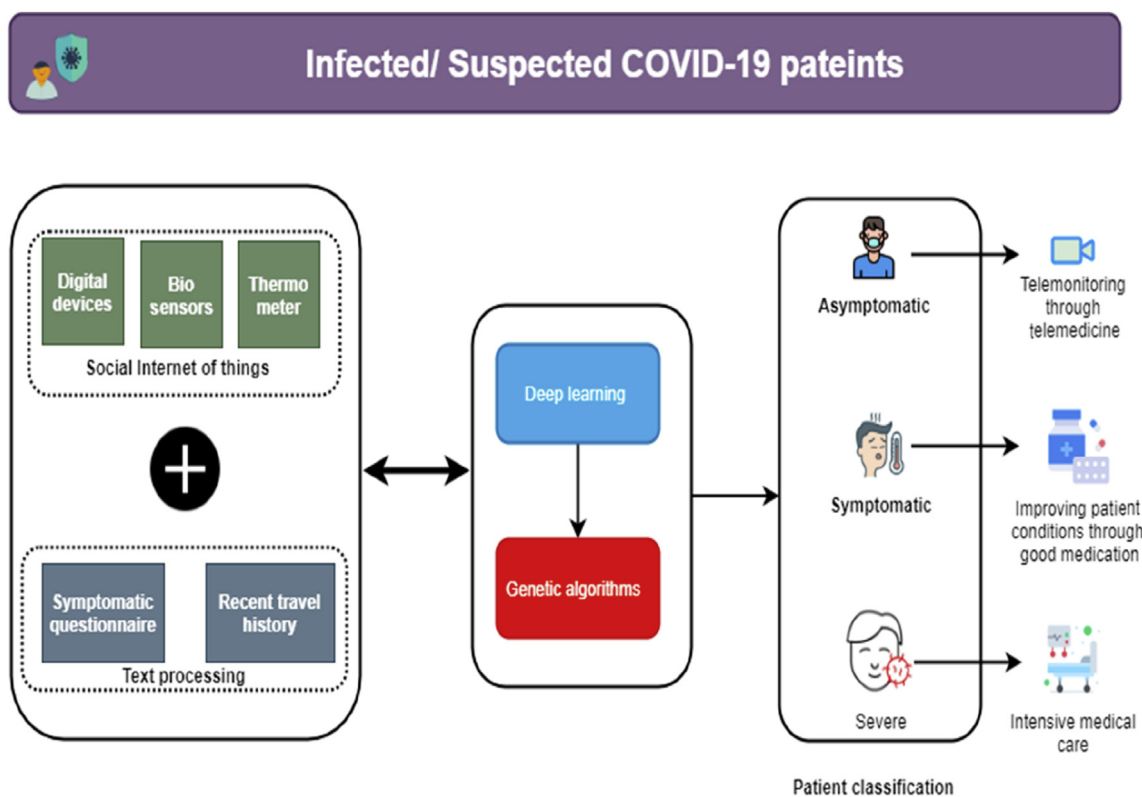


Figure 1: Telemedicine monitoring framework to assist the COVID-19 infected/suspected population.

Respiratory Syndrome Coronavirus, Middle East Respiratory Syndrome Coronavirus, Ebola, and Zika. For instance, if a person is exposed to mild COVID-19 symptoms, doctors recommend a home quarantine. However, a greater risk of psychological issues like anxiety, depression, and distress is possible. To reduce this risk, different computer mechanisms and digital technologies are recommended. Yet, to date, there is no reliable and authenticated telemedicine system to mitigate the risk of infection. In this work, we present a conceptual framework (Figure 1) for the remote monitoring of infected and suspected COVID-19 patients. This integrated system may guarantee controlled management not only of positive patients but also asymptomatic and chronically ill patients in the COVID-19 outbreak and/or similar emergencies.

The proposed model is framed with both Social Internet of things (SIoT) and Artificial Intelligence (AI) techniques such as text processing, deep learning, and genetic algorithms. The SIoT is used to collect the symptomatic information of COVID-19 infected patients. Digital devices, biosensors, and thermometers can help to provide daily information such as heart rate, blood pressure, body temperature, galvanic skin response. After having collected the required information, with a mixture of deep learning, text processing, and genetic algorithms the model framework is employed to create a comprehensive classification model to verify patient condition (symptomatic, asymptomatic, or severe conditions). Three types of telemedicine services can be offered within the proposed modelling framework as mentioned below.

- If the patient is asymptomatic, telemedicine monitoring will be continued until the incubation period is complete.
- If the patient is symptomatic but mild to moderate, continuous expert contact will be maintained through video conferencing to mitigate further symptoms.
- If the patient has severe conditions, immediate information can be conveyed to emergency medical services for the ultimate provision of intensive care.⁶

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Conflict of interest

The authors have no conflict of interest to declare

Ethical approval

The authors did not have permission for direct communication with human participants in the study and no ethical issues were encountered during the study presentation.

Authors' contributions

GP and GB conceived and designed the study, conducted research, provided research materials, and collected and

organised data; GN analysed and designed the framework; GP, GB, and FA wrote the initial and final drafts of the article and provided logistic support. All authors have critically reviewed and approved the final draft and are responsible for the content and similarity index of the manuscript.

Appendix A. Supplementary data

The supplementary material associated with symptomatic classification using machine learning algorithms⁶ can be found in the work of AI chatbot application during the COVID-19 pandemic <https://doi.org/10.1016/j.jtumed.2020.12.010>.

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Article

Assessment of Awareness and Knowledge on Novel Coronavirus (COVID-19) Pandemic among Seafarers

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Abstract: *Background:* The ongoing pandemic due to the novel coronavirus (COVID-19) is becoming a serious global threat. Experts suggest that the infection can be controlled by immediate prevention measures. Sailing is one of the occupational categories more vulnerable to this virus outbreak due to the proximity of the working conditions. *Objective:* Awareness and knowledge assessments of seafarers towards the current epidemic is mandatory to understand the effectiveness and success of the infection control measures adopted by shipping companies. *Methods:* In this study, we presented an online questionnaire survey to determine the knowledge levels of COVID-19 among seafarers. The data were collected by self-reported survey, and analysis was done by the analysis of variance (ANOVA). The *t*-test was used to understand the knowledge attitude differences to COVID-19 among different occupational groups of seafarers, and the *p*-value \leq of 0.05 was considered statistically significant. *Results:* Among 1,458 responses received, 92.82% had a college or university degree. The results reported that the mean COVID-19 knowledge score was 5.82 (standard deviation = 0.51, range 0–6), and the overall correct percentage was 97%. There was a statistically significant difference between age groups ($F(4, 1453) = 5.44, p < 0.001$) and educational groups ($F(4, 1453) = 1.52, p < 0.001$). The knowledge score was not significantly different across the educational status of the participants ($F(2, 1455) = 1.52, p = 0.220$). *Conclusions:* The present study highlighted good knowledge and behaviours among sailors about COVID-19. However, shipping companies need to come up with new campaigns to hold optimistic practices and suitable guidelines on ships, including cruise boats, to keep sea workers always alert and collaborative in mitigating the spread of COVID-19.

Keywords: COVID-19 spreading; online survey; awareness and knowledge; ships; seafarers



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1. Introduction

The novel coronavirus disease, or COVID-19, was first identified in December 2019 at a Wuhan wet market in China and then constantly spread all over the world at a rapid pace [1]. As of 5 January 2021, more than 85 million cases have been reported, including 1.86 million deaths [2]. In many cases, COVID-19 develops mild-to-moderate symptoms. In some cases, it might cause severe sickness, including pneumonia and, consequently, death. A person who is infected by the virus usually takes five to seven days to develop symptoms, and it can extend up to 14 days [3].

Currently, many European countries like Italy, France, Germany, and others have been exposed to the second wave of the COVID-19 pandemic [4]. These countries were severely hit by the first wave of pandemic during the spring, which was followed by the second wave during late summer and autumn. Epidemic data present the virus characteristics, and its effects are varied between these two periods. The symptoms like pneumonia, dyspnea, fever, cough, chronic neurological diseases, and type 2 diabetes mellitus are often found in both waves. In severe cases, the symptoms usually get worse gradually after

the initial appearance. To slow down the spreading of the virus and reduce its effects, governments around the world have made travel restrictions and closed their country's borders [5]. Various ports and air terminals are closed, ships' entries are denied, and all planes grounded.

Due to the limited medical resources, natural exposure to new environments and crowded, enclosed areas make the high risk of the present novel pandemic spread among many cruise ships [6]. On 4 February 2020, the UK-registered ship named the Diamond Princess was exposed to a large outbreak of COVID-19, and this was quarantined for about one month at Yokohama, Japan. More than 700 individuals were infected, including 14 deaths [7]. Over 40 cruise ships have confirmed positive cases of COVID-19 infection onboard, and port authorities and governments are advising people to avoid travelling on cruise ships and restraining ships from docking [8]. Besides, many maritime transport lines have been suspended to prevent the epidemic spread [9].

Seafarers are the unsung heroes of this pandemic, because over 90% of the world trade, including medical goods, raw materials, essential foods, and manufactured goods, depends on them [10]. Based on a report published by the International Maritime Organization (IMO), seafarers are collateral victims of this pandemic emergency, as travel limitations have left a huge number of them abandoned on boats or unfit to join ships [11]. Moreover, commercial fishing is a main source of the world's food. Several sailors are ready for stretched out work timeframes; to maintain a strategic distance from becoming infected, crewmembers need to change all the time, and this includes nearly 100,000 sailors every month [12,13].

The COVID-19 pandemic has introduced phenomenal circumstances around the world. The worldwide health authorities have been focused on controlling the disease by mitigating actions to limit the fast-spreading. Currently, two vaccines—namely, Pfizer-BioNtech and Moderna's—are authorized and recommended to prevent COVID-19; additionally, the presence of more than 50 COVID-19 vaccines are in trials, yet the world is looking for safe and effective ones [14]. Of the problems caused by the COVID-19 pandemic, around 90,000 sailors are now stuck on cruise ships without passengers [15]. Since the ship is a closed environment, there is a high chance of being infected. After being at sea for at least 14 days, and if no crewmember shows the symptoms of the COVID-19 illness, then a ship can be considered as virus-free and, eventually, safe.

The recent literature on COVID-19 highlights scientific knowledge or epidemic projections, especially in the public health environment [16]. Outcomes integrated with scientific knowledge tend to identify the key safety-related issues. Apart from the clinical and healthcare aspects like the safety of medical doctors, social and occupational safety, and, in particular, mental health, they have gained large attention from the COVID-19 scientific community [17]. The individuals living in closed environments like ships should have basic knowledge when addressing key social issues, including an urgent need to understand and believe the science about the COVID-19 pandemic that is shattering the present world.

This study presents an online cross-sectional survey designed to understand seafarers' behaviour and knowledge during COVID-19. A similar study was conducted on USA residents during the early epidemic phase to evaluate their knowledge levels and behavioural characteristics [18]. This study is among one of the first attempts to measure the knowledge on COVID-19 among crew members of merchant ships addressing requests for telemedical advice to the Centro Internazionale Radio Medico (C.I.R.M., International Radio Medical Centre).

2. Methods

2.1. Participants

The current cross-sectional investigation enlisted a sample of seafarers from the C.I.R.M. [19]. With more than 100,000 seafarers assisted onboard ships, the C.I.R.M. is the maritime telemedical centre with the largest experience of medical assistance to sailing seafarers. It was established in 1935 to give free radio medical advice to ships of all

nationalities navigating in international waters. The C.I.R.M. is the Italian Telemedical Maritime Assistance Service (TMAS). The online questionnaire was delivered to 5000 seafarers, and 1458 (about 30%) agreed to provide consent to participate in this survey. We assumed that the participants that did not show interest in this study was due to a lack of internet on-board, staying with family because of fear caused by COVID-19, or a low-level knowledge of English.

2.2. Survey

The questionnaire included in the survey was refined by phrase changing, the possibility of adding new questions, and modifications of other research studies that provide extensive knowledge on the COVID-19 epidemic. Two C.I.R.M. doctors thoroughly reviewed the final questionnaire to make sure each item of the survey was clearly understood. The final questionnaire consisted of 25 questions and was distributed through a Google Form link.

The survey was organized into three sections: demographic characteristics, including age, rank onboard, members onboard, and educational status, etc. (5 items); personal characteristics (14 items); and the knowledge questionnaire had 6 questions regarding clinical presentation (2 questions), COVID-19 transmission routes (2 questions), and prevention and control (2 questions). Moreover, the questionnaire was adapted from previous studies on COVID-19 knowledge [18,20]. These questions were answered by correct and incorrect options. As a result, a correct answer was assigned “1”, and an incorrect answer was assigned “0”.

Before starting the survey, seafarers read an informed consent explanation that portrayed that cooperation was deliberate and that they could stop whenever. By tapping on a “next” button, members were considered as agreeing to finish the online questionnaire. The survey consisted of closed-ended questions, of which six permitted the seafarers to have the chance to give further details if the “other” alternative was chosen from the multiple-choice questions. The closed-ended questionnaire consisted of categorical, dichotomous, multiple-choice, and Likert-type questions on five-point rating scales. At the end of the questionnaire, we requested the participants provide final feedback regarding their participation in the study.

2.3. Reliability and Validity of Responses

The main objective of any questionnaire is to gather relevant information most reliably and validly. These factors are commonly associated with the conduction and selection of valid research instruments. As mentioned, this was a study related to onboard behavioural characteristics of seafarers, and we adopted the face validity method that was done by an analysis of the data using Cohen’s Kappa Index (CKI). A kappa value that was greater than 0.6 was accepted as a valid question [21]. The items in the knowledge questionnaire were further validated with the CKI scale.

2.4. Statistical Analysis

Demographic variables such as age, rank, and educational status were done using frequency analysis. Frequencies of correct answers to knowledge questions were determined. A one-way analysis of variance (ANOVA) was used to determine the differences in the mean knowledge scores between the age groups, rank groups, and educational status. The *t*-test was used to understand the knowledge attitude differences to COVID-19 among different occupational groups of seafarers, and a *p*-value of ≤ 0.05 was considered statistically significant. Statistical analysis was carried out by IBM SPSS v.26 (Armonk, New York, NY, USA).

2.5. Ethical Approval

The review board members and the Ethics Committee of C.I.R.M. approved this study. The checklist for research ethics during the COVID pandemic was adopted from the UK

research integrity office (UKRIO) guidelines [22]. This study was reviewed and approved by the C.I.R.M. Research Ethics Committee (ESI/2020/017). All participants provided consent by responding to a yes/no inquiry toward the beginning of the survey before they responded to the first question.

3. Results

Table 1 includes the participants' basic demographic characteristics: age group, rank onboard, and educational status. Table 2 presents nine questionnaires that were administered to measure the awareness about COVID-19, including clinical characteristics, transmission, prevention, and control. Among the total number of the respondents, the majority (97.87%) of them reported that they are aware of the novel coronavirus outbreak. Of the respondents that reported, 93.63% said that they were never infected by the new coronavirus, and 88.73% of the respondents reported that none of the people in their immediate social environments were infected.

Table 1. Participant demographic and awareness characteristics.

Demographic Characteristics	N	%
Gender		
Male	1241	85.11
Female	217	14.89
Age (Years)		
<20	21	1.4
20–30	332	22.8
30–40	431	29.6
40–50	571	39.2
>60	103	7.1
Education		
Primary education	44	1.01
College/University education	1237	92.82
Secondary School education	177	6.17
Rank on board		
Deck Officers	579	39.72
Deck Rating	281	19.24
Engine Officers	268	18.35
Engine Rating	220	15.11
Galley	111	7.58

Regarding behaviours, 42.57% of the participants reported that they were moving with other staff onboard, and just 0.22% of participants used a bed previously used by someone who got infected. Most seafarers (98.4%) provided a correct response on the transmission of the novel coronavirus. Regarding mental health status, 33 (2.24%) seafarers reported feeling lonely, 862 (59.13%) seafarers reported feeling well, 395 (27.10%) seafarers reported missing family/friends and 168 (11.53%) seafarers reported feeling overstressed.

The correct answers to knowledge questions ranged from 91.8% to 99.4% (Table 3). The mean COVID-19 knowledge score was 5.82 (standard deviation = 0.51, range 0–6), and the overall correct percentage was 97%. Most of the seafarers (99.4%) were aware of the COVID-19 clinical symptoms, and 95.7% realized that all infected individuals did not develop into severe cases. Viral infections are highly contagious among the people who live nearby and spread by respiratory droplets. Most respondents (97.3%) were aware that COVID-19 can be caused by human transmission when infected persons cough or sneeze.

Table 2. Awareness on COVID-19 onboard.

Q1. Are you aware of the novel coronavirus outbreak?		
Heard from Others	13	0.90
No	18	1.23
Yes	1427	97.87
Q2. Are you or have you been infected with the novel coronavirus?		
Do not know	86	5.92
No	1365	93.63
Yes, confirmed	7	0.45
Q3. Do you know people in your immediate social environment who are or have been infected with the novel coronavirus?		
Do not know	106	7.25
No	1294	88.73
Yes, confirmed	42	2.91
Yes, not confirmed	16	1.11
Q4. Are you closely moving with other staff onboard?		
No	196	13.41
Sometimes, I cannot avoid	642	44.02
Yes	621	42.57
Q5. Was your travel history associated with infected countries in the last two months?		
Maybe	52	3.58
No	414	28.41
Yes	992	68.01
Q6. Have you used a bed previously used by someone who got infected by coronavirus?		
May be	18	1.23
No	1436	98.5
Yes	3	0.22
Q7. Which of the following is correct about the transmission of the novel coronavirus?		
Do not know	11	0.78
The novel coronavirus is not transmissible	3	0.22
The novel coronavirus is transmissible from person to person.	1435	98.44
The novel coronavirus is transmitted by animals to humans only	8	0.56
Q8. Are your handwashing for at least 20 s?		
Yes	1366	93.68
No	92	6.32
Q9. How is your mental health during these periods		
Missing family and friends	395	27.1
Feeling lonely	33	2.24
More often getting stress	168	11.53
Feeling well	862	59.13

Table 3. Frequency of correct answers to the knowledge questions. CKI: Cohen’s Kappa Index.

Knowledge Questions	N (Correct%)	CKI
KQ1: The main clinical symptoms of COVID-19 are fever, fatigue, shortness of breath, and dry cough.	1449 (99.4)	0.7
KQ2: Not all persons with COVID-19 will develop into severe cases. Those who are older and have chronic illnesses such as diabetes, heart diseases, cancer, and chronic kidney diseases are more likely to have severe cases.	1395 (95.7)	0.6
KQ3: The COVID-19 virus spreads via respiratory droplets of infected individuals.	1418 (97.3)	0.8
KQ4: By wearing masks onboard, it is possible to control the speed of the virus spreading.	1338 (91.8)	0.9
KQ5: Isolations and treatment of people who are infected with COVID-19 are effective ways to reduce the spread of the virus.	1443 (99)	0.8
KQ6: People who have contact with someone infected with the COVID-19 virus should be immediately isolated. In general, the observation period is 14 days.	1448 (99.3)	0.7

Based on the guidelines provided by the World Health Organization (WHO), it is evident that wearing facemasks only can help prevent becoming infected with the virus [23]. In this study, 92% of participants agreed that spreading of the virus can be controlled by wearing masks onboard; 99% mentioned that treatment and isolation are promising ways to reduce the virus transmission, and 99.3% provided the correct response on the incubation period of COVID-19. These findings appreciate the well-known knowledge of emphasizing maintaining onboard social distancing to control further infections. There was a statistically significant difference between the age groups ($F(4, 1453) = 5.44, p < 0.001$) and rank groups ($F(4, 1453) = 32.18, p < 0.001$), as determined by one-way ANOVA. The knowledge scores were not significantly different across the educational statuses of the participants ($F(2, 1455) = 1.52, p = 0.220$) (Table 4).

Table 4. Background characteristics of seafarers and knowledge scores of COVID-19 by age, rank, and educational status.

	Demographic Characteristics			
	N (%)	Knowledge (Mean + S.D)	F-Test	p-Value
Age Group				
<20 Years	21 (1.44)	5.43 + 0.81		
20–30 Years	312 (21.4)	5.76 + 0.56		
31–40 Years	440 (30.2)	5.84 + 0.49	5.44	<0.001
41–50 Years	573 (39.3)	5.86 + 0.44		
>51 Years	112 (7.7)	5.79 + 0.60		
Rank category				
Deck officer	579 (39.7)	5.98 + 0.12		
Engine officer	268 (18.4)	5.76 + 0.57		
Deck Rating	281 (19.3)	5.73 + 0.61	32.18	0.220
Engine Rating	220 (15)	5.74 + 0.60		
Galley	110 (7.5)	5.51 + 0.76		
Educational status				
Primary school	44 (3)	5.70 + 0.55		
Secondary school	177 (12)	5.85 + 0.45	1.52	<0.001
College/University	1237 (85)	5.82 + 0.52		

The data on the knowledge of daily preventive measures by seafarers are summarized in Figure 1. As shown, few respondents had limited knowledge due to a low educational status. Among the total respondents, 1412 (97%) indicated that they avoid face touching,

1347 (92.38%) anticipated covering their faces when they sneezed or coughed, and 986 (68%) chose disinfectants for cleaning their hands when soap was not available. Moreover, 1226 (84%) followed social distancing onboard, and 1128 (77.3%) wore masks while moving onboard. To increase their immune systems, 801 (55%) preferred to do exercise, 481 (33%) habitually drank ginger tea, and only 47 (3%) were interested in using antibiotics.

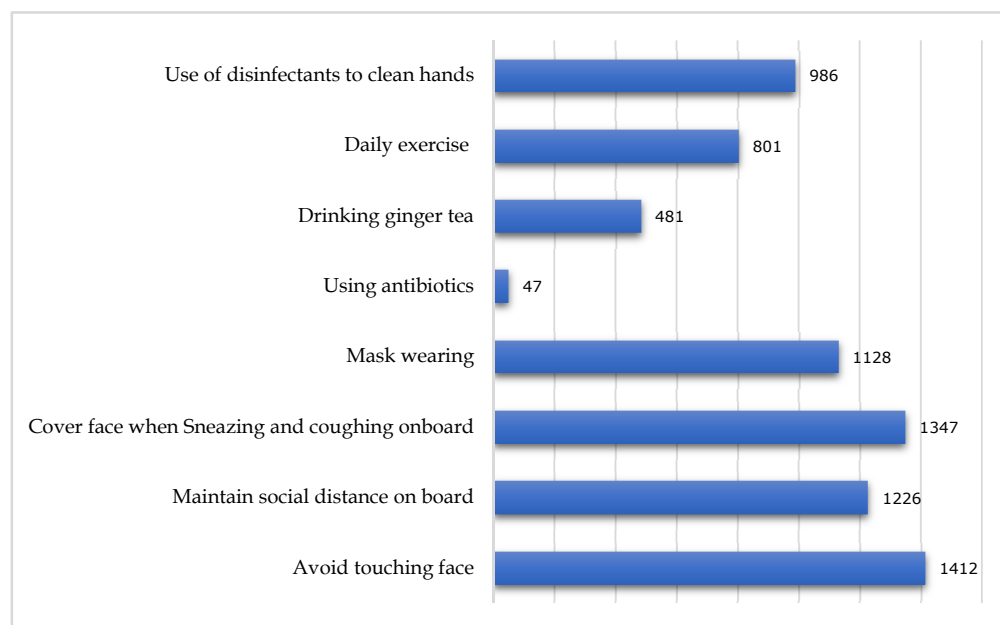


Figure 1. Onboard individual prevention measures by seafarers.

4. Discussion

Many studies were found related to the knowledge, attitudes, and practices (KAP) concerning the COVID-19 outbreak [24–27], but the literature search did not identify any works on seafarer COVID-19 knowledge assessments. Due to this, we developed a tool to investigate COVID-19 knowledge, including behavioural characteristics and the necessity of onboard health measures.

4.1. Personal Awareness

The personal awareness questionnaire was created to understand the factors that decide virus transmission onboard and further classified into three constructs, such as environment hygiene, socio-travel characteristics, and poor health literacy. These, indeed, are considered the four factors that demonstrate seafarers' knowledge of COVID-19 transmission.

Early data on public health practices embraced to forestall the spread of COVID-19 might help control the virus transmission; it is also necessary to publicize knowledge of the psychological characteristics of the stigma and social discrimination (SAD) in pandemic realities [28,29]. Recent evidence confirmed that the COVID-19 disease is transmitted by either physical contact or respiratory droplets of an infected person [30]. Moreover, contact transmission can be possible when an infected individual onboard touch their nose, eye, or mouth mucosa, and the virus can also be transferred from one surface to another by contaminated hands. Due to this, hand hygiene is mandatory to prevent the COVID-19 virus spread. In this study, 97.3% of seafarers agreed with the concept that the virus spread was caused by respiratory droplets of contaminated individuals. Rubbing hands with alcohol-based soap for at least 20 s is an effective approach to neutralize viruses like corona because of an oily surface membrane that is decomposed by soap [31]. The highest number (93.68%) of seafarers mentioned that they do 20-s hand washes with alcoholic soaps.

Travel behaviour is another important characteristic of the spread of COVID in any working culture. Due to global trading during the pandemic, the percentage of the popula-

tion engaged in international travel is higher in Western countries like Europe, the USA, and others. In the present study, 992 (68.01%) seafarers mentioned that they travelled to infected nations during April and May 2020. Moreover, COVID-19 can largely spread among the populations of infected cases in the next social environment [32]. Respondents mentioned that about 58 (4%) people were suspected of contracting COVID-19 during working conditions, and 42 members were confirmed as infected. Maintaining social distancing with other employees also prevents the virus spread, but sometimes, it is hard to avoid staff movements in closed environments. 40% of participants mentioned that they are aware of social distancing but are unable to escape from unexpected situations, and 42.57% are closely moving with others. Maintain isolation onboard for people who are confirmed or suspected by COVID-19. A person in isolation is not supposed to leave the place and keep away from the public on the ship. Others should also be aware of not sharing the belongings of infected people. Most of the seafarers (98.5%) did not intend to use the bed of a COVID-19-infected person.

Poor health literacy about COVID-19 is an underrated global public health issue. Significant health literacy already seems like an important tool for the prevention of non-communicable diseases like an ongoing epidemic [33]. In the present research, 97.87% of members said that they were aware of the present virus outbreak, and 98.44% of respondents were well informed about it being caused by human transmission.

4.2. Seafarers' COVID-19 Knowledge

COVID-19 is an ongoing pandemic with serious threats to public health [34]. Since most of the vaccines are under trials, preventive measures are the only solution to control it, and therefore, everyone should have minimum knowledge on this novel virus. Attempts to change behaviours are basic in limiting the easy transmission of diseases like COVID-19, and it is unclear whether people knew about the risk of disease and adjusted their behaviours during the early times of the pandemic [35]. Due to its highly contagious nature in enclosed areas, seafarers' behaviours on a ship are probably the main factor in deciding the spread of a COVID-19 epidemic. Their behaviours are affected by their perceptions and individual knowledge.

The study outcomes indicated that most of the seafarers were knowledgeable, and respondents achieved a mean of 97% in the knowledge questionnaire. This value is higher than other audiences, like the general public and health workers, which ranged from 62% to 81.4% [24–27]. In this study, the 92.82% rate of correct answers is probably related to the cultural background of the respondents that mostly had a college or university education. This is also due to the time that the questionnaire distribution happened during the virus outbreak. During this time, seafarers already gained some knowledge regarding COVID-19 prevention and transmission causes via the internet, media platforms, or colleague discussions. The close associations found among educational background, age, and knowledge ($p < 0.001$) supports our claims. On the other hand, the knowledge of daily preventive measures by seafarers was much appreciable. Very few respondents had limited knowledge due to a low educational status.

In terms of the seafarers' behavioural characteristics on ships, the respondents presented a positive and encouraging approach towards COVID-19. About 96% agreed that the virus does not develop into a serious illness unless in the presence of other chronic diseases. These inspirational mentalities and high trust in the control of COVID-19 can be clarified by the marine industries' phenomenal activities and brief reaction times for taking tough control and prudent steps against COVID-19 to defend ship workers and guarantee their better health. These measures include isolation, avoid travelling on other ships, regulations on mask-wearing, and sanitization of the workplace regularly.

4.3. Study Strengths and Limitations

This is probably the first study that investigated the awareness and knowledge regarding COVID-19 among the seafarer population. The data collection involved nearly

30 shipping companies, including more than 1,000 ship workers. The preliminary results encourage ship authorities to provide explicit guidelines and plan preventive actions to avoid the future spread of the virus at ship working places. Despite the promising knowledge outcomes, the present study had some limitations. Since the data analysis was conducted with the help of a self-reported questionnaire, there is a chance of biased outcomes. Forthcoming works must use administrative questionnaire data to overcome this issue. Besides, community-based sample (like seafarers) studies cannot provide as much evidence on the severity of pandemics as the data collected through participants of author networks. On the other hand, the highest number of participants were from European shipping companies, and future research needs to include worldwide merchant ship members.

5. Conclusions

The current global pandemic caused by the COVID-19 disease is creating awful situations for both seafarers and marine industries. By maintaining a close relationship between shipping companies, flag and port states, and others, maritime service providers can protect seafarers' health and, simultaneously, the public [36]. Certain web-based interventions like online questionnaires can enhance the individual knowledge of seafarers by informing, educating, reminding, and monitoring to fight against the ongoing epidemic. Hygiene conditions, waste management, and room sanitation onboard are mandatory to protect an individual's health during virus outbreaks, including COVID-19. Guaranteeing continuous handwashing and practices in waste management at working stations will help to control the person-to-person transmission of the virus. This study was conducted during the COVID-19 first wave, and we would like to recontact the participants to evaluate their behaviours at the surge of the present second wave. Alternatively, telemedicine represents the most realistic approach to provide medical assistance at sea. The same technologies respecting legal and ethical standards [37] should be considered for providing health education of seafarers.

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Institutional Review Board Statement: The study was conducted according to the guidelines of the Declaration of UK research integrity office (UKRIO) during COVID-19 by the Ethics Committee of C.I.R.M.

Informed Consent Statement: Informed consent was obtained from all subjects involved in the study.

Data Availability Statement: The COVID-19 data were extracted from the public domain data repository of the Centre for Systems Science and Engineering (CSSE) at John Hopkins University.

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