



# INTERNATIONAL MARITIME HEALTH

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## INTERNATIONAL MARITIME HEALTH

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Dear Writers,  
Dear Colleagues,

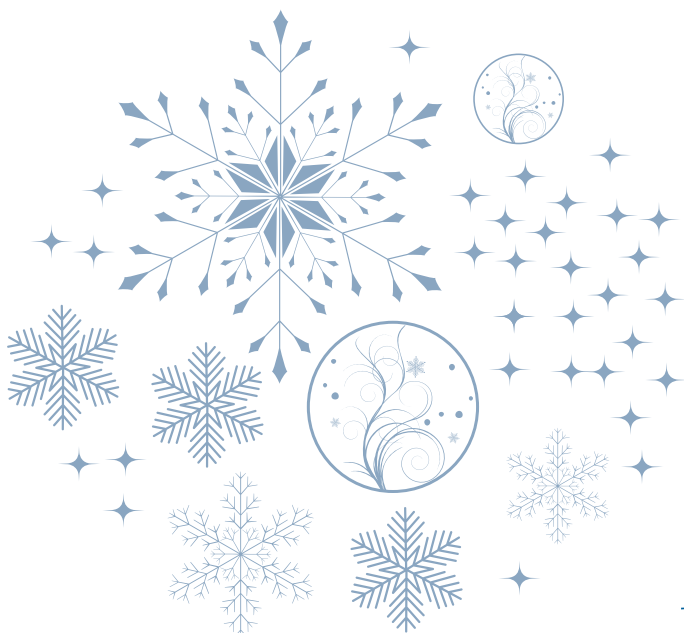
I am writing to all International Maritime Health (IMH) Journal Cooperators and Friends. The year 2019 is nearly finished. It was a good year for the IMH improvement and growth. We have more and more authors and valuable publications. The newly created award “The best IMH scientific article of the year” has shown that we publish interesting papers. The number of the citations is growing. The evaluation of the IMH is also getting better every year.

For the upcoming Christmas Holidays and the New Year we would like to wish you all good health, peace and a lot of happiness. Have a wonderful time with your Families and Friends.

At the same time, please don't forget about the IMH Journal...

*Maria Jezewska*  
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*Merry Christmas*  
*and*  
*Happy New Year 2020*





# Exposure to fumigants in containers: a questionnaire assessment on 125 French dockers

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## ABSTRACT

**Background:** Cases of intoxications to gas from container's atmosphere have been described. For diagnosis, *Fum Ex 2* questionnaire has been developed by the European Society for Environmental and Occupational Medicine. The aim of this study was to enhance knowledge on health effects of toxic substances in containers and to validate this questionnaire in medical follow-up and diagnosis.

**Materials and methods:** In 2014, 125 French dockers answered the questionnaire in a face-to-face interview.

**Results:** 83.5% declared no exposure to fumigants or pesticides. Most frequently declared symptoms were fatigue and neurological disorders for dockers and respiratory irritation for refrigeration technicians. Only 28 workers wore regularly individual protection equipment.

**Conclusions:** A "healthy worker" effect could explain low level of symptoms. *Fum Ex 2* questionnaire is relevant for diagnosis. Workers in all steps of the logistic transport chain and consumers are exposed to containers' atmosphere.

(Int Marit Health 2019; 70, 4: 195–201)

**Key words:** dockers, fumigants, container, occupational toxicology, maritime health

## INTRODUCTION

The international transport of goods strongly evolved during the last decade. This part of maritime transport grew up from 6 to 9 billion tons between 2003 and 2014 where 42% was done by bulk carriers. Containerised harbour traffic rose to 5.6% in 2013 with a total of 651,1 million 20 foot equivalent units [1].

The multiplicity and high frequency of intercontinental maritime routes (South-East Asia – Europe and America essentially) exposes to the risks of pests scattering. Furthermore, to protect the quality of foodstuffs and other transported products, it is recommended by the Food and Agriculture Organisation of the United Nations Organisation to treated goods by fumigants [2]. However, those fumigants in containers could be responsible for acute or chronic occupational exposure for port staff, dockers, warehouse workers and employees of logistics platform to toxic, carcinogenic chemicals.

Baur et al. [3] published in 2015 a review on those health risks. Main cases were dockers and causative agents were, in order of frequency: formaldehyde, phosphine, methyl bromide, sulphuryl difluoride, ethylene dioxide, 1,2-dichloroethane (ethylene dichloride), dichloromethane and chloropicrine. These chemical products exhibit acute irritating effects: ocular, respirator and nasal, but also neurologic deaths were described further to acute exposures with high concentrations of some of the gases, in particular phosphine and bromomethane. Also solvents like dichloromethane (chloromethane), benzene and toluene are frequently noted in the atmosphere of containers and can come directly from goods or cleaning procedures. Studies performed in the harbours of Hamburg, Rotterdam and Gothenburg showed that exposure limits for such toxic industrial chemicals were exceeded in the atmosphere of a high percentage of the container units [4, 5].

Medium and long-term neuropsychological disorders have been described with all those volatile substances [3, 6].

✉ Dr. David Lucas, French Society of Maritime Medicine (Société Française de Médecine Maritime [SFMM]), Brest, France, e-mail: d.lucas@metrabrest.com

Also respiratory symptoms are well documented. Since many of the substances found are carcinogenic to human (or probably carcinogenic), long term carcinogenic effects could also be expected [7].

The European Society for Environmental and Occupational Medicine (EOM) developed a questionnaire for clinical assessment of occupational exposure to these products [8]. The aim of this study was to enhance knowledge on health effects of toxic substances in container and to validate the aforementioned questionnaire in medical follow-up and diagnosis.

## MATERIALS AND METHODS

We translated into French the Fum Ex2 questionnaire of the EOM and send it to Profs. Budnik and Baur for re-appraisal. The French version of the questionnaire was applied by an occupational physician or an occupational nurse of Brest and Le Havre health centres, respectively, during a face-to-face interview. Before the study was done, all involved physicians and nurses had information on the aim, means and methods, volatile substances in container and their respective health impact. These physicians and nurses have been working in those centres for more than 3 years and have been trained in occupational health. During the interview of the workers, occupational staff was able to inform and explain the questionnaire and the asked occupational exposures.

Unlike for methyl bromide exposure, there is no known biomarker for phosphine exposure, so it wasn't possible to measure exposure with biomonitoring.

The study was performed in October and November 2014. Every docker who came for a routine medical (re-)examination into the occupational centre was asked to participate.

Inclusions criteria were: working as a docker or in a related occupation during the study period, agreement to fill in the questionnaire.

All questionnaires from Brest and Le Havre were collected by the Brest health centre and analysed with sphinx software. The frequency of symptoms was described for the whole group; frequencies were also compared between subgroups of workers.

## RESULTS

One hundred and twenty-five dockers (100 from Le Havre and 25 from Brest) from a total of 130 (5 did not agree to participate) could be included in the study.

### POPULATION CHARACTERISTICS

The study group included 124 men and 1 woman, median age was 33 years, and mean time at the workplace was 10 years. 46.24% of them were smokers. 103 declared to work as a docker; the others include refrigeration technicians (5), managers (4), tank workers or port engine drivers (13).

83.5% declared that they had not been exposed to fumigants or pesticides. Only 5 workers declared still to be in contact with phosphine, 1 with methylene dichloride and 11 had been exposed in the past. For the 6 workers still being exposed, mean duration of exposure was 3.5 hours per week. In the majority of this group, exposure took place in container atmospheres.

Four of the refrigeration technicians (5 workers) answered that they were still exposed.

For individual protection equipment, 28 mentioned to have worn it regularly, 51 never, the others did not answer. Out of the personal protective devices, gloves were first with 75%, respiratory masks for dust (50%), respiratory mask for gas and solvents (43%) and clothes (32%).

Work-related symptoms, listed in Fum Ex2 questionnaire, reported by workers are in Table 1.

For the refrigeration technicians, most declared symptoms were fatigue (3, sometimes), irritation symptoms (airways 3, mucosa 2) and dyspnoea (3). In the population of dockers, the most common symptom was also fatigue (52%), followed by neurological symptoms (headache 44%) and irritation (airways 27%, ocular 15%) and dyspnoea (18%).

After including answers in two subgroups, namely "often-regularly-sometimes" and "rarely-never", we used a Chi-square test for statistical analysis. There was a significant relation between dyspnoea, headaches and the workplace of dockers. Refrigeration technicians reported less neuropsychological symptoms (depression, sleep disorders, headache, concentration disorders, emotional lability), but more irritating effects. The population is too small for statistical analyses of subgroups.

With the exception of mucosa irritation ( $p$  value = 9.4%), no significant association of symptoms was found for regular exposure to fumigants.

For the question: have you been exposed to fumigants in the past years, there was a significant relation with memory disorders ( $p$  = 0.028; with 3 workers out of 11 exposed, and 3 in the subgroup of 83 workers never exposed) and dyspnoea ( $p$  = 0.098; 4 workers out of 11 exposed, and 13 out of the 83 never exposed subgroup).

Refrigeration technicians declared significantly higher individual protection equipment wearing than the other workers ( $p$  < 0.01). In the subgroup of refrigeration technicians, there wasn't a significant relationship between exposure to fumigants and mean time working in the workplace on the one hand and one of the symptoms listed in the questionnaire on the other hand.

## DISCUSSION

Our data on the exposure and symptoms of workers having been engaged in container traffic in two French ports add information on health risks to already published

**Table 1.** Frequencies (in %) of workers who reported work-related symptoms in the past 12 months

	No answer	Often	Regularly	Sometimes	Rarely	Never
Fatigue	0	3 (2.4)	9 (7.2)	52 (41.6)	11 (8.8)	50 (40)
Seizures	1	0	0	0	0	125
Concentration disorders	0	0	2 (1.6)	10 (8)	4 (3.2)	108 (86.4)
Emotional lability	0	0	5 (4)	6 (4.8)	5 (4)	109 (87.2)
Sadness, depression	0	0	4 (3.2)	7 (5.6)	3 (2.4)	111 (88.8)
Sleep disorders	0	5 (4)	15 (12)	22 (17.6)	4 (3.2)	78 (62.4)
Impaired balance	1	2 (1.6)	2 (1.6)	1 (0.8)	1 (0.8)	118 (94.4)
Tremor	1	0	4 (3.2)	3 (2.4)	2 (1.6)	115 (92)
Headache	0	0	14 (11.2)	38 (30.4)	23 (18.4)	50 (40)
Chest tightness, dyspnea	0	0	9 (7.2)	14 (11.2)	6 (4.8)	96 (76.8)
Airways irritation, cough	0	1 (0.8)	7 (5.6)	31 (24.8)	20 (16)	66 (52.8)
Mucosa irritation	0	3 (2.4)	6 (4.8)	18 (14.4)	13 (10.4)	85 (68)
Eye irritation	0	1 (0.8)	5 (4)	13 (10.4)	9 (7.2)	97 (77.6)
Nausea	0	0	0	6 (4.8)	2 (1.6)	117 (93.6)
Dizziness	0	0	0	5 (4)	6 (4.8)	114 (91.2)
Muscle cramps	1	2 (1.6)	6 (4.8)	38 (30.4)	6 (4.8)	72 (57.6)
Memory disorders	0	0	2 (1.6)	8 (6.4)	5 (4)	110 (88)
Dysgeusia	0	0	1 (0.8)	2 (1.6)	2 (1.6)	120 (96)
Numbness	0	0	2 (1.6)	13 (10.4)	4 (3.2)	106 (84.8)
Diarrhoea, abdominal pain	0	0	1 (0.8)	17 (13.6)	5 (4)	102 (81.6)

experiences from other ports. Lists of various chemical products, especially intendedly applied fumigants and volatile organic compounds from the industrial processes, including their concentrations in container atmosphere, were reported from ports in Netherlands, Germany, Sweden, Australia [5, 9, 10, 11]. The EU-OSHA reports on “Health risks and prevention practices during handling of fumigated containers in ports” summarised the literature data on fumigants and levels of exposure [12]. The high numbers of samples, the different locations in the world and type of goods transported in those studies give us information on a broad spectrum of endangering chemicals in container atmospheres. Due to the mainly international transport of goods we can assume that French dockers have the same level of exposure than their colleagues in other countries.

In our study, we are able to include 125 dockers working in two French ports, different in size and container traffic. Dockers in Le Havre only work for container traffic and in Brest, as typical of a medium size port, they work with container traffic as well as with cereal and hydrocarbon transport on bulkers. We used the Fum Ex2 questionnaire which was elaborated by the EOM. It was validated by experts in toxicology, occupational health and maritime med-

icine, especially from Germany and Netherlands with high experience in the subject.

The relatively high number of subjects and the use of this questionnaire increased the sensitivity of our study and allow us to analyse the results. Unfortunately, subgroups of agents and occupations are mostly too small for significant analysis. Physicians and nurses of the occupational centres had specific training before the study to learn and understand when and where dockers could be exposed to fumigants in containers’ atmosphere. The questionnaire was filled in during face-to-face interviews or by debriefing the workers by an occupational physician or nurse of the occupational centre team; reading was done just after answering. In the second case, all answers were confirmed in face-to-face interview by an occupational physician or a nurse. Goals were to limit misunderstanding of questions and to increase exposure assessment relevance with information and explanation to workers. The high response rate (124/125) confirms efficiency of the method.

The first and pregnant result is the low percentage of workers who declared symptoms. We can explain this by a “healthy worker effect”. We have a young population, median age at 33 years, and a mean time at workplace at 10 years. Maybe, workers left their job before our study

because of occurrence of symptoms, especially neuropsychological once which could occur after chronic exposure. With 80% of workers answering that they haven't been exposed to chemicals from containers, it's more probable that individual (low to medium level?) exposures were not recognised due to lack of knowledge to link unspecific symptoms to occupational hazards. This may also explain that we could not detect a relationship between declared symptoms and duration of working in the individual occupation.

Refrigeration technicians included in our study were only 4% of workers but 45% of the group with at least one clinical symptom. Nowadays, dockers have to handle containers but not to open and unload them. They only do it if containers are damaged or to assist custom officers. But, refrigeration technicians regularly wash containers after their maintenance. During washing, they can be exposed to residual fumigants (such as aluminium phosphide powder, methyl bromide from treated wood platelets, good stuffs still in containers). Another possible exposure source is natural degradation of container floors. Svedberg found one off-gassing from the container floor in an experimental study. Carbon monoxide (6 ppm.), methanol (8 pm.), and formaldehyde (1 ppm.) were found in container atmospheres [13].

Limitations of our study are: Not all study participants might have been aware of their exposure to fumigants, since it is well known that fumigated and otherwise contaminated containers and goods are not correspondingly labelled and declared in the documents of transport. Further, in our study, atmosphere measurements in workplaces and biomonitoring for assessment of exposure to fumigants or their metabolites in urine or blood were not performed. As mentioned, noticed symptoms might have been unspecific and falsely not related to occupational exposure.

Acute exposures to bromomethane have been observed at Rotterdam for 2 men unloading import containers and a truck driver [6]. Same conditions have been noted for 3 custom officers and a consignee's agent [14]. In October 2015, 4 workers were exposed to phosphine in Le Havre during unloading import containers in a warehouse. Also a mover described an acute exposure to phosphine when unloading furniture from South America [13]. Data published in previous studies and our results demonstrate that health risks due to fumigants and toxic chemicals from the production processes move along and beyond the maritime transport logistic chain and reach warehouses and even sellers and consumers. In 26 cases of fumigants exposure during unloading containers, majority worked in a warehouse and by laboratory analysis ethylene dichloride, methyl bromide, phosphine and methylene chloride were identified [15]. Also, Kloth et al. [16] published a paper on 6 storage room workers exposed to fumigants off gassing from shipped products. They worked in a medium sized

European company, which received electronic production parts from south East Asia and South America. Following each incident, the workers noticed irritation symptoms and after second and third accident neurologic disorders. The 6 German workers, French mover and workers in Rotterdam described the same acute and chronic symptoms after exposure to fumigants. Besides important acute effects after exposure to high atmospheric concentration of toxicants (cardiac arrhythmia or failure, neurologic and pulmonary diseases and death), chronic effects have to be considered. Neuropsychological symptoms occurring several years after an accidental exposure (1 to 7 in Netherlands, 5 in French mover) are rarely linked to occupational exposure but they have high social and health impact for workers. Most of them have to move from their jobs, they have long sick leave period and high impact in non-occupational daily activities [6, 14, 17].

The type of volatile toxic agents differs between workplaces and tasks. Phosphine, bromomethane and 1,2-dichloroethane are the most frequently used fumigants in freight container transport. This is important especially for workers who open and enter first containers, i.e. dockers, custom officers, port authority people, consignee's agents, warehousemen, and movers. During goods unloading, gas trapping or activation of aluminium phosphide, bromomethane from wood pellets are still possible. For refrigeration technician the situation is the same. For warehouse and logistic workers who unload boxes from the container, methylene chloride and ethylene dichloride are frequently found. They are used as fumigants and also come directly from goods. Exposures to solvents like formaldehyde, benzene, toluene, and xylene have also been described in some studies [3, 18].

There's an urgent need for a systematic approach towards applied effective preventive measures. Firstly, promotion of substitution or at least use of lower concentration of fumigants in container's atmosphere should be done. Actually, technical processes and equipment for chemical risk assessment in containers' atmosphere are developed in European countries. In polluted containers, different systems of active ventilation are tested in France and used in several ports and logistic warehouses. Nevertheless, at the individual level, awareness should be raised and rising education and training intensified. In our study, less than 20% of workers were aware of the problem and only 22% declared wearing individual protective equipment regularly. The lack of information and knowledge was also underlined by Petersen in 2014 and Jepsen before. Manual workers were less aware about toxic pollutants in containers than managers [19]. In France, dockers' and custom officers' trade unions already communicated on container's toxic atmosphere. However, such information should also reach

other workers such as movers, warehouse workers, truck drivers, sellers.

The EOM Fum Ex2 questionnaire was developed for diagnosis of occupational or environmental intoxications by fumigants. In the study of Budnik et al. published in 2013 [4], between 2006 and 2012, 164 subjects with presumed fumigant intoxication and 30 controls were recruited and the Fum Ex2 questionnaire was used to select exposed collectives. Exposure assessment was quantified with exposure biomonitoring and 86 patients (including the 26 from the preliminary study of Preisser et al. [15]) had confirmed exposure to fumigants. The effect biomonitoring was used to corroborate long term exposure. Results were used for classified long-term past exposure [4].

In our study, workers had some difficulty understanding the questionnaire. This questionnaire is at this time a part of diagnostic scheme of occupational or environmental intoxication to fumigants with clinical examination, biomonitoring and paraclinical exams. It has to be used in face-to-face interviews, as recommended by DiMoPEX Group [20]. For the daily routine use and screening of populations at risk, we developed a quicker questionnaire which can be easily filled in by the worker and a guide for paraclinical exams (Appendix 1). The latter will be evaluated and compared with the presented data obtained by Fum Ex2 questionnaire in a future study.

## CONCLUSIONS

Long-term impact of exposure to fumigants and other toxic chemicals in container atmospheres and their contaminated goods is surely underestimated and often not link to them. People often do not refer to such exposure in cases where such exposure is a possible cause of clinical pictures. A specific study on long-term impact of exposure on workers but also on seller and consumer population is needed. The importance is underlined by a recent study with experimental outgassing performed on packaging materials and textiles with high level of ethylene dichloride out gassing from a doll 21 days after container unpacking [21].

We used Fum Ex2 questionnaire in a large population of dockers who could be exposed to fumigants and other toxic chemical in container atmosphere; however, few symptoms were declared by workers. A lack of knowledge on this risk and a “healthy worker” effect are likely. It is important that endangering exposures are now more frequent beyond the port traffic, i.e. in the following logistic transport chain. This refers to refrigeration technicians, manual workers in warehouses and logistic units, truck drivers, sellers and consumers.

Our study underlines the need of comprehensive information and education of workers about this occupational problem and the individual preventive measures. Actions of communication and technical guides made by the French

National Institute of Security should improve the situation. We have now two different questionnaires on the subject, the Fum Ex2 questionnaire for diagnosis and the SFMM for screening. We propose the latter shorter one with guide for medical tests (Appendix 1); but evaluation of it still has to be done.

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**APPENDIX 1.** Questionnaire: assessment of exposure to chemical toxins in containers' atmosphere SFMM**Administrative data:**

First Name:

Second name:

Age:

Sex:

**Occupational data:**

Workplace:

Time at workplace:

Exposing tasks:

	Yes/no	Frequency	Gas and/or fumigants, if known
Opening containers			
Unloading containers			
Unloading bulk carrier			

**Clinical signs:**

Do you remember an exposure?

During those work tasks, have you experienced clinical signs like:

Respiratory	Wheezing	Yes/No
	Cough	Yes/No
Nasal	Nasal irritation	Yes/No
	Epistaxis	Yes/No
Digestive	Nausea/vomiting	Yes/No
	Diarrhoea	Yes/No
Neurological	Headaches	Yes/No
	Dizziness	Yes/No
	Consciousness disorders	Yes/No
	Muscular weakness	Yes/No

## Chronic exposure:

Respiratory symptoms	Medication for asthma	Yes/No
	Wheezing	Yes/No
	COPD	Yes/No
Neurological symptoms	Concentration disorders	Yes/No
	Memory disorders	Yes/No
	Libido disorders	Yes/No
	Depression	Yes/No
	Smelling or gustative disorders	Yes/No
	Paraesthesia of lower limbs	Yes/No

**Medical test:****Initial:**

- ECG and cardiologic consultation
- blood: haemoglobin, renal function, liver enzymes
- spirometry
- ergovision and colour vision test

**If acute exposure (in short-time):**

- human biomonitoring in blood and urine (methyl bromide, ethylene oxide, ethylene dichloride, chloropicrin, methylene chloride)
- blood test with haemoglobin, ionogram, renal function, liver enzymes and muscle enzyme, troponin
- ECG
- spirometry ± methacholine test

**Chronic exposure:**

- spirometry and methacholine test
- neuro-psychological tests
- colour vision test
- cranial computed tomography

# Daily sleep quality and naval work performance: the role of leadership

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## ABSTRACT

**Background:** Poor sleep is a growing concern in naval settings. Previous research has demonstrated that both civilian and military naval work strains sleep quality as well as a negative relationship between sleep quality and crew work performance. Variables moderating this relationship, such as leadership are of interest. **Materials and methods:** The present paper investigates how sailors' daily variations in sleep quality influence self-rated naval work-performance and interacts with perceived daily transformational leadership during a 30-day naval training mission.

**Results:** Using multi-level analysis, we found significant positive main effects of sleep quality and transformational leadership on naval work performance. Transformational leadership moderated the sleep quality-work performance link. Individuals who experienced higher levels of leadership were less prone to reductions in performance after poor sleep.

**Conclusions:** Overall, the results suggest that leadership can partly negate some of the reduction in performance that often accompanies poor sleep, and that leadership becomes more important as the crew becomes sleepier.

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**Key words:** naval work performance, sleep quality, transformational leadership

## INTRODUCTION

The last decades have seen an increase in focus on sleep in naval settings [1]. Both military and civilian naval operations consist of continued wakefulness, decreased sleep quality and partial sleep deprivation [1, 2]. These developments have raised two concerns, firstly that reduced sleep impairs the health and well-being of sailors and seamen. Secondly, that poor sleep causes a decrease in human functioning and subsequent naval work performance. Research indicates that directly increasing time available to sleep and taking measures to ensure sleep quality bring both tangible health and work performance benefits [3]. However, the naval work situation is characterised by situations where the option to decrease workload and increase

crew sleep duration is impossible. In these work situations, sometimes referred to as continuous operations, measures that keep performance high in spite of increasing crew fatigue are of interest. The purpose of the current study is to investigate the relationships between sleep quality, naval work performance and leadership during a real-world naval training scenario. It aims to test the role of leadership as a moderator of the sleep quality-work performance link. A large number of laboratory studies find a positive relationship between sleep quality and human performance [4], and some studies have workplace effects. These include positive relationships with job satisfaction [5], organisational citizenship behaviour [6], and work engagement [7]. Unfavourable effects of poor sleep include unethical behaviour [8, 9],

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workplace deviance [10], risk for injuries [11], and abusive supervision [8]. However, fewer studies have investigated the real-world effects in naval settings, and the effects do not necessarily carry over to the maritime workplace. The naval workplace periodically consists of sustained operations to meet extraordinary demands and often includes shift and night work, disrupting the sleep wake cycle [1]. Leaders of naval personnel may not be able to directly influence the amount or quality of sleep onboard, but their leadership still arguably have an important role. Especially, when crew fatigue and sleepiness increases. Naval leaders are in the position to use social and motivational processes to activate and stimulate otherwise sleepy sailors to increase their naval work-performance. Experiencing high quality naval leadership may thus decrease the impact of poor sleep quality on naval work performance.

### SLEEP AND NAVAL WORK PERFORMANCE

Both civilian and military naval work is multi-faceted and tasks range from complex to simple and very brief to continuous. Some works duties include the entire crew, and some are relegated to the individual sailor. The overall performance of each individual sailor is determined by a complex interaction of self and organisational variables, including the level of fatigue. Given the role of poor sleep quality as a strong predictor of fatigue, it is likely to influence the individual's work-performance [1]. This notion is supported by a large body of empirical evidence [12–14]. Reductions in sleep have a number of predictable and well-known effects on cognition and mood [15] and reviews of experimental research using both simple and complex works find reductions in human functioning and performance at most levels of sleep deprivation [16]. Sleep theories postulate that long periods of wakefulness increase lapses in attention and unresponsiveness due to episodes of micro sleep [17]. Periods of unresponsiveness lead to increased errors, especially in tasks that require sustained vigilance [18]. Other proposed mechanisms include the role of motivation, disruptions of the circadian rhythm, and situational factors [19, 20]. The “state instability” hypothesis posits that human performance becomes more variable during sustained wakefulness because sleep initiation processes reduce the capacity to maintain alertness and attention [19]. Another explanation to the performance impairing effects of poor sleep is that the latter causes a general reduced work motivation, as the motive for sleeping increases and compete with work motivation [20]. Based on the research cited here, we propose that sailors experiencing poor sleep quality show a reduction in naval work performance. Formally stated: *Hypothesis 1: Daily sleep quality is positively associated with daily naval work performance.*

### SLEEP, NAVAL PERFORMANCE AND THE ROLE OF LEADERSHIP

Leaders of naval personnel are in an extraordinary position to influence their followers sleep and naval work performance because they live and work in the same circadian work environment. This is in contrast to leaders who rarely see workers outside daytime office hours. There are several candidates for leadership models that can describe successful naval leadership with different implications for naval leaders aiming to buffer the negative work-performance effects of poor sleep quality among the crew. In general, leadership refers to an individual's ability to influence, motivate, and make others capable of contributing to the effectiveness and success of the organisation [21]. Early research efforts into the leadership process focused on leadership traits and behavioural and contingency theories [22]. Later, the role of the leader as a constructive transactional agent emerges as one who rewards and punishes based on a transactional model [23]. Within a sleep-performance context, a transactional leader mitigates some of the reductions in performance due to sleep loss by utilising praise, reprimands, and rewards, and is responsive to drops in performance. The transactional leader of sleep-deprived personnel motivates by appealing to the individual's sense of self-interest [22], and this might entail more leisure time or other perks awarded to sailors who do not let their performance drop. However, given the pervasiveness of poor sleep quality during naval missions, a more pro-active leadership style might be better suited to buffer the negative effects of sleep loss on performance, such as transformational leadership (TL). TL is characterised by pro-active behaviours that seek to provide a sense of mission and to stimulate higher-order intrinsic needs [23]. TL are charismatic and encourage their followers to put the group's interest first [24], and they have the ability to transform work efforts into a more a more collective vision through inspiration and team commitment [25]. This process might be well suited to reducing the impact of poor sleep on naval teams and individual sailors' functioning. Engaging and inspirational leaders who focus on stimulating individuals might increase vigilance, efforts, and motivation among their sleep-deprived subordinates. TLs are seen as role models to emulate during hardships and are found to stimulate positive energy and proactive involvement among followers [26]. In addition, TL has been shown to stimulate cohesion, collective focus and performance under stress [27]. TL is thus a likely candidate for reducing the daily impact of varying levels of sleep quality on naval work performance. This may happen in several different ways. TLs give more individual consideration. This may reverse the social withdrawal associated with poor sleep [28]. In addition, the inspirational element of TL may also contribute to the moderating effect. A leader

who inspires and creates commitment within the group [29] might be more likely to activate sleepy individuals who are more withdrawn in the social work dynamic [30]. Especially during naval missions with monotonous work and little variation in work duties, were the effects of reduced sleep quality might be most prominent. Based on this we predicted that high levels of TL would increase naval work performance in general and moderate the effects of reduced sleep quality on performance. Formally stated: *Hypothesis 2: Daily transformational leadership is positively associated with daily naval work performance* and *Hypothesis 3: Daily transformational leadership decreases the impact of poor sleep quality on daily naval work performance.*

## MATERIALS AND METHODS

### DESIGN, PARTICIPANTS AND PROCEDURE

In all, 78 Norwegian naval cadets were included in a 30-day diary study during an ongoing sailing mission at the Royal Norwegian Naval Academy. We measured demographic information and pre-mission work performance before the mission. The mission was part of the cadets training to become naval officers and lasted for 10 weeks. The naval cadets crewed a large sail-ship, with limited modern technology to aid the navigation, and their training mission included two crossings of the Atlantic Ocean and the North Sea during the storm season. The 30-day diary period started the first day at sea. The cadets completed questionnaires every day at the same time (approx. 1700). During the voyage, the naval cadets functioned in roles as leaders or crewmembers on all levels of the organisation, including roles as squad leaders (7 subordinates), quarter-leaders (23 subordinates), or duty captain (78 subordinates). The cadets lived in close quarters, sleeping in hammocks. The voyage is considered to be challenging, as the cadets are relatively unexperienced sailors. The challenging nature is also due to high operational tempo, unpredictable environment, serious potential negative consequences for mistakes, lack of sleep, seasickness, workload and the socialisation into a new and unknown work environment. The cadets are on duty 4 × 2 hours each 24 hours. During down time, they are subject to many other works (e.g. feedback sessions, preparations, theory classes and ship manoeuvres) leaving them with 6 to 8 hours for relaxation and sleep. The sample consisted of 70 (89.7%) male cadets and 8 (10.3%) female cadets. The mean age of the cadets was 22.9 ± 2.2 years. The cadets signed informed consent forms before the mission. The data collection has been approved by the Norwegian Centre for Research Data.

### TRAIT LEVEL MEASURE

**Pre-mission work performance.** We measured self-rated pre-mission work performance with four items from the

work performance subscale developed by Goodman and Svyantek [31]. The measure functions as a control variable limiting the possibility of response bias in the daily self-report performance measure. The cadets judge themselves on items measuring their usual performance on duty. Example items include; *“I fulfil all the requirements of my job”*. The cadets marked their response on a five-point scale (1 = totally disagree to 5 = totally agree). Cronbach’s alpha for the measurement was 0.71.

### DAY LEVEL MEASURES

We adapted existing questionnaires from their existing format, to short day level measurements to customise the questionnaires to a diary format.

**Day level sleep quality.** We measured day level of sleep quality with a single item: *How well have you slept the last 24 hours?* The cadets responded on a six-point scale (1 = very poor, 2 = quite poor, 3 = poor, 4 = quite well, 5 = good, 6 = very good).

**Day level perceived transformational leadership.** We assessed day level perceived TL with seven items from the MLQ-5-X [32]. Example items include; *“My leader communicates a clear and positive vision of the future (Vision), is clear about his/her values and practices what he/she preaches (leading by example), instils pride and respect in others, inspires me by being highly competent (Charisma)”*. Cadets rated their daily leader on a 5-point scale (1 = totally disagree to 5 = totally agree). The average within-level Cronbach’s alpha for the 30 days was 0.87.

**Day level self-rated work performance.** Self-rated naval work performance was measured with four items from the same work performance subscale developed by Goodman and Svyantek [31]. Example items include; *“I have performed my work duties in a sufficient manner, during today’s shift. I have completed the work described in my job description, during today’s shift. I have met the formal requirements in my work, during today’s shift”*. Responses were provided on a five-point frequency scale (1 = totally disagree to 5 = totally agree). The average within-level Cronbach’s alpha or the 30 days was 0.82.

### STRATEGY OF ANALYSIS

STATA version 15 with mixed multi-level modelling to take the nested structure of the diary data into account was used to analyse the data. Within- and between-cadet correlations were obtained with Mplus. In the current study, the daily measures (sleep quality, leadership and naval work performance) constitute the within-individual level of analysis. The control variable pre-mission work performance constitute the between level of analysis. The data is comprised of daily observations (Level 1; n = 1913) nested within individual cadets (Level 2; n = 72). We centred day level

measurements around the person's mean and pre-mission work performance on the grand mean to have meaningful interpretations of interactions between day and person level [33]. This centring procedure [34] removes between-individual variance from the level 1 variables. This eliminates the possible confounding effect of individual differences on daily outcomes. Missing data was handled with case wise deletion resulting in  $N = 1898$  level 1 observations nested within  $N = 76$  individuals in the multi-level models. We tested three multi-level models on daily measures on naval work performance to investigate the effect of sleep and leadership. One unpredicted null model, the predicted main effect model as well as an interaction model were tested. We graphically plotted the marginal effects of the interaction effect between TL and sleep quality. Two slopes were plotted as one standard deviation (SD) below and above the centred score for TL, as well two SD above and below person-centred mean sleep quality (labelled very poor-very good). We used chi-squared tests to post estimate significant differences between the marginal effects, as well as two likelihood ratio tests ( $\chi^2$ ) to test model fit.

## RESULTS

### DESCRIPTIVE STATISTICS

Means, standard deviations, within person- and between person-level correlations for all study variables are presented in Table 1. The mean and the SD shows that the analysis of sleep data is predominantly focused on discovering effects of medium, to quite well, and not poor sleep quality. The mean daily work performance and TL was also quite high, indicating that the crew is working effectively and with high quality leadership. We found a small positive correlation between sleep quality and naval work performance, at the day level. The results also show a small positive correlation between TL and work performance, at the day level. The control variable pre-mission work performance showed a small correlation to daily work performance. The interclass correlation was 0.39 for daily work performance, 0.44 for daily sleep quality and 0.18 for daily TL. The lower interclass correlation of leadership is likely due to the fact that the cadets took turns being leaders. The high interclass correlation for sleep quality show that much of the variance in sleep quality is based on individual sleep patterns, controlled for by centring daily sleep quality measures within individuals.

### MULTILEVEL HYPOTHESIS TESTING

The results of the multi-level analysis of the impact of sleep quality, quantity and TL on naval work performance are shown in Table 2. Hypothesis 1 predicted a positive relationship between sleep quality and naval work performance.

In support of Hypothesis 1, we found a significant positive main effect of sleep quality on naval work performance ( $B = 0.10$ ,  $p < 0.01$ ). In support of Hypothesis 2, we found a positive association with daily TL and daily work performance. The control variable of general work performance was also positively related to daily work performance ( $B = 0.22$ ,  $p < 0.01$ ). The main effects model explained 6% of the between person variance and 7% within person variance. The likelihood ratio test indicates showed that the main effect model improved model fit from the null model ( $\chi^2 (1) = 52.09$ ,  $p < 0.05$ ).

Hypothesis 3 stated that higher levels of perceived leadership would buffer the effect of sleep quality on performance. We found a significant negative interaction between TL and sleep quality on naval work performance ( $B = -0.077$ ,  $p < 0.01$ ), supporting Hypothesis 3. The effect is small, but the interaction model shows better model fit compared to the main effects model ( $\chi^2 (1) = 7.08$ ,  $p < 0.05$ ). The plotted interaction pattern of TL as a moderator of sleep quality on naval work performance is shown in Figure 1. Both low ( $\chi^2 (1) = 55.44$ ,  $p < 0.01$ ) and high ( $\chi^2 (1) = 9.71$ ,  $p < 0.01$ ) TL slopes were found to be significant. The differences between slopes become non-significant at very good sleep quality. The predicted value for an individual experiencing very poor sleep quality but high TL is comparable to an individual with very good sleep quality, but low TL. The predicted difference in naval work performance between low and high TL becomes non-significant at two standard deviations above mean centred sleep quality.

## DISCUSSION

The aim of this study was to investigate the day-to-day relationship between sleep quality, TL and naval work performance during a naval training mission. We found that the results supported the hypothesised relationships between daily events. The uniqueness and significance of these findings lies within the highly controlled context and daily diary data collection. The context is a controlled but natural workplace and leadership contexts where individual and team work performance have important consequences for the entire crew and are recorded daily, allowing for within-person deviations to be interpreted. The methodological approach used in the current study allows for the results to be interpreted as daily deviation from individual's baseline sleep and leadership and is important for two reasons. Firstly, that there are notable individual differences in sleep quality [35] that may confound between-individual studies of sleep and naval work behaviour. Secondly, that individual differences in leadership ratings are removed, via person centred TL scores. Although the cadets took turns being leaders, cross-sectional leadership surveys are likely to also measure general attitudes towards leaders. The find-

**Table 1.** Means, standard deviation, and within person and between person level correlations for study variables (n = 1913 occasions, n = 72 cadets)

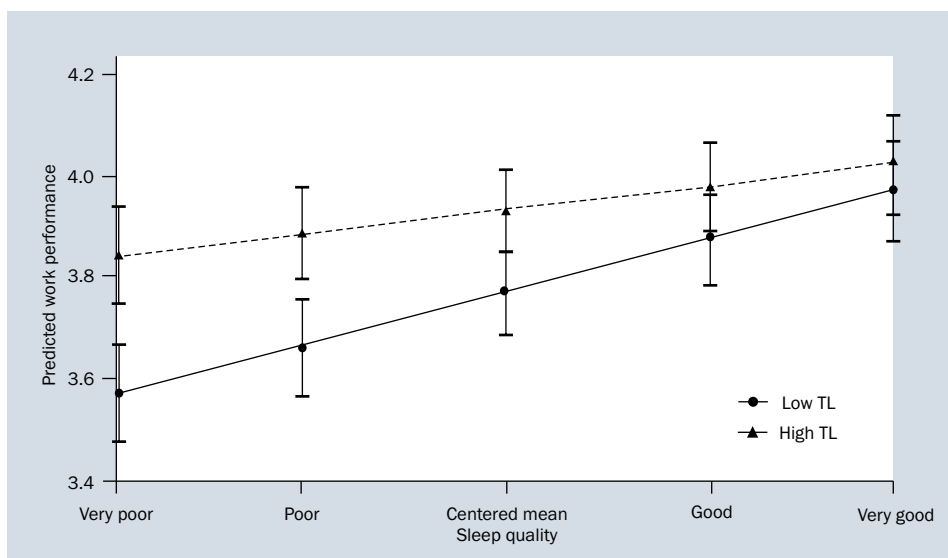
Variables	$\bar{X}$	SD	1	2	3	4
<b>Day-level</b>						
1. Sleep quality	4.09	0.49	1.00	0.04	-0.01	0.03
2. Work performance	3.85	0.54	0.04**	1.00	0.009	0.03*
3. Transformational leadership	3.58	0.49	0.003	0.03**	1.00	0.005
<b>Person-level</b>						
4. Pre-mission work performance	4.22	0.40	-	-	-	1.00

Correlations below the diagonal are correlations on the within (day) level and correlations above the diagonal are correlations on the between (person) level; \*p < 0.05; \*\*p < 0.001; SD – standard deviation

**Table 2.** Null, main and interaction model of sleep quality and transformational leadership (TL) on work performance

	Null model		Main model		Interaction model	
	B	SE	B	SE	B	SE
Intercept	3.85**	0.04	3.85**	0.04	3.85**	0.04
Pre-mission work performance			0.22*	0.098	0.22*	0.09
Sleep quality			0.10**	0.01	0.10**	0.01
TL			0.16**	0.02	0.16**	0.02
Sleep quality × TL					-0.08**	0.03
Variance level 2 (person)	0.118 (37.6%)	0.02	0.111	0.01	0.112	0.01
Variance level 1 (day)	0.183 (62.3%)	0.006	0.172	0.005	0.170	0.005
AIC†	2391.95		2274.21		2269.14	
BIC††	2408.60		2307.51		2307.98	
Likelihood ratio test	-		123.74**		7.08**	
Log likelihood	1192.97		1131.10		1127.57	

\*p < 0.05; \*\*p < 0.01; †Akaike information criterion; ††Bayesian information criterion; SE – standard error



**Figure 1.** Predicted values of the sleep quality and transformational leadership (TL) interaction on naval work performance. Marginal effects at 1, 2 and 3 standard deviation (SD) above and below mean sleep quality and 1 SD above and below mean TL.

ings and practical implications of the results are discussed further below.

### SLEEPY FOLLOWERS AND THEIR LEADERS

The results of the main effect model showed that sleep quality is positively associated with naval work performance, in similarity with previous findings [28, 36, 37]. The relationship between the two variables implies that a poor night's sleep is associated with reductions in work performance. The results cannot conclusively rule out that poor sleep quality only indirectly affects performance, by lowering mood and the tendency to low self-rating in all aspects. In addition, another interpretation of the finding is that when naval cadets negatively deviate from their usual naval work performance, they search for causes such as poor sleep quality. However, when the results are paired with the wide range of other experimental and correlational research showing a positive link between sleep quality and human functioning, we believe that the effect is at least partly due to sleep to performance effects. These may include the lowering of self-control [14], having sleep drive as a competing force, or negative changes to mood and cognition [4, 15]. The study also underscores the importance of leadership to achieve high work performance, a sentiment supported by theory and a high number of leadership studies [24, 26, 29]. The effects of sleep and TL on naval work performance show similar correlations.

The moderation of the sleep quality-work performance link by TL supports the current study's primary hypothesis. Sailors with a more inspirational, charismatic, pro-active leader, showed a significantly smaller drop in performance when they were faced with poor sleep quality. The moderating buffer interaction shows that the difference in work-performance between low and high TL are largest at lower levels of sleep quality. In simpler terms: Sleepy sailors need leadership more than rested sailors do. The magnitude of the effect is such that a cadet experiencing poor sleep but high TL, has about the same naval work performance as a cadet experiencing sufficient sleep quality, but lower levels of TL. The moderating role of TL can be interpreted in different ways, and we offer the following interpretation. The mean naval work performance experienced by the sample in this study is quite high, indicating that the participants are motivated, high-functioning, and capable. The sample is a selected group of individuals, working in non-typical novel and likely engaging work context (a naval training mission), which increase the work performance of each individual. A transformational naval leader transforms the work into a collective and more meaningful endeavour and sets a good example [23]. However, if the individuals are highly qualified, selected, motivated, well rested, with a high sense

of group membership and cohesion, the scores on a limited scale for work performance may peak. The plotted interaction pattern in Figure 1 shows that at two SDs above mean sleep quality, the predicted differences in work performance between cadets' experiencing high and low TL become smaller. Both cadets with high and low TL show very high levels of work performance when experiencing high-quality sleep. It is likely that a poor sleep quality reduces the initial psychological and social processes that originally supported high levels of naval work performance. When this happens, the performance rewards of high TL take effect. An inspirational, charismatic, leader whom creates a collective identity and promotes ownership of the work being done is more likely to engage otherwise sleepy and socially withdrawn cadets. The potency of high TL increases as individuals become sleepier and more fatigued. High TL leaders have a large impact on sleepy cadets, because they need leadership more. TL is often associated with high performance groups such as military teams [38]. The results of this study suggest that the effect of leadership in a high-performance work group is most prominent when otherwise very high functioning followers experience fatigue.

The results also partially answer the question: *When does naval leadership matter?* Leadership researcher have identified several contingencies under which leadership matter more or less, including opportunities for leadership, leader constraints, type of industry and many more [21]. This is the first study that uses human physiology as a contingency for leadership, and the results of the current study support the notion that in high performance contexts leaders matter most during hardship and fatigue. The same overall pattern is likely to emerge in a sample of non-high performing individuals, but the effect of TL would likely be present at all levels of sleep quality and fatigue. The practical implications of the current study's findings are presented below.

### PRACTICAL IMPLICATIONS

The effects of low-quality sleep represent a practical problem in any naval organisation, especially during high intensity shift work [39]. For leaders of naval personnel, the available evidence and the results from this study supports measures to increase sailors sleep quality when possible [3]. This could entail measures to ensure less chronobiological disturbances, better sleep environment, reducing general stress and clear separation of work and leisure time. The results also document that leaders can indirectly affect naval work performance when there are no options to directly increase sleep quality. The use of leadership to stave off symptoms of fatigue presents a way to buffer the negative effects of poor sleep quality on naval work performance.

## LIMITATIONS AND FURTHER STUDIES

As the present study comprised selected naval cadets, this put a limit on the generalisability of the findings. All measures were based on self-report, meaning that the findings may be partly be due to subjective reactions to differing levels of fatigue and sensitivity towards negatively toned questions, as well as increasing the risk of the common method bias [40]. Future studies could mitigate this problem with the use of objective measures of sleep (i.e. actigraphs) and using senior member judgement of naval work performance. However, given the high proportion of variance being on daily within cadet changes, it is unlikely that different response pattern between cadets invalidates the day level results. In addition, the results are likely not due to response patterns in daily naval work performance as the regression models includes pre-mission general work performance as a control variable. Another limitation concerns the use of a single item measure of sleep quality, which renders reliability analysis impossible. The use of non-Likert six-point scale also hurts the psychometric properties of the scale. However, single-item measures of sleep quality are used in many sleep diaries with predictive validity, and they maintain their predictive validity and their robust correlations to multiple-item scales of sleep quality and to objective measures of sleep [41]. Thus, single-item measurements might be a practical solution in regards to cost efficiency without compromising the predictions in diary studies [42]. Nevertheless, to confirm the current study's findings, future studies should employ multi-item sleep scales to avoid any possible bias associated with single-item measures. Future studies would also benefit from a more age diverse sample. Both the main effect of sleep quality on naval work performance and the moderating effect of leadership may vary across different age groups.

## CONCLUSIONS

Overall, the results suggest that leadership can partly negate some of the reduction in naval work performance that often accompanies poor sleep, and that leadership becomes more important as the crew becomes sleepier.

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# Basic differences in the health profile between seafarers from the Philippines and Denmark

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## ABSTRACT

**Background:** Seafarers in international trade are today recruited world-wide based on qualifications and costs. Health is another aspect. In this study, two cohorts of seafarers from the Philippines and Denmark undergoing pre-employment health examinations were compared. The purpose is to investigate differences in the outcome of the examinations and compare basic parameters.

**Materials and methods:** Two cohorts of equal number of seafarers from the Philippines and Denmark were established. A total of 9,654 consecutive health examinations at a large clinic in the Philippines were compared with a group with the same size examined in a number of clinics in Denmark. The Filipino seafarers were screened according to different company standards whereas the Danish seafarers were examined according to statutory standards.

**Results:** The age structure was different. Only 18% of seafarers from the Philippines were 45 years of age or above whereas almost 43% of the Danish seafarers were in this age category. Obesity was frequent in both cohorts although depending on the standard used as reference. Extreme obesity (body mass index, above 35) was 10 times more frequent among the Danish seafarers. A total of 4.4% of the Filipino seafarers were declared unfit whereas only 0.5% were found unfit among the Danish seafarers. Among the latter, 5.2% were found fit with limitations, which is a category not used in the Philippines.

**Conclusions:** The two groups are inhomogeneous and the health examinations the seafarers underwent differ. Comparisons should be done with caution. The difference in the age distribution of the two groups of seafarers is important factor due to the strong impact of age on health. Obesity was of major concern in both groups, although there were more with severe overweight and especially with extreme overweight among the Danish seafarers. Smoking frequency seems to be on the same level.

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**Key words:** maritime medicine, pre-employment health examinations

## INTRODUCTION

The maritime business is becoming increasingly globalised. Shipowners have their ships flagged where business is easiest. Crews are recruited internationally. Well-educated crews are found in many places round the world and nationality plays a minor role in many shipping companies [1]. Selection of crews is increasingly based on the total cost. Crew expenses depend on salaries and employment conditions. International salaries for highly qualified seafarers are becoming closer to each other, but considerable better

employment conditions generally makes seafarers from Western countries more costly.

Health is an upcoming cost of seafarers. Health expenses in foreign ports, repatriation costs and claims have increased focus on this issue in some parts of the world. The insurance companies, in the maritime world named P & I Clubs, have responded to this and introduced programmes to avoid employing seafarers who potentially may be an economic burden [2]. Despite worldwide use of pre-employment health examinations [3] repatriation

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of seafarers is common and the economic costs are high [4, 5].

This study is a comparison of the basic results of pre-employment health examinations in one large clinic in the Philippines and in Denmark. The purpose is to compare the outcome of the examinations and compare basic parameters, including age structure, overweight and smoking habits, and identify weaknesses and strengths in the two groups of seafarers.

## MATERIALS AND METHODS

A total of 9,654 consecutive health examinations from the large Halcyon Marine Healthcare Systems (Manila) – a clinic serving a large number of manning agencies – were drawn from the clinics database and anonymised before analysed. The examinations were done in the period from 5 January 2015 to 29 December 2015. The health examinations were performed according to the standards of a number of manning agencies and shipping companies. The seafarers included were all examined for the first time in the Halcyon Marine Healthcare Systems. Their maritime history was not available. The examined seafarers were to work in the international maritime industry.

A cohort of seafarers of similar size examined in Denmark was afterwards withdrawn from the Danish register on statutory health examinations performed in clinics in Denmark [6]. The examination is based on international guidelines [7]. The retrieval started with the newest recorded examination in 2015 and then going backwards until a total of 9,654 examinations were included. The Danish participants were residents in Denmark. The statutory Danish health examination only gives access to work on Danish registered ships. In both cohorts, a seafarer could only be included once.

As the system functions different in the two countries, there are also different outcomes of the examinations. In Denmark, seafarers may be “fit with limitations”, which means they get permission to work in e.g. a limited geographical area, in certain positions or reduced length of the validity of the certificate. In the Philippines, the result is either you are fit or unfit. In some cases, the recorded result of the examination is

“Expired”. This means that the process of the health examination was not finished within a certain time limit. Similar situations may occasionally occur in Denmark, but it is not recorded.

Body mass index (BMI) is used in this study to compare overweight. For Filipino seafarers, two different standards are used, namely an international standard and an Asian standard. The international standard defines obesity as a condition with a BMI of 25 or above [8]. The Asian standard defines BMI of 23 and above as obesity [9]. For Danish seafarers, only the international standard was applied. The international standard defines severe overweight when BMI reaches 30 or above. The Asian standard defines severe overweight when BMI is 28 or above.

Information about smoking only exists in the Philippine data. A smoker was defined as a person who defined himself/herself as a smoker.

## RESULTS

### RESULTS OF THE EXAMINATION

The overall results of the health examinations are presented in Table 1.

The age distribution of all seafarers in the two cohorts is presented in Table 2.

The two groups of seafarers are in some aspects quite different in composition. There are many more working in catering and hotel jobs among the Filipino seafarers. To make the age distribution more comparable, the age distribution of seafarers working in traditional maritime positions on deck and in engine room is shown in Table 3.

Chief engineers examined in Denmark had a mean age of 52.0 years ( $n = 329$ ) and the same category examined in the Philippines ( $n = 183$ ) had a mean age of 49.6 years.

Captains examined in Denmark had a mean age of 54.2 years ( $n = 1045$ ) and the same category examined in the Philippines ( $n = 42$ ) had a mean age of 48.4 years.

### OVERWEIGHT

In Figure 1, the percentage of seafarers with overweight is shown. The proportion of seafarers with a BMI exceeding

**Table 1.** The final results of the health examinations in the Philippines and in Denmark

Result of examination	Filipino		Danish	
	Number	Percentage	Number	Percentage
Fit for duty without limitations	8987	93.1%	9104	94.3
Fit with limitations	0	0%	502	5.2%
Unfit	428	4.4%	48	0.5%
Expired	239	2.5%	0	0%
<b>Total</b>	<b>9654</b>	<b>100.0%</b>	<b>9654</b>	<b>100.0%</b>

**Table 2.** Basic age distribution in the two study populations

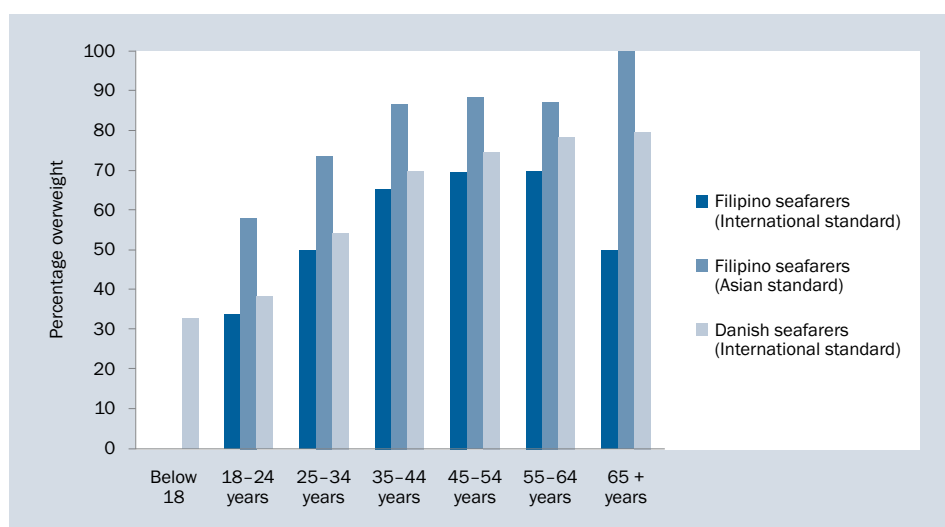
Age group [years]	Female seafarers				Male seafarers			
	Filipino		Danish		Filipino		Danish	
	Number	Percentage	Number	Percentage	Number	Percentage	Number	Percentage
Below 18	0	0.0%	24	2.1%	4	0.0%	135	1.6%
18–24	116	23.9%	343	29.9%	1574	17.2%	1265	14.9%
25–34	267	54.9%	275	23.9%	3291	35.9%	1750	20.6%
35–44	88	18.1%	168	14.6%	2645	28.9%	1730	20.3%
45–54	13	2.7%	217	18.9%	1312	14.3%	1972	23.2%
55–64	2	0.4%	116	10.1%	338	3.7%	1316	15.5%
65+	0	0.0%	6	0.5%	4	0.0%	337	4.0%
<b>Total</b>	<b>486</b>	<b>100.0%</b>	<b>1.149</b>	<b>100.0%</b>	<b>9.168</b>	<b>100.0%</b>	<b>8.505</b>	<b>100.0%</b>

**Table 3.** Age distribution of male seafarers in traditional maritime positions on deck and the engine room

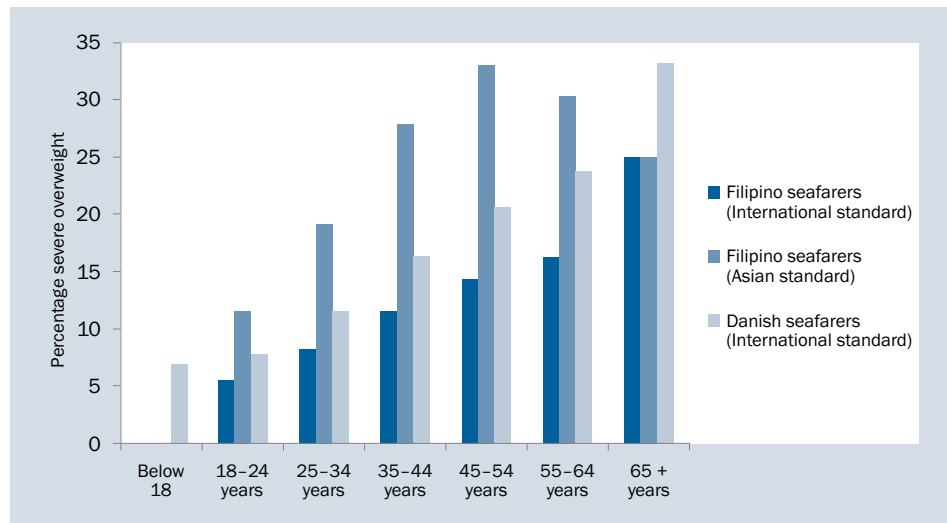
Age group [years]	Male seafarers, deck and engine			
	Filipino		Danish	
	Number	Percentage	Number	Percentage
Below 18	4	0.1%	135	2.1%
18–24	1140	17.7%	1128	14.4%
25–34	2078	32.3%	1589	20.3%
35–44	1921	29.8%	1569	24.4%
45–54	1004	15.6%	1832	28.4%
55–64	294	4.6%	1236	15.8%
65+	2	0.0%	329	4.2%
<b>Total</b>	<b>6.443</b>	<b>100.0%</b>	<b>7.818</b>	<b>100.0%</b>

the definitions of overweight was compared in each age group. The results from the two cohorts have been compared for each age group using chi-square statistic (Social Science Statistics). For all age groups except seafarers of 65 years of age and above the results are statistically significant (p-value < 0.05).

The analysis of severe overweight is presented in Figure 2. Among the 941 Filipino seafarers with severe overweight (international standard), 28 were female. The results from the two cohorts have been compared for each age group using chi-square statistic. For all age groups except seafarers of 65 years of age and above the results are statistically significant (p-value < 0.00001). A total of 49 (0.5%, 3 females and 46 males) of the Filipino seafarers were extremely obese (BMI 35 and above). In comparison, there were



**Figure 1.** Comparison of the percentage of overweight in different age-groups of seafarers (both sexes)



**Figure 2.** Comparison of the percentage of severe overweight in different age-groups of seafarers (both sexes)

600 Danish seafarers (6.2%, 72 females and 528 males) with extreme obesity.

### SMOKING

A total of 14.0% of the female seafarers and 32.0% of the male seafarers were recorded as smokers. Both among females and males, the highest rate were found in the age group 25–34 years. The percentage was 16.1% and 34.5%, respectively. For both genders, the lowest rate were seen among 18–24 years old seafarers, where the figures were 10.3% and 26.9%, respectively.

Among the male non-smokers, 55.2% were overweight whereas 58.5% of the smokers were overweight. Male seafarers with severe overweight had a smoking frequency of 10.8% whereas 9.6% of the non-smokers were overweight.

Smoking rates between deck and engine officers and deck and engine ratings were compared and the results are shown in Table 4. The difference between officers and rating is significant at  $p < 0.01$  (chi-square statistic).

### DIABETES

In both countries, all seafarers are examined for the presence of diabetes. In the Philippines fasting blood glucose is measured and seafarers with elevated levels have to undergo an oral glucose tolerance test. At the initial screening, 295 out of 6592 (4.5%) had blood glucose levels of 7.0 mmol/L or above. In the age group 18–24 years, 0.8% blood glucose levels were 7.0 mmol/L or above, increasing to 16.5% in the age group 55–64 years.

In the Danish dataset, 262 (2.7%) of those who were declared fit were recorded as having diabetes. The type of diabetes was only recorded in 111 cases. Among these 111 seafarers, ten had type 1 diabetes and the remaining 101 seafarers had type 2.

**Table 4.** Smoking frequency among Filipino officers and ratings in deck and engine departments

Smoking, Filipino seafarers	Non-smoker	Smoker	Percentage smokers
Officers, deck and engine	1309	458	25.9%
Ratings, deck and engine	3158	1560	33.1%
Total	4467	2018	31.1%

### DISCUSSION

The present study is a comparison of basic data of two cohorts of seafarers from the Philippines and Denmark. No such studies seem to have been made earlier. Both represent seafaring countries of major importance and the crews are to some extent competing for the same positions in a globalised maritime business.

The Danish cohort may be seen as representative of the seafaring population in Denmark, but there are likely to be selection bias in the Filipino cohort. The seafarers in the two countries are subject to different regulations and the two groups differ in a number of ways. The Filipino seafarers have to meet a number of different standards and have been through a strong selection process in their career. A strong “healthy worker effect” can be expected [10]. The Philippine data only include health examinations performed in one clinic, but due to the fact that they are only seafarers examined for the first time in the clinic, it is likely that they are comparable to other Philippine seafarers. Few Danish seafarers are declared unfit and the Danish seafarers are therefore probably not exposed to the same selection pressure. In Denmark, there may although be a considerable self-selection due to health problems due to

access to social benefits [11]. As the Danish cohort includes all seafarers examined in the country in the selected period, they are per definition representative of Danish seafarers.

The results of the health examinations vary considerably in the two cohorts although the results are not fully comparable. Among the Filipino seafarers, 2.3% never fulfilled the examination process, whereas all recorded Danish cases came to a conclusion. Danish examinations not completed may in some cases never been recorded.

The percentage of seafarers declared unfit was higher in the Philippines. The purpose of the examinations is different in the two countries, which is reflected in the results. The differences between the two groups cannot be interpreted as differences in the health condition in the two groups but more likely reflect the differences in two very different systems. The Filipino system is in principle an insurance-based system, where the employers want to reduce costs by avoiding potentially unhealthy seafarers [2]. There are variations in standards to be met from different manning agencies and shipowners. Seafarers from the Philippines are to work world-wide on long contracts. They are therefore to meet higher standards compared to other settings, e.g. Denmark, where limitations in field of work on board, area of trade and validity of the health certificate may be acceptable conditions. The Danish health examinations are based on a statutory based scheme with a limited insurance aspect and only fulfilling the minimum standards defined by International Labour Organisation [5]. The health insurance of the seafarers is paid by the Danish government although the shipowners contribute. The shipowner may have a more limited interest in the health status of the employed compared to most other countries, where the shipowners are to pay the full costs.

The age distribution between the two groups of seafarers is remarkable. The overall difference in mean age is more than 5 years. The age distribution is influenced by a large proportion of seafarers employed in catering and hotel business. When looking at male seafarers working in the deck and engine compartments, the differences are even more pronounced and these seafarers are competing for the same positions. There are more than three times as many Danish seafarers in the age group 55–64 years. Among captains and chief engineers, age differences are less, and the differences thus to some extent are likely to reflect differences in position the two nationalities in the maritime hierarchy. As burden of disease increases steeply with age [12], the significant differences in age structure is from an economic point of view a big advantage to the Philippine seafarers. Health expenditures can be expected to be considerable lower making this group more competitive.

Seafarers of both nationalities showed high frequency of overweight although the Danish seafarers are statistically

significant most overweight and thus have a higher risk of obesity related morbidity and mortality. The differences were more pronounced when looking at severe overweight. The Danish seafarers are known to have a considerable higher level of overweight compared to the rest of the population in Denmark [13]. The metabolic syndrome has been shown to be frequent among Danish seafarers. In a survey, one in four had the syndrome [14].

About one third of the male seafarers from the Philippines were smokers. In a recent Danish survey, 30.6% were current smokers [15]. There is thus no evidence for marked differences for this risk factor. Diabetes and pre-diabetic conditions were common in both nationalities but the figures are not directly comparable. A steep increase in abnormal fasting blood glucose with age was seen among the Filipino seafarers. Almost 3% of the fit Danish seafarers had a diagnosis of diabetes. According to international standards, type 1 diabetes should not be permitted to work at sea [7], but may be accepted according to Danish standards. The total number is likely to be low, and self-selection is likely to be important, as diabetes is more common in the Danish population than among the seafarers.

## CONCLUSIONS

The present study show a major difference in the age distribution of the two groups, which may be the most important factor when evaluating differences in health between the two groups of international seafarers. Obesity was of major concern in both groups, although there were more people with severe overweight and especially with extreme overweight among the Danish seafarers. Smoking seems to be on the same level. The more strict health standards to be met in the Philippines are likely to create a more pronounced healthy worker effect. In conclusion, the risk of lifestyle-related disease is likely to be lower among the Filipino seafarers.

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# Medical evacuation on high seas

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## ABSTRACT

*A previously healthy Indian male seafarer aged 34 years, presented with vague perianal symptoms to the Master on a Very Large Crude Carrier (VLCC) in the Pacific Ocean. Over a few days, his condition deteriorated, and the company's medical consultant ashore, based on telephonic consultation, transmitted information and photos, diagnosed the condition as a life threatening case of Fournier's gangrene. The ship was then almost 1140 nm from the port. The consultant instructed the Master to intensify antibiotic treatment and started necessary procedures for an urgent complex medevac. Arranged by the United States Coast Guard, it involved deployment of two helicopters, two fixed wing aircrafts and an air tanker. Helicopters needed to be refuelled mid-air to increase their range of operations. Rendezvous point was 478 nm from Santa Barbara, California. 3½ hours after lift off from the vessel, the helicopter landed at Santa Barbara airport and the patient was transported to hospital. State-of-the-art treatment ashore preserved both testicles and after long term recovery the seafarer was again fit for ship duty.*

(Int Marit Health 2019; 70, 4: 216–219)

**Key words:** medical aid to ships, helicopter evacuation, Fournier's gangrene

## INTRODUCTION

Every occupation has its own associated hazards, so does seafaring. Apart from occupational hazards of work on board, being away from medical treatment adds to the seriousness of the situation. Ships carry essential medicines as recommended by International Maritime Organisation (IMO) [1] and Flag state [2]. All crew are required to undergo medical training according to IMO Standards of Training, Certification and Watch-keeping (STCW) Convention [3]. But even the Master, who has more advanced training because he/she is responsible for all medical care aboard, is not really competent to handle serious medical emergencies at sea. All such cases need to be landed ashore for expert treatment. During an emergency, when the ship is still far away from port, complex medical evacuation needs to be carried out by a helicopter.

## CASE REPORT

The patient was a 34-year-old healthy Indian seaman. No previous history of diabetes mellitus, hypertension. Serological tests for human immunodeficiency virus (HIV) and hepatitis B negative. He had been sailing for the past few months on board a Marshall Island Flag, Very Large Crude

Carrier (VLCC), 333 m in length, 299,235 dead weight tonnage (dwt). Current voyage was from Singapore to Long Beach, California, USA. The vessel had an operational speed of 12 knots and a maximum speed of 15 knots. Expected date of arrival at Long Beach was 6 December 2018. The vessel had a total crew of 29 including the Master, 27 Indian and 2 Indonesian nationals.

On 17 November 2018, he complained of pain and burning around anal area after defecation. No bleeding per rectum. No constipation. According to company's rules about illnesses and injuries amongst crew aboard, the Master, contacted company's medical consultant for advice regarding management of the condition. The vessel was at position 32 32.2 N / 152 50 E, Distance to Go (DTG) 4754 nm. The consultant recommended the following: stool softening medication available on board and high fibre diet to avoid constipation; avoid straining for stools; anaesthetic ointment for local application; ibuprofen 400 mg tablets for pain relief if necessary.

On 21 November the vessel reported that the patient had developed multiple external piles. He complained of feverish feeling, exhaustion and was unable to work. He also complained of pain in right gluteal region. He was

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**Figure 1.** Swollen scrotal contents referred to as “hydrocoele” by the Master

prescribed by consultant Ampicillin 500 mg twice daily. On 26 November, the Master contacted and reported that the patient had developed a swelling of the scrotal contents on right side (which he described as “hydrocoele”, Fig. 1) that increased in size rapidly over next 2 days.

On 29 November, at 10:40 local time / GMT-9 (the vessel was at position, 30 22.40 N / 138 41.45 N, DTG 1142 nm), the Master reported that some discharge was oozing out of the scrotum and the antibiotic was changed to Amoxicillin 875 mg + Clavulanic acid 125 mg to cover both Gram positive and negative bacterial infection. The patient had difficulty getting up, even to go to the rest room, and a condom drainage system was prepared and connected to a urine collecting bottle. Swelling and redness over right thigh was reported. Urine output, although not measured, was very small in quantity, darkly coloured. Photos received at frequent intervals from the vessel revealed the patient to be toxic, scrotum appeared oedematous, skin chocolate brown in colour indicating gangrenous state. Skin over right thigh was red and inflamed. Infection appeared to have spread up to right mid-thigh level. Provisional diagnosis of Fournier’s gangrene was made. Photos were shared with a senior consultant surgeon who concurred with the diagnosis (Fig. 2). Injection Cefuroxime 750 mg was available on board and was prescribed twice daily, deep intramuscularly. Method of preparation of the injection fluid and administration was explained to the Master who was told to read the relevant pages from the International Medical Guide for Ships [4]. The Master and his mates managed to execute this without any difficulty.

The medical consultant feared that that the patient might die unless he was rushed to a hospital for surgical intervention. Vessel operators / charterer had to be convinced about the urgency of situation and that course correction



**Figure 2.** Necrotised scrotal skin and evidence of inflammation on right upper thigh

and increased speed may be required to evacuate the sick crew member. This was agreed to immediately, which helped make further decision making. Rescue Coordination Centre, Alameda, USA, was impressed upon about the emergency situation. Landing permits and immigration formalities were completed post-haste by the local agents.

On 30 November, around 18:00 local time / GMT-8 (the vessel was at 30 26.8 N / 128 37.9 W, DTG 668 nm), the Master reported that there was foul odour around the scrotal area, pulse 104 per min, blood pressure 106 / 74 measured digitally. He was advised to gently clean the area with weak solution of polyvidone

In the meanwhile, the Rescue Coordination Centre, Alameda, USA had carried out assessment of situation and assets available. In view of the distance from land, suitable helicopters available for such a long distance evacuation were sourced. Two Black Hawk (HH 60) helicopters with two paramedics in each and two fixed wing C-130 aircrafts were to be used for medevac. Based on the speed of the VLCC, medical evacuation was planned on 1<sup>st</sup> December around 13:00 PST. Rendezvous position selected, 30 26.45 N and 127.512 W, was 478 nm from Santa Barbara, California, USA (Fig. 3).

Sequence of medical evacuation events on 1 December 2018 as reported by the Master is as follows:

- 12:28: C-130, Aircraft, designated call sign Rescue 07 called the vessel on VHF channel 16 for safety briefing. Rendezvous point was changed due to operational delay of the helicopters
- 12:30: Commenced safety briefing on VHF channel 16
- 12:42: Completed safety briefing
- 12:50: Helicopter landing checklist completed
- 12:55: Aircraft Rescue 07 informed approaching towards the vessel and making round above the vessel



**Figure 3.** Helicopter route from Davis–Monthan Air Force Base, Tucson, Arizona to the vessel and to Santa Barbara

- 13:00: Aircraft Rescue 07 advised the vessel to alter course 270 and speed 10 knots, as two helicopters, designated call signs Rescue 09 and Rescue 02, were coming shortly to evacuate the patient
  - 13:15: Both helicopters started making rounds around the vessel
  - 13:18: Helicopter Rescue 09 came to landing area on the vessel and two paramedics were winched down on board the vessel
  - 13:20: Helicopter Rescue 02 came to landing area on the vessel and two paramedics with stretcher were inched down
  - 13:30: Two injections were given, one on each arm (no details available)
  - 13:45: The patient on deck in a stretcher
  - 13:56: The patient picked up by helicopter Rescue 02 by winching along with two paramedics and away
  - 14:00: Helicopter Rescue 09 came to landing area on the vessel and picked up two paramedics by winching
- Helicopters landed at Santa Barbara airport, California, USA at 17:30 PST and the patient was taken to Santa Barbara Cottage Hospital for surgical treatment.

Emergency Room assessment revealed following areas of concern in this critically ill patient:

- acute respiratory failure with hypoxia;
- adult respiratory distress syndrome;
- septic shock;
- acute anaemia;
- acute kidney injury;
- ischiorectal abscess;
- necrotizing soft tissue infection.

There was extensive necrotizing fasciitis of the entire scrotum extending into the right inguinal area, groin, proximal right thigh, buttocks and ischiorectal space. There was active drainage of pus from the perirectal region on the right side of perineum. Additionally, there was some drainage from the right scrotum. The entire scrotum was oedematous and pus-filled, with most of the skin black due to necrosis.

During surgical intervention, there appeared to be good blood flow to the cord on right side as well as blood flow to corporal bodies. Superficial tissue surrounding the penis – almost 90% circumferentially – was necrotic. There was a small skin island to the base of the penis skin. Deeply, tissue appeared viable. Tunica vaginalis surrounding the left testicle appeared necrotic. Both testicles appeared viable with blood flow to tunica albuginea. Both cords and testicles were preserved and placed in a pouch created above pubis.

Colostomy was done to prevent faecal contamination of the wound.

The patient underwent a number of surgical interventions and remained in Intensive Care Unit for extended period of time. Five weeks after admission the patient was uneventfully evacuated by air on stretcher to Mumbai (Bombay), India where he was hospitalised for further treatment, including skin graft procedures and colostomy closure.

He remained in hospital for over 6 weeks. He was followed-up for 2 weeks thereafter and advised physiotherapy. He has since been declared physically fit to resume work.

## DISCUSSION

Medical aid to a seriously ill or injured sailor on high seas is always a problem. Means for communication with shore has improved tremendously over the past few years. Real time information can be exchanged with doctors ashore but in case of serious medical situation the crew is helpless not being competent to implement instructions. In such situations, means of evacuation and distance from port with medical facilities play a major role.

Very Large Crude Carriers, by their sheer size, do not go alongside in any port and casualty evacuation is always a challenge. It has to be carried out by a boat or in case of emergency situation by using a helicopter. VLCCs often receive pilot and stores on board from helicopters. Helicopter landing area is marked on the deck and the crew is well versed in helicopter landing procedure [5].



Pre-employment medical examination plays an essential role in selecting healthy crew. Those joining VLCCs need special consideration as voyages are long and there is no “port stay”. Those with pre-existing diseases need additional evaluation and assessment by a specialist. If the medical condition recurs, it cannot be investigated and treated on board before becoming life threatening, telemedicine notwithstanding. Persons with past medical history of peptic ulcer, obstructive lung disorders (COPD), prostatic hypertrophy, irritable bowel (IBS) etc. do not become unfit to undertake long voyages at sea but the risk of serious recurrence arising at sea needs to be assessed in each case so also the contingency plan for rapid intervention ready, should a problem arise. Such a seafarer could be considered for employment on a coastal or near coastal voyage where, in case of an emergency, crew can reach onshore medical facility within a short time.

It must also be remembered that shipping companies, charterers, are often reluctant to deviate from course and speed due to commercial reasons.

Fournier gangrene is a specific form of necrotizing fasciitis, localised on the external genital organs, as well as in the perineal region, accompanied by thrombosis of the feeding arteries, leading to gangrene of the skin and subcutaneous tissue, with manifestations of severe septicaemia and multiple organ failure. This is an extremely rare disease that occurs in 1.6 cases per 100,000 men per year, amounting to 0.02–0.90% of total admissions to the surgical hospital. Average age of the patient is 50.9 years and the ratio of men to women is 10:1. This disease often appears in immuno-compromised patients with diabetes, obesity, and malignant neoplasms. The basic treatment of Fournier gangrene includes an extensive emergency surgical intervention combined with antibiotic therapy to control septicaemia. Prognosis is directly related to the timing of medical care. Treatment delay is accompanied by a high lethality, reaching 90%, due to development of septic shock and its associated complications. Testes are not affected because of their independent blood supply. Testicular artery arises from the abdominal aorta just below the renal artery and then entering the spermatic cord [6].

Very Large Crude Carrier had an operational speed of 12 knots and a top speed of 15 knots. There is an exponential increase in fuel consumption when speed is increased and could be about US \$ 2–3000 per day over and above calculated fuel cost which the charterers would have to bear. Even if the VLCC could sustain continuous top speed, theoretically only 72 additional nm could be

covered every day, 360 nm instead of 288 nm. Medevac may have been less complex if the vessel could reach a port, but once septicaemia sets in, how the body reacts and the outcome cannot be predicted. Whether the patient could have survived an extra day or two on board is beyond comprehension. Additionally, a weekend was approaching when things move at a slow pace. Death on board would have had severe psychological impact on the rest of the crew, so also to the ship owners, managers, charterers, in fact, everyone connected to the VLCC.

Decision to evacuate was appropriate under the circumstances and shipowners, ship operator, charterer and all others supported the medical evacuation wholeheartedly. Regional Coordination Centre Alameda, USA played a yeoman service, utilising all available resources on a war footing. Black Hawk (HH 60) helicopters were to be launched from Davis-Monthan Air Force Base, Tucson, Arizona at 0630 PST. One of the fixed wing C-130 was to be overhead the VLCC for Command and Control and coordinate the operations. Second C-130 aircraft ensured 100 per cent redundancy in the event of an emergency on board one of the aircraft, the other aircraft would already be on scene and able to conduct an immediate rescue. Both were carrying extra rescue personnel including gear such as Rescue crafts that can be deployed for the rescuers to use. Helicopters were fitted with a special mid-air refuelling rig allowing them to receive fuel and continue flying en-route to rendezvous location. Refuelling air tanker provided fuel to both helicopters. Pilots of the helicopters flew almost 880 nm for 7 hours to reach the rendezvous point and then another 3½ hours to Santa Barbara airport. Planning and execution of this mammoth operation is truly commendable.

This wholehearted support saved a life!

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# Medical kit for single-handed offshore yacht races

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## ABSTRACT

**Background:** The medical kit is the basis of medical support in maritime environment; it is defined by international or national regulations and guidelines. For offshore races, rules and recommendations are proposed by national or international sailing federations. Sailing and racing offshore alone presents specificities that sometimes make it difficult to apply the usual recommendations. The epidemiology of single-handed offshore race is dominated by traumatic risks. Medical events are relatively rare because competitors are high-level athletes, generally young and subject to complete medical assessments. The scarcity of available scientific data makes it necessary to choose appropriate methods for developing recommendations. The purpose of this work is to propose a medical kit adapted and applicable to these situations.

**Materials and methods:** The method used was that of “Professional recommendations by formal consensus of experts” derived from the Rand/UCLA method. After a critical analysis of the literature, a panel of 19 experts having expertise in medicine in maritime environment was gathered from various medical specialties (cardiologist, internist, intensivist and emergency physician, ear-nose-throat physician and general practitioner) and from varied medical activities. They had not declared any direct conflict of interest.

**Results:** A medical kit proposal has been developed. The choice of drugs was based on the analysis of the epidemiology of medical events observed during the last offshore races. The experts’ choice was to reduce the quantity of medication and medical devices in order to limit the risk of confusion of medicines and dosages. Drugs with significant side effects or requiring third party monitoring have been removed. Medical devices designed to do an intervention impossible to perform on oneself have also been eliminated.

**Conclusions:** Solo sailing remains a marginal maritime activity with specific risks. The development of single-handed races requires an adaptation of medical support through the development of a specific medical kit and adapted training. The formalised consensus of experts seems to be an appropriate method for developing recommendations in the field of maritime medicine.

(Int Marit Health 2019; 70, 4: 220–225)

**Key words:** medical kit, single handed, offshore yacht races

## INTRODUCTION

The medical kits, with medical training and telemedical advices, are the basis of the medical support in the maritime environment. They are defined by international or national regulations [1, 2]. Scientific societies have also proposed recommendations mainly in the field of cruising. For offshore yacht races regulations and recommendations are proposed by the national or international federations [3]. The practice of single-handed offshore races presents specificities that sometimes make it difficult to apply the usual recommendations. The epidemiology of single-handed offshore races

is dominated by traumatic risks [4, 5]. Medical events, apart from dermatological problems [6], are rare because skippers are high-level athletes, generally young and subject to full medical assessments. The purpose of this work is to propose a medical kit adapted and applicable to this activity.

## MATERIALS AND METHODS

The method used was that of “Professional recommendations by formal consensus of experts” derived from the Rand/UCLA method. After a critical analysis of the literature, a panel of 18 experts (Appendix 1) having expertise in med-

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icine in maritime environment was gathered from various medical specialties (cardiologist, internist, intensivist and emergency physician, ear-nose-throat physician and general practitioner) and from varied medical activities. They had not declared any direct conflict of interest. The members of the rating group were required to complete the questionnaires submitted to them in their entirety. Next to each item of the questionnaire is placed a numerical scale graduated from 1 to 9, the value 1 means that the contributor judges the proposal totally inappropriate (or not indicated, or not acceptable), the value 9 means that the contributor judges the proposal is entirely appropriate (or indicated, or acceptable), the values 2 to 8 reflect the possible intermediate situations, the value 5 corresponds to the indecision of the contributor. Two rounds of quotation are carried out. The final ranking of the various proposals was made by calculating the median and the distribution of quotations in strong agreement, relative agreement, indecision, lack of consensus. For the final recommendations, only proposals with strong or relative agreement were selected [7].

## RESULTS

A proposal for a medical kit has been developed (Table 1). The organisation of the kit should allow for intuitive use, possibly using colour-coded modular arrangements, and should include an easily accessible list of content. The drugs are listed Anatomical Therapeutic Chemical (ATC) code (The ATC Classification System) [8] and by generic name followed by the indication for use and whether or not to contact the Telemedical Advice Service (TMAS) before a procedure or administration of a drug.

## DISCUSSION

The choice of the medicines was based on the analysis of the epidemiology of medical events observed during the last offshore races [4, 5, 6, 9]. In the same therapeutic class, an analysis of the recent recommendations of learned societies or health authority organisations has made it possible to choose the most relevant medicine according to evidence-based medicine. The experts' choice was to reduce the quantity of medicines and medical devices in order to limit the risks of confusion of the medicines and their dosages, taking into account the limited space and weight allotment on board, and the cost to the skippers for whom it is not a priority. Medicines with significant side effects or requiring special monitoring have been eliminated.

Medical devices designed to perform techniques impossible to execute on oneself have also been eliminated. The other criteria of choice were to promote a compact and light presentation, biochemically and environmentally stable. These recommendations represent the basic minimum endowment, and can be supplemented according to local

regulations or requests from race organisers. Skippers with specific pathologies and who have passed the selection tests will have to complete the medical kit by the specific drugs of their pathologies.

## CARDIOVASCULAR DRUGS

They are present in all medical kit for the management of heart failure, acute coronary syndrome or a rhythm disorder. In the case of single handed offshore race, epidemiology [5, 9] does not show any major cardiovascular events, although they are still possible. The population of offshore skippers is essentially a young population, high-level athletes, prepared and medically followed before their departure. In addition, if an acute coronary syndrome occurred it would be difficult to start an anti-platelet or anticoagulant treatment with haemorrhagic risks without diagnostic confirmation. Only DL-lysine acetylsalicylate acid in oral sachet was kept [10]. The furosemide, often recommended, has not been retained, the possibility of cardiac or renal decompensation with hydro saline inflation that would not have been revealed before the race is unlikely, the risk in the maritime environment is rather the risk of dehydration.

## ANALGESICS

Level one is represented by paracetamol, for more intense pain paracetamol/nonsteroidal anti-inflammatory drugs combination is recommended [11, 12]. In case of major pain or failure of previous measures, an opioid, morphine sulphate 10 mg, should be administered. Given the risk of side effects and the difficulty of performing a titration under good conditions, the choice of the oral route is preferred. To avoid any risk of confusion and overdose, all other medicines have been eliminated as well as presentations involving several medicines.

## PSYCHOTROPIC AND SEDATIVE DRUGS

Psychotropic agents and anxiolytic sedatives, mainly benzodiazepines, are proposed in medical kit for the management and treatment of agitation states, panic attacks or sleep disorders [13]. These drugs can be useful in commercial navigation or crewed sailing but can be dangerous in solitary navigation. They can lead to a decrease in alertness and combativeness and drowsiness, more rarely can they be responsible for paradoxical effects and hallucinations [13]. For all these reasons they have been eliminated from the medical kit.

## VASOPRESSIVE CATECHOLAMINES

The only indication in these situations is the treatment, in emergency, of acute anaphylaxis (stage II and III) of food or drug origin. Under these conditions, the recommended medicine is adrenaline in intramuscular injectable solution with 0.3 mg pre filled syringes in self-injectable device, two

**Table 1.** Recommended medicines and equipment on board off-shore racing yachts

Medical Support for single-handed Offshore Yacht Races – Medical Kit Inventory\*

X indicates that Telemedical Advice Service (TMAS) should be contacted before a procedure or administering a drug.

<b>LIST OF RECOMMENDED MEDICINES AND EQUIPMENT ON BOARD OFF-SHORE RACING YACHTS</b>				
<b>World Health Organization Format</b>				
<b>Item no.</b>	<b>ATC code</b>	<b>Recommended medicine and dosage strength representing best practice on board off-shore racing yachts</b>	<b>Indications on board off-shore racing yachts</b>	<b>Need to contact TMAS</b>
<b>MEDICINES</b>				
1	A02AE03	Lansoprazole 30 mg tablet	To treat gastro-oesophageal reflux; to treat ulcer disease	x
2	A03AX12	Phloroglucinol 80 mg	To relieve intestinal or urinary spasms	x
3	A06AB02	Bisacodyl 5 mg tablet	For treatment of constipation	
4	A07CA	Oral rehydration salts sachets	To prevent or treat dehydration	
5	A07XA04	Radecadotril 100 mg tablet	Antidiarrheals	
6	C05AX	Haemorrhoid preparations – proprietary preparation of choice	Haemorrhoid preparations	
7	B02AA02	Tranexamic acid tablet 500 mg	Treatment of haemorrhage	x
8	C01CA24	Adrenaline auto-injector 0.5 mg	To raise blood pressure in anaphylaxis; to dilate airways in severe asthma or anaphylaxis	
9	D01AC02	Miconazole 2% ointment (30 g)	To treat fungal skin infections	
10	D06BA01	Silver sulfadiazine cream (50 g)	Treatment of burns	
11	D06BB03	Acyclovir 5% cream (10 g)	To treat cold sores	x
12	G01AF02	Clotrimazole 500 mg pessary	To treat vaginal fungal infections	x
13	J01XX01	Fosfomycin tablet	Single dose treatment of uncomplicated acute cystitis in women	x
14	J01CR02	Amoxicillin + clavulanate 1000/200	To treat infections responsive to this antibiotic	x
15	J01DD04	Ceftriaxone 1 g ampoule	To treat infections responsive to this antibiotic	x
16	J01FG01	Pristinamycin tablets 500 mg	To treat infections responsive to this antibiotic	x
17	J01MA02	Ciprofloxacin 500 mg tablet	To treat infections responsive to this antibiotic	x
18	P01AB01	Metronidazole 400 mg tablet	To treat intestinal infections responsive to this antibiotic	x
19	H02AB07	Prednisone 10 mg tablet	To treat severe asthma; to treat other inflammatory conditions	x
20	M01AE01	Ibuprofen 400 mg tablet	To treat inflammation; to reduce mild to moderate pain, especially if associated with inflammation	
21	N01BB02	Lignocaine gel (6 mL)	Local anaesthetic	
22	N02AA01	Morphine sulphate (oral) tablet 10 mg	Opioid analgesic (treatment of moderate to severe pain)	x
23	N02BA01	Acetylsalicylic acid 300 mg	To inhibit formation of blood clots in angina pectoris, myocardial infarction, stroke	x
24	N02BE01	Paracetamol 1 g tablet	To reduce pain and fever	
25	N07CA02	Cinnarizine 25 mg tablet	To prevent and treat motion-sickness	
26	R06AE07	Cetirizine tablet 10 mg	Anti-histaminic, anti-allergic	x
27	S01AA09	Tetracycline eye ointment (4 g)	Eye infection	x
28	S01AA16	Rifamycin ophthalmic ointment	Eye infection anti-infective preparations for ophthalmological use	x
29	S01CA01	Tobramycin/Dexamethasone eye/ear drops (10 mL)	To treat eye and ear infections	x
30	S01XA02	Retinol eye ointment	Topical preparation for repairing eye	x
31	S02AA12	Rifamycin ear drop	Ear infection	

→

**Table 1. cont.** Recommended medicines and equipment on board off-shore racing yachts

<b>LIST OF RECOMMENDED MEDICINES AND EQUIPMENT ON BOARD OFF-SHORE RACING YACHTS</b>				
<b>World Health Organization Format</b>				
<b>Item no.</b>	<b>ATC code</b>	<b>Recommended medicine and dosage strength representing best practice on board off-shore racing yachts</b>	<b>Indications on board off-shore racing yachts</b>	<b>Need to contact TMAS</b>
<b>EQUIPMENT</b>				
<b>DRESSING MATERIAL AND SUTURING EQUIPMENT</b>				
32		Wound closure strips	Adhesive skin closures	
33		Skin stapler × 35 staples	Wound staplers	
34		Stapler remover	Wound staplers	
35		Assorted wound plasters	Adhesive dressing	
36		Adhesive wound dressing 10 × 10 cm	Adhesive dressing	
37		Sterile gauze compresses 10 × 10 cm	Sterile gauze compresses	
38		Low adherent dressing 10 × 10 cm	Gauze dressing with non-adherent surface	
39		Tulle gras dressing	Healing dressing	
40		Haemostatic dressing	Haemostatic agent	
41		Elastic fixation bandage 6 cm × 4 m	Bandage	
42		Tubular bandage 5, 8, 10 cm × 10 m	Bandage	
43		Adhesive surgical tape 2.5 cm × 10 m	Bandage	
44		Chlorhexidine solution S02AA09	Antiseptic	
45		Sterile gauze swabs 5 × 5 cm	Sterile swabs	
46		Adhesive elastic bandage 7.5 cm × 4.5 m	Bandage	
47		Cohesive bandage 7.5 cm × 4.5 cm	Bandage	
48		Trauma tourniquet	Compressing device (bandage), to control bleeding	
49		Gloves non-sterile, disposable	Gloves	
<b>INSTRUMENTS</b>				
50		Bandage scissors (tough cut scissors)	Scissors	
51		Artery clamp	Haemostatic clamp	
52		Splinter forceps (tweezer)	Forceps	
53		Scalpel, sterile, disposable	Disposable scalpels	
<b>EXAMINATION AND MONITORING EQUIPMENT</b>				
54		Stethoscope		
55		Sphygmomanometer manual	Blood pressure set	
56		Sphygmomanometer automatic	Blood pressure set	
57		Large blood pressure cuff	Blood pressure cuff	
58		Thermometer digital	Thermometer	
59		Pulse oximeter	For monitoring of oxygen saturation	
60		Urine testing strips 10 parameters	Reactive strips for urine analysis	
61		Blood glucose testing kit/25 strips + 25 needles	Reactive strips for blood analysis	
<b>EQUIPMENT FOR INJECTION, INFUSION AND CATHETERISATION</b>				
62		Syringes 5 mL	Equipment for injection	
63		Needle 23 G hypodermic	Equipment for injection	
64		Needle subcutaneous	Equipment for infusion	x

**Table 1. cont.** Recommended medicines and equipment on board off-shore racing yachts

<b>LIST OF RECOMMENDED MEDICINES AND EQUIPMENT ON BOARD OFF-SHORE RACING YACHTS</b>				
<b>World Health Organization Format</b>				
<b>Item no.</b>	<b>ATC code</b>	<b>Recommended medicine and dosage strength representing best practice on board off-shore racing yachts</b>	<b>Indications on board off-shore racing yachts</b>	<b>Need to contact TMAS</b>
GENERAL MEDICAL AND NURSING EQUIPMENT				
65		Ethanol 70% hand cleanser gel 250 mL	An alternative to hand washing	
66		Medical guide		
67		Medical observation forms		
68		Cold pack	To reduce swelling and pain	
69		Dental repair kit		x
IMMOBILISATION AND TRANSPORTATION EQUIPMENT				
70		Malleable splint	For immobilizing bone and soft tissue injuries	
71		Neck collar, semi-rigid, adjustable	For neck immobilisation	

\*List of recommended medicines and equipment as stated in SFMM Consensus Paper on Medical Support for Single handed Off Shore Yacht Races – Medical Kit Inventory

doses must be available and the treatment must be carried out in connection with a TMAS.

## DEVICES AND PERFUSION SOLUTION

The setting up of an intravenous and prolonged infusion seems difficult to achieve in single-handed navigation and not without danger. Emphasis should be placed on the early detection of dehydration states and its correction by electrolytic supply via the digestive tract.

It was not included in these proposals anything which relates to hygiene products (sunscreen, lipstick, dermatological soap, hand protection products and for seat and feet). No survival bag has been proposed as in some other recommendations.

## CONCLUSIONS

The single-handed offshore yacht race remains a marginal practice with specific risks. The development of this type of races requires an adaptation of medical support through the development of a specific medical kit with adapted training. The formal consensus of experts seems to be an appropriate method for the development of recommendations in the field of maritime medicine. The evolution of the medical kits over time is inevitable by adapting to the new epidemiological collections available and according to the evolution of the human constraints of the boats.

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## APPENDIX 1. SFMM Position Paper. Medical Support for single handed Offshore Yacht Races – Expert group

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# Health status of a sample of Beninese seafarers examined on the occasion of medical fitness for work at sea

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## ABSTRACT

**Background:** In view of the considerable risks involved in maritime work, the medical fitness of seafarers is of paramount importance. A study carried out in May 2018 in Benin made it possible to describe the health profile of seafarers who received a medical examination before boarding and to identify the diseases likely to hinder their medical aptitude for this profession.

**Materials and methods:** This is a retrospective cross-sectional study that was based on 125 medical files registered from 2013 to 2017 and selected on the basis of the criteria of completeness, readability and non-overload of the entries.

**Results:** The results showed that more than half (63.2%) of the seafarers in our series are over 40 years old. The prevalence of high blood pressure was 28.4% in the seafarer population. Obesity was detected in 21.5% of subjects. Of the moderate cases of hearing loss found, 4 out of 5 worked at the machine station. The unrestricted fitness level was 86.4%. One (0.8%) case of physical restriction and 12.8% of cases of mandatory wearing of medical glasses at work were reported. The “healthy worker effect” may underestimate the risk of marine activity to the health of seafarers when referring to the general population.

**Conclusions:** The study provides opportunities to improve the seafarers’ health situation in accordance with international provisions such as the Maritime Labour Convention, 2006 (MLC, 2006) ratified by Benin in June 2011.

(Int Marit Health 2019; 70, 4: 226–231)

**Key words:** work, sea, fitness, disease

## INTRODUCTION

The sea is dangerous, Thierry Sauvage said in an article published in 2014 [1]. Dominique Jégaden specified that the contact between the human being and the maritime environment, whether for professional reasons, proximity or leisure, generates all kinds of pathogenic and accidentogenic situations [2]. These two statements raise the whole issue of the occupation of seafarers.

In this context of high risks, the international community has taken all appropriate measures to reduce the damage through the standards of the International Labour Organisation (ILO) and the International Maritime Organisation (IMO). These standards are relayed at national level after ratification.

Shipowners and seafarers therefore are subject to international requirements for occupational safety and health. Among these requirements, the medical fitness for the function of seafarers is of paramount importance.

Benin ratified the Maritime Labour Convention, 2006 (MLC, 2006) on June 13, 2011. Since then, its approach to medical surveillance of seafarers’ health has entered a process of continuous improvement that it is important to assess regularly. In the present study, we decided to assess this Beninese medical surveillance focused on a sample of Beninese seafarers serving on a ship under Beninese flag in Benin. The main objectives were to describe the health status of these seafarers and to

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identify the diseases likely to hinder their medical fitness for this profession.

## MATERIALS AND METHODS

### FRAMEWORK AND TYPE OF STUDY

The study was conducted at the Unit of Research and Teaching in Occupational Health and Environment (URESTE) in charge of medical examinations of seafarers in Benin.

This is a descriptive and retrospective cross-sectional study that relies on the medical data of seafarers from all socio-professional categories examined on the occasion of a visit in order to determine their medical fitness for work at sea (pre-employment, periodical or return to work) from 2013 to 2017.

### SAMPLING AND INCLUSION CRITERIA

This study used a non-probability sampling method.

All medical records established in the URESTE study period were systematically tabulated.

At the end of the recounts, the files meeting the following criteria are included in the study:

- records from 2013 to 2017;
- completeness of the filling of the file;
- readability of the file;
- no overloading of entries on the file.

Thus, files that do not meet the above requirements are systematically excluded from the study.

### COLLECTION OF DATA

In addition to the tabulation of all medical records from 2013 to 2017, data collection also included the review of national and international standards for seafarers' occupational safety and health at sea.

### VARIABLES STUDIED

- Age and sex of seafarers
- Types of ship
- Health profile:
  - Medical and surgical history
  - Declared lifestyle (tobacco, alcohol and drugs)
  - Health situation on board
  - Results of medical examinations (visual acuity, auditory acuity, clinical and paraclinical data)
- Diseases screened at risk of incapacity
- Fitness rate in relation to work-position (bridge, machine, catering and others) and degree of fitness (unrestricted or restricted)

### DATA PROCESSING AND ANALYSIS

The data was processed and analysed using the EPI INFO® software. A simple descriptive analysis was done with some comparisons between some exposure and outcome variables.

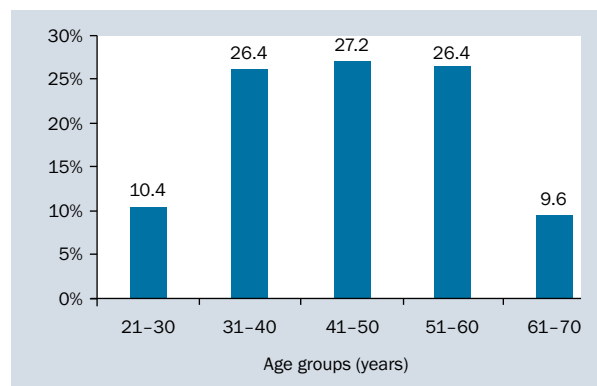


Figure 1. Distribution of seafarers by age group

The p-value significance threshold for the data was set at 5%.

### ETHICAL CONSIDERATIONS

Medical data of seafarers are kept confidential against any access by persons outside the service of URESTE. Although they are not aware of exploitation for scientific research purposes such as this, their data are not subject to illegal manipulation, contrary to research ethics and the international code of ethics for occupational health professionals.

## RESULTS

### AGE AND SEX OF SEAFARERS

The average age of seafarers was  $45 \pm 11$  years old. The youngest is 21 years old, the oldest being 66 years old (Fig. 1). The subjects aged 31 to 60 are the most numerous (80%) in the maritime profession. They are all male.

### MEDICO-SURGICAL HISTORY AND LIFESTYLE

The most commonly reported disease is high blood pressure for which they are on treatment (15.1%) in addition to eye troubles (6.3%), haemorrhoids (2.4%) and gastritis (1.6%). Those who reported drinking alcohol regularly accounted for 5.6% of the workforce.

### CLINICAL DATA

#### Visual acuity with and without corrective lenses and colour perception

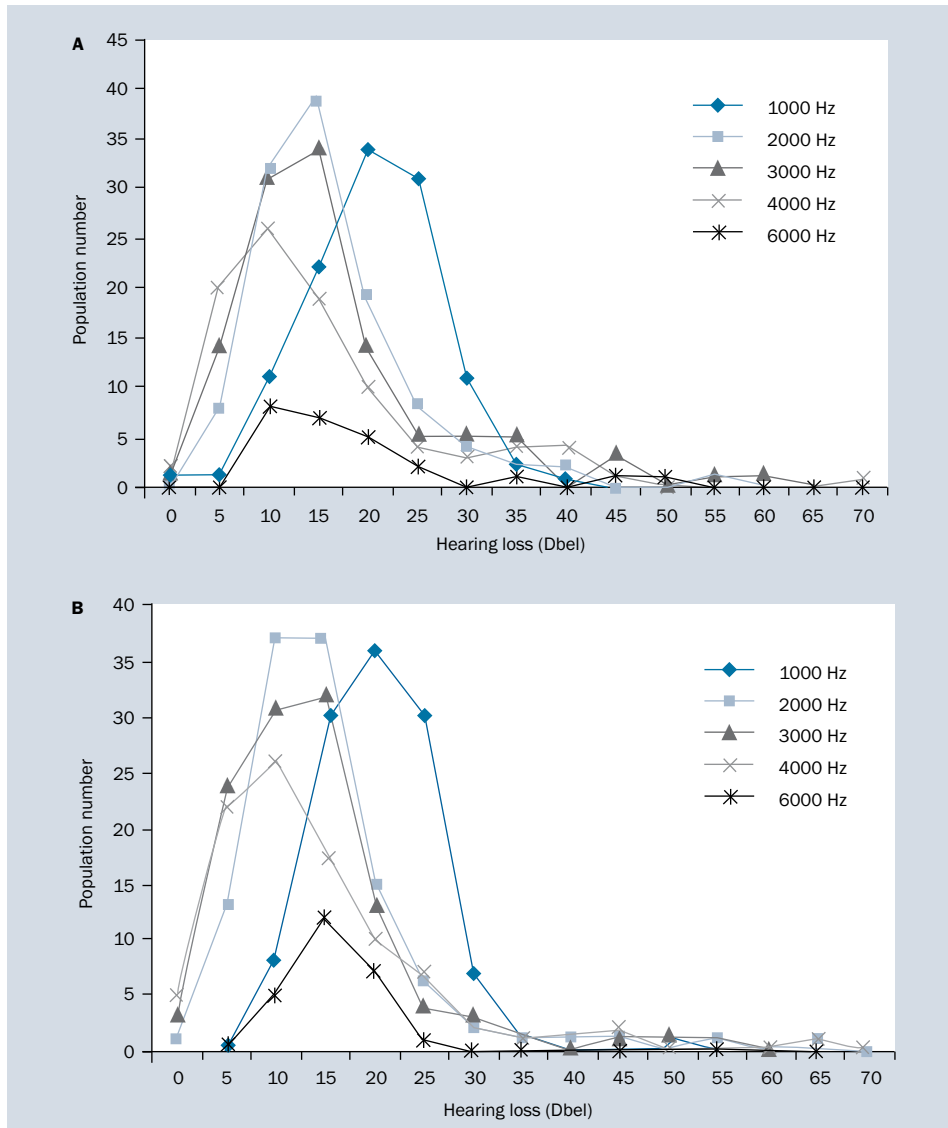
In Benin as in many other French-speaking countries the measurement of visual acuity is done by using Monoyer scale.

By reading letters at a distance of 5 metres the visual acuity is calculated from 0 to 10/10.

Even if it is recommended by STCW Code Table A-I/9, the Snellens test is not used in Benin. The limit of

**Table 1.** Distribution of seafarers according to their visual acuity on Monoyer scale

Visual acuity (to ten)	Without correction		With corrective lenses	
	Number	%	Number	%
< 6	4	3.4	0	0
6–8	12	10.2	2	28.6
> 8	102	86.4	5	71.4
<b>Total</b>	<b>118</b>	<b>100</b>	<b>7</b>	<b>100</b>



**Figure 2.** Distribution of seafarers according to their left (shown on the panel A) and right (shown on the panel B) auditory acuity

visual acuity (eventually with corrective lenses) for an onboard work place (assessed by Monoyer scale) is 5/10 (Table 1).

Some cases of low visual acuity have been found in seafarers.

No colour perception disorder was detected.

### Hearing acuity

The Figure 2 above shows that most of the seafarers examined had good hearing acuity on all frequencies studied. However, 3 individuals had moderate hearing losses of 30 to 35 dB (A) on the 2000, 3000 and 4000 Hz frequencies.

**Table 2.** Distribution of seafarers according to their right hearing at 4000 Hz and the workstation

Workstation	Right hearing at 4000 Hz in dB (A)		Total	P
	≤ 30 dB	> 30 dB		
Deck [n]	43	1	44	0.0928
Line	97.7%	2.3%	100.0%	
Column	51.8%	20.0%	50.0%	
Machine [n]	27	4	31	0.0928
Line	87.1%	12.9%	100.0%	
Column	32.5%	80.0%	35.2%	
Restoration [n]	13	0	13	0.0928
Line	100.0%	0.0%	100.0%	
Column	15.7%	0.0%	14.8%	
Total [n]	83	5	88	0.0928
Line	94.3%	5.7%	100.0%	
Column	100.0%	100.0%	100.0%	

**Table 3.** Distribution of seafarers according to their left hearing and the workstation at 4000 Hz

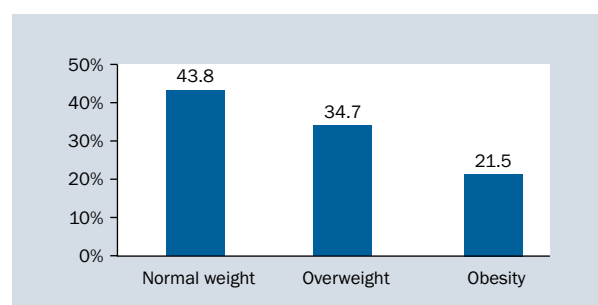
Workstation	Left hearing at 4000 Hz in dB (A)		Total	P
	≤ 30 dB	> 30 dB		
Deck [n]	42	2	44	0.0167
Line	95.5%	4.5%	100.0%	
Column	53.2%	22.2%	50.0%	
Machine [n]	24	7	31	0.0167
Line	77.4%	22.6%	100.0%	
Column	30.4%	77.8%	35.2%	
Restoration [n]	13	0	13	0.0167
Line	100.0%	0.0%	100.0%	
Column	16.5%	0.0%	14.8%	
Total [n]	79	9	88	0.0167
Line	89.8%	10.2%	100.0%	
Column	100.0%	100.0%	100.0%	

Subjects who did not perceive sounds above 30 dB (A) (as shown in Table 2) at the frequency of 4000 Hz at the right ear are mostly (80%) at the machine station.

Subjects who did not perceive sound above 30 dB (A) (as shown in Table 3) at the frequency of 4000 Hz at the left ear are mostly (77.8%) at the machine station.

### Body mass index

Normal-weight subjects are those with the body mass index (BMI) less than 25. Overweight subjects are those with a BMI of 25 to 30. Obese subjects have higher BMI than 30 (Fig. 3).



**Figure 3.** Distribution of seafarers according to their body mass index

### Blood pressure

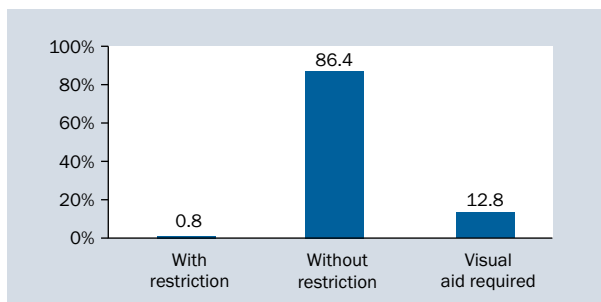
High blood pressure has been detected in almost one-third of seafarers in the past five years (Table 4).

### Physical examination

The physical examination data were poor and consisted of 2 cases of discrete opacities of the lens (early cataract), 3 cases of abdominal pain on palpation (probable peptic

**Table 4.** Distribution of seafarers by blood pressure (BP)

Systolic BP	Diastolic BP		Total
	< 90	≥ 90	
< 140	72 (62.07%)	4 (3.45%)	76 (65.52%)
≥ 140	7 (6.03%)	33 (28.45%)	40 (34.48%)
Total	79 (68.1%)	37 (31.9%)	116 (100%)



**Figure 4.** Distribution of seafarers by medical fitness notice

gastritis), 2 cases of varicose veins of the lower limbs, and 1 case of tympanic perforation without inflammation or suppuration. The rest of the physical examination was unspecific about all 125 medical visits.

### URINE TESTS

The search for glycosuria, proteinuria and haematuria using urinary strips was negative for all 125 seafarers.

### NOTICE OF MEDICAL FITNESS

Most of the fitness notices were given without restriction (86.4%). 12.8% of the medical examinations led to the following conclusion: visual correction is needed at the on-board work-place (wearing corrective lenses). In 0.8% of the cases, fitness with restriction was concluded (Fig. 4).

## DISCUSSION

### LIMITATIONS AND BIASES OF THE STUDY

The study was conducted on a sample of 125 medical records of seafarers received from 2013 to 2017, over a period of 5 years. This is not a cohort study. Hence, it is not possible to conclude regarding any change in individual health even if the seafarers had the possibility to be seen at least 2 times in this relatively long period.

The collected anamnesis for each individual was based on a proper declaration. There was no medical record for prior health trouble for these candidates for first employment at sea or seafarers yet. Moreover some of the candidates were looking for work. So we could cast doubt on their reliability if these people know that their medical histories are supposed to impair their fitness for work at sea. These anamneses are part of punctual examinations such as taking blood pressure that are not constituting a “long life” medical file.

Nevertheless, seafarers who come for medical check-ups prior to boarding are generally those who are supposed to be in good health. As Gollac said, “a worker occupies a position only if his health permits” [3]. Then we can probably face a self-selection bias in our study [4].

### HEALTH STATUS OF THIS SAMPLE OF BENINESE SEAFARERS

#### Age, high blood pressure and obesity

Our seafaring population is made up of aging subjects who are therefore more exposed to age-related diseases, particularly cardiovascular diseases. The influence of age in the physical fitness of the workers is well established.

High blood pressure was reported by 15.1% of seafarers and they were under treatment. Other cases were found at the medical visits, bringing the prevalence of high blood pressure in the seafarers’ population to 28.4%. This prevalence appears to be slightly higher than that found in the general population in Benin, which was 27.9% in 2008 [5]. Further studies are needed to investigate if the maritime work could be considered here as an inductor of high blood pressure. In fact, on-board noise exposure or stress could represent some risk factors that could explain this prevalence.

Maritime work would also be taken into account to explain the prevalence of obesity at 21.5% in our series. This is almost the same situation in Denmark in 2007 where 25% of seafarers were obese with a BMI > 30 compared to 12% of the adult male Danish population [6].

The maritime work-obesity-high blood pressure relationship is simple to understand and resides essentially in the sedentary nature of the maritime activity. This is a closed, often cramped work environment where physical exercise and sport opportunities in most vessels are virtually non-existent.

#### Visual and auditory state

All of the seafarers examined met the STCW criteria for visual acuity and colour vision. However, vision problems are to be considered for 12.8% of seafarers (Table 1) who were required to wear medical glasses. The main was ametropia. The fact that visual acuity and colour vision of this sample of seafarers fit with the standards of watchkeeping are singular but could be explain by a self-selection bias.

Auditory acuity testing has been normal for most seafarers. Of the moderate cases of hearing loss recorded, 4 out of 5 are revealed as to work at the machine station. It is known to researchers in maritime medicine that the machine station in a ship is an important source of noise exposure. The international regulations are firm on this issue, particularly with regard to the assessment of risk during medical examinations for seafarers and the application of hearing protection measures.

### MEDICAL FITNESS OF SEAFARERS

It must be admitted that the act of issuing medical fitness decisions in Benin is essentially based on the screening for disabilities that are incompatible with the maritime activity or that may be aggravated by it. Medical examina-

tions are carried out according to ILO/IMO guidelines [7]. No definitive unfitness decision has been formulated in our series. It should be noted that in general, notifications of unfitness are rare because Zevallos in the Netherlands, having studied a much larger population of seafarers (7617) in 2012, found 0.6% of unfitness and 4% of restricted fitness cases [8]. This small difference in results could be explained by the fact that seafarers, in the socio-economic context in Benin, do not present themselves for the medical examinations for fitness until they feel well (self-selection bias) and because of the disproportionate size of the sample.

### DISEASES THAT MAY HINDER THE FITNESS OF SEAFARERS

We found that the following diseases are likely to hinder the medical fitness of seafarers in the medium and long term.

In the medium term, these are cardiovascular diseases (hypertension, coronary insufficiency) and metabolic disorders (diabetes, gout, metabolic acidosis). Contributing factors would be the personal history of hypertension, the age of individuals, obesity related to physical inactivity and diets too fat and salty on board ships. These cardiovascular risks, which account for about 80% of marine medical evacuations [9], are present even though they are obscured by the self-selection bias under our methodological approach [10].

In the long term, chronic visual disturbances should be feared if workplace lighting is inadequate, hearing impairment and occupational deafness at the machine station level when prevention measures are not rigorously applied.

In addition, the problems of venous insufficiency with types of varices of the lower limbs and haemorrhoids are to be taken into consideration because of the favourable conditions such as the sedentariness and the absence of regular physical and sport exercises on board the ships.

### CONCLUSIONS

The results of this study present a sample view of fitness for work at sea of seafarers regularly embarked in Benin. By regarding the health status of this population, we identified surveillance elements and ways to control conditions that may hinder the seafarers' medical fitness for work at sea.

Since 2011, Beninese seafarers' doctors declare fit or unfit seafarers in accordance with Beninese regulations based on ILO/IMO guidelines on medical examinations of seafarers, which are developed based on the MLC 2006 principles and the STCW requirements and national specific regulations. This application suggests that the health status of this population is now better assessed. Nevertheless, when taking a look at the low percentage of health troubles leading to unfitness (that could be sometimes related to work), further investigations are needed to know if occupational diseases and work-related accidents in Beninese seafarers are correctly prevented by application of appropriate measures or if affected seafarers quit their work activity (due to these kind of health troubles) without medical follow-up by seafarers doctors.

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# Burnout and job satisfaction among Turkish oceangoing seafarers

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## ABSTRACT

**Background:** Seafaring includes a great variety of stressors that may let seafarers suffer from burnout syndrome. Job satisfaction is one of the most important factors affecting burnout. This study aims to determine the factors that affect job satisfaction and burnout levels of Turkish oceangoing seafarers who work actively on Turkish flagged ships.

**Materials and methods:** The questionnaire was applied to participants in a face-to-face mode or by e-mail. The first part of the questionnaire consisted of 12-item which included socio-demographic and health-related information. Thus, according to their health status and socio-demographics, seafarers were classified and their impact on job satisfaction and burnout were examined by nonparametric comparison of multivariate samples analysis. Maslach Burnout Inventory (MBI; 22 items) and Minnesota Satisfaction Questionnaire (MSQ; 20 items) were used. Spearman's rho correlation analysis was used to determine the relationship between the sub-factors of the scales. 203 seafarers, 133 of them deck/engine cadets and 186 of them working on deck, aged 18–60 years participated in the study.

**Results:** Negative correlation between job satisfaction and burnout was found by correlation analysis. Department and happiness while working on board were found as common important factors that vary according to both job satisfaction and burnout. According to these parameters, job satisfaction increased while burnout decreased or vice versa in both deck and engine and total.

**Conclusions:** According to the results, it was determined that deck officers are more prone to high burnout levels and low job satisfaction levels than the engine department. In addition, the results show that as happiness increases, job satisfaction increases and burnout decreases.

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**Key words:** burnout, job satisfaction, seafarer, Maslach Burnout Inventory, Minnesota Satisfaction Questionnaire

## INTRODUCTION

Working life has an important place in human life. Employees spend most of their time in the workplace. Today's intensive business relations force employees physically and mentally, and as a result, employees suffer from a syndrome called burnout. Various occupational groups face high levels of stress due to their organisational structure and working conditions [1]. Heavy workload and interpersonal mismatch in the working environment are important risk factors for burnout [2]. In spite of the technological progress, shorter contract duration on board and safety standards

improvements in the maritime sector, seafarers are still under stressors, such as long working hours, separation from family, lack of social life, fatigue, sleep deprivation, work-related stress, piracy danger, maritime accident risk, multinational crew, diseases and limited recreation activity [3]. Due to these stressors, seafarers are prone to burnout.

Burnout was defined by Freudenberger for the first time in the mid-1970s. According to Freudenberger [4], burnout is the exhaustion occurring in the employee's energy as a result of failures, overloading, wear, loss of power and unmet expectations. Maslach [5], who made the most important

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contributions to the literature on the concept of burnout, developed the burnout inventory. According to Maslach [4], burnout is discussed in three dimensions. These are emotional exhaustion (EE), depersonalisation (DP) and personal accomplishment (PA) [5].

Emotional exhaustion is at the centre of burnout. In the emotional exhaustion feeling, which is generally related to work stress, the individual is in an emotionally intense working tempo. In this case, the individual is exposed to other people's demands and forces himself/herself. The main reason for the emergence of emotional exhaustion is overwork and conflict in the workplace [6]. Depersonalisation shows the interpersonal dimension of burnout. In the depersonalisation dimension, an employee uses humiliating statements against the workmates and individuals they serve and perform a cynical attitude. Under these behaviours, there are feelings of alienation and defence. Emotionally exhausted individuals limit their relationship with people and psychologically move away from people [7]. In the personal accomplishment, the employee feels insufficient and thinks that he/she is not competent enough to do the job. This concept refers to the tendency to evaluate oneself negatively. A decrease in motivation is observed. The individual makes self-assessment and thinks that there is no progress related to job and efforts are a waste of time [8]. Employees with burnout syndrome will be more inefficient and unsuccessful. They can perform worse than the officially expected results. On the other hand, they may be more unwilling to help their colleagues. Therefore, they may lose their position in the organisation [9].

Job satisfaction is a concept directly related to burnout. Job satisfaction is defined as the employees' perception of the work and their emotional response to this perception and the degree of satisfaction of their needs [10]. Job satisfaction is the satisfaction or dissatisfaction that employees feel towards their jobs. While a person with high job satisfaction has a positive feeling about the job, the person with low job satisfaction has a negative feeling about the job [11]. There is a linear relationship between job satisfaction and professional performance. As job satisfaction increases or decreases, the professional performance increases or decreases, respectively. The social environment at work, working conditions, wages, rewards, the nature of the work and the clarity of job descriptions affect job satisfaction [12].

A limited number of studies on burnout or job satisfaction among seafarers are obtained from the literature review in the maritime domain. Previous studies show that seafaring includes high stress and serious risks. Work stress, fatigue, and individual isolation have negative consequences on the seafarers which may lead to burnout [13]. Intense work pressure and separation from family have an impact on the emotional health of seafarers [14]. Intensive and

long working hours increase depersonalisation [15]. Less than 6 months of working time, low stress and quality of sleep are the factors in the reduction of burnout [16]. The study conducted among Croatian seafarers shows that they are most satisfied with the payment, and least satisfied with the achieved benefits and work organisation on board. The study also shows that separation from family and working conditions on board are the primary sources of job dissatisfaction [3]. Work stress, rewards, dispositions, and job design also influence job satisfaction. Job satisfaction positively correlates with job performance.

This is the first study to assess the relationship between job satisfaction and burnout levels of seafarers. In this study, it is aimed to determine the factors that affect the job satisfaction and burnout levels of Turkish oceangoing seafarers who work actively on Turkish flagged ships. This paper is divided into four chapters. In the introduction part, the definition and dimensions of burnout, the statement of job satisfaction is given and the literature is reviewed. In the second part, the data collection process and the statistical method are explained. In the third part, results are introduced. Lastly, a brief discussion and conclusion are presented.

## MATERIALS AND METHODS

### DATA COLLECTION AND SAMPLE

Roasoft online calculator was used for sample size calculation. In Turkey by the end of March 2018, the number of actively working seafarers was 29345. According to population statistics, the sample size was calculated at 269 with 90% confidence level and 5% error. 250 participants were selected randomly. The sample was recruited by sharing the questionnaires online with Google Forms (e-mail) and by conducting it face-to-face. 203 seafarers responded (response rate: 81%). The data are collected when the participants are on board. Seafarers participating in the study are working on oil tankers and the contract period is between 3 and 6 months. The questionnaire consists of three parts. First part includes demographic characteristics of the participants. The second part of the questionnaire includes burnout questions and finally job satisfaction questions were asked in the third part. To evaluate burnout and job satisfaction, the Maslach Burnout Inventory (MBI) and Minnesota Job Satisfaction Scale (MJSS) were used. Cronbach-Alpha internal consistency coefficient was found to be 0.869 for MBI (EE,  $r = 0.868$ , DP,  $r = 0.705$ , PA,  $r = 0.766$ ) and 0.917 for MJSS (Internal satisfaction,  $r = 0.879$ , External satisfaction,  $r = 0.832$ ). This coefficient was appropriate and therefore, could be used in this study.

The demographics of the participants were measured with thirteen questions such as age, gender, education, etc., which could be seen in Table 1.

**Table 1.** Demographic characteristics of the participants (N = 203)

		N	%
Age [years]	18–30	158	77.8%
	30+	45	22.2%
Gender	Female	29	14.3%
	Male	174	85.7%
Education	High school/Associate degree	13	6.4%
	Bachelor degree/Graduate level	190	93.6%
Parental education – Mother	Primary school	92	45.8%
	High school	61	30.3%
	Associate/Bachelor degree/Graduate level	48	23.9%
Parental education – Father	Primary school	70	34.5%
	High school	48	23.6%
	Associate bachelor degree/Graduate level	85	41.9%
Department	Deck	186	91.6%
	Engine	17	8.4%
Experience (on board)	3–6 months	54	26.7%
	6–12 months	80	39.6%
	1–3 years	24	11.9%
	3 years and over	44	21.8%
Position	Deck/Engine cadet	133	65.6%
	Officer/Engineer	70	34.4%
Disliked work when working on board	Staff problems	81	40.5%
	Document processing	79	39.5%
	Operational processing	14	7.0%
	Other	26	13.0%
Are you happy to work on board?	I'm not happy at all	21	10.4%
	I'm a little happy	25	12.4%
	Neither happy nor unhappy	65	32.2%
	I'm happy	68	33.7%
	I'm so happy	23	11.4%
Do you have any medication?	No	191	94.1%
	Yes	12	5.9%
What was the last reason you went to the doctor?	No	34	16.7%
	Pain	52	25.6%
	Chronic disease	31	15.3%
	Other (psychological etc.)	86	42.4%



**Table 2.** Distributions of scales (MBI and MJSS)

	<b>N</b>	<b>Mean ± SD</b>	<b>Median (min–max)</b>
Emotional exhaustion	203	1.72 ± 0.8	1.67 (0–4)
Depersonalisation	203	1.42 ± 0.85	1.40 (0–4)
Personal accomplishment	203	1.56 ± 0.71	1.63 (0–4)
Burnout	203	1.59 ± 0.6	1.64 (0.25–3.82)
Internal satisfaction	203	3.53 ± 0.71	3.58 (1–4.92)
External satisfaction	203	3.31 ± 0.78	3.38 (1.13–5.00)
Job satisfaction	203	3.44 ± 0.69	3.50 (1.40–4.85)

MBI – Maslach Burnout Inventory; MJSS – Minnesota Job Satisfaction Scale; SD – standard deviation; min – minimum; max – maximum

**Table 3.** Correlation analysis between scales

<b>r</b>	<b>Internal satisfaction</b>	<b>External satisfaction</b>	<b>Job satisfaction</b>
Emotional exhaustion	–0.550*	–0.428*	–0.532*
Depersonalization	–0.360*	–0.287*	–0.351*
Personal accomplishment	–0.417*	–0.331*	–0.415*
Burnout	–0.610*	–0.479*	–0.595*

\*p < 0.001

Maslach Burnout Inventory has three sub-dimensions named emotional exhaustion, depersonalisation, personal accomplishment. Emotional exhaustion refers to emotions that are emotionally depleted by an individual's excessive long-term interaction with other people. Depersonalisation is that employees behave like objects to the people they serve, make disparaging remarks, and show an indifferent, cynical attitude. Personal accomplishment defines a person's feelings of competence and success in their work.

Minnesota Job Satisfaction Scale consists of five-point Likert 20 items as follows completely dissatisfied is 1, dissatisfied is 2, neither dissatisfied nor satisfied is 3, satisfied is 4 and completely satisfied is 5. The scale has two sub-dimensions named internal and external satisfaction. Internal satisfaction consists of elements related to the internal quality of the job, such as success, recognition or appreciation of the internal factors, the job itself, job responsibility, promotion and change of duty due to promotion. External satisfaction consists of elements related to the work environment, such as corporate policy and management, the manner of supervision, relations with managers, colleagues and subordinates, working conditions, and wages. To summarise total and sub-dimension scores descriptive statistics were used (Table 2).

## STATISTICAL ANALYSIS

Descriptive statistics were calculated for continuous variables (mean, standard deviation [SD], minimum, maximum,

median) and categorical variables (N, %). Spearman's rho correlation analysis was used to determine two non-normally distributed variables. It is shown in Tables 3 and 4, and Figures 1 and 2. To investigate the effects of demographics on both burnout and job satisfaction levels, "Nonparametric Comparison of Multivariate Samples Analysis" was used due to the lack of assumptions. Homogeneity (Box's test,  $p < 0.05$ , Levene's test,  $p < 0.05$ ) and multivariate normal distribution (Shapiro Wilk,  $p < 0.05$ ) assumptions are not provided. It is shown in Table 4. The statistical significance level was determined as 0.05. The analysis was conducted by utilising SPSS 24.0 (Statistical Package for the Social Sciences) and R Studio. Nonparametric Comparison of Multivariate Samples Analysis is utilised by "nrmv" package which provides a nonparametric approach to multivariate inference [17].

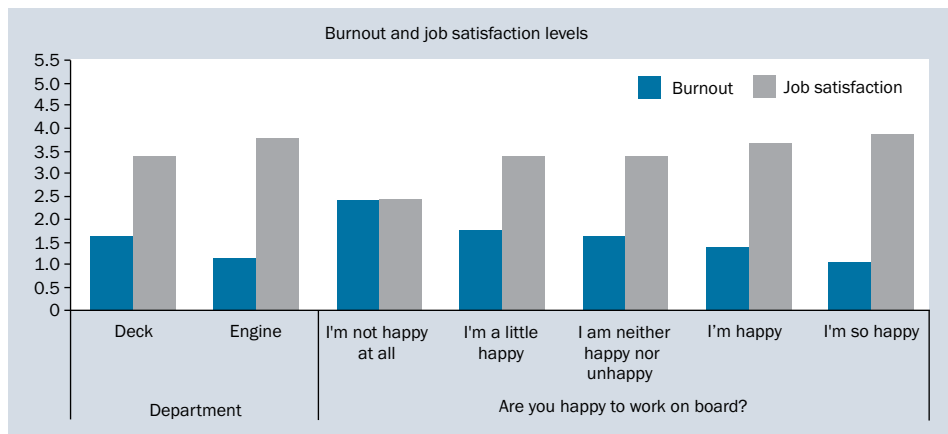
## RESULTS

Demographics were evaluated by frequencies and column percentages. According to Table 1, 29 (14.3%) women and 174 (85.7%) men participated in this study. 158 of 203 participants (77.8%) are between 18 and 30 years. The educational status of 190 of 203 participants (93.6%) is a bachelor's degree and graduate level. Mother's education status is mostly primary school, whereas father's education status is mostly associate and bachelor's degree and graduate level. 186 (91.6%) participants are working in the deck department. 80 of 203 participants (39.6%) have

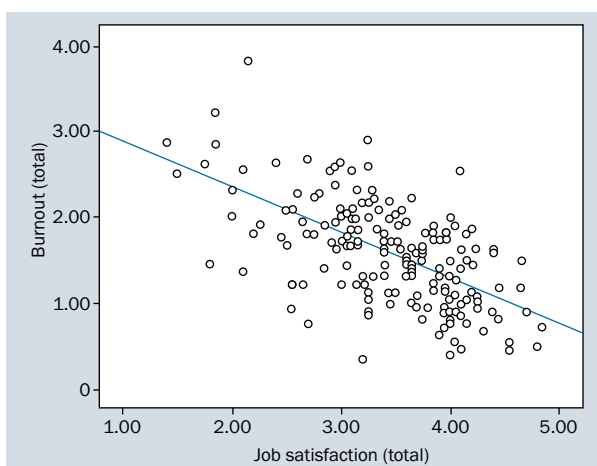
**Table 4.** Nonparametric comparison of multivariate samples analysis for demographics

		N	Burnout Mean ± SD (relative effect)	Job satisfaction Mean ± SD (relative effect)	Wilks Lambda	p	Permutation test – p
Department	Deck	186	1.65 ± 0.59 (0.779)	3.41 ± 0.69 (0.320)	5.505	0.005	0.004
	Engine	17	1.04 ± 0.48 (0.220)	3.82 ± 0.53 (0.679)			
Are you happy to work on board?	I'm not happy at all	21	2.6 ± 0.47 (0.914)	2.44 ± 0.58 (0.130)	13.380	< 0.001	< 0.001
	I'm a little happy	25	1.79 ± 0.47 (0.624)	3.36 ± 0.56 (0.453)			
	Neither happy nor unhappy	65	1.67 ± 0.45 (0.558)	3.35 ± 0.60 (0.439)			
	I'm happy	68	1.06 ± 0.44 (0.392)	3.67 ± 0.56 (0.600)			
	I'm so happy	23	1.59 ± 0.69 (0.240)	3.84 ± 0.68 (0.692)			

SD – standard deviation



**Figure 1.** The significant differences between burnout and job satisfaction scores in common



**Figure 2.** Scatter plot of burnout and job satisfaction relationship

worked on board for 6–12 months. 133 of 203 participants (65.6%) are deck/engine cadets. 79 (39.5%) participants disliked document processing when they are working on

board and 68 (33.7%) participants are happy to work on board. 86 (42.4%) of them went doctor for other reasons like psychological etc.

Distributions of scales are shown in Table 2. All the sub-dimensions and total burnout's scores display similar distributions between 0 and 4. Similarly, job satisfaction scores and sub-dimensions are changed between 1 to 5 and show similar distributions.

According to correlation analysis, there is a significant relationship between all paired scales (Spearman's rho,  $p < 0.05$ ). There are negative moderate statistically significant correlations between emotional exhaustion and internal satisfaction, external satisfaction, job satisfaction. There is a negative weak correlation between depersonalisation and internal satisfaction, external satisfaction, job satisfaction. There is a negative weak correlation between personal accomplishment and internal satisfaction, external satisfaction, job satisfaction. There are negative moderate statistically significant correlations between burnout and internal satisfaction, external satisfaction, job satisfaction (Table 3).

Figure 2 supports the correlation results and shows a negative relationship between burnout and job satisfaction in a moderate way.

The significant results were presented in Table 4 for comparison of burnout levels and job satisfaction according to demographics. The department and happiness effect is highly significant (Wilks Lambda,  $p < 0.05$ ). The empirical nonparametric relative department effect and happiness effect are listed for burnout and job satisfaction in Table 4. The probability that a randomly chosen from deck department exhibits a larger percentage of burnout than a randomly chosen person from seafarers (including deck) is 0.779. Similarly, the probability that a randomly chosen from not happy at all during working on board exhibits a larger percentage of burnout than a randomly chosen person from seafarers (including not happy at all) is 0.914. To implement all the pairwise comparisons according to happiness status “snonpartest” function is used to provide a more detailed comparison using a subset algorithm [17]. The multiple comparisons of all happiness levels and all variables are shown significant results (Wilks Lambda,  $p < 0.05$ ). The point that draws attention is that while the burnout relative effect of not happy at all ones is high, the job satisfaction relative effect of so happy ones is high.

To sum up the results, Figure 1 shows the significant differences between burnout and job satisfaction levels in terms of department and happiness status. According to the figure, the negative relationship is noticeable.

To prevent the instability caused by the sample (deck  $N = 186$  and engine  $N = 17$ ) and taking into account the results of the multivariate analysis which were found to be significant, the data was divided into two parts as deck and engine. To show the relationship between job satisfaction and burnout levels, correlation analysis was performed on

two divided data. According to correlation analysis, there is a significant relationship between job satisfaction and burnout both in deck and engine groups (Spearman’s rho,  $p < 0.05$ ). The relationship is found negative and moderate. The moderate level relationship in the engine is found to be stronger than the deck with  $-0.864$  ( $p < 0.001$ ) correlation coefficient (Table 5).

Figure 3 supports the correlation results and shows a negative relationship between burnout and job satisfaction in a moderate way separately both deck and engine department.

### DISCUSSION AND CONCLUSIONS

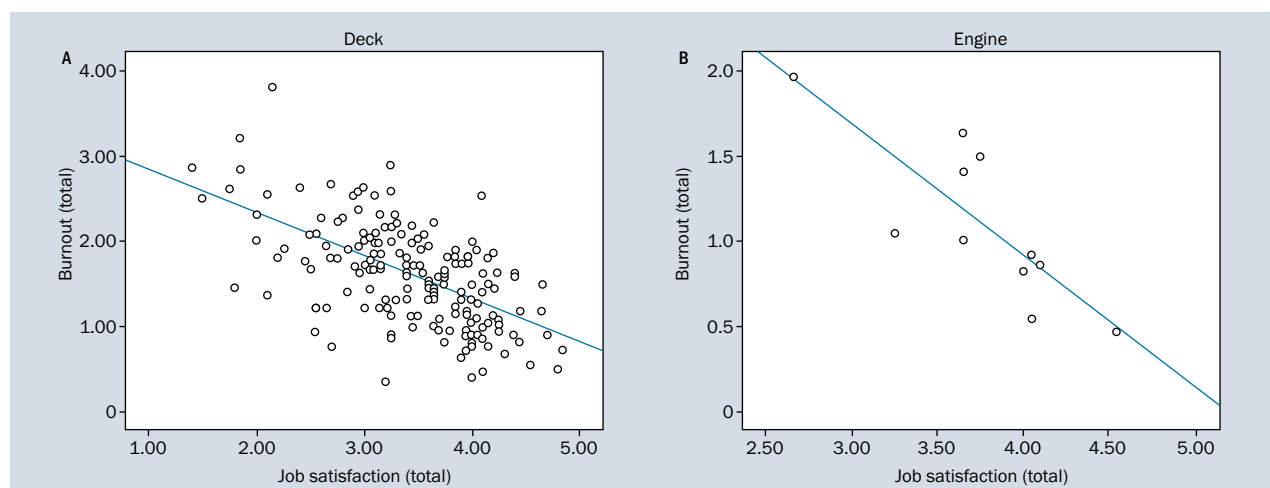
The main purpose of the study is to examine the relationship between seafarers’ burnout and job satisfaction levels. The negative statistically significant relationship between burnout and job satisfaction is found and supported by work conditions and happiness conditions while working on board.

Working on board is difficult and complex; being away from home and loved ones, fatigue, long working hours, limited space, inadequate sleep and multinational factors [18]. This is also related to the happiness of the seafarers, while the satisfaction of the seafarers who work happily high and the burnout is low. In a previous study that includ-

**Table 5.** Correlation analysis between job satisfaction and burnout (according to department)

		Job satisfaction	
		Deck	Engine
Burnout	Deck	-0.572*	
	Engine		-0.864*

\* $p < 0.001$



**Figure 3.** Scatter plot of burnout and job satisfaction relationship according to department; **A.** Deck; **B.** Engine

ed 136 people who work on average 36 hours per week, showed a negative correlation between happiness during work activities and burnout [19].

As the working conditions of seafarers are rough, intention to leave occurs. While the age increases, the intention to leave decreases. Similarly, as the age increases, job satisfaction increases and burnout decreases. In this study, the department is found to be an important factor affecting job satisfaction and burnout. The study that targeted 139 deck and engineering officers showed similar results. The average of chief engineer has a higher job satisfaction level than deck officers [20].

The first limitation of the study was a sample in terms of gender. Our participants are mostly men. Therefore, we cannot generalise our findings to women. The second limitation of the study is the fact that the participants are mostly working on deck and the participation of deck/engine cadets are more than officers. In future studies, the sample could be selected more from deck department and officers. The last point is all the participants are from Turkey. The research can be expanded by selecting multinational seafarers from different countries. In the following studies, comparisons can be made by measuring psychophysiological data.

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# Analysis of faecal bacteria isolated from air and seawater samples following an emergency sewage discharge into the Gulf of Gdansk in 2018 – preliminary study

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## ABSTRACT

**Background:** Knowing the numbers of bacteria in coastal atmospheric air as well as in coastal waters significantly contributes to a better understanding of the processes affecting the health of people who stay temporarily or permanently in areas where the synergistic effect of the atmospheric conditions and the aquatic environment on a human body is particularly strong.

**Materials and methods:** Seawater and air samples were collected from 22 May to 22 July 2018 in the seaside towns of Hel, Puck, Gdynia, Sopot, Gdansk-Brzezno, all located along the Gulf of Gdansk. The number of psychrophilic, mesophilic as well as coliform bacteria and *Escherichia coli* was determined in both the water and the ambient air samples. In total, 232 seawater and coastal air samples were collected for the study purposes.

**Results:** The study showed a deterioration of coastal waters and atmospheric air in the Gulf of Gdansk which may have resulted from an increase of potentially pathogenic mesophilic bacteria following the emergency discharge of raw sewage from the Gdansk-Wschod wastewater plant.

**Conclusions:** An increase in the number of coliform bacteria and *Escherichia coli* in the seawater and in the air across the Gulf of Gdansk is related to the emergency sewage discharge.

(Int Marit Health 2019; 70, 4: 239–243)

**Key words:** coastal air, seawater, bacteria, the Gulf of Gdansk

## INTRODUCTION

The Baltic coast is one of the most popular tourist destinations in Poland. It is of key importance that coastal waters near popular seaside resorts are free from physical and microbiological contamination [1, 2]. Unfortunately, it is often the case that both treated and raw sewage from seaside towns is discharged into the sea [3, 4]. Moreover, the outflow of rainwater and floods also contributes to the biological as well as chemical contamination of the coastal seawaters [5–7]. An example of this type of event was a serious malfunction at the Mishref Pumping Station, which resulted in sewage discharge and an increase in the number of coliform bacteria, *Escherichia coli* and faecal streptococci in the waters of the Gulf of Kuwait [8]. Potentially pathogenic bacteria, mould fungi and

enteroviruses are a significant factor influencing bathing water quality. In the light of the most recent studies, contamination of the seawaters with potentially pathogenic coliform bacteria (*Citrobacter*, *Klebsiella*, *Proteus*, *Enterobacter*, *Escherichia coli*) or faecal streptococci (Enterococci) poses a serious health hazard for humans. It has been indicated that these microorganisms may cause gastrointestinal disturbances, airways disorders and skin allergies [9–13]. Since microorganisms which are present in the seawater may be easily transferred into the atmospheric air, it is important to monitor the sanitary and epidemiological conditions of the seawater and coastal air [6, 14]. Thus, the supervision over the disposal of treated sewage into the Gulf of Gdansk (among others from the two largest sewage treatment plants in Poland) has become a necessity.

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As an example, the emergency discharge of raw sewage into the Motława river flowing into the Martwa Wisła river between 15 and 18 May 2018 caused a rapid deterioration of sanitary conditions in Gdansk. Therefore, the aim of the study was to determine the level of faecal bacteria in the waters surrounding the Gulf of Gdansk and the air over the Gulf following the emergency discharge of raw sewage from the Gdansk-Wschod Sewage Treatment Plant.

## MATERIALS AND METHODS

### MATERIAL SAMPLING

Samples of the seawater and the air from the seaside towns lying along the Gulf of Gdansk: Hel, Puck, Gdynia, Sopot and Gdansk-Brzezno were collected between 22 May and 22 July 2018. The sea surface microlayer of  $\leq 100 \mu\text{m}$  was sampled using the glass plate method [15, 16]. In total, 116 samples of seawater were collected from the waters surrounding the Gulf of Gdansk.

Air samples were collected 50 cm above the water surface and at a 1 m distance from the shoreline in the direction of the Gulf of Gdansk. Air samples were collected for 10 min with an Air Sampler SAS Super 100 (Turin, Italy) which utilizes the impaction method. In total, 116 air samples were collected for the study purposes.

### SAMPLE ANALYSIS

#### Microbiological analysis of seawater

The membrane filtration method [17] was used to examine the water samples. Seawater samples of 100 mL were passed through sterile filters (0.45 pore diameter) and placed on selective agar mediums.

The number of coliform bacteria of the Enterobacteriaceae family, including *Citrobacter*, *Klebsiella*, *Proteus*, *Enterobacter* and *Escherichia coli*, was estimated on Merck Chromocult coliform agar (Germany) after 24 h incubation at 37°C. The colony-forming unit (CFU/m<sup>3</sup>) was used to determine the number of bacteria in seawater samples of 100 mL.

The overall number of psychrophilic and mesophilic bacteria was determined after the incubation of 1 mL seawater samples on tryptic soy agar from Merck (Germany). The results were read after 72 h and 48 h incubation at 22°C and 37°C. The colony-forming unit (CFU/m<sup>3</sup>) was used to determine the number of bacteria in seawater samples of 1 mL.

Gram-stained preparations were made. Aminopeptidase, catalase tests were performed and the glucose fermentation activity of the examined bacteria under anaerobic conditions was measured. In addition, *Staphylococcus aureus* was differentiated from *Staphylococcus epidermidis (albus)* saprophytic isolates using the rabbit plasma test. *Pseudomonas aeruginosa* bacteria were determined on Merck Cetrimide Agar (Germany) after 24 h incubation at 37°C.

#### Microbiological analysis of bioaerosols

The number of psychrophilic and mesophilic bacteria, coliform bacteria and *Escherichia coli* in the air sampled at a distance of 1 m from the shoreline in the direction of the Gulf of Gdansk was determined as outlined in detail by Michalska et al. [18].

The colony-forming unit (CFU/m<sup>3</sup>) was used to determine the number of bacteria in the air samples. Feller's measurement table, attached to the air sampler manual, was used for the enumeration of microorganisms in the air samples [18, 19].

#### Meteorological conditions

During air sampling, between 22 May and 22 July 2018, air temperature and humidity, as well as the speed and the direction of wind, were recorded with a GMH 3330 thermo-hygrometer (Greisinger, Germany). The air temperature ranged between 15°C and 27°C. The relative humidity ranged from 39% to 70%, and the wind speed was from 0 km/h to 32 km/h. Air samples were not collected during a rainfall event.

#### STATISTICAL ANALYSIS

The minimum and maximum mean, as well as the standard deviation of the values measured over the study period, were calculated for the overall numbers of psychrophilic, mesophilic, coliform bacteria and *Escherichia coli*. Statistical analysis was performed with Statistica 12.0 (StatSoft Inc.).

## RESULTS

### DETECTION AND ENUMERATION OF BACTERIA IN THE COASTAL WATERS IN SEASIDE TOWNS IN THE GULF OF GDANSK

In 2018, the mean number of psychrophilic bacteria isolated from the waters in the seaside town of Hel was  $334.000 \pm 311.500$  CFU/1 mL. In another seaside town, Puck, the mean number of psychrophilic bacteria was  $5.433 \pm 862$  CFU/1 mL. In Gdynia, the mean number of psychrophilic bacteria was  $15.084 \pm 1.326$  CFU/1 mL, whereas in another seaside city, Sopot,  $11.228 \pm 6.621$  CFU/1 mL. By contrast, the mean number of psychrophilic bacteria in the coastal waters near the seaside town of Gdansk-Brzezno was higher than the number of the psychrophilic bacteria isolated from samples collected in Sopot and Gdynia, and equal to  $24.114 \pm 47.309$  CFU/1 mL.

The mean number of mesophilic bacteria in the waters near Hel was  $311.500 \pm 350.681$  CFU/1 mL. In the seaside town of Puck, the mean number of mesophilic bacteria was  $3.967 \pm 611$  CFU/1 mL. By contrast, the mean number of mesophilic bacteria in Gdynia was  $7.008 \pm 4.195$  CFU/1 mL, and in Sopot it was  $9.146 \pm 5.606$  CFU/1 mL. In Gdansk-Brzezno the mean number of mesophilic bacteria was

**Table 1.** Minimum and maximum number of bacteria detected in the atmospheric air over the Gulf of Gdansk in 2018

	The number of psychrophilic bacteria [CFU/m <sup>3</sup> ]		The number of mesophilic bacteria [CFU/m <sup>3</sup> ]		The number of coliform bacteria [CFU/m <sup>3</sup> ]		The number of <i>Escherichia coli</i> [CFU/m <sup>3</sup> ]		The number of <i>Pseudomonas aeruginosa</i> [CFU/m <sup>3</sup> ]		The number of <i>Staphylococcus aureus</i> [CFU/m <sup>3</sup> ]	
	Min	Max	Min	Max	Min	Max	Min	Max	Min	Max	Min	Max
Hel	890	3543	866	3150	0	551	0	8	0	95	0	16
Puck	803	1181	370	724	32	47	0	8	0	0	0	0
Gdynia	650	984	540	870	10	32	0	0	0	0	0	0
Sopot	32	3386	27	3307	0	7	0	6	0	167	0	19
Gdansk-Brzezno	55	5774	16	4856	0	149	0	95	0	236	0	0

higher in comparison to the number of mesophilic bacteria in Sopot and was equal to  $15.850 \pm 24.230$  CFU/1 mL.

At a further stage of the study, it was attempted to detect potentially pathogenic bacteria, including coliform bacteria, *Escherichia coli*, *Pseudomonas aeruginosa* and *Staphylococcus aureus* in the seawaters of the Gulf of Gdansk. In the studies carried out in 2018, the mean number of coliform bacteria in the seaside town of Hel was  $2.805 \pm 2.800$  CFU/100 mL. The mean number of coliform bacteria in Puck was  $1.157 \pm 169$  CFU/100 mL and in Gdynia it was  $2.500 \pm 381$  CFU/100 mL. The mean number of coliform bacteria isolated from samples collected in Sopot was significantly higher when compared to the samples from Gdansk-Brzezno,  $32.803 \pm 80.058$  CFU/100 mL and  $5.439 \pm 7.452$  CFU/100 mL, respectively.

The mean number of *Escherichia coli* in the waters surrounding the town of Hel was  $206 \pm 396$  CFU/100 mL, whereas in Puck this number was  $223 \pm 12$  CFU/100 mL. In Gdynia, the mean number of *Escherichia coli* detected in the waters of the Gulf of Gdansk was  $10 \pm 7$  CFU/100 mL. On the other hand, the mean number of *Escherichia coli* seen in Gdansk-Brzezno was slightly higher than in Sopot ( $211 \pm 228$  CFU/100 mL vs.  $139 \pm 179$  CFU/100 mL, respectively).

#### DETECTION AND ENUMERATION OF BACTERIA PRESENT IN THE AIR OF THE SEASIDE TOWNS IN THE GULF OF GDANSK

The studies carried out in 2018 demonstrated that the mean number of psychrophilic bacteria detected in Hel was  $1.645 \pm 1.273$  CFU/m<sup>3</sup>. The number of psychrophilic bacteria in Puck was  $1.021 \pm 195$  CFU/m<sup>3</sup>. In Gdynia, the number of psychrophilic bacteria was  $811 \pm 165$  CFU/m<sup>3</sup>, whereas in Sopot it was  $506 \pm 1.165$  CFU/m<sup>3</sup>. The number of psychrophilic bacteria in air samples from Gdansk-Brzezno was significantly higher ( $2.287 \pm 2.677$  CFU/m<sup>3</sup>) in comparison to the number of psychrophilic bacteria isolated from samples collected in the above mentioned coastal towns.

According to the study findings, the mean number of mesophilic bacteria in samples from the town of Hel was  $1.510$

$\pm 1.101$  CFU/m<sup>3</sup>. The number of mesophilic bacteria in the air of the Gulf of Gdansk in Puck was  $588 \pm 191$  CFU/m<sup>3</sup>. The number of mesophilic bacteria in Gdynia was  $702 \pm 163$  CFU/m<sup>3</sup>, while in Sopot it was  $486 \pm 1.141$  CFU/m<sup>3</sup>. The number of mesophilic bacteria was significantly higher in samples collected in Gdansk-Brzezno ( $1.832 \pm 2.104$  CFU/m<sup>3</sup>), in comparison to Puck, Gdynia and Sopot.

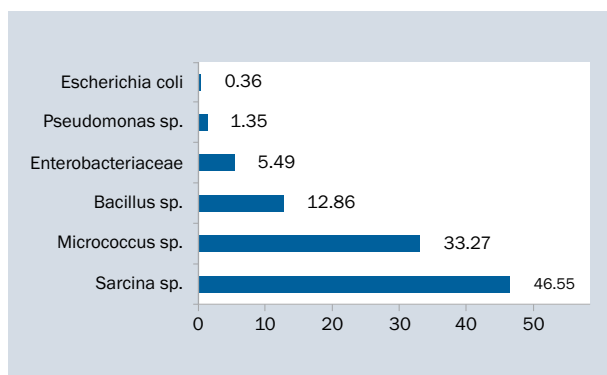
The mean number of coliform bacteria isolated from samples collected in Hel was  $198 \pm 261$  CFU/m<sup>3</sup>. The number of coliform bacteria in the air in the seaside town of Puck was  $39 \pm 8$  CFU/m<sup>3</sup>. In Gdynia, the number of coliform bacteria ( $20 \pm 10$  CFU/m<sup>3</sup>), was higher in comparison to the number of coliform bacteria detected in Sopot. In Sopot, the number of coliform bacteria was  $3 \pm 2$  CFU/m<sup>3</sup>. A distinctly higher number of coliform bacteria was detected in Gdansk-Brzezno –  $67 \pm 68$  CFU/m<sup>3</sup>.

In 2018, the number of *Escherichia coli* strains isolated from samples collected in Hel was  $2 \pm 4$  CFU/m<sup>3</sup>. In Puck the number of *Escherichia coli* in the air was  $3 \pm 5$  CFU/m<sup>3</sup>. No *Escherichia coli* strains were detected in the air of the seaside city of Gdynia. The number of *Escherichia coli* in the air in Sopot was  $1 \pm 2$  CFU/m<sup>3</sup>. In 2018, a higher mean number of *Escherichia coli* was detected in Gdansk-Brzezno –  $18 \pm 31$  CFU/m<sup>3</sup>.

The minimum and maximum numbers of the bacteria detected in the atmospheric air across the Gulf of Gdansk within the study period are presented in Table 1.

#### IDENTIFICATION OF THE BACTERIA ISOLATED FROM AIR SAMPLES

Gram-positive cocci were detected in the air samples collected in the seaside towns of Hel, Puck, Gdynia, Sopot and Gdansk-Brzezno (79.96%), including *Micrococcus sp.* (33.27%), *Sarcina lutea* (46.55%) and *Staphylococcus aureus* (0.14%). Gram-positive bacteria of the *Bacillus* genus (*Bacillus sp.* 12.86%) as well as Gram-negative bacilli (7.19%), including *Pseudomonas aeruginosa* (1.35%), *Escherichia coli* (0.36%) and other bacilli of the *Enterobacteriaceae* family (5.49%) were also isolated (Fig. 1).



**Figure 1.** Percentage distribution of the bacteria isolated from the air samples collected in the Gulf of Gdansk in 2018

### THE INFLUENCE OF METEOROLOGICAL PARAMETERS ON THE NUMBER OF BACTERIA IN THE AIR IN THE SEASIDE TOWNS LOCATED ALONG THE GULF OF GDANSK

At a later stage of the study, an analysis was carried out on the influence of the meteorological parameters such as relative humidity, air temperature, speed and direction of wind on the number of psychrophilic, mesophilic, coliform bacteria and *Escherichia coli* in the atmospheric air at the Gulf of Gdansk.

The maximum number of psychrophilic, mesophilic, coliform bacteria and *Escherichia coli* in the atmospheric air was recorded when the air temperature ranged between 19.5°C and 25°C, and the relative humidity was between 53% and 65%. The number of psychrophilic, mesophilic, coliform bacteria and *Escherichia coli* in the air was also significantly higher when the wind speed exceeded 32 km/h and the direction of the wind was north or northeast (N, NE), i.e. when the air blown towards the shoreline had been in contact with the water surface for an extended period of time.

### DISCUSSION

The study carried out in 2018 demonstrated a higher number of psychrophilic, mesophilic, coliform bacteria and *Escherichia coli* both in the coastal waters and in the atmospheric air of the seaside towns and cities (Hel, Puck, Gdynia, Sopot, and Gdansk-Brzezno) located at the Gulf of Gdansk, in comparison to previous studies (the studies carried out at the seaside locations between 1998 and 2005 showed a lower number of psychrophilic and mesophilic bacteria). For instance, in Gdansk-Brzezno the maximum number of mesophilic bacteria in the coastal air was 204 CFU/m<sup>3</sup> (period 1998–2005), whereas in 2018 the number reached 4856 CFU/m<sup>3</sup>. In Sopot, the number of the isolated mesophilic bacteria was 550 CFU/m<sup>3</sup> vs. 3307 CFU/m<sup>3</sup> in 2018 (Table 1) [20, 21]. A study by Kruczalac et al. [22] conducted in 1998 also demonstrated a lower mean number of psychrophilic bacteria – 50 CFU/m<sup>3</sup>, and mesophilic bacteria – 15 CFU/m<sup>3</sup>.

A hypothesis was put forward that the results of the present study demonstrating a higher number of psychrophilic, mesophilic, coliform bacteria and *Escherichia coli* in the seawater and the atmospheric air could be the consequence of a sewage discharge into the Motława River. In May 2018, there was an emergency discharge of raw sewage into the Motława River. As a result, 2,300 m<sup>3</sup> of sewage per hour was flowing into the Gulf of Gdansk. Similarly, due to a malfunction at the Mishref Pumping Station, massive quantities of raw sewage was being discharged directly into the gulf for the period of 3 years (2009–2012); this led to bacteriological contamination of a coastal section of about 20 km [8]. Other studies, however, suggest that it is heavy rainfall or floods which contribute to a higher number of faecal bacteria in coastal seawaters. As an example, heavy rain (precipitation rate of 2.5 to 7 cm) caused the contamination of the coastal seawaters between California and Mexico with faecal bacteria [5]. At a further stage of the study it was attempted to assess the influence of meteorological conditions on the presence of bacteria in the air of the seaside towns of Hel, Puck, and Gdansk-Brzezno as well as the seaside cities of Gdynia and Sopot, all lying along the Gulf of Gdansk. The maximum number of bacteria was detected at the air temperature between 19.5°C and 25°C and the relative humidity between 53% and 65%. The speed and direction of wind increased the number of psychrophilic, mesophilic, the coliform bacteria and *Escherichia coli*. The present study also demonstrated that the number of the above mentioned bacteria isolated from air samples was higher when the wind was blowing from the north and northeast (towards the land). The results of previous studies also indicated a statistically significant correlation between the speed and direction of wind and the number of psychrophilic and mesophilic bacteria in the coastal air over the Gulf of Gdansk [20, 21, 23]. It has also been confirmed that bacteria present in the seawater are capable of transferring themselves to the air [20, 21, 23]. Our studies indicated that the direction and speed of wind affect the composition of coastal aerosol, and consequently change the atmospheric conditions for people who sunbathe, swim in the sea or do water sports. This is caused by the fact that apart from the ions of sea salts and iodine, the sea aerosols contain microorganisms such as cyanobacteria, diatoms, bacteria, fungal spores and products of their metabolism [24–26]. The results of previous studies indicate that the presence of bacteria and their endotoxins in the air may contribute to the development of many diseases [10, 18, 24, 27–30].

### CONCLUSIONS

In 2018, significantly higher concentrations of psychrophilic, mesophilic, coliform bacteria and *Escherichia coli* were observed in the seawater and air of the Gulf of Gdansk. It is important that the authorities and enterprises



responsible for the sanitary and epidemiological supervision of coastal waters warn people of seawater contamination as promptly as possible. At the same time, they should impose restrictions on the use of bathing areas in case of any malfunctions at the sewage treatment plants, sudden downfalls of rain or floods.

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# Gastrointestinal infections in returned travelers

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## ABSTRACT

Gastrointestinal infections are one of the most frequent medical conditions diagnosed in patients who travel to tropical or subtropical destinations. The most common disorder occurring in up to 60% travelling people is travelers' diarrhea (TD). The illness is defined as a minimum of three loose stools within 24 hours; in most cases TD is caused by the enterotoxigenic *Escherichia coli*. Its symptoms usually persist for 4–5 days and resolve spontaneously or on self-administered empirical antimicrobial therapy, but in case of an invasive infection, it is necessary to seek medical care. As most tourists travel for 1–2 weeks, the disease often persists or develops upon return; therefore, it is important to raise awareness of TD's clinical features and treatment options among physicians from travelers' home countries unaccustomed to this health problem. Another issue, which is gaining more and more importance in recent years, is post-infectious irritable bowel syndrome, a chronic disturbance affecting up to 17% of patients, who have had travelers' diarrhea. This review aims to promote prophylaxis of gastrointestinal disorders and to extend knowledge about their after-effects in returned travelers.

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**Key words:** gastrointestinal infections, travelers' diarrhea, treatment, prophylaxis

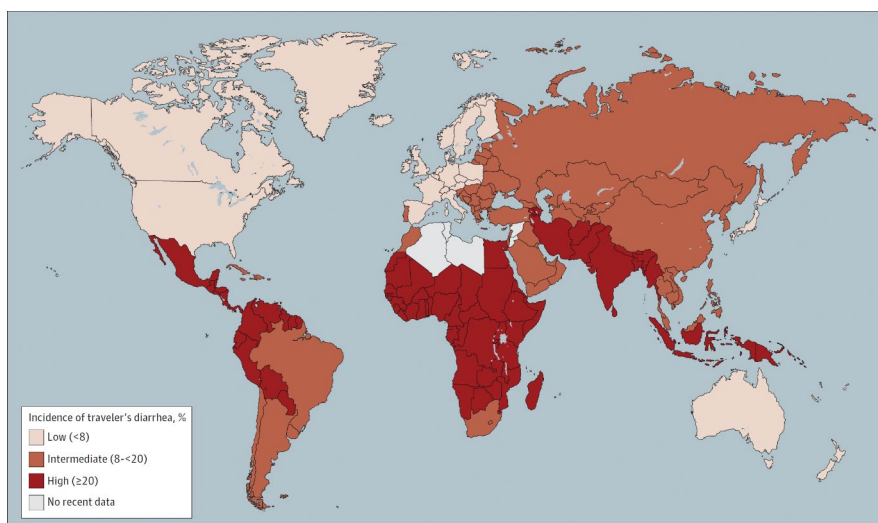
## INTRODUCTION

Gastrointestinal (GI) infections are one of the most frequent health problems among people travelling to low income countries [1, 2], which may greatly affect tourists' holiday or business plans [3]. Among the etiological factors bacteria were found to be the most common, but viruses and parasites may also be responsible for GI infections. The risk factors commonly associated with GI infections include lack of compliance with hygiene practices, drinking tap water or eating food of unknown origin [4]. Travelers' diarrhea (TD) is by far the most common GI infection among travelling people [4, 5]. Its symptoms usually appear within the first 1–2 weeks of travel; in 10% of patients can persist more than a week [1], although the median duration is 2 days [6]. As exotic destinations are becoming increasingly popular among tourists, physicians working in developed countries are now more likely to see patients presenting with a travel-related health problem which persists or develops upon return.

## EPIDEMIOLOGY

About half a billion people from developed countries travel internationally each year, of whom as many as 100 million travel to a developing regions of the world [4]. Among the latter, 60% will develop diarrhea [7], and 8% will seek medical help during or shortly after travel. The age groups that are most likely to be affected by GI disorders include children (younger than 2 years old) and young adults [4]. The most common GI infection, i.e. TD [4, 5], occurs in 20% to 50% of travelers [6] (the indexes depending on a source), or 11 million of travelling people annually [3]. A total of 17% of patients return home with clinical manifestations of the disease, and 2% develop symptoms after their return [6]. GI infections are a common problem which requires pre-travel advice. It is worth noting that in the last 20 years the number of TD cases during a 2-week trip has decreased remarkably, from 65% to 10–40% depending on the destination (Fig. 1) [8].

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**Figure 1.** Incidence rates of travelers' diarrhea in the initial 2 weeks of stay in various regions of the world among visitors residing in industrialized countries, 1996–2008. Source: Steffen R, Hill DR, DuPont HL. Traveler's diarrhea: a clinical review. *JAMA* 2015; 313: 71–80 [8]

## RISK FACTORS

Most cases of GI infections are transmitted through the fecal-oral route [9]. For this reason, most, if not all, risk factors are related to hygiene and eating habits. The major risk factors can be broadly divided into two categories: environmental and host hazards. The most important of the environmental hazards is the travel destination. The highest risk for GI infections is reported from developing countries, which is due to poor standards of sanitation and hygiene [3, 4, 9, 10]. The income level is inversely proportional to GI incidence rates [7]. According to the results of a retrospective observational analysis of 6,086 travelers by an international association of travel medicine clinics, travel to Sub-Saharan Africa, South America and South Asia is associated with the highest risk of GI infection, with India and Nepal having the highest risk of all countries analysed in the study. This applies to all pathogens responsible for GI infections (bacteria, parasites, and viruses) [7]. No geographical association has been found for persistent diarrhea [10]. In some regions, such as Northeast Asia and Northern Mediterranean the risk has lowered compared to a study performed in 1986, possibly by the improvement of tourism infrastructure [4, 7]. Another risk factor is related to the style of travelling. In general, backpacking is said to present a high risk for GI disorders, most likely due to more risky behaviour, such as drinking tap water and eating street food [4]; however, luxury all-inclusive hotels and cruises are not always safer than cheap hostels, because of serving food stored for a long-term [3, 11]. Also, eating in private homes is safer than eating in restaurants [3]. Some foods and beverages are especially risky, e.g. shellfish, which accumulates many pathogens within (*Vibrio cholerae*, Norovirus, HAV) [4] and drinks with ice cubes, which are usually

prepared from tap water (may be contaminated with fecal bacteria) [3]. Travelers need to keep in mind that contact with local animals can result in a *Campylobacter* or *Giardia* infection. Another issue to consider is the length of travel and stay. Normally, the longer the trip, the higher the risk of a GI infection [6]. A minimum of 2-week stay in South or Southeast Asia, Middle East and South America holds the highest risk of acquiring a GI disorder [4]. As for the host hazards, the most relevant is the age of a traveller. Teenagers and young adults are in the highest risk group [6, 7, 11], and children are the ones who are the most often hospitalised [11]. There is no difference between sexes as to the risk of acquiring a GI infection [6, 11]. People with hypochlorhydria and patients treated with antacids are more likely to fall ill [11, 12] as higher level of gastric acid would have had bactericidal effect. Some genetic features, although rarely assessed [11], give an interesting insight into travel infections – people with blood group O or with mutation in interleukin (IL)-8 [3, 4], lactoferrin or IL-10 [4] gene, are prone to TD [3]. Immunocompromised patients are also more likely to acquire a GI illness during travel, and are more often diagnosed with protozoan infections [3], which may lead to persistent diarrhea.

## TRAVELERS' DIARRHEA

Travelers' diarrhea is defined as 3 or more stools per day, sometimes with additional symptoms, such as abdominal cramps, tenesmus, nausea, vomiting, fever, chills or prostration, all starting during or shortly after travel. In 5–15% cases of diarrhea blood or mucus may occur in stools (dysentery) [13]. The World Health Organization adds the number of stools greater than normal for a relevant individual to the definition [11]. TD occurs as a result of

**Table 1.** Distribution of pathogens in acute cases of travelers' diarrhea by geographical region

Pathogen	Latin America (%)	Asia (%)	Africa (%)	Middle East (%)
Enterotoxigenic <i>E. coli</i>	17–70	6–37	8–42	29–33
Enteroinvasive <i>E. coli</i>	2–7	2–3	0–2	1
Other <i>E. coli</i> (EPEC, EAEC, EHEC)	5–15	1	2–7	NA
<i>Shigella</i> spp.	2–30	0–17	0–9	8–26
<i>Salmonella</i> spp.	1–16	1–33	4–25	2
<i>Campylobacter jejuni</i>	1–5	9–39	1–28	1–2
<i>Aeromonas</i> spp.	1–5	1–57	0–9	1
<i>Plesiomonas shigelloides</i>	0–6	3–13	3–5	1
<i>Vibrio cholerae</i> non-O1	0–2	1–7	0–4	2
<i>Yersinia</i> spp.	NA	0–3	NA	1
Rotavirus spp.	0–6	1–8	0–36	NA
<i>Entamoeba histolytica</i>	NA	5–11	2–9	NA
<i>Giardia intestinalis</i>	1–2	1–12	0–1	NA
<i>Cryptosporidium</i> spp.	NA	1–5	2	NA
No pathogen identified	24–62	10–56	15–53	50–51

NA — not available; Source: Castelli F, Pezzoli C, Tomasoni L. Epidemiology of travelers' diarrhea. J Travel Med. 2001; 8(Suppl. 2): S26–S30 [19]

exposure to local enteric pathogens during international relocation.

**Etiology.** The pathogen causing TD is identified in only 40–60% of travelers with symptoms. The identification of the pathogen is not always needed, considering the symptoms are usually either self-limiting or disappear rapidly after empirical self-administered therapy [3]. However, when diagnosed, the predominant pathogen worldwide is the enterotoxigenic *Escherichia coli* (ETEC) [2, 4, 12, 14] (Table 1). ETEC has been identified in 33.6% of patients suffering from TD in South America, 31.2% in Africa and 30.1% in South Asia. According to different sources, from 50 to 85% cases of TD are caused by bacteria [2, 3], whereas 10–15% of cases are caused by viruses, mostly in Africa and South America [15]. Parasites are estimated to cause 17% of TD cases, and are often identified in patients with persistent diarrhea [3]. However, even 34–41% cases are caused by a mixed infection, the frequent co-pathogens being ETEC and EAEC (enteroaggregative *E. coli*) [4]. ETEC,

EAEC, *Campylobacter*, *Salmonella*, *Shigella* and *Vibrio* spp. are the most common bacteria found in patients with TD [2, 4, 16]. Others have specific geographical distribution, e.g. *Aeromonas* spp. and *Plesiomonas shigelloides* are often found in Asia [3] while *Campylobacter* spp. has been the most identified pathogen in travelers to Southeast Asia (32%), which is important to remember when adjusting the treatment, as there is a high resistance of these strains to commonly used ciprofloxacin [4]. Viruses, especially the norovirus species, are often connected with outbreaks of the illness in small travel communities such as passengers of a cruise ship [3, 17]. Rotavirus infection is a common diarrhea cause in travelers to Mexico [2]. *Giardia intestinalis* and *Entamoeba histolytica* are the most common protozoa causing TD, although *E. histolytica* is thought to be overdiagnosed as it is indistinguishable microscopically from its harmless cousin *E. dispar*. *Giardia*, *Cyclospora* and *Cryptosporidium parvum* are often identified in returned travelers with persistent diarrhea [9, 18, 19]. Russia and Nepal are locations where parasites are commonly identified among travelers with diarrhea [2].

Some cases of acute diarrhea with short incubation period may be a consequence of consuming toxins which have already been released by bacteria, mostly in food which has not been stored properly. The most common toxin-producing bacteria include *Clostridium perfringens*, *Staphylococcus aureus*, *Bacillus cereus* and *Clostridium botulinum*. The most threatening infections are by *C. perfringens* type C (they may lead to necrosis of the intestine wall) and by *C. botulinum* (with subsequent injury of the nervous system) [2]. A non-infectious cause of TD is ciguatera toxin which accumulates in big reef fish in the Pacific and the Caribbean area. It causes acute diarrhea followed by neurological symptoms [20].

**Clinical course.** According to the statistics, the onset of symptoms occurs most frequently either on the first 3–4 days abroad or on the 10<sup>th</sup> day of the trip (Table 2). The untreated TD lasts 4 days [4], while half of the patients recover even faster — within 48 hours. The mean duration of patient's incapacity is less than 1 day [8]. TD has a wide range of course paths, from self-limiting indisposition to a serious condition with a need of hospitalisation. In 1% of cases TD evolves from an acute distress to a chronic disease and sometimes it may have long-term consequences on the overall health of the patient [4, 11] causing, among others, post-infectious irritable bowel syndrome (PI-IBS) [8]. In most cases the clinical course is mild and diarrhea consists of no more than 5 stools per day, while accompanying symptoms are nothing more but nausea and abdominal pain [4]. 1% of patients require hospitalisation. General practitioners who encounter patients with diarrhea returning from a travel should be aware of the impact this

**Table 2.** Etiology and clinical symptoms of gastrointestinal disorders in returned travelers

Etiology	Incubation period	Symptoms	Duration of symptoms
<i>Campylobacter jejuni</i>	2–5 days	Fever, abdominal pain, vomiting, diarrhea	2–10 days
<i>Clostridium difficile</i>	5 days – 5 months	Fever, abdominal pain, diarrhea	4 days – weeks
<i>Escherichia coli</i> O157:H7	1–8 days	Abdominal pain, vomiting, acute diarrhea often with blood	5–10 days
Enterotoxigenic <i>Escherichia coli</i> (ETEC)	1–3 days	Abdominal pain, watery diarrhea	3–7 days
<i>Salmonella enteritidis</i>	1–3 days	Fever, abdominal pain, vomiting, diarrhea	4–7 days
<i>Shigella</i> spp.	24–48 h	Fever, abdominal pain	4–7 days
<i>Vibrio cholerae</i>	24–72 h	Life threatening dehydration caused by watery diarrhea and vomiting	3–7 days
<i>Vibrio parahaemolyticus</i>	2–48 h	Watery diarrhea, abdominal pain, nausea, vomiting	2–5 days
<i>Yersinia enterocolitica</i>	24–48 h	Fever, abdominal pain, vomiting, diarrhea with blood	1–3 weeks
Norovirus	12–48 h	Fever, muscle pain, abdominal pain, nausea, vomiting, diarrhea	12–60 h
Rotavirus	24–72 h	Fever, nausea, vomiting, watery diarrhea	4–10 days
<i>Giardia intestinalis</i>	9–15 days	Persistent diarrhea, abdominal pain, bloating, weight loss	> 14 days
<i>Entamoeba histolytica</i>	8–30 days	Diarrhea with mucus and blood, abdominal pain; chronic type of amoebiasis (amoebic liver abscess)	> 14 days
<i>Cryptosporidium parvum</i>	3–12 days	Watery diarrhea, abdominal pain, nausea, vomiting, weight loss	> 14 days

Source: Korzeniewski K. Gastrointestinal disorders in returning travellers. FMR 2018; 12(4): 115–126 [4]

disease can have. Diarrhea interferes with absorption of some medications – warfarin and other anticonvulsants as well as oral contraception. Loss of fluids leads to electrolyte disorders and is especially dangerous for young children. Some pathogens, common especially in Southeast Asia, such as *Shigella*, *Salmonella* and *Campylobacter*, can lead to Reiter's syndrome or trigger an inflammatory disease in the intestine. Over 10% of patients with TD develop post-infectious irritable bowel syndrome [3].

**Pathophysiology.** Understanding the pathogenesis of TD will suggest the right path of the treatment. Bacteria, the main cause of TD, use colonisation factors (such as fimbriae and pilli) to colonise the intestine; virulence factors like enterotoxins, endotoxins and cytotoxins that cause the symptoms as well as some bacteria invade the intestinal mucosa themselves [9]. ETEC and *Vibrio cholerae* release enterotoxins in the small intestine. These particles increase levels of cAMP by deregulating adenylate cyclase, which escalates the production of secretory fluid, and, in effect, causes watery and abundant diarrhea termed secretory diarrhea. This type of diarrhea with acute abdominal pain is characteristic for cholera [9, 20]. Other enterotoxins yield a similar effect, but through a different path – lipopolysaccharide endotoxin through cGMP pathway [21], ciguatera

toxin through calcium-dependent pathway and *Shigella* toxin through nitric oxide pathway. Each of them induces watery diarrhea. Another mechanism of non-inflammatory diarrhea, seen often in persistent diarrhea as well as rotavirus infections, uses the law of osmosis. In osmotic diarrhea poorly absorbable substance creates osmotic pressure across the mucosa of the intestine wall [9]. It is easy to fall into dehydration as liquids pass to the lumen of the intestine according to the concentration gradient. The diarrhea is frothy and exploding and ceases after fasting. Exudative, inflammatory diarrhea with blood, mucus and pus in stool (dysentery) is caused by bacteria that invade mucosa and release cytotoxins [4]. They act mostly in the distal part of the intestines – distal ileum and colon. Cytotoxins kill cells by suppressing the synthesis of proteins (shiga toxin produced by *Shigella dysenteriae* type 1), creating pores in the cell membrane (hemolysins released by *Vibrio parahaemolyticus*) or ceasing the extension of actin filaments. This type of diarrhea is usually accompanied by systemic symptoms – fever and a rise of inflammation markers in blood [9]. Some bacteria combine various diarrheal mechanisms and cause secretory and inflammatory diarrhea simultaneously – these are the capacities owned by *C. jejuni*, *Salmonella* spp. and *Aeromonas* spp. Among

protozoa, *E. histolytica* causes a severe disease by creating ulcers on the intestine wall using cytolysis, proteases, toxins and phagocytosis. It can also spread to other organs, especially the liver, and reside within. *Giardia* attaches itself to the wall of the small intestine, but its virulence factors have not been yet discovered [9].

**Diagnosis.** Diarrhea without the inflammation component (fever or blood in stool) lasting less than 5 days usually does not require pathogen investigation [9, 10]. Nonetheless, we should consider further diagnostics when the symptoms are severe, when there was an outbreak of symptoms in one group of travelers, when diarrhea is persistent, when the patient is immunodeficient or when in differential diagnosis we suspect that the patient may suffer from an inflammatory bowel disease. Choosing the right treatment should be guided by a thorough interview which, apart from the existing symptoms, focuses on the destination of the travel and the medical history of the patient. It is also crucial to know the incubation period of certain pathogens; generally, symptoms that persist no longer than 2 weeks indicate a bacterial or viral infection, while longer lasting cases suggest parasitic etiology and require specific treatment. Conventional methods of diagnostics include microbiological culture for bacteria, immunoenzymatic tests for viruses, and microscopic assessment of stool samples for parasites. If these methods appear to be insufficient, looking for pathogen's DNA in patient's blood will deepen the search [2]. However, diagnostics can encounter several challenges. For example, diarrhoeagenic *E. coli* shares part of its genetic sequence with commensal strains [15]. Also, the identification of *E. histolytica* is problematic because it is impossible to distinguish it microscopically from non-pathogenic *E. dispar* [9]. Apart from investigation to discover the pathogen which caused the disease, several common tests should also be performed, such as full blood count, liver enzymes, renal functioning, to assess the overall health of the patient [4].

**Treatment.** Most cases of travelers' diarrhea are mild and self-limiting and resolve without medical attention [7]. Many tourists receive pre-travel advice from their doctors and carry a TD kit with them to administer self-treatment if necessary. The main objective of self-treatment of a simple TD, which is not associated with any accompanying symptoms, is to compensate the loss of body fluid and to soothe the symptoms. Easy informal methods of rehydration include eating soup and drinking sugar-flavoured water and biting on salty crackers. Formal oral rehydration therapy is recommended to the most vulnerable groups of patients, e.g. infants, young children and the elderly, as well as to any patient with cholera-like diarrhea [3]. Diarrhea is not a contraindication against eating solid foods as they induce the recovery of damaged enterocytes [4]. In more severe cases antimicrobials (mentioned below) carried in travel-

er's kit are to be self-administered by the patient. Despite self-treatment being a very common practice, there are several situations when medical attention is required. These include: lack of improvement after 24 hours of the initial onset of symptoms, high fever, severe abdominal pain, signs of dehydration, frequent vomiting, which makes it impossible to compensate the loss of fluids, blood stains in stool or melena, no rapid improvement after self-treatment and persistent diarrhea of more than 3–4 days. Severe or uncomfortable diarrhea is usually treated by a 3-day empirical course of wide-spectrum-antibiotics [3]. Antimicrobial treatment shortens the duration of symptoms to a day and a half (in comparison with the average of 4 days in cases of untreated TD) [8]. The common choice is fluoroquinolone (ciprofloxacin, 750 mg once daily for 1 to 3 days) and azithromycin (500 mg once daily for 3 days or 1000 mg in a single dose) as a second option [3, 8]. However, azithromycin should be considered as the first-line treatment option for tourists travelling to Southeast Asia for the reason that a majority of infections in the region are caused by *Campylobacter*, which shows 60% resistance to fluoroquinolones [1]. Rash, photosensitivity and GI complaints are rare side-effects of using fluoroquinolones. However, fluoroquinolones were found to interact with some drugs such as warfarin, phenytoin, ciclosporin and theophylline, as well as they are not recommended for pregnant women and small children. Although it acts more slowly than ciprofloxacin in *Campylobacter*-negative patients, azithromycin does not alter the pharmacokinetics of other drugs and is a good alternative for children (however, it has not been licensed for use by pregnant women). A relatively new antimicrobial is semi-synthetic rifaximin. The studies have shown that in cases of a secretory diarrhea treatment with rifaximin (200 mg 3 times daily for 3 days) [8] is as effective as with ciprofloxacin [3]. It is not absorbed through the intestinal wall and thus it does not cause any systemic effects [4]. However, rifaximin has not been tested on patients presenting with diarrhea complicated by fever, systemic toxicity or blood stained stools, thus it is not recommended in such cases. Although antisecretory and antimotility agents, such as loperamide, will reduce the passage of stools even by 65%, they may have a negative effect on the clinical course of diarrhea, especially in cases of an invasive infection; this is due to the fact that they cease the evacuation of the pathogen through the intestines and they have no direct effect on the disease-causing microorganisms [3]. Antibiotic treatment will not resolve diarrhea of viral etiology. However, most viral cases are mild and resolve spontaneously within 24–72 hours. On suspicion of a parasitic infection, persistent diarrhea should be treated with metronidazole, which is the treatment of choice in cases caused by *Giardia intestinalis* infection [4]. Each case of a diarrhea complicat-

**Table 3.** Travelers' diarrhea management algorithm

PRE-TRAVEL										
<b>Pre-travel advice:</b>										
1. Definitions of TD and classification of severity.										
2. Importance of oral rehydration through fluid and salt intake for all TD.										
3. Information on effectiveness of treatments for TD and the risk of travel, TD and antibiotic use with the acquisition of multi-drug resistant bacteria.										
4. Provision of empiric treatment medications as indicated by itinerary and practitioner-traveler determination.										
5. Intra- and post-travel illness follow-up recommendations.										
DURING TRAVEL										
Self-determination of illness severity										
Mild	Moderate	Severe								
Diarrhea that is tolerable, not distressing, does not interfere with planned activities	Diarrhea that is distressing or interferes with planned activities	Diarrhea that is incapacitating or prevents planned activities								
		<table border="1"> <thead> <tr> <th>Non-dysentery</th> <th>Dysentery*</th> </tr> </thead> <tbody> <tr> <td>May use loperamide as an adjunct to antibiotics</td> <td>May use loperamide as an adjunct to antibiotics</td> </tr> <tr> <td>+/-</td> <td>+</td> </tr> <tr> <td>May use antibiotic</td> <td>Should use antibiotic</td> </tr> </tbody> </table>	Non-dysentery	Dysentery*	May use loperamide as an adjunct to antibiotics	May use loperamide as an adjunct to antibiotics	+/-	+	May use antibiotic	Should use antibiotic
Non-dysentery	Dysentery*									
May use loperamide as an adjunct to antibiotics	May use loperamide as an adjunct to antibiotics									
+/-	+									
May use antibiotic	Should use antibiotic									
May use loperamide or bismuth subsalicylates	May use loperamide alone OR as an adjunct to antibiotics									
	+/-	+								
	May use antibiotic	Should use antibiotic								
POST-TRAVEL										
Acute TD should be treated empirically as above										
Microbiologic testing is recommended in returning travelers with severe or persistent symptoms or in those who fail empiric therapy										
Multiplex molecular diagnostics are preferred in patients with persistent or chronic symptoms										

\*All dysentery is considered severe. Source: Riddle M, et al. Guidelines for the prevention and treatment of travelers' diarrhea: a graded expert panel report. J Travel Med. 2017; 24(Suppl. 1): S57-S54 [22]; TD – travelers' diarrhea

ed by fever and bloody stools or cholera-like watery diarrhea should be further investigated by obtaining and assessing blood and stool samples; treatment should be adjusted according to test results (Table 3) [22].

### PERSISTENT OR REFRACTORY DIARRHEA

Persistent diarrhea accounts for 2% of all TD cases. It is defined as diarrhea lasting more than 14 days, although in 1% of cases it may persist longer than 4 months. Refractory diarrhea is a diarrhea which does not respond to antibiotic therapy at all or relapses soon after the completion of treatment. In such cases multi-resistant bacteria or protozoa are usually found to be responsible for the infection. The etiology of persistent or refractory diarrhea often remains unknown, in spite of a wide range of available diagnostic methods. A number of different etiologies, not only infectious, should be taken into consideration. Initial investigation of persistent diarrhea should include, apart from a thorough interview, examination of at least 3 stool samples collected on different days, to be examined in the light microscopy for the presence of intestinal parasites, and for a bacterial culture (especially for *Salmonella*, *Shigella* and *Campylobacter*) [8]. Stool should also be examined for fecal leukocytes, lactoferrin and occult blood. For as long as the results of the above-mentioned tests are awaited,

the patient should avoid dairy products and should take the hydrogen breath test for lactose intolerance if dietary restriction was inconclusive. Further investigations include GI endoscopy with a biopsy of the small or the large intestine, if the symptoms indicate a distal infection. If major symptoms still exist and weight loss is progressive, the patient should be examined for celiac disease by measuring the serum anti-transglutaminase antibodies [10]. Some patients develop symptoms of inflammatory bowel disease after a trip to the tropics. Other possible diagnoses include neoplasia and endocrinopathy. Additionally, some medications could be the cause of persistent diarrhea.

In the absence of a specific etiologic diagnosis, the following therapy is suggested:

- discontinuation of medications which can cause diarrhea (e.g. laxatives, antibiotics, diuretics);
- administration of antimotility agents, such as loperamide; bismuth subsalicylate; probiotics, e.g. *Lactobacillus* or *Saccharomyces*, which prevent antibiotic-associated diarrhea;
- dietary modification to avoid food which irritates the bowel, i.e. alcohol, spicy food, caffeine;
- cholestyramine resin to bind bile-acids;
- bulk agents, e.g. psyllium, which increase fecal capacity of holding water [10].

## POST-INFECTIOUS IRRITABLE BOWEL SYNDROME (PI-IBS)

Post-infectious irritable bowel syndrome is a problem affecting 3% to 17% of patients after they had experienced TD [8, 23]. When chronic enteric infection and organic GI disease are excluded, symptoms such as abdominal pain and altered bowel movement habits are suggestive of an irritable bowel syndrome which has developed after gastroenteritis or TD [23, 24]. There are some generally recognised factors which are associated with the development of PI-IBS, e.g. the severity of TD, the number of TD episodes, the history of pre-travel diarrhea or other adverse life events, and the etiology factor of TD being a heat-labile toxin-producing ETEC. Other risk factors include young age and female gender, as well as personality features, e.g. being prone to stress, anxiety, having a high level of neuroticism and somatisation. If TD is caused by a bacteria which destroys the intestine wall (e.g. *Salmonella*, *Shigella* or *Campylobacter*), the risk of developing PI-IBS afterwards further increases [24]. Giardiasis often imitates the PI-IBS, causing malabsorption and subsequent bloating, nausea and vomiting [18]. The results of a prospective cohort study suggest that TD patients treated with antibiotics were less likely to develop PI-IBS than patients who cured spontaneously [25], although some meta-analyses include antibiotics as a risk factor [24]. More studies need to be performed to assess the etiologic factors of PI-IBS and in result to define the right treatment strategies [18].

## PREVENTION OF GASTROINTESTINAL INFECTIONS

Prevention against GI infections should begin well before the travel by seeking advice from a family doctor or a specialist in travel medicine. This advice should include such topics as hand hygiene, choice of safe food and beverages and fluid replacement. It should mention the situations when seeking professional medical help is crucial. Unfortunately only 2% patients comply with the instructions [11].

The common advice to avoid street food is hard to follow as trying local cuisine is considered as a part of cultural experience [13]. Local street food is often described as the most delicious by the ones who dared to try it. Therefore, the patient should at least remember that freshly prepared food which is served steaming hot (at least 70 centigrade degrees), peeled or highly citrus fruits and dry foods are the safest [11]. Old rule “Cook it, boil it, peel it or forget it” still functions well [4].

Many bacteria can be swallowed with a sip of water, especially *Shigella* which has a low infective dose. A traveller should avoid tap water and ice cubes [3, 4], and stick to purified bottled water. It is to be remembered that tap water is often sold as purified water in bottles in many developing countries [3]. Carbonated water is safer to

drink as it has a lower pH which kills enteropathogenic bacteria; there were some cases of diarrhea in Mexico and Portugal caused by contaminated noncarbonated bottled water. Boiling water for 1 min kills most of the bacteria (on high altitudes above 2000 m water should be boiled for at least 3 min) [26]. Alcohol consumption has not been identified as a preventive method nor a risk factor of TD [6].

Another form of pre-travel prevention is vaccination. There are several vaccines recommended for travelers: against typhoid fever, viral hepatitis A, and cholera. The latter is known in several countries like Canada and Sweden as “a travelers’ diarrhea vaccine”, as it gives a partial (7%) cross-protection against heat-labile toxin-producing ETEC. Although its protective efficacy against ETEC lasts 3 months only, some patients could benefit from getting vaccinated [4].

Although there is an improvement of hygiene status in developing countries [11], washing hands with water and soap or cleaning them with an antibacterial gel should never be avoided [4]. Bismuth subsalicylate taken as a preventive medication 4 times a day during travel reduces the risk of TD by 65%. Its adverse effects include turning the tongue and stools black – the latter should be considered when diagnosing bloody stools. Salicylate compounds should be avoided by patients who take anticoagulants or salicylate on the long term [8]. The use of synbiotics, prebiotics and probiotics has not been supported by any study thus its use in order to prevent TD is not recommended [13]. Chemoprophylaxis is usually not recommended because of higher cost than eventual self-treatment, although there are four groups of people for which we should propose this form of prevention. These include people who take short 3–5-day trips and cannot be trapped in a hotel room with GI symptoms (i.e. sportsmen, businessmen, musicians, lecturers), patients who have already experienced TD and can be considered as prone to it, immunodeficient patients suffering from chronic diseases, AIDS, cancer, heart failure or diabetes treated with insulin, and the last group – patients who have requested for chemoprophylaxis [27]. A popular drug is rifaximin, which would prevent 72% of infections [4].

## CONCLUSIONS

Gastrointestinal disorders remain the most common problem among travelers that can ruin every vacation or an international business meeting. In most cases the symptoms are either self-limiting or disappear after easy empirical 3-day antimicrobial treatment. Doctors in home countries will encounter either patients with acute diarrhea which started at the end of the trip, or persistent diarrhea, mostly caused by parasites. Sometimes travel masks the real reason of sickness, so non-infectious and post-infec-



tious diagnoses should also be taken into consideration. These include lactose intolerance, celiac disease, neoplasm, post-infectious irritable bowel syndrome, and side-effects of the medications.

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# INFORMATION FOR AUTHORS

The International Maritime Health will publish original papers on medical and health problems of seafarers, fishermen, divers, dockers, shipyard workers and other maritime workers, as well as papers on tropical medicine, travel medicine, epidemiology, and other related topics.

Typical length of such a paper would be 2000–4000 words, not including tables, figures and references. Its construction should follow the usual pattern: abstract (structured abstract of no more than 300 words); key words; introduction; participants; materials; methods; results; discussion; and conclusions/key messages.

Case Reports will also be accepted, particularly of work-related diseases and accidents among maritime workers.

All papers will be peer-reviewed. The comments made by the reviewers will be sent to authors, and their criticism and proposed amendments should be taken into consideration by authors submitting revised texts.

Review articles on specific topics, exposures, preventive interventions, and on the national maritime health services will also be considered for publication. Their length will be from 1000 to 4000 words, including tables, figures and references.

Letters to the Editor discussing recently published articles, reporting research projects or informing about workshops will be accepted; they should not exceed 500 words of text and 5 references.

There also will be the section Chronicle, in which brief reports will be published on the international symposia and national meetings on maritime medicine and health, on tropical parasitology and epidemiology, on travel medicine and other subjects related to the health of seafarers and other maritime workers. Information will also be given on training activities in this field, and on international collaborative projects related to the above subjects.

**All articles should be submitted to IMH electronically online at [www.intmarhealth.pl](http://www.intmarhealth.pl) where detailed instruction regarding submission process will be provided.**

Only English texts will be accepted.

Manuscripts should be typed in double line spacing on numbered pages and conform to the usual requirements (Ref.: International Committee on Medical Journals Editors. Uniform Requirements for Manuscripts Submitted to Biomedical Journals, JAMA, 1997; 277: 927–934).

Only manuscripts that have not been published previously, and are not under consideration by another publisher, will be accepted.

Full texts of oral presentations at meetings (with abstracts printed in the conference materials) can be considered.

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

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

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

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

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

## REFERENCES

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

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

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