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Letter from the Editor

Dear Readers, Dear Colleagues,

Coronavirus disease (COVID-19) outbreak is a fact. In March 2020 World Health Organization (WHO) made the assessment that Covid-19 is characterized as a pandemic. The situation is dynamic.

All the world, all medical authorities are focused on fighting this disease. It is the greatest challenge at the moment. The most important problems are: preventing the spread of the disease, medical treatment of infected patients, vaccine discovery. But also for people who require mental and psychosocial well-being support is especially significant.

The sudden global emergence of Covid-19 illness is of great interest for maritime health as well. Therefore, we publish three Editorial Announcements: "Coronavirus Disease 2019 as a challenge for maritime medicine", "Coronavirus (Covid-19) outbreak on the cruise ship *Diamond Princess*" and "COVID-19, guests and crews of cruise: observation on Thai citizens".

In addition in the same issue "International Maritime Health" publishes for your two press releases of relevance to maritime health:

— INTERNATIONAL MARITIME ORGANIZATION (IMO) CIRCULAR LETTER NO. 4204/ADD. 1: "COVID-19 — IMPLEMENTATION AND ENFORCEMENT OF RELEVANT IMO INSTRUMENTS" (Source: http://www.imo.org/en/MediaCentre/HotTopics/Documents/CL.4204-Add.1%20English.pdf; accessed: 3rd March 2020)

This circular of 19th February 2020 issues information and guidance, based on recommendations developed by the World Health Organization (WHO), on the precautions to be taken to minimize risks to seafarers, passengers and others on board ships from the novel coronavirus (2019-nCoV).

— CRUISE LINES INTERNATIONAL ASSOCIATION (CLIA) — "STATEMENT ON COVID-19" (Source: https://cruising.org/news-and-research/press-room/2020/march/clia-covid-19-toolkit; accessed: 3rd March 2020)

This press release of 2nd March 2020 from CLIA provides details on how the CLIA cruise line members will deal with cruise passengers and crew after 27th February 2020.

Take care of yourself, stay safe and healthy at this time!

IMH Editorial Board

IMO — INTERNATIONAL MARITIME ORGANIZATION

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Circular Letter No.4204/Add.1
19 February 2020

To: All IMO Member States
United Nations and specialized agencies

Intergovernmental organizations
Non-governmental organizations in consultative status with IMO

Subject: **COVID-19 — Implementation and enforcement of relevant IMO instruments**

The Secretary-General informs that he has received reports regarding the impacts on the shipping industry resulting from the sudden and rapid outbreak of the COVID-19 coronavirus. In response to this situation, the Secretary-General has issued guidance through Circular Letter No. 4204.

Flag State authorities, port State authorities and control regimes, companies and shipmasters should cooperate, in the current context of the outbreak, to ensure that, where appropriate, passengers can be embarked and disembarked, cargo operations can occur, ships can enter and depart shipyards for repair and survey, stores and supplies can be loaded, certificates can be issued and crews can be exchanged.

The principles of avoiding unnecessary restrictions or delay on port entry to ships, persons and property on board are also embodied in articles I and V and section 6 of the annex of the FAL Convention.

Several IMO instruments contain provisions that may be relevant to the impact on shipping caused by the outbreak of COVID-19. These include, but are not limited to:

- the International Convention for the Safety of Life at Sea, 1974;
- the International Convention for the Prevention of Pollution from Ships, 1973;
- the International Convention for the Control and Management of Ships' Ballast Water and Sediments, 2004;
- the International Convention on Standards of Training, Certification and Watchkeeping for Seafarers, 1978; and
- resolution A.1119(30), *Procedures for port State control, 2017*.

In addition, the Secretariat has received the following communication from the International Labour Organization (ILO):
"In the context of the evolving coronavirus outbreak, the effective protection of the health and safety of seafarers should be a priority. Under the International Labour Organization's (ILO) Maritime Labour Convention, 2006, flag States must ensure that all seafarers on ships flying their flag are covered by adequate measures for the protection of their health and that they have access to prompt and adequate medical care whilst working on board. The Convention also requires port States to ensure that seafarers on board ships in their territory who are in need of immediate medical care are given access to medical facilities on shore."

COVID-19 is a severe public health challenge that requires understanding and close cooperation among all Member States to overcome challenges related to the implementation and enforcement of the relevant IMO instruments.

The Organization will continue to closely monitor the situation and the Secretary-General will provide additional information as appropriate and will bring these matters to the attention of the relevant organs of the Organization, in particular the Maritime Safety Committee, the Marine Environment Protection Committee, the Facilitation Committee and the Legal Committee.

PRESS RELEASE | MARCH 02, 2020

Cruise Lines International Association (CLIA) Statement on COVID-19

WASHINGTON, DC (1 MAR 2020) — Cruise Lines International Association (CLIA), the leading voice of the global cruise industry, issued today the following statement in response to recent developments concerning COVID-19 and its impact on the global cruise industry.

"The health and safety of cruise passengers and crew is and remains the number one priority of CLIA and its member lines, which make up over 90% of ocean-going cruise capacity worldwide.

Given the evolving nature of the ongoing COVID-19 — and based upon prevailing guidance from global health authorities, including the World Health Organization (WHO) — CLIA Members have adopted the following enhanced protocols for ocean-going guests and crew who have recently traveled from or through Iran, South Korea and China, including Hong Kong and Macau. These enhanced policies, which are in effect as of 27 February 2020, build upon those which were first implemented on 31 January 2020 and focus on conservative measures, as the situation evolves, to appropriately and effectively screen every guest and crewmember on every ship prior to boarding.

- CLIA Members are to deny boarding to all persons who have traveled from, visited or transited via airports in Iran, South Korea and China, including Hong Kong and Macau, within 14 days before embarkation.
- CLIA Members are to deny boarding to all persons who, within 14 days before embarkation, have had close contact with, or helped care for, anyone suspected or diagnosed as having COVID-19, or who is currently subject to health monitoring for possible exposure to COVID-19.
- CLIA Members are to conduct preboarding screening necessary to effectuate these prevention measures. Enhanced screening and initial medical support are to be provided, as needed, to any persons exhibiting symptoms of suspected COVID-19.

In coordination with cruise lines, medical experts and regulators around the world, CLIA and its member lines will continue to closely monitor for new developments related to the coronavirus and will modify these policies as necessary with the utmost consideration for the health and safety of passengers and crew. With strict measures in place, as guided by national and international health authorities, CLIA and its member lines do not believe restrictions on the movement of ships are justified.

Importantly, the cruise industry is one of the most well-equipped and experienced when it comes to managing and monitoring health conditions of those onboard, with outbreak prevention and response measures in place year-round. Furthermore, ships must be fitted with onboard medical facilities, with shipboard medical professionals available around the clock, 24/7, to provide initial medical care in the event of illness and help prevent disease transmission."

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Coronavirus Disease 2019 as a challenge for maritime medicine

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On 11 March 2020 World Health Organization (WHO) "made the assessment that Coronavirus Disease 2019 (COVID-19) can be characterised as a pandemic". Six weeks earlier, on 30 January 2020, the outbreak caused by a novel coronavirus was declared a Public Health Emergency of International Concern [1].

The history of this new threat to human population is very short with rapid evolution in his perception and unprecedented decisions to limit global communication that have never been seen before in the era of technical civilisation.

The first cases of pneumonia of unknown origin which was linked to a seafood and wet animal wholesale market in Wuhan, China were reported on 31 December 2019 [2]. In mid-March 2020 there are 133,860 cases worldwide in 122 countries with 4967 deaths in all continents excluding Antarctica. The rate of increase in the number of new cases and deaths outside of China does not decrease [3]. The lack of both: effective antiviral therapy and the possibility of active immunisation (vaccine) means that the basic tool to fight the epidemic is an old weapon, which was used in the past against highly contagious infectious diseases: quarantine and isolation. Fortunately, now it is enhanced by the possibility of early, effective detection of infection using methods of molecular biology.

On 12 February 2020 a new strain of zoonotic coronavirus which has not been previously identified in humans was named severe acute respiratory syndrome coronavirus 2 (SARS-CoV-2). COVID-19 is a name of a new disease associated with this virus. Human-to-human transmission via respiratory droplet or direct contact with infected subjects was confirmed and also a clinical picture from mild disease of respiratory tract to severe pneumonia and life threatening respiratory failure has been extensively described. Mean mortality is estimated to be ~3.5% with rapid increase in older patients reaching 15% in the group of > 80 years and with underlying medical conditions [4]. Still many issues on persistence of contagiousness, type and efficacy of immune response, risk of reinfections are not fully explained, becoming a scientific challenge.

At present SARS-CoV-2, due to its dynamic spread all over the world, appears to be a significant threat to public health in all spaces, especially in international transport, including maritime conveyance. The problem of dealing with a suspected case of COVID-19 does not bypass board ships, not only cruise ships. Dramatic fate of tourists imprisoned on luxury cruise ships because of spread of SARS-CoV-2 infection on board was an unexpected and shocking consequence of rapid, inauspicious changes of epidemiological situation on mainland. It has highlighted the need to train personnel working at sea in area of epidemiology, understanding of psychosocial conditions of epidemic and the basic principles of infectious disease prevention. It turned out necessary to prepare documents organising the rules of conduct in the event of a new epidemic threat on board ship. Early detection, prevention, and control of COVID-19 on ships appeared to be important tasks both to protect the sea workers' and travellers' health and to avoid transmission of the virus by disembarking passengers and crew members who are suspected of having COVID-19 [5, 6].

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Coronavirus (Covid-19) outbreak on the cruise ship *Diamond Princess*

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INTRODUCTION

The whole world has recently been following the media frenzy covering the quarantine of *Diamond Princess*, the first cruise ship that had an outbreak of coronavirus illness (Covid-19) on board. It developed soon after the occurrence of China's Covid-19 outbreak, which — according to the World Health Organization (WHO) — "poses a very grave threat for the rest of the world" and should be viewed as "Public Enemy Number 1" [1]. Lasting more than 14 days, the ship quarantine is unprecedented for the cruise industry, and some maritime health issues of concern may be worth addressing already shortly after the interned passengers and crew had finally disembarked the vessel.

THE CRUISE VESSEL OUTBREAK

Diamond Princess had been on a cruise that originated in Yokohama on 20 January 2020 and included stops in Kagoshima, Hong Kong, Vietnam, Taiwan and Okinawa before returning to Yokohama on 3 February. A passenger, who disembarked on 25 January in Hong Kong, developed a cough on 19 January and on 1 February tested positive for SARS Coronavirus II, a novel virus causing an illness now internationally known as Covid-19. The Japanese government requested that *Diamond Princess* stay at port in Yokohama, with no passengers or crew disembarking. During 3–4 February, the health status of all passengers and crew was checked by questionnaire by quarantine officers, and respiratory specimens were taken from symptomatic passengers, crew, and their close contacts to test for the coronavirus. On 5 February, a lab-confirmed case of Covid-19 led the Japanese Ministry of Health, Labour and Welfare, to initially quarantine *Diamond Princess* for 14 days with passengers requested to stay in their cabins. As of 5 February, there were a total of 3711 multinational individuals (2666 passengers and 1045 crewmembers) on board [2].

The primary purpose of vessel quarantine has always been to protect the public ashore by preventing exposure to potentially contagious passengers and crew, regardless of consequences for those aboard. Ships are bound by international treaties to follow port rules and protocols, and in this case *Diamond Princess* followed the instructions of the Japanese health authorities to the letter while also working closely together with the United States (US) Centers for Disease Control and Prevention (CDC) [3].

Coronavirus virus is thought to spread mainly from person-to-person, between people who are in close contact with one another (within about 6 feet) through respiratory droplets produced when an infected person breathes, coughs or sneezes. It may be possible to get Covid-19 by touching a virus-contaminated surface or object, and transmission might also happen before people show symptoms. Most Covid-19 cases have so far been mild; the overall average mortality rate is estimated at 1–2%, but may change over time [4].

Shortly after quarantine was decided for *Diamond Princess*, some passengers developed symptoms and tested positive for Covid-19. They were hospitalised ashore while the rest had to remain in their cabins [2].

During the quarantine, the number of persons showing symptoms and testing positive for the virus increased steadily. For a time, the vessel had the largest concentration of cases outside of mainland China, where the virus is thought to have originated [4].

Due to the nature of the ship, individual isolation of all those aboard was not possible. Sharing cabins was necessary, and some crew had to perform essential extra duties while passengers remained aboard. Transmission toward the end of the quarantine period occurred mostly among crew or within passenger cabins [2].

The initial quarantine period was scheduled to end on 19 February. As of 20 February, over 1600 individuals have been disembarked from the *Diamond Princess*. Nearly all disembarked individuals had observed 14-day quarantine without sharing a cabin with a confirmed case, had received a recent negative polymerase chain reaction tests, and

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had passed a medical screening for symptoms (e.g. fever, cough). At that time 619 cases had been confirmed (16.7% of the population on board), including 537 passengers and 82 crewmembers. A total of 3011 respiratory specimens had been tested, and 621 were positive (20.6%), including double tests. Persons aboard between 70 and 89 years of age were the most affected. Of all confirmed cases, 318 (51%) were asymptomatic when the respiratory specimen was collected (308 passengers and 10 crew) [2].

On 27 February Princess Cruises confirmed that disembarkation of all guests aboard *Diamond Princess* had been completed. Of the remaining crew, some departed by foreign government charter flights, while the rest were taken to a local quarantine facility to complete a secondary quarantine required by the Japan Ministry of Health [5].

As of 29 February, Japan's Ministry of Health reported that 705 people from the ship had contracted the virus [2]. CDC announced the same day that 44 passengers flown back to the US had tested positive. At that time 6 people who were on the ship had died in hospitals [3].

QUARANTINE AND CONFINEMENT ISSUES ABOARD

Cruise vessels are isolated communities with a high population density, crowded public rooms and living accommodation, shared sanitary facilities, and common water and food supplies. Hence, infectious diseases are easily transmitted aboard, by infected persons and through contaminated surfaces, food and water. This also makes handling outbreaks on ships very difficult, in particular the quarantine of large numbers of passengers and crew.

Presence aboard a ship of a newly discovered virus that spreads person-to-person, and possibly via contaminated surfaces and asymptomatic persons, is certainly a challenge, especially when testing possibilities are limited and time-consuming, and getting test results takes days. A Thai physician suggests why early tests on fluids from noses and throats often turns out negative: "The virus lodges deep in the lower windpipe and lungs, so patients will not have a cough or sore throat when they first develop the disease" [6]. Another concern: some Covid-19 patients that seemed cured and tested coronavirus negative, have later had positive tests. This could be due to "reinfection" because of insufficient immune response to the initial infection or "bi-phasic" virus behaviour; the virus lies dormant before creating new symptoms ("reactivation"). Or inconsistent results might be attributed to testing discrepancies.

Adding to the challenge on board *Diamond Princess* are the facts that initial Covid-19 symptoms are similar to those of influenza and the common cold (fever, cough, respiratory issues), and the Covid-19 outbreaks ashore and then on board started at the height of the annual global influenza epidemics. On a positive note, the risk of confusing influenza symptoms with those of Covid-19 may have been reduced in the crew population because most *Diamond Princess* crewmembers are annually vaccinated against influenza according to company policy and might already have received this season's dose.

What makes Covid-19 especially problematic for cruise ships, is an **incubation time of 2–14 days — and possibly longer**, and quarantine of *Diamond Princess* was therefore necessary for all exposed persons for that long period. Anyone who developed symptoms and tested positive for Covid-19 at any time during their 14-day isolation period may have been contaminated *before* quarantine started. They then had to be isolated off the ship until they tested negative and could be declared non-contagious. And when new patients were diagnosed, their immediate pre-isolation contacts had to be traced and quarantined as well [2].

In addition to those who got the virus before they were quarantined, further persons on board may test positive for Covid-19 during or after the quarantine period if the cabin seclusion was incomplete, which can easily happen because those in isolation have to be tested, fed and aired mainly by the ship's crew.

CREW EXPERIENCE FROM PREVIOUS OUTBREAKS

Whether on land or at sea, managerial mistakes will always be made at the start of an outbreak, especially when the illness is caused by hitherto unknown pathogens. Previous outbreak experience helps, and most cruise vessels are quite well prepared to handle smaller outbreak, like those caused by norovirus, the most common cause of acute gastroenteritis outbreaks on cruise ships [7].

A cruise vessel the size of *Diamond Princess* would normally be expected to have a medical staff of 2 doctors and 3 nurses. That is usually sufficient for daily routine shipboard work, but even a small number of norovirus patients will tax a staff of that size to the limit, even though the average isolation time for such patients is less than two days on a well-run ship.

An outbreak of viral gastroenteritis on a cruise ship, defined as involving more than 3% of passengers or crew [7], demands the involvement of all officers and crew and will quickly exceed the capacity of the ship´s medical staff. Outside assistance will then be essential, but is not always available — for a variety of reasons.

However, an outbreak of a contagious disease where symptomatic patients and their contacts must be isolated for a minimum of 14 days, longer than the length of the average cruise, is truly worrying and brings a multitude of new challenges. The long incubation period alone will drastically influence the practice of cruise ship medicine for the foreseeable future.

CHALLENGES DURING THE CURRENT OUTBREAK

The media focus has primarily been on the ordeal of the *Diamond Princess* passengers, but the controversial 2-week quarantine was even more difficult for the cruise ship's 1045 crewmembers. Cruise vessels are staffed to provide high-level service to their passengers, and the crew is usually kept busy enough by performing their regular duties. During quarantine all kinds of additional services had to be provided — not in public rooms but individually to the passenger cabins, and crewmembers had to do extra tasks, for which they in many cases had not been trained, to keep the quarantined ship running. And they had to do it all while they knew themselves to be at arguably greater risk of getting the illness than the passengers they were serving. They had frequent, although limited, contact with the quarantined passengers, and interacted closely and constantly with other, potentially contagious co-workers during work and off duty, sharing rooms, toilets, and dining spaces. Thus, although effectively protecting the public *ashore*, quarantine for those *aboard* was flawed. Consequently, both passengers and crew increasingly felt helpless, anxious, and fearful, and over time various degrees of mental and physical exhaustion were common [8].

A particular quarantine challenge is that *Diamond Princess* like most cruise vessels has a diverse multinational and multicultural passenger and crew population, with very different service expectations and reactions to authoritarian rules regarding behaviour. After all, people were virtually incarcerated for more than 14 days; in many instances with other persons they wouldn't usually spend so much time with in one small room on a daily basis; the lucky ones had balconies, but many passengers and most of the crew had indoor windowless cabins.

Quarantine is a logistic nightmare for shore-side and ship management and for supervisors at all levels aboard. They must ensure consistently safe and professional operation of all aspects of the vessel, 24/7, also under extraordinary circumstances. Therefore, a primary goal and ongoing challenge will be to keep up morale and motivate a steadily more overtaxed crew to continue not only to work but also to provide the expected "excellent cruise service". There is furthermore constant pressure from the cruise company, port and health authorities, and media for continuously updated documentation of all aspects of their actions. Moreover, unprecedented operations have to be organised: enhanced safety and security measures, special daily housekeeping activities, mobile food and beverage services to all cabins under 'biohazard' conditions, daily strictly supervised walks on deck for passengers with interior windowless cabins, prompt and decisive handling of accidental and planned breeches of confinement, and so on and on.

MEDICAL STAFF CHALLENGES

The highest-risk group aboard for contracting Covid-19, the ship's few doctors and nurses faced medical and mental health burdens of their own. They must try to handle non-Covid-19 emergencies and regular medical issues of passengers and crew as they usually do, but confined persons are not allowed to visit the Medical Facilities so consultations must be done in the cabin, with limited diagnostic possibilities. Also, the obligatory clinical evaluation and testing of all the potentially infected persons must be done in the cabins as well; just try to imagine the time and effort — and man power — it will take to just make brief individual visits to thousands of people in their living quarters aboard — while ensuring that the contagion is not transferred from cabin to cabin and while trying not to get contaminated yourself.

All the issues addressed above meant additional work for the vessel's medical staff. In such situations they must somehow get prompt medical and other support from ashore, to be arranged through the company's medical headquarter ashore. The Medical Department of Princess Cruises has for many years been in the lead of providing first-rate medical care for passengers and crew and, being part of a large corporation, have the expertise and resources that smaller cruise lines do not command. But support provided from the outside will often be from persons who, unfamiliar with conditions on board, will themselves require help from the already overworked ship staff. For the quarantine-related tasks the ship's medical staff received unspecified assistance from outside, and as of 28 February, one quarantine officer who worked on the ship had contracted the virus [2].

LESSONS LEARNED?

Retrospectively, it is easy to criticise how the quarantine was handled. Again, the primary quarantine goal for the Japanese port authorities was to protect the public ashore, but trying to keep passengers apart from each other and from crew by retaining them in their cabins was not an ideal solution because potentially contagious crew had to interact among themselves and serve the passengers to keep the ship operation running. Failing to isolate the crew of the *Diamond Princess* from the beginning of the quarantine likely contributed to further virus transmission to passengers and crew during the quarantine time and made it necessary to subject the remaining crewmembers to another full quarantine period ashore **after** all passengers had debarked [2].

The Covid-19 **quarantine** might have serious adverse effects. There will be expert medical and psychological care of all the involved crewmembers during on-going seclusion [5] — and hopefully also long-term follow-up at home. This will be necessary to counteract post-traumatic stress reactions from involuntary frontline work in a dangerous environment — and from the subsequent quarantine ashore.

Dealing with quarantine of a foreign-flagged and -operated ship is difficult for a single government, and there is clearly a need for a worldwide framework to tackle future crises. Hence, the cruise industry, governments, international maritime organisations, and other stakeholders should push for global treaties to ensure that ports cannot turn away ships with outbreaks but must arrange for urgent quarantine of all potentially contaminated persons not aboard but **ashore**, as well as for urgent shore-side isolation and hospitalisation of all suspected and symptomatic patients.

Diamond Princess during the first months of 2020 is to be considered a ***de facto*** epidemiological laboratory. Evidence gathered from its outbreak will provide important information for the global Covid-19 investigation and must be shared fully to promote future contingency plans and to improve health conditions on all cruise vessels. When (not if) further Covid-19 and similar outbreaks on ships occur, detailed industry plans for worldwide cooperation regarding emergency medical staffing and assistance need to be in place.

FUTURE CRUISING

High risk of contracting a contagious illness with an incubation time > 14 days, transmittable through contagious asymptomatic persons and possibly via contaminated surfaces, will change the practice of cruise ship medicine as we know it. Fear of contracting Covid-19 will prevent many prospective customers from booking cruises, in particular itineraries that might include future endemic areas. But before long, a bigger passenger and prospective crewmember concern will be the risk of involuntary quarantine for weeks to months aboard or/and abroad — far away from home.

Eventually, especially when an effective vaccine has become available, conditions may normalize to the extent that Covid-19 will not appear more frightening than influenza. Then the focus will shift to maintaining normal shipboard life as much as possible, whilst implementing standard outbreak prevention measures to reduce the risk of transmission, like less touching and lots of hand washing.

ADDENDUM

To watch a video where Dr. Grant Tarling, MD, MPH, Chief Medical Officer for Princess Cruises, explains the issues to guests aboard the *Diamond Princess* on 12 February 2020, please see https://www.youtube.com/watch?v=PGQZjkFg-8ZM&t=55s. The published commentaries are mostly complementary, while the more critical ones demonstrate clearly how little the public at large understands of shipboard life.

CONFLICT OF INTEREST

The author has no commercial, financial or other relationships related to the subject of this article. He has worked as ship's doctor for many cruise companies, including once for Princess Cruises (Star Princess 2013).

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COVID-19, guests and crews of cruise: observation on Thai citizens

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COVID-19 is a new emerging infection starting from China [1]. This new disease was imported to many countries such as Thailand [2]. After the firs importation to Thailand as the first country, there are already more than 20 countries with imported disease. At first, the importation of disease is mainly by air travel. However, the new consideration is raised when there is an emerging problem of disease outbreak at international tourist cruise. The outbreak on *Diamond Princess*, which was detected in Japan, became an interesting situation.

Here, the authors would like to discuss on the observations on Thai citizens on that cruise. Based on available data, there 2 Thai guests and 23 Thai crews. From 3700 people on the cruise, there were 25 Thais and 3 of those Thais (1 guest, 2 crews) got infection. The rate of infection among Thai citizens on the cruise is equal to 12% (95% confidence interval [CI]: 4.15–34.69%). The infection rate among Thai guests and crews are 50% (95% CI: 12.5–100%) and 8.7% (95% CI: 2.31–32.69%), respectively. Based on this observation, the infection rate among Thai guests is higher than that of Thai crews. It might reflect that the guest of the tourist cruise has a higher chance than crew to get disease in case of outbreak of new infection.

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Medical ultrasound on cruise ships

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In this issue of "International Maritime Health" Boniface et al. [1] report a case where an ultrasound examination performed aboard a cruise ship triggered an emergency medical evacuation of a young female crewmember. The ship's doctor identified an ectopic pregnancy by ultrasound and the diagnosis was confirmed by remote tele-medical review of the images. The authors emphasize that point-of-care ultrasound examination can remove uncertainty from the decision to urgently evacuate, and they make a compelling plea for all cruise vessels to have ultrasound equipment and staff with skills to use it and to correctly interpret the findings.

Sonography on cruise ships is not a new idea, but it has been slow to catch on. When the then Japanese-owned *Crystal Cruises* brought out its first luxury vessel in 1990, its Medical Facilities had an ultrasound device. It was bulky and not very user-friendly, and the ship's doctors had limited or no hands-on ultrasound experience. Sonography was therefore rarely attempted, and the images had never any decisive influence on patient handling.

Curiously though, once in the early years, a passenger couple presented in the Medical Facilities of *Crystal Harmony* shortly after embarkation to have the wife's vague abdominal discomfort sorted out. When the husband, a radiologist, saw the ultrasound device, he wanted to use it to exclude acute appendicitis. He found nothing abnormal, but the ship's doctor was not convinced and — considering the ship's immediate itinerary — insisted on a port referral. A few hours later the ship left for its scheduled 2-week cruise to remote Antarctica — without the couple, but with a very relieved medical staff aboard. Ectopic pregnancy had been diagnosed by ultrasound ashore and treated surgically there.

Not long after this incident the device was removed from *Crystal Harmony*, and ultrasound equipment was not even ordered for the company's next two vessels.

But that was long ago, and — as Boniface et al. [1] write — ultrasound equipment has evolved rapidly over the past two decades. The devices have become smaller and far easier to use, they are more portable and durable, and the relative cost has decreased considerably. Basic ultrasound is now part of medical education and advanced training is done during emergency medicine and other specialisations in many countries.

Hence, ultrasound is now a low-cost, reliable, diagnostic tool that can be used on cruise ships by bedside providers with some focused basic skills, in particular when ultrasound expert backup is available from Tele-Medical Assistance Services (TMAS) ashore, as in the case of Boniface et al. [1].

They state that medical care aboard cruise ships follow guidelines from the American College of Emergency Physicians (ACEP) and suggest to include point-of-care ultrasound in future revisions. It may not be instantly clear to international readers why the authors refer to a document from a **national** association.

The reason is simple; there are no **international** rules and regulations dealing with the practice of cruise ship medicine. International organisations, like the International Maritime Organisation (IMO), have never shown much interest in the practice of cruise ship medicine. Maybe this will change in the near future, following the intense media attention of the recent coronavirus (Covid-19) outbreak on M/S *Diamond Princess* [2].

Let's return to the early 1990s, when mass cruise tourism was in its infancy. Some members of ACEP had briefly worked on cruise ships and been appalled by the low status of ship's doctors and poorly equipped ship infirmaries. To remedy that and seeing cruise ship medicine as an attractive alternative career path for emergency physicians, they started in 1990 a Section for Cruise Ship and Maritime Medicine within ACEP [3].

While creating guidelines for cruise ship medicine, the Section initially suggested that only United States (US) trained emergency physicians should be hired as doctors on cruise ship since most cruise passengers were American. ACEP had to turn that proposal down because very

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few cruise ships were US registered, and most ship doctors were non-US citizens. In 1995 ACEP published its first "Health Care Guidelines for Cruise Ship Medical Facilities", the result of consensus among active ship's doctors. They were very basic, specified just a few laboratory tests, and X-ray equipment only on ships delivered after 1997 [3]. But they were still strongly opposed by the cruise industry that did not want any focus on illness aboard ships and worried about costs and potential liability.

Nevertheless, over the ensuing years it became apparent that cruise ship doctors and the industry had common goals, and for many years ACEP has collaborated with the Cruise Lines International Association (CLIA) to further develop and implement the Guidelines. Representing more than 95% of global cruise capacity, CLIA is the world's largest cruise industry trade association and focused on passenger satisfaction, particularly regarding service, safety, security and health [4]. As they are now mandatory for CLIA oceangoing Cruise Line Members, the **ACEP Guidelines can be considered a minimum global industry standard.**

In the 2019 revision of the ACEP/CLIA Guidelines, a comprehensive document, ultrasound equipment is not mentioned. Guideline 8.1. on imaging states "X-ray imaging capabilities which includes one X-ray generator and one processing/developing system" [3]. Hence, at this time it is up to each cruise company to decide on ultrasound use.

Getting the necessary ultrasound equipment on board all cruise ships and ensure proper training and skills of all present and future cruise ship doctors will be a formidable undertaking. Yet the German Maritime Medical Association, another **national** organisation, has issued guidelines that make ultrasound and medical staff qualified to use it **mandatory** on (the few) cruise vessels registered in Germany [5].

Whether ultrasound equipment is included in cruise ship medicine guidelines or not, there will be an increasing number of ships that will carry it and ship's doctors that will use it. Therefore maritime TMAS around the world must already now prepare for providing remote experts to direct on board less experienced ultra-sonographers to obtain and interpret images that can impact patient care in real-time, in particular in cases when urgent evacuation may be an issue.

Structuring ultrasound training into ports during turnaround, as found feasible by Boniface et al. [1], may work — for some ships in some ports. It is hardly a workable solution for the whole industry and does not meet ACEP ultrasound standards [6].

The challenge remains the training and certification programme for a global medical staff workforce and the over-reads, but it is just a matter of time before point-of-care ultrasound will be the norm on all cruise ships.

CONFLICT OF INTEREST

The author has no commercial, financial or other relationships related to the subject of this article. He has worked as ship's doctor and medical consultant for many cruise companies.

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Suicide, fatal injuries and drowning among the crews of United Kingdom and Bermuda registered cruise and passenger ships from 1976 to 2018

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ABSTRACT

Background: *Little has been reported about mortality among crews in passenger shipping. The aim of the study was to determine the detailed causes and circumstances of deaths from unnatural causes among crews employed in United Kingdom (UK) and Bermudan registered passenger shipping, their trends, how they relate to the type of passenger ship and crew rank and to discuss preventative measures.*

Materials and methods: *A longitudinal study from 1976 to 2018, based on reviews of marine accident investigation reports, death inquiry files, cruise shipping websites and online searches.*

Results: *One hundred and forty crew fatalities in UK (127) and Bermudan (13) passenger ships were identified: from accidents and drowning (91), suicides and disappearances at sea (38), homicide, other and unexplained causes (11). Over the 43-year study period, a reduction in mortality (per 1000 ship-years) from accidents and drowning was identified (mean annual reduction: 4.3%; 95% confidence interval: 2.1–6.5%) but no significant reduction for suicides and disappearances at sea (annual reduction: 1.2% confidence interval: –1.3% to +3.7%). Most suicides and disappearances (70%) were among customer service staff and, of 19 employed on large cruise ships, most (79%) were non-Europeans.*

Conclusions: *The number of suicides and probable suicides is a cause for concern, especially among customer service staff on cruise ships. These findings indicate the need for interventions to reduce suicide risks. Further studies are needed to improve the targeting of interventions. These will need both to analyse the circumstances of individual deaths and derive suicide rates according to rank, department and nationality, based on reliable population denominators.*

(Int Marit Health 2020; 71, 1: 12–19)

Key words: suicides, fatal accidents, cruise ships, passenger ferries, seafarers

INTRODUCTION

In recent years, several studies have reported on mortality in passengers who have sailed in cruise ships and/or other types of passenger vessels [1, 2]. Many other studies have reported on morbidity in cruise ship passengers, including injuries [3–5], various communicable diseases including gastroenteritis and influenza [3, 6–10], and acute cardiovascular diseases [11]. Little has been reported on mortality and its causes among crew members who serve on board cruise or passenger ships.

The main aims of this study were firstly, to determine the detailed causes and circumstances of fatalities from unnatural causes among crews employed in United Kingdom (UK) and Bermuda registered passenger ships from 1976 to 2018, and how they relate to factors including their rank on board and the type of passenger ship in which they were serving. Secondly, to assess trends over time in mortality rates and to discuss preventative measures for reducing mortality.

Over many decades, increased or high suicide rates have been reported quite consistently among seafarers employed in

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merchant shipping across Europe, when compared with general populations [12–17]. This has led to increasing concerns in recent years about suicide risks and suitable preventative measures for seafarers. This study provides an opportunity to look at the distribution of events by type of ship and the rank of the seafarers dying from this cause in passenger shipping.

MATERIALS AND METHODS

INCLUSION CRITERIA

This study examined reported deaths from unnatural causes among crew members who were "signed on" under articles of agreement (contracts) and working on board UK registered passenger ships of 100 gross registered tonnage and over between 1976 and 2018. The study included only those deaths that arose at work or within 30 days of any discharge ashore from work to hospital. This definition of passenger shipping includes cruise ships, passenger carrying ferries and a small number of other passenger vessels. As some of the major British cruise ships, such as the *Queen Mary II*, *Queen Victoria*, *Arcadia* and *Caribbean Princess*, have been registered or re-registered with the Bermudan ship registry (a register in the Red Ensign group, based in a UK Crown Dependency) the study additionally and similarly included all crew deaths in Bermudan registered passenger vessels during the same study period. In 2010, UK and Bermuda accounted for 6.7% of the world's 524 cruise ships and 2.8% of the world's 6810 passenger ships [18].

The study excluded deaths among crews who were employed in merchant vessels other than passenger ships, such as cargo and offshore supply ships, and in all other forms of water-craft. Deaths among non-crew members such as passengers and port workers were also excluded, as were deaths that occurred when crews were signed off their ships. The study period was the 43 years from 1st January 1976 to 31st December 2018.

STUDY INFORMATION SOURCES

Deaths at sea, including work-related deaths, in British shipping have not usually been registered with the local registrars of deaths, nor included in central national mortality statistics or decennial census publications, but instead they have been registered separately at the Registry of Shipping and Seamen. Deaths from accidents, injuries, drowning and disappearances at sea are normally investigated by maritime authorities. In this study, details of deaths in UK and Bermuda passenger shipping were identified mainly from death inquiry files held by the UK's principle maritime investigative authority, the Marine Accident Investigation Branch and from death inquiry files and death registers at the Registry of Shipping and Seamen. Other information sources used include Lloyd's Register of Shipping casualty returns and data [19, 20], the British Newspaper Archive [21], cruise shipping websites and other online searches.

POPULATIONS AT RISK

The numbers of crew employed in UK and Bermudan passenger ships is not available from any information source. However, the numbers of passenger ships registered annually with the UK and Bermudan ship registries were obtained from Lloyd's Register of Shipping publications [18]. These show (Fig. 1) a very moderate reduction in the

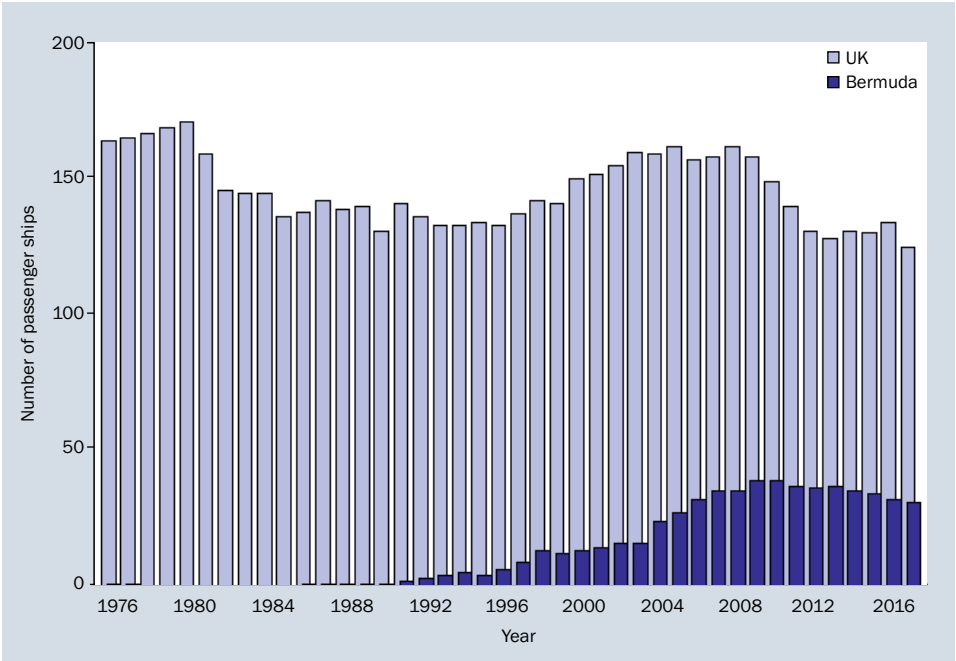

Figure 1. Numbers of United Kingdom (UK) and Bermuda registered passenger ships over time

numbers of passenger ships under the two flags combined, particularly in the most recent years and with a modest interim peak in the years around 2005. However, both cruise ships and passenger ferries have increased in size over time, especially in the smaller Bermudan fleet through the registration of several very large cruise ships in the last 15 years, including the *Queen Mary II* and the *Queen Victoria*. Although crewing levels as well as the numbers of ships have fallen over time, increases in the sizes of the ships means that the total crew employed in UK and Bermudan passenger shipping is likely to have remained quite stable or increased slightly over the 43-year study period [18].

METHODS OF ANALYSIS

The main study factors assessed were, firstly, the rank of the deceased at the time of death, which was categorised as ship captains; deck officers; engineers; deck ratings; engine room ratings; and customer service staff. Two fatalities among radio officers were included with deck officers and two deaths among "other" staff were included with customer service staff, there were no deaths among cadets. The type of ship was classified into three categories; large cruise ships (≥ 40,000 gross tonnage), small or medium size passenger ships (< 40,000 gross tonnage) and passenger ferries (that mostly ranged 3,000–15,000 gross tonnage).

The main outcome measure was mortality by cause of death. Cause of death was grouped into accidents, suicides, homicides and other or unexplained causes. Historically, many crew have disappeared at sea, and these deaths have usually been categorised with suicides, while others that have been found drowned, often in docks and rivers when off-duty, have conventionally been included with accidents. A previous study of UK shipping found through examination of death inquiry files and crew statements that more than 80% of disappearances at sea were most likely suicides and that more than 80% of 'found drowned' cases were most likely accidents [22].

Accidents were grouped into three categories; ship accidents, involving an accident or incident to the passenger ship, such as capsize, foundering or fire; (on-duty) occupational accidents, affecting crews individually during work duties; and off-duty accidents which occur during leisure time. Mortality rates were expressed per 100 (passenger) ship-years. Logistic regression modelling was used to assess mean annual changes in mortality rates and their significance through 95% confidence intervals (CI). Fisher's exact test was used to compare crew nationality groupings (British; other European; Asian; other nationalities; unspecified nationality) for seafarers who died through accidents and drowning, compared with suicides and disappearances at sea. Significance was based on the conventional 5% level.

RESULTS

Overall, there were 140 crew deaths identified, 127 in UK and 13 in Bermuda registered passenger ships. Apart from the *Herald of Free Enterprise* disaster in 1987, the passenger ships from which most crew fatalities occurred were the *Queen Elizabeth II* (11 deaths from 1978 to 2004), and the *Canberra* (7 deaths from 1976 to 1993).

One hundred and thirty-five of the 140 (96%) were men, the mean age was 37.2 years (standard deviation [SD]: 11.9; range: 17–63 years). 90 (64%) of the 140 deceased were British. The remainder were other European (16), Asian (22), other nationalities (7) or unspecified nationality (5). The deceased were employed in the deck (39), engine (25) and customer service (86) departments.

The 140 crew fatalities were from accidents and drowning (91), suicides and disappearances at sea (38), homicide, other and unexplained causes (11; Tables 1 and 2).

SUICIDES AND DISAPPEARANCES AT SEA

Of 13 recorded as suicides, 6 jumped overboard, 6 were found hanged and 1 died through other means. 25 further crew who disappeared at sea also most likely jumped overboard, based on examination of death inquiry files, crew statements and marine accident investigation reports.

The mean age at death at the time of suicide or disappearance was 36.3 years (SD: 12.4; range: 18–61 years), 95% male. All but 5 of the 38 deaths arose at sea; from cruise or passenger ships in the North Atlantic and Caribbean Sea (7), North Pacific and South Pacific (8) and other seas (9) and from ferries around the UK (9).

Most of the 38 deceased (27; 71%) were employed as customer service staff and most of these (19; 70%) were employed on large cruise ships, the others were on ferries or small/medium size passenger ships. Of the 19 who were employed as customer service staff in large cruise ships, most (63%) were Asian and three others were also non-European. In the most recent years, suicides and disappearances at sea largely involved customer service staff who were employed on board large cruise ships (Fig. 2). As reliable data on the crewing pattern on these vessels are not publically available it is not possible to compare rates of suicide, but only to point to the numbers of deaths.

There has been no significant reduction in mortality from suicides and disappearances over the 43-year study period (mean annual reduction: 1.2%; 95% CI: –1.3% to +3.7%; Fig. 3).

MORTALITY FROM ACCIDENTS AND DROWNING

The 91 fatal accidents and drowning include 46 from ship accidents, largely through the *Herald of Free Enterprise* disaster off Zeebrugge in 1987 (38 crew lost along with 155 passengers) and a collision between two passen-

Table 1. Causes of all crew fatalities from unnatural causes in United Kingdom and Bermuda registered passenger ships, 1976–2018

	Rank of the deceased						
Cause of death	**Captains**	**Deck officers**	**Engineers**	**Deck ratings**	**Engine room ratings**	**Customer service staff**	**(Total)**
Accidents and drowning							
*Ship accidents:**							
Foundered or capsized		1	2	3	4	29	(39)
Collisions			1	2	1		(4)
Fires or explosions			2	1			(3)
Occupational accidents:							
Lifeboat testing drills				3			(3)
Falls on board		1		2		1	(4)
Struck by mooring ropes		2		1			(3)
Struck by motor vehicles on decks		1			1		(2)
Struck/crushed by watertight doors					3	2	(5)
Struck by other moving objects			2	1			(3)
Scalded in engine rooms					2		(2)
Other occupational accidents				2	1		(3)
Off-duty accidents and drowning:							
Swimming or bathing accidents					1	5	(6)
Traffic-related accidents ashore			1	1	1	2	(5)
Falls on board			1			1	(2)
Falls in docks, returning to ship				2		1	(3)
Other drowning				1		3	(4)
All other deaths from unnatural causes	1		1	14	1	32	(49)
Total	**1**	**5**	**10**	**33**	**15**	**76**	**(140)**

*Includes 38 crew fatalities through the capsize of the *Herald of Free Enterprise* passenger ferry

Table 2. Causes of all crew fatalities from unnatural causes according to the type of ship in United Kingdom and Bermuda registered passenger ships, 1976–2018

	Type of passenger ship			
Cause of death	**Large cruise ships**	**Small/medium passenger ships**	**Passenger ferries**	**(Total)**
Accidents and drowning:	13 (25%)	10 (19%)	30 (55%)	**(53, 100%)**
Ship accidents*	1	1	6	**(8)**
Occupational accidents	6	4	15	**(25)**
Off-duty accidents and drowning	6	5	9	**(20)**
Suicides and disappearances at sea	23 (61%)	3 (8%)	12 (32%)	**(38, 100%)**
Homicide, other and unexplained causes	7	1	3	**(11)**
Total	**43**	**14**	**45**	**(102)**

*Excludes the 38 crew fatalities through the capsize of the *Herald of Free Enterprise* passenger ferry

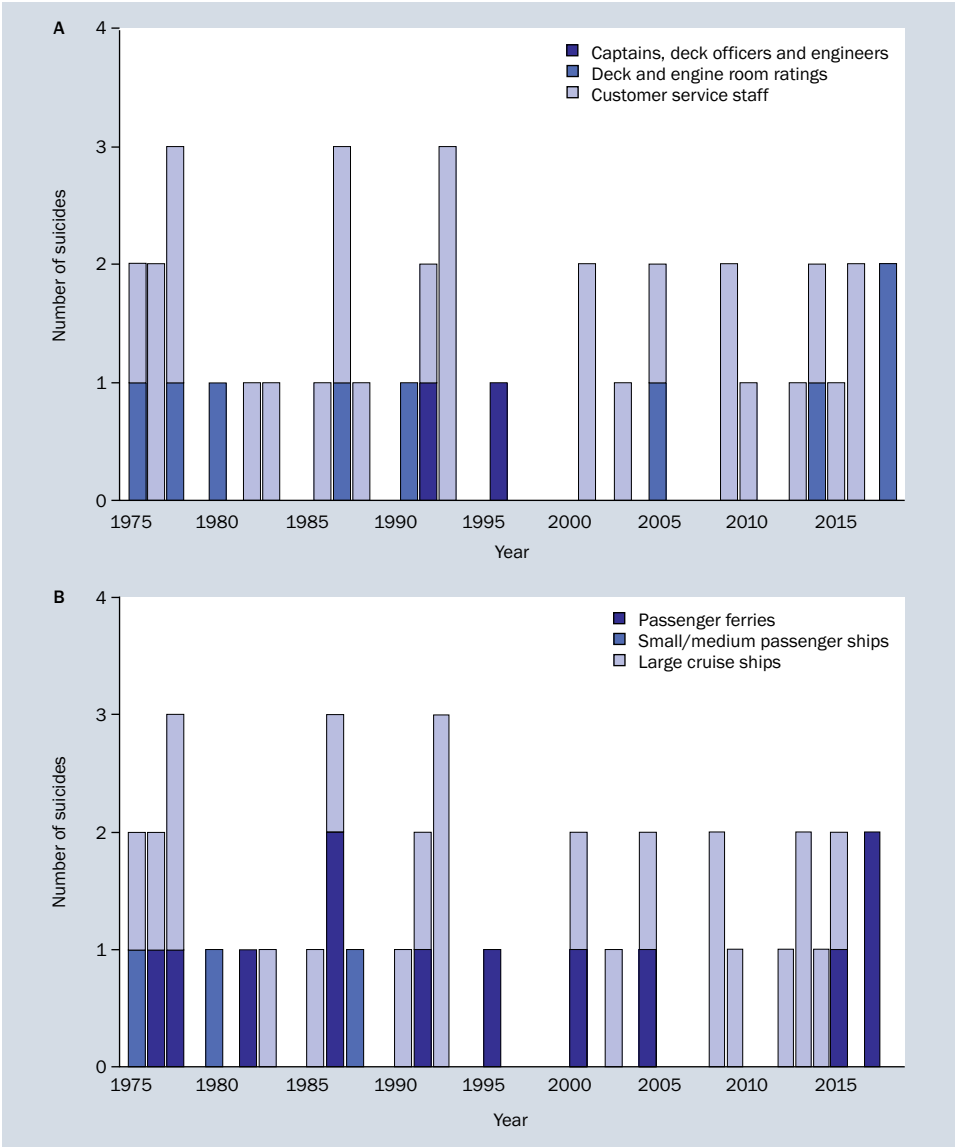

Figure 2. Trends in suicides and disappearances at sea among crew in United Kingdom and Bermuda registered passenger ships, 1976–2018, according to: rank of the deceased (**A**), and type of passenger ship (**B**)

ger ferries in the North Sea off Harwich in 1982 (4 fatalities). 25 fatal occupational (personal, on-duty) accidents or drowning refer largely to seafarers who were crushed in watertight doors, falls on board, vehicle injuries on ferries, struck by mooring ropes and davits breaking during lifeboat testing drills. 20 off-duty accidents and drownings were largely from swimming and bathing accidents from beaches, traffic accidents ashore and falls into or drowning in docks (Table 1).

The mean age at the time of accident or drowning was 37.0 years (SD: 12.1; range: 17–63). Three of the 91 (3%) crew who died from accidents and drowning were female. 73 were British and 10 were other European, and 8 were Asian or of other or unspecified nationality, with a significantly different nationality profile to those who died through suicide or disappearance at sea ($p = 0.002$). Most fatal occupational accidents affected deck or engine room ratings (15; 60%), whereas most off-duty accidents occurred among customer service staff (12; 60%; Table 1).

There has been a significant reduction over time in mortality from accidents and drowning (mean annual reduction: 4.3% per annum; 95% CI: 2.1–6.5%; Fig. 3).

HOMICIDES AND OTHER DEATHS FROM UNNATURAL CAUSES

Three homicides were due to injuries involving non-UK crew members of 2 large cruise ships and a UK crew member of an Irish Sea passenger ferry. Eight other deaths from

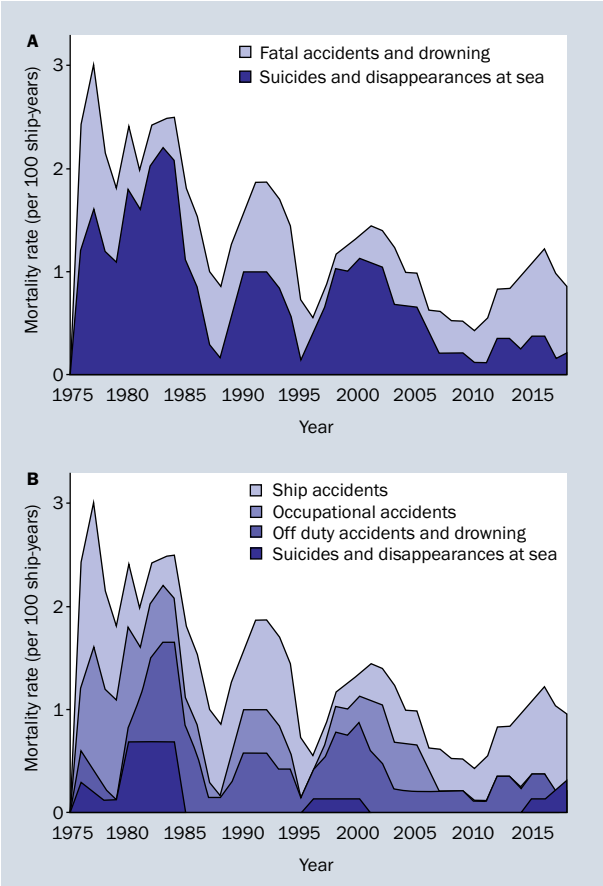

Figure 3. Trends in mortality from accidents and drowning, suicide and disappearances at among crew in United Kingdom (UK) and Bermuda registered passenger ships, 1976–2018; **A.** With types of accidents and drowning combined; **B.** With types of accidents and drowning disaggregated by type. Notes: Mortality rates are smoothed using 5 year moving averages. Excludes the 38 fatalities through the capsize of the *Herald of Free Enterprise* passenger ferry in 1987

unnatural or inconclusive cases were due to alcohol and drug intoxication (2), unexplained injuries (2), asphyxiation through an acute schizophrenia episode and on vomit (one each) and unspecified causes (2).

DISCUSSION

The study includes two related national ship registers and is limited to passenger vessels, a sector now dominated by cruise ships and passenger/vehicle ferries. Mortality from accidents is typically lower in passenger shipping than in cargo-carrying shipping sectors, where a high proportion of accidents are linked to cargo-related operations, such as asphyxiation or falls in cargo holds, cargo-related crushing injuries or falls overboard (which are largely absent in passenger shipping), as well as falls in docks when returning to ships from ashore and casualties involving small coastal-trading cargo ships [14, 22]. The reduction since the 1970s in mortality from accidents and drowning in passenger shipping is comparable with similar reductions over time in merchant shipping more generally [22].

It could be expected that ferries with their usually short and regular passages would have relatively lower case fatality than other forms of shipping, given speedy access to shore based services, while cruise liners, with their well equipped and staffed medical centres would also be expected to have better outcomes and hence lower mortality arising from injury events.

The outstanding feature of the study is the predominance of suicides and disappearances at sea in the cruise sector, with a stable level during the study period against a background of falling numbers of deaths from accidents and injury. The observation that a high proportion of suicides on large cruise ships occurred among, mainly Asian, male customer service crew, although the numbers were small, may reflect the high proportion of crewmembers from Asia who are performing these duties. It does however indicate the importance of targeting interventions to reduce suicide risk at this group if the overall numbers of suicides are to be reduced. Because of the limitations of the available data it is not possible to calculate mortality rates using the at-risk populations employed and so the number of ships registered has been used as a less than ideal surrogate for this. As in other studies [23], some deaths from other unnatural and unexplained causes may also have been due to suicide.

Recent reviews and reports have identified a number of uncertainties and controversies about the importance of suicide as a cause of death in seafarers and the contributory causes for this, notably the experience of social isolation among seafarers [24, 25]. Customer service staff, who are mainly recruited from Asian countries, tend to have longer periods away from their home and at sea, often of the order of 9 months, than other groups of crew. They may not define themselves as career seafarers and thus be accepting of the way of life on board, also they are working in an environment that is managed by crew with ethnic backgrounds and expectations that differ from their own. All of these aspects may exacerbate social isolation with its attendant risks. Findings from other sectors of employment indicate that low skilled trades, caring, leisure and other service occupations have high suicide rates relative to the general population [26, 27]. Other contributory factors in these sectors, which may be in common with on board customer service crew, are socio-economic, including low pay, low job security and low socio-economic status [28]. The number of female suicide cases is low, especially in relation to the proportion of female customer service crew. This may reflect

the lower incidence of suicide in females found in studies in other settings.

Strengths of this investigation are that it is the first study that has focussed specifically on the mortality of crews who are employed on board cruise and passenger ships. It is based on two large defined populations serving UK and Bermuda registered passenger ships and covers a long 43-year study period to assess trends in mortality. It is also based on reliable information sources that have been used in previous investigations of mortality in the maritime industries [16, 22, 23]. The major study limitation is that the numbers of crew employed in UK, Bermuda and almost all other passenger fleets world-wide are not known. Mortality rates have therefore been presented in terms of the much inferior numbers of passenger ship-years, rather than according to the person-years employed, so that the findings on trends in mortality should be considered as indicative. It is also likely that the notification, documentation and therefore study ascertainment of fatal accidents, through the maritime authorities, would have been more complete than for suicides and homicides.

CONCLUSIONS

These results do not immediately point to specific remedial actions, although recent reports do make a series of potential proposals, such as reducing stigma around mental health issues and social isolation, promoting positive social environments for staff on-board seafarer communities and peer support programmes [29]. Our findings would be enhanced by improvements in the documentation of non-accidental deaths in passenger shipping and in the maritime industries more generally, compared with that for fatal accidents. Also by further studies in the cruise sector that would be able to assess the detailed circumstances surrounding incidents of suicide and disappearance at sea using psychological autopsy methodologies as well as using baseline population information on gender, age, ethnicity, rank and ship department in the populations at risk.

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Field study of anthropomorphic and muscle performance changes among elite skippers following a transoceanic race

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ABSTRACT

Background: *Ocean racing has become increasingly demanding, both physically and psychologically. The aim of the study was to assess global changes after a transoceanic race.*

Materials and methods: *Eight male sailors were evaluated pre- and post-race through anthropometric measurements (weight, skinfold, girth at different level and estimated body fat percentage), multifrequency tetrapolar bioelectrical impedance, muscular performance, visual analogic scale for perceived fatigue and Critical Flicker Fusion Frequencies for cerebral arousal.*

Results: *Compared to pre-race values, a significant decrease in body weight (–3.6 ± 1.4%, p = 0.0002) and body composition with reduction of body fat percentage (–15.1 ± 3.5%, p < 0.0001) and fat mass (–36.4 ± 31.4%, p = 0.022) was observed. Muscle performance of the upper limb was preserved. In the lower limb, monohulls skippers showed a significant reduction of jump height (–6.6 ± 4.8%, p = 0.022), power (–11.7 ± 7.3%, p = 0.011) and speed (–14.6 ± 7.4%, p = 0.0006) while a multihulls skipper showed a gain in speed (+0.87%), power (+8.52%), force (+11%) resulting in a higher jump height (+1.12%). These changes were inversely correlated with sea days (Pearson r of –0.81, –0.96 and –0.90, respectively, p < 0.01).*

Conclusions: *Changes in body weight and composition are consistent with previous data indicating a probable negative energy balance. The main finding demonstrates a difference in muscular conditioning between upper and lower limbs that might be explained by differential workload related to boat architecture (trampolines) or handling.*

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Key words: anthropometry, skinfold thickness, impedance, bioelectrical, weight loss, flicker fusion, muscle strength

INTRODUCTION

Ocean racing has changed a lot in the last 30 years. Boat designers have tried to find ways to increase power, while reducing weight, however with few concessions to sailor's comfort. Therefore, these high-performance racing boats tend to go faster. For instance, 60-feet monohulls boat from the International Monohulls Open Class Association (IMOCA), completing the round-the-world solo race ("Vendee Globe": 21,638 nautical miles), decreased the time needed from under 100 days in 2001, down to 90 days in 2005,

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below 85 days in 2009, 78 days in 2013 and to finally reach 74 days in 2017.

Consequently, boats handling has become increasingly demanding, both physically and psychologically. Indeed, offshore racing is an arduous activity involving hard mental and physical work carried out in strenuous environmental conditions. The watch system makes it impossible to get a full night sleep deterring physical and mental performance as well as meal frequency [1]. Also, according to the nature of their sport, sailors involved in offshore racing can be exposed to injuries and other health problems that can endanger their lives [2]. Unfortunately, the distance from onshore health facilities and lack of professional presence on board might explain why only scarce scientific data are available. A review based on a systematic search of medical databases employing predefined criteria, using the terms offshore racing/sailing, solo sailing or open sea racing could only identified less than 20 publications on the subject over the last 40 years [2–15]. All those studies only included a very limited number of subjects (case report to a dozen individuals), albeit a very specific population (Caucasian males in their mid-thirties) and were mostly focused on energy expenditure/intake and sleep deprivation.

More data are available about the physiological challenges of competitive sailing, for instance related to the America's Cup [16, 17], albeit this is not the exact same sailing discipline as the later ignores the continuous demanding efforts of long-haul sailing. According to a recent review [18], the most influential factors in determining sailing performance, including dinghy sailing with smaller boats like Laser or the "America's Cup" with large boats, are related to the sailor's physical characteristics, sailing techniques, decision-making abilities, tactical skills or psychological characteristics.

In competitive sailing, there are different types of boats that demand various types of effort by the sailor, which is why knowledge of their specific physical and physiological features for each type of vessel is necessary. Unfortunately, the field of ocean racing remains mostly unexplored. To find out more about this issue, the Pen Duick company (Paris, France) gave us the opportunity to carry out measurements on skippers participating in the two-handed 2009 "Transat Jacques Vabre" between Le Havre, France and Puerto Limón, Costa Rica (4335 nautical miles).

Therefore, the aim of the study was to assess global physical changes among offshore skippers with a specific focus on muscular strength after a transoceanic race.

MATERIALS AND METHODS

After being informed of the purpose and experimental procedures of the study, 8 Caucasian male skippers without any of them paired on the same boat (7 sailing an IMOCA and 1 sailing a Multi 50) volunteered to participate and signed a written informed consent. The study was approved by the local Academic Bio-Ethical Committee of Brussels (CE2008/66) and was conducted in accordance with the Declaration of Helsinki [19]. All participants were subjected to the same data collection procedure, which was applied before the race and within 6 hours after arrival in Puerto Limón. Therefore, each skipper is his own control.

Anthropometric measurements performed by the same qualified investigator with 5 years of experience followed the protocol of the International Society for the Advancement of Kinanthropometry (ISAK) [20] and include body mass measured to the nearest 0.05 kg with a digital scale (SECA 220, Seca gmbh & Co., Hamburg, Germany), skinfolds at six different sites (triceps, subscapular, supra-spinal, abdominal [umbilical], anterior tight, medium calf) using a Harpenden calliper (Harpenden skinfold calliper, Bay international, West Sussex, England), and girths at six different sites (arm girth relaxed, forearm, supra-patellar, thigh, mid-thigh, medial calf) with a flexible anthropometric steel tape (Lufkin W606PM, cooper industries, Ohio, United States) to the nearest 0.1 cm. By convention, all anthropometrical measurements were taken on the right side of the body (all skippers were right-handed). Each measurement was taken twice. If the difference between the first and the second reading was > 5% for skinfolds and > 1% for girths, a third measurement was taken and the mean of the two nearest measurements was calculated as the final value. Percentage body fat (%BF) was calculated using the Yuhasz formula (%BF = 0.1051 × (∑6 skinfolds) + 2.585) [21], because it was designed for athletes and fit individuals, which is the case of our population [22].

Since biometrical multifrequency impedance analysis (BIA) is a widely accepted method for the determination of body composition (total body water [TBW], extracellular fluid [ECF] and intracellular fluid [ICF]) due to its simplicity, speed and non-invasive nature [23], we used a single channel, tetra polar bioimpedance spectroscopy device that scans 256 frequencies between 4 kHz and 1000 kHz for the estimation of body composition in healthy individuals (SFB7, Impedimed Inc., Carlsbad, USA). Fat-free mass (FFM) and fat mass (FM) are then calculated on the device.

Strength assessment included measurement of the maximal voluntary handgrip strength (HGS) and the vertical jump performance [24]. To avoid injury, a standard warm-up routine, consisting of jumping, stretching and gripping at submaximal intensity preceded the actual tests. HGS was measured three times with an electronic hand dynamometer (Newgen medical EH101, Pearl, Buggingen, Germany) [25] and the mean value was used for analysis and comparison. Vertical counter movement jump performance was assessed using an accelerometer (Myotest, Myotest Inc., Sion, Switzerland) [26]. A total of 5 maximal vertical jumps

Table 1. Pre- and post-transoceanic race anthropometric data of offshore sailors (n = 8)

	Pre-race	Post-race	P (Paired t test)
Weight [kg]	81.8 ± 10.1	78.9 ± 10.1	0.0002**
Body mass index [kg/m^2]	25.4 ± 1.1	24.5 ± 1.3	0.0001**
Percentage of body fat [%BF]#	12.2 ± 2.4	10.4 ± 2.3	< 0.0001**
Skinfold [mm]:			
Triceps	13.9 ± 5.2	10.6 ± 3.7	0.0019*
Subscapular	18.5 ± 5.2	15.0 ± 4.5	0.0011*
Supra-spinal	17.6 ± 6.2	14.9 ± 5.9	< 0.0001**
Umbilical	25.6 ± 6.7	18.7 ± 7.9	0.0002**
Front tight	9.7 ± 2.8	9.5 ± 2.5	0.516
Medium calf	6.4 ± 2.6	5.9 ± 2.6	0.227
Girth [cm]:			
Forearm	29.7 ± 1.7	29.8 ± 1.4	0.557
Arm	29.9 ± 1.9	30.3 ± 1.5	0.161
Thigh	53.2 ± 2.7	51.7 ± 3.0	0.0025*
Mid-thigh	45.6 ± 3.5	44.2 ± 3.7	0.0095*
Supra-patellar	39.4 ± 3.2	39.1 ± 3.2	0.139
Medium calf	38.0 ± 1.3	37.6 ± 1.1	0.111

*p < 0.01; **p < 0.001; #Calculated according the Yuhasz formula (%BF = 0.1051 × (∑6 skinfolds) + 2.585)

were evaluated and accelerometric data were stored during the assessments and subsequently downloaded for jump height (cm), power (w/kg), force (N/kg), and speed (cm/s) calculations. The mean for each value, calculated on the three highest jumps, was used for analysis and comparison.

In the present study, non-muscular fatigue (central) was assessed by means of Critical Flicker Fusion Frequency (CFFF) and by a 100-mm visual analogue scale (VAS). CFFF was assessed with a specific watertight device (Human Breathing Technology, Trieste, Italy) previously fully described by Balestra et al. [27]. Thanks to the design of the device, it is impossible for the subjects to be aware of the actual flicker frequency through the whole test. When there is a change in LED light from fusion to flicker (or flicker to fusion), the subject acknowledges it to the investigator and the reached frequency is recorded. For each sample, the mean of three consecutive tests was calculated and used for analysis. For VAS testing, we used the same methodology as in Lafère et al. [28] where the same VAS scale is presented twice but in opposite directions: one asked to evaluate the 'energy level' (from sleepy/0 to energetic/10), the second asked to evaluate the "tiredness level" (from energetic/0 to sleepy/10). Should the difference between the first and the second reading be > 10%, a third measurement ("tiredness level") was taken and the mean of the two nearest measurements was calculated as the final value.

Since all data passed the Kolmogorov-Smirnov test, allowing us to assume a Gaussian distribution, they were analysed with a Student's paired t-test or a one-way ANOVA with Bonferroni post-hoc test.

Since each skipper is his own control, taking the pre-race values as 100%, percentage changes were calculated for each parameter, allowing an appreciation of the magnitude of change between each measurement rather than the absolute values.

Existing correlation between significant statistical results and age, initial weight or days at sea was assessed through a Pearson correlation coefficient test and linear regression when possible.

All tests were performed using a standard computer statistical package, GraphPad Prism version 5.00 for Windows (GraphPad Software, San Diego California USA). A threshold of $p < 0.05$ was considered statistically significant. All data are presented as mean ± standard deviation (SD).

RESULTS

The mean age of the 8 subjects was 39.7 ± 5.3 years and height 1.79 ± 0.97 m. All other anthropometric characteristics pre- and post-race are summarised in Table 1. We observed a significant decrease in body weight (–3.6 ± ± 1.4%) from 81.8 ± 10.1 to 78.9 ± 10.1 kg ($p = 0.0002$, paired t-test, df = 7) and a similar significant reduction of

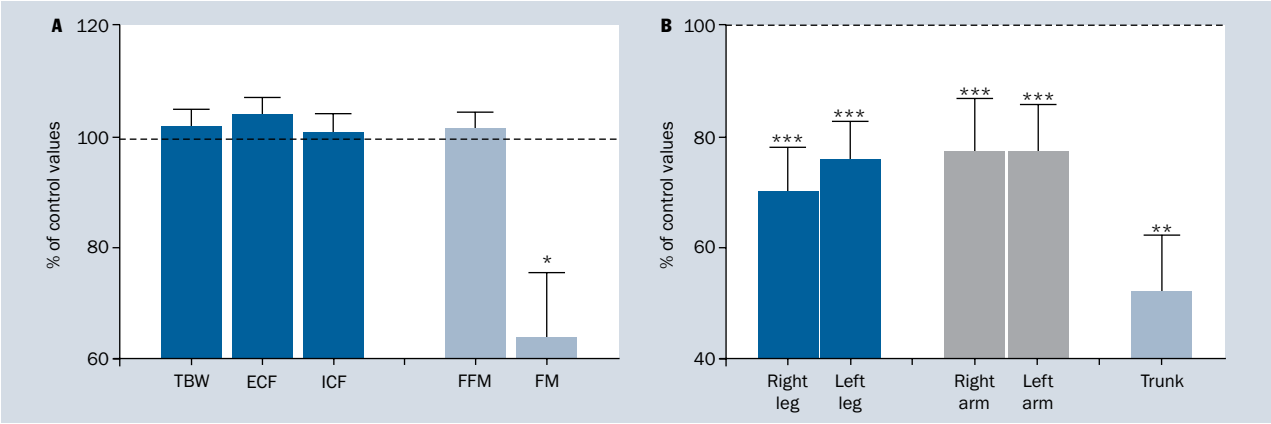

Figure 1. Percentage variation of global impedancemetry (**A**) and segmental fat mass (**B**) after a transoceanic race (n = 8). Pre -race value is taken as 100%. Each subject is compared to his own pre-race value. Means and standard deviations are shown in graph; ***p < 0.001; **p < 0.01; *p < 0.05; TBW — total body water; ECF — extracellular fluid; ICF — intracellular fluid; FFM — free fat mass; FM — fat mass

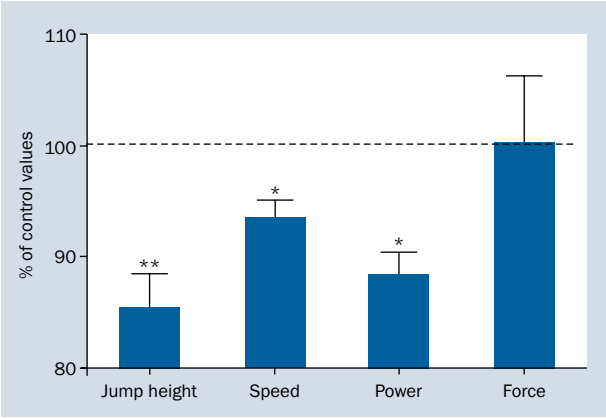

Figure 2. Percentage variation of lower limb muscle performance after a trans-oceanic race (n = 8). Pre-race value is taken as 100%. Each subject is compared to his own pre-race value. Means and standard deviations are shown in graph; **p < 0.001; *p < 0.05

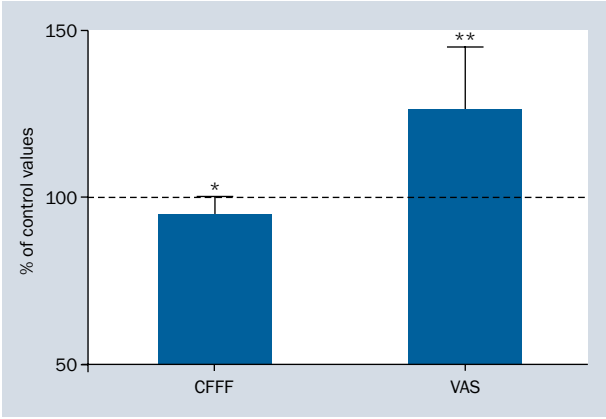

Figure 3. Percentage variation of perceived fatigue after a trans-oceanic race (n = 8). Pre-race value is taken as 100%. Each subject is compared to his own pre-race value. Means and standard deviations are shown in graph; **p < 0.001; *p < 0.05; CFFF — Critical Flicker Fusion Frequency; VAS — Visual Analog Scale

the body mass index (BMI: –3.2 ± 1.7%) from 25.4 ± 1.1 to 24.5 ± 10.3 kg/m^2 (p = 0.0001, paired t-test, df = 7). Based on skinfold measurements and the Yuhasz formula, this weight reduction seems to be associated with a modification of body composition with a significant reduction of the %BF (–15.1 ± 3.5%) from 12.2 ± 2.4 to 10.4 ± 2.3 % (p < 0.0001, paired t-test, df = 7). However, this modification seems to be at the expense of the upper body with some significant decreased skinfolds at tricipital, subscapular, supra-spinal and umbilical level. No significant changes were identified on the lower limb. Unlike skinfold measurement, muscle circumference did not show significant change in the upper limb, while a significant decrease was noticed in the lower limb at mid-tight and maximal thigh level.

Analysis of body composition by BIA (Fig. 1) showed no difference in hydration (TBW: from 55.4 ± 6.0 to 55.8 ± 5.3% of total weight, p = 0.571; ECF: from 22.7 ± 3.0 to 23.3 ± ± 3.8% of total weight, p = 0.307; ICF: 32.7 ± 3.2 to 32.4 ± ± 1.6% of total weight, p = 0.878, paired t-test, df = 6) and FFM values (75.7 ± 8.2 to 75.7 ± 7.2 kg, p = 0.878 paired t-test, df = 6). However, we observed a significant reduction of FM (–36.4 ± 31.4%) from 6.6 ± 4.1 to 3.2 ± 0.9 kg (p = 0.022 paired t-test, df = 6). Segmental impedance indicated that this reduction in fat mass is evenly distributed between the different segments of the body. Although the trunk presented the greater reduction of fat mass (–48.3 ± ± 28.1%), this result is not significant (p = 0.247, one-way ANOVA, F (4, 30) = 1,433).

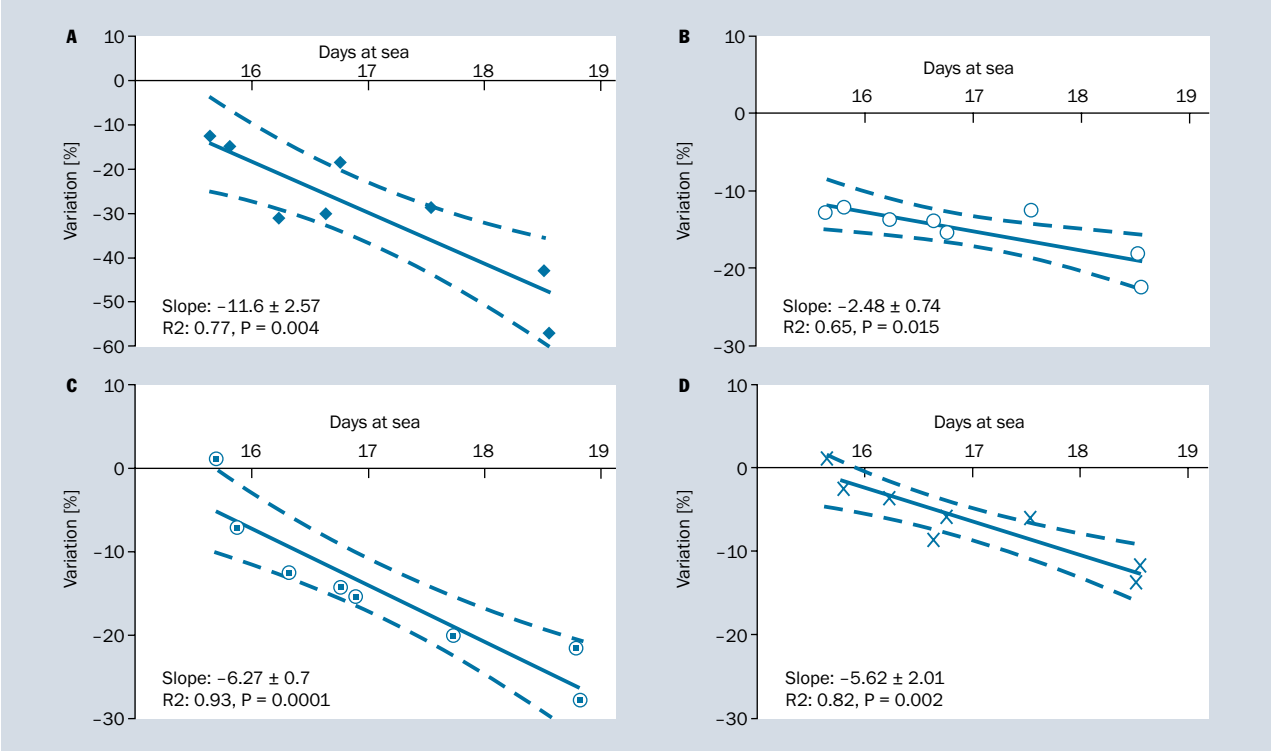

Figure 4. Correlation calculation and linear regression of the magnitude umbilical skinfold (**A**), body fat (%BF) (**B**), jump height (**C**) and speed (**D**) changes and days at sea (n = 8).

Muscle performance of the upper limb seemed to be preserved as HGS values did not change significantly after the race from 53.6 ± 8.3 to 51.8 ± 8.7 N (p = 0.228, paired t-test, df = 7). On the contrary, results of the lower limb showed significant impairment (Fig. 2). The speed (–6.6 ± ± 4.8%) and power (–11.7 ± 7.3%) developed by the extensor muscles of the lower limbs during counter movement jumps decreased from 237.8 ± 30.3 to 221.8 ± 28.0 cm/s (p = 0.022, paired t-test, df = 7) and from 44.8 ± 7.8 to 39.7 ± 8.9 w/kg (p = 0.011, paired t-test, df = 5). Jump height was also significantly decreased (–15.5 ± 7.4%) from 29.3 ± 6.3 to 25.4 ± 6.1 cm (p = 0.0006, paired t-test, df = 7). However, the force (N/kg) developed by the same muscles, did not show any significant difference between measurements made before and after the race (Force: 22.8 ± ± 3.1 *vs.* 22.4 ± 2.0 N/kg, p = 0.930, paired t-test, df = 7).

Perceived fatigue was significantly higher after the race (Fig. 3). Subjective evaluation (VAS) showed an increase of 25.9 ± 19.3% in the level of tiredness at 126 ± 19.3% of pre-race value (p = 0.0067, paired t-test, df = 7), while objective evaluation of cerebral arousal showed a consistent decrease in CFFF by 5.6 ± 5.7% of CFFF at 94.4 ± 5.8% of pre-race value (p = 0.028, paired t-test, df = 7).

To depict the magnitude of the race, the first multi 50 raced for 5050 nautical miles and crossed the line after 15 days 15 hours, 31 minutes while the first IMOCA crossed the line a few hours later after 15 days 19 hours and 22 minutes and 4730 nautical miles of travelled distance. Our last volunteer crossed the finish line after 18 days 13 hours and 26 minutes. A Pearson correlation calculation demonstrated that the magnitude of umbilical skinfold, %BF, jump height and speed changes were inversely correlated with days at sea (Pearson r of –0.87, –0.81, –0.96 and –0.90, respectively; Fig. 4). Since all differences reached statistical significance (p < 0.01), we can reject the idea that the correlation is due simply to random sampling. This relation is further confirmed by linear regression. No other correlation could be found between statistically significant results and age or initial weight.

DISCUSSION

Measuring physiological parameters during sailing races is technically and logistically difficult. Nonetheless, this study contributed valuable data on global physical changes in the 2009 "Transat Jacques Vabre", a two-handed offshore sailing race.

Previous studies demonstrated that professional sailors incur severe sleep loss with marked performance impairment [8–11]. In case of prolonged sleep restriction, the balance between sleep homeostasis and circadian rhythm

process is disturbed, which induces an adaptive response. Pressure for sleep during wakefulness increases and dissipates exponentially during subsequent sleep, hence the efficacy of brief periods of sleep providing significant performance recuperation. However, sleep restriction practiced on a chronic basis induces cumulative performance deficits [29]. Our results confirmed an increased perceived fatigue both on subjective (VAS) and objective assessment (CFFF). Indeed, CFFF has been used with success in several models of extreme exposure such as divers [28, 30], pilots [31] or parabonauts [32] and has been seen as a global index of cerebral arousal, however with an easier set-up. Since, it was demonstrated on short races that it was possible to minimise anxiety and perceived fatigue with adequate sleep to optimise performance and efficiency [8], it implies that an improved arousal may be a surrogate of an improved performance. We therefore advocate introducing CFFF measurement into skipper's individual assessment to better identify the optimal moment or need for sleep.

As already demonstrated in several studies [4, 5, 7, 33], we observed a significant reduction of bodyweight (–3.6 ± ± 1.4%) at the expense of FM (–36.4 ± 31.4%). According to segmental BIA of FM, the reduction of fat mass was more pronounced in the abdomen (–48.3 ± 28.1%) than in the limbs (–25.1 ± 22.5%). Although not statistically significant, this trend makes sense as abdominal adipose tissue (both visceral and subcutaneous) represents about 45% of the total adipose tissue volume among lean men between 39 and 49 years [34]. Since it was not possible to assess the daily nutritional intake, we can only assume a negative energy balance. The hypothesis of negative energy balance makes sense in regards of the significant reduction of waist circumference. Indeed, according to different studies the mean total daily energy expenditure during offshore race may vary between 14.5 [33] and 19.3 MJ/d [4], which is very high. More, it was demonstrated on an offshore race of 500 nautical miles long that the time spent performing sedentary (< 1.5 METs, excluding sleeping) or light activity (between 1.5 and 2.9 METs) predominates with an average of 92% of the wake time [11]. This may be assimilated to an endurance exercise known to increase the maximum consumed oxygen, improve the capability of skeletal muscles to produce energy via the aerobic system and to reduce weight [35].

The main finding of our study reports a difference in muscular conditioning between upper and lower limbs. Indeed, no loss of HGS was noticed while there is a clear and significant impairment of the leg physical capacity with a reduction of jump height, speed and power. A recent case report has produced similar result after an oceanic race that lasted 64 days [1]. According to this report, this is explained by a leg disuse responsible for a decreased maximum oxygen uptake and maximum workload during cycling measured 10 days after completion of the race. A deeper look at skinfolds and muscle circumferences could explain this difference. In the upper limb, we noticed a significant reduction of skinfolds, confirming the loss of fat, while arm and forearm circumferences are not modified suggesting a gain of muscle. On the opposite, in the lower limbs, the skinfolds are not modified, while there is a significant reduction of the circumference of the thigh suggesting a loss of muscle. Analysis of the different muscular activities when on board, could explain these results. Activity of the lower limbs is essentially static, often sub-maximal whereas upper limbs activity, during race, is explosive and often maximal (using grinders and winches to shape the sails in coordination with the trimmers boat) [36]. When outside, sailors usually stay in the cockpit located at the helm, where the majority of ropes are positioned, allowing for sails adjustments. Except in the event of changing and reefing sails, skippers avoid moving towards the bow. When inside, the available room does not allow the skippers to maintain an upright position, except for the smaller ones or when the boat goes upwind. They remain seated in front of the chart table, in order to receive and study the weather forecasts, calculate the best route, or during bad weather conditions. This can be clearly considered as a lower limb detraining [37]. Indeed, it is agreed that if activity is sufficiently reduced, muscle atrophy will ensue with associated loss of force and power [38, 39]. It is further interesting to note that all of the participants within the study decreased their performance (i.e. losing strength in the lower limb) with one exception. Indeed, the only skipper of our sample engaged in multi 50 conserved his leg functionalities. He even ameliorated them with a gain in speed (+0.87%), power (+8.52%) and force (+11%) resulting in a higher jump height (+1.12%). A shorter stay at sea compared to the other sailors might explain this. However, when compared to the fastest IMOCA participants, who arrived within hours of the multi 50 (difference of 3 h 50 min 20 s), the slope of the curve between pre- and postrace results are significantly different. We can hypothesize that the presence of "trampolines" set between the portside/starboard hulls and the main hull could be responsible for this. Indeed, continuously crossing of the trampolines to manoeuvre the boat requires greater range of motion in lower limbs, with increased torque and bigger flexion allowing more intense muscular recruitment in this type of activity [40] preserving leg physical capacity.

Although both fatigue and loss of weight after an offshore race were previously demonstrated, this provides some external validity to our results. However, we were surprised by the extent of the reported changes and the difference that a few days can make in weight, body composition and performance. Since we were limited by logistical constraint and a very specific population, our sample was small. This

may have biased our results. However, using each skipper as his own control mitigated any risks of underestimating or overestimating the magnitude of the changes.

CONCLUSIONS

Even if our sample size was small, including only 20% of skippers engaged in the race, we showed race-induced impairment of fatigue, body weight, body composition, and leg physical capacity. The results of this study confirmed previous data but on a larger scale same race. Although it does not allow us to determinate which phenomena are directly implicated, we could say that the subjective feeling of weakness of the lower limbs experienced by sailors seems to be multifactorial: nervous system plasticity, loss and/or fibre modifications.

The results of our study lead to a reflexion on the necessity of conceiving specific trainings for IMOCA class sailors. Indeed several factors (sleep time, eating habits, sufficient hydration, etc.), have become essential in preparation, and for success of ocean racing. In addition to these factors biometrical and strength changes induced by this type of competition should be considered. This could help the development of specific training program or exercises while at sea to prevent such leg detraining.

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Lessons from a historic example of diving safety rules violation: the case of Greek sponge divers

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ABSTRACT

This study presents a historical example of systematic safety rules violations by professional sponge divers in Greece during the early 20th century. In light of absolute unaccountability in favour of economic competition and in the absence of state oversight, the profession of sponge diving had developed into a deadly undertaking.

The study is based on a report compiled by Professor of Hygiene and Microbiology Konstantinos Savvas, which was addressed to the Ministry of Marine Affairs. Savvas' report rested on data concerning hospitalised divers derived from the medical records of warship 'Kriti' (Crete), which escorted groups of Greek fishing vessels to four of their expedition in the Mediterranean over the period 1900–1903.

Although the events explored herein took place at a time much different from the modern era with its numerous advancements in hyperbaric medicine, enhanced divers' professionalism and the establishment of labour rights and strict safety regulations, we should not overlook the human factor of professional exploitation that leads to the violation of safety rules. On the other hand, supervisory authorities entrusted with the responsibility of overseeing professional activities ought to be vigilant on a constant basis, especially in times of economic crisis that may lead to lax state functioning.

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Key words: decompression sickness, Greece, history, Konstantinos Savvas, sponge diving

INTRODUCTION

A professional diver has to perform a series of underwater tasks using exclusively self-contained breathing apparatuses. These tasks include underwater ship repairs, dock construction, aquaculture, etc. Regardless of the needs or competition in market economies, however, divers' compliance with safety rules while underwater remains a crucial issue.

By examining the records of a Greek warship from the early 20th century, the study illustrates the lasting risk of inadequate or even inexistent safety among professional divers in conditions of economic competition. The pressing need for work amidst the harsh economic crisis that tormented Greece in the late 19th century, coupled with commercial competition, employers' demands for quick profits, and divers' low earnings that forced them to exhaustive dives in order to earn more money, had taken their toll on safety. In addition, the absence of state controls emboldened employers to push towards increasing their profits in the name of competition.

ARCHIVAL SOURCES

The study was based on two Greek archival sources: a) the report on decompression sickness (also known as the divers' disease), which was prepared by Konstantinos Savvas, Professor of Microbiology and Hygiene at the Medical School of the University of Athens, on behalf of the Royal Medical Council and addressed to the Ministry of Marine Affairs (1904), and b) the data collected by Dr. Sfinis onboard the warship 'Kriti', which escorted Greek fishing vessels in the Mediterranean.

Professor Konstantinos Savvas (1861–1929) was the founder of Hygiene, Epidemiology and Microbiology in Greece (Fig. 1). Besides infectious diseases, Savvas took up issues of occupational health and safety. The tragic rates of morbidity and mortality among Greek sponge div-

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Figure 1. Professor Konstantinos Savvas (1861–1929) (Historical Archive of the Department of Microbiology, Medical School, National and Kapodistrian University of Athens)

ers prompted Savvas to examine the issue. To this end, he started collaborating with the officer Dr. Sfinis, who gave him the data contained in the medical records from four expeditions dated from the period 1900–1903 [1]. In an effort to fully comprehend the physiology of underwater diving, Savvas travelled to the Diving Academy facilities of the Imperial Russian Navy in Kronstadt in 1903, whereas he also studied numerous educational dives on the coasts of Finland [2, 3].

SPONGE DIVING IN GREECE (19TH–20TH CENTURY)

Sponge diving constitutes a legendary chapter of the Greek naval history. Over the centuries, sponge diving techniques evolved from diving without equipment to diving suits. After the establishment of the modern nation state of Greece, the first diving suits were introduced in the Aegean islands — both those that were liberated and the ones that remained under Ottoman control — in the first half of the 19th century. The capability of staying underwater for longer periods of time soon gave rise to the problem of overfishing. The Ottoman Empire had prohibited sponge diving using diving suits up to three miles off its coast. During summer, the Greek fishing vessels collected sponges on the Tunisian coast, moving to Egypt and Cyprus in the winter. In the early 20th century, more than 500 fishing vessels were actively harvesting sponges around the Greek islands, of which 150 carried oxygen pumps and diving suits. Sponge trade was highly lucrative, while companies had established branches in Western Europe where sponges were sold as a luxury good. In light of protecting them from raids by other countries' ships, fishing vessels grouped into fleets, each of which was escorted by a warship. The coexistence of fishing vessels within the same fleet (200–250 vessels) did not necessarily imply their cooperation, since the islands competed fiercely for the distribution of marine sites of sponge harvesting [4].

STUDIES ON DECOMPRESSION SICKNESS

Human efforts to prolong their underwater stay on the seabed gradually led to the creation of new distinct scientific branches of Medicine. Alfred Léroy de Méricourt became interested in decompression sickness and published his relevant thesis titled '*Considérations sur l'hygiène des pecheurs d'éponges*' in 1868, while Alphonse Gal travelled to Greece in order to complete his own thesis that was published in 1872, where he recorded the symptoms of the disease by himself [5–7]. He gradually became more interested in the supply of compressed air to mines and caissons of underwater constructions, such as the construction of large bridges like the Eads Bridge in St. Louis and the Brooklyn Bridge in New York City, where decompression sickness or '*caisson disease*' was also observed. On account of that observation, Alphonse Jaminet (1871) and Andrew Smith (1873) — the doctors overseeing the construction of Eads Bridge and Brooklyn Bridge respectively — published two studies describing the disease and their experiments [8, 9]. In 1878, Paul Bert laid the foundations of hyperbaric medicine in his monumental work '*La Pression Barométrique rechearches de Physiologie Expérimentale*' [10, 11].

Despite widespread dissent, it appears that the dangers of the disease had been known in Greece at least since the 1860s, when the first diving suits were used by the Dodecanesian sponge divers. In 1867, Auguste Denayrouze published a manual on the use of diving suits, which offered clear and specific instructions to those who descended up to 50 metres: 'Ascending very slowly, the diver can avoid abrupt transition to atmospheric pressure. Periodical stops (during ascent) help to make decompression smooth' [4]. Studies on decompression sickness were also conducted in Greece. In 1881, I. Tetsis published his study titled '*L'île*

d'Hydra et les maladies des plongeurs' in Paris, distinguishing between four levels of the disease: temporary cerebral congestion, paraplegia, haemorrhage that may lead to death, and comatose state that always leads to death [4]. Of major importance was the study of K. Katsaras, who studied 62 divers suffering from the disease [12].

THE MEDICAL RECORDS OF WARSHIP 'KRITI'

The warship accompanied the Greek fishing fleets in four expeditions: 7 May – 20 October 1900, 12 May – 20 October 1901, 17 May –16 October 1902 and 15 May – 24 October 1903. The health records of divers who suffered from the disease between 1900 and 1903 were handed to Savvas and highlighted various aspects and risk factors of the disease.

WORKING CONDITIONS

The problem of decompression sickness lay in the highly problematic business model of the time and started long before the expedition itself. In order to be able to equip their ships, captains were forced to borrow heavily from the banks. They also borrowed capital from the private sector with interests of 24% to 36%, which had to be repaid within 6 months, while their ships or even homes were put up as collateral for those loans. Moreover, it was lenders who provided captains with the necessary equipment, usually at very high prices. As a result, captains were already indebted before they had even set sail and their only hope lay in harvesting large quantities of sponges. Any delays in their departure meant that divers had wasted their salaries, thus they too could only set their hopes on harvesting many sponges since they would accordingly get a share of the profits. Captains were faced with pressing loans that gave rise to irrational demands for more and more dives, a reality that proved to be a major risk factor for accidents. The captains' burden was passed on to the divers who, according to Savvas, '*lost their freedom and became slaves of the captain*'. Similarly, the oral testimonies of captains indicate that they, in turn, were slaves of their lenders: '*When you have borrowed a lot of money and mortgaged your house, you have to earn that money and the time is not enough. Therefore, the people (divers) must ascend quickly*'; '*How many hours does the day need to have for me to be able to do my job, to earn the money that is not mine, to pay the bank, to pay the people?*' [4].

THE DIVERS' PROFILE

The profile of the proud diver and tragic hero who boldly confronts real and mythical dangers in the great depths of the sea and thoughtlessly spends all his money while on land, since any of his next trips might be his final one, has long been inscribed in Greek historical consciousness. On the other hand, the drama of mothers and wives of dead or handicapped divers has been an integral part of island societies [4]. Each ship was manned by 8–12 divers aged 19–45, many of whom came from continental Greece in search of easy profits but lacking familiarity with the marine environment. For instance, the records revealed that numerous divers had formerly worked as farmers, shepherds, carpenters, builders, barbers, railroad employees or in various other professions that were completely unrelated to marine life and the dangers of the sea.

SAFETY RULES

The records of warship 'Kriti' illustrate that safety rules were essentially absent from diving. The Hellenic Navy employed no divers who would dive to such great depths, since their main mission rested in performing maintenance tasks on the hulls of ships. This was the main reason why no casualties were recorded in the Navy, coupled with the rigorous military standards that were strictly followed by its divers. Civilian divers, on the other hand, experienced a totally different situation. The whole process was outside state regulation and anyone could become a diver, even without training, while basic safety rules were absent from fishing vessels whose equipment was outdated and dangerous.

The inspections of fishing vessels conducted by officers and doctors revealed crucial violations in relation to their equipment, like diving suits lacking maintenance, helmets lacking lanterns or cables of communication with the ship, oxygen pump pistons lubricated with animal fat that contaminated the air inside helmets, or pumps that channelled hot air due to their poor maintenance. A notable effect of these deficiencies was the case of the release and detachment of a diver's helmet while working at a depth of 40 metres. Professional divers dived up to 6 times during their shift and usually worked at a depth of 45–60 metres, sometimes reaching 80 metres. They ascended really fast and would '*hurl at high speed and immediately remove their diving suit in order for the next diver to use it and for them to go to rest*'. Each dive lasted 40–50 minutes: '*On 27 June 1903, a diver of the ship Evangelistria dived to 30 metres and remained on the seabed for 50 minutes, then ascending fast and not smoothly. After one hour and a half, he dived again to the same depth and remained underwater for 45 minutes. One hour later he dived to 30 metres and stayed for 35 minutes. When he ascended, he reported dizziness and lost his consciousness. As soon as he regained consciousness, he felt numbness on his limbs and was unable to stand. Complete paralysis ensued...*'

A regretful finding rests in the testimonies of divers, who secretly entrusted them to the Navy officers. Some captains ignored divers' signals for ascent, not allowing them to

return to the ship or forcing them to dive again when they considered the quantities of sponges they had harvested to be insufficient. On the other hand, some operators of oxygen pumps mentioned that divers themselves often ignored their signals in light of discovering hundreds of sponges, suffering from what they called '*seabed drunkenness*' that made them want to collect them all [4].

The divers' diet was satisfactory and included fish, meat and legumes, while they had 2 to 4 meals a day. Pressure and tension, however, led to excessive smoking and alcohol consumption. Savvas considered the usual practice of consuming an alcoholic drink in between dives to be burdensome for the divers' overall health. In a time when the concept of risk factor was unclear, Savvas was able to distinguish alcohol as a significant factor that could cause accidents.

DECOMPRESSION SICKNESS IN NUMBERS

According to Savvas, Paul Bert had been informed that 30 Greek divers died on average every year during the 1870s. The studies conducted by Greek doctors referred to ten deaths per year but indicated equally high rates of disability. Between the years 1878–1900 it was estimated that approximately 100 divers had died while more than 800 were left paralysed. Unfortunately, there is no conclusive and systematic data on the exact number of victims per island. For instance, it has been reported that '*more than 15 died every summer*' in the Dodecanese during the 1870s. Russian Professor Karolus Flegel, a renowned and staunch objector of diving using a diving suit, pointed out that at least 800 divers had died from the island of Kalymnos since the introduction of the diving suit, a number that remains to be verified [4].

The records from the period 1900–1903, however, offered a more coherent picture of the prevailing situation. The records of 'Kriti' included the number of patients, the seriousness of their condition, as well as the number of those who did not survive. All patients were grouped into age groups, whereas the doctors also classified symptoms into 'disorders of the central nervous system', 'heart disorders' and 'lung disorders'. Particular attention was paid to paralysis, which was categorised as 'upper limb paresis', 'lower limb paresis', 'hemiplegia', 'upper limb paralysis', 'lower limb paralysis', 'perfect lower limb paralysis' and 'paralysis of the whole body'. Over the 4-year period covered in the records, a total of 936 divers were hospitalised, of whom 152 in serious condition. Twenty one of these 152 patients passed away, while those who survived developed some kind of disability. Ages 21–35, especially 26–30 (46%), represented the age spectrum that was mostly affected by decompression sickness. As far as the type of paralysis is concerned, paralysis of the lower extremities was the most common.

The presence of the warship and the lax controls did not have any effect on captains, since the legislative framework was essentially non-existent and the naval officers were unable to intervene. On the other hand, many captains pulled away from the fleets and resumed their oppressive behaviour towards divers. For instance, 60 divers working on the fishing vessels that had abandoned the fleet in 1901 died outside Benghazi in Libya.

This situation changed during the last expedition of 'Kriti' in 1903, when the naval officers acquired extended powers that allowed them to conduct sworn interrogations. This tactic scared the captains, who began to adhere to the newly-established safety rules of the Ministry of Marine Affairs. The interrogations carried out in 1903 revealed that — besides the three divers hospitalised aboard 'Kriti' who passed away — another 24 divers had also died in that same year. On the other hand, the officers were unable to verify the worrying allegations of another 40 dead divers. In any case, contemporary estimates placed the total number of Greek divers onboard the Greek shipping vessels during the last expedition of 'Kriti' at 900, of whom 100–150 either died or acquired some kind of disability. It should be clarified that the failure to record the total number of deaths may have been due to the fact that some islands remained under Ottoman control and thus the Greek ships still carried the Ottoman flag. As a result, the Greek authorities were informed of accidents only when a captain contacted the Greek consulates in the Greek islands controlled by the Ottomans.

MEDICAL FINDINGS FROM THE RECORDS

Savvas' report confirmed the aggravating factors for decompression sickness that were already mentioned in contemporary bibliography, namely diving depth, duration of stay on the seabed and number of consecutive dives. The disease was linked to the three stages of diving: increasing pressure during descent, high atmospheric pressure while on the seabed and abrupt divers' ascent. According to the records, decompression sickness appeared shortly after ascent and removal of the helmet of the diving suit. Divers suddenly felt malaise, dizziness and imbalance, pain in the precordium that extended to the left shoulder and nape, headache, tinnitus, aphasia, thirst and burning in the epigastrium.

Divers presented shortness of breath for 30 minutes, followed by faint and anaesthesia for 15 minutes. By the time a diver regained consciousness, all symptoms had disappeared only to be replaced by symptoms of paralysis. Over the next 4–8 hours, the unfortunate diver felt numbness throughout his body, losing his ability to move and experiencing paraesthesia in the upper and lower limbs. This situation resulted in hemiplegia, monoplegia or cervical

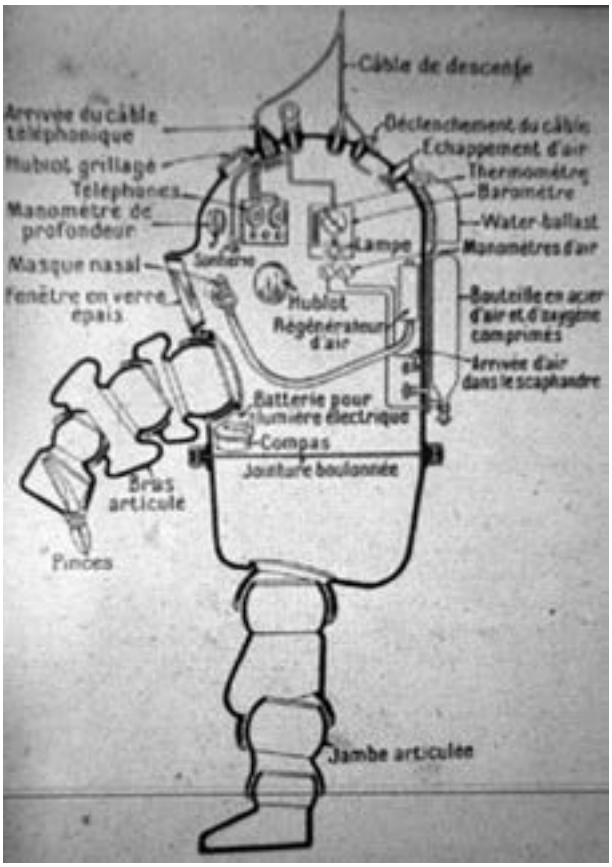

Figure 2. Metal suit P-7 Neufeldt and Kuhnk in section. Glass-slide from the lectures of Prof. Savvas on Divers' Hygiene. (Prof. K. Savvas Collection, Historical Archive of the Department of Microbiology, Medical School, National and Kapodistrian University of Athens)

Figure 3. Test of P-7 Neufeldt and Kuhnk (France 1926). Glass-slide from the lectures of Prof. Savvas on Divers' Hygiene. (Prof. K. Savvas Collection, Historical Archive of the Department of Microbiology, Medical School, National and Kapodistrian University of Athens)

and head movement ability only. Over the next 3–5 days, the diver experienced urinary retention that was followed by urinary incontinence. Upon his recovery, the patient was able to walk only with the help of a walking cane.

STATE INTERVENTION IN RESPONSE TO SAVVAS' REPORT

Following the tragic conditions that came to light from the data, the Ministry of Marine Affairs was called upon to take immediate action at various levels. At that point, the influence of Professor Savvas' prestige came into play, definitely corroborated by his relationship with the royal family. Numerous of his proposals were eventually taken into account and largely influenced the nature of the divers' profession.

The first measure provided for keeping a book where captains recorded all dives performed by the divers onboard their ships. Each entry had to include the site, depth and duration of a dive, along with the name of the diver and the signatures of the captain and two representatives of the divers who oversaw the whole process. Upon returning from an expedition, the captain handed over the book to the port authorities for inspection.

In turn, divers had to be healthy, that is, not suffer from cardiac, haematologic, urinary or nervous system diseases (or rheumatic diseases, based on contemporary medical perceptions), whereas dives had to be performed 3–4 hours after consuming a meal. In addition, professional divers had to be aged 21–35, while the establishment of the School of Divers was decided, where prospective divers would obtain a diploma and basic first aid knowledge.

The safety rules that were introduced were designed in line with those of the German Navy in 1898. This should not come as a surprise, given that Prof. Savvas had received further training in the Institute of Public Health of Berlin and was generally familiar with the German scientific way of thinking. Based on those criteria, the duration of under-

water stay was defined as follows: 1 hour at 9–10 metres, 15 minutes at 23–25 metres, 10 minutes at 35–42 metres, 5 minutes at 42–47 metres, 3 minutes at 47–50 metres and 1 minute at 50–55 metres. As far as the other technical parameters were concerned, the rate of ascent was set at 2 metres per minute, while oxygen pressure should not exceed 5 atmospheres (atm). It was also determined that 3 months after their therapy, divers could start diving again on the following terms: no more than 3 times a day, at depths of 8–10 metres, remaining underwater for 15–30 minutes.

A key development that originated from Savvas' report was the fact that divers were no longer unprotected, as employers were to be held accountable and subject to punishment. Firstly, captains were now prohibited from coercing divers to multiple dives, whereas they had no right to ask a diver to dive when the latter suffered from any disease. Moreover, in the event of an accident, interrogations were carried out and those deemed responsible were brought to justice. In this context too, Savvas proposed that the laws of the German Criminal Code were put in place. Although a diver's death would be regarded as negligent homicide, the sentences ranged from heavy fines and seizure of the ship to imprisonment for 3 months to 3 years. But Savvas left nothing to chance, as he took another aspect of the problem into account and provided for the establishment of a pension fund for divers, which was maintained through employers' contributions and offered financial assistance to the widows and orphans of deceased divers. Additionally, a special framework was established that prevented lenders from imposing interest rates of more than 10%, thereby relieving captains from the strain of repayment and fear of their ships being confiscated. As a result, captains' behaviour towards the divers changed altogether.

In spite of scientific work, decrees, legislative efforts and public complaints, the concept of work-related accidents and the identification of the causes of death in sponge diving remained controversial until the whole sector became obsolete in the aftermath of World War II. Even in the 1970s, divers demanded that their whole salaries were paid in advance, on the grounds that they would likely never return from the upcoming expedition [4].

Being the most relevant experts, the doctors of the Hellenic Navy continued their research unabated. Two doctors who had been trained in Kronstadt promoted the adaptation of the diving tactics of Greek sponge divers to new standards, suggesting that they stayed on the seabed for a brief period of time and ascended slowly [13, 14]. After tackling the problem of decompression sickness, Professor Savvas became involved in other sectors of public health and focused on the major infectious diseases of the time. Nevertheless, he continued to reflect on issues pertaining to the health of professional divers from an educational perspective, incorporating them in the lectures on hygiene that he offered to his students at the Medical School (Figs. 2, 3).

CONCLUSIONS

The history of Greek sponge divers in the early 20th century represents a classic and timeless example of safety rules violation arising from economic competition and hardship. Lacking regulation and any form of state oversight, professional sponge diving proved to be extremely deadly. Of course, that era was completely different from modern times in relation to divers' professionalism, safety rules and labour rights, since nowadays a strict legal framework has been put in place to protect professional divers. The prospect of exploitation, however, which leads to violations of the safety rules governing this high-risk profession under the pressure of competition, coupled with voluntary or involuntary acceptance of such situations by the divers themselves, poses a serious risk factor for accidents. On the other hand, the institutions entrusted with overseeing the profession must always be alert and prepared, especially in times of financial crisis when working conditions are subject to changes and pressures.

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Mental health problems and suicide in the younger generation — implications for prevention in the Navy and merchant fleet

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ABSTRACT

Psychologists and psychiatrists worldwide are expressing concerns regarding the growing prevalence of mental health problems and the incidence of suicide in young adults. The reasons are seen in the extremely high tempo of social changes, information pressure, and values evolution in the younger generations, which are exposed to growing inequalities, loneliness and lack of social support. Poverty, social isolation, consumerism, hedonism, and unrealistic expectations of the future generate in the vulnerable part of the young adults inevitable frustrations, which give way to depression, anxiety, addictions, and suicide. This creates additional risks for the situation on board ships, both military and merchant, and requires greater efforts during pre-admission selection and in the course of the service or voyages. Suicides in the Navy are better registered than in the cargo fleet and are lower than in the same age and gender groups from the general population, and usually lower than in other types of forces. Data on suicides in the civilian maritime sector are less conclusive, but suggest it as a growing problem, especially considering stress on board. Recent studies revealed quite a lot of mental health problems in the merchant fleet crews, including depression, anxiety, and suicidal thoughts. Among the reasons such factor as "flag of convenience" strategy that implies lower standards, recruiting of the less trained and lower-paid workforce, multinational and multilanguage rotating crews, higher workload and stress and insufficient level of the pre-employment medical examination are mentioned. Recent trends in the mental health of the youth demand higher awareness both in the military ships and in the merchant fleet. We consider that more education and training aimed at mental health problems identification and stress-resilience promotion are needed both for the military and civilian staff on board. Better education of the whole personnel and "healthy ship" approach (better recognition of the crew members' needs, attention to mental health problems, nutrition, physical activity, etc.) may be applied both for the Navy and merchant fleet.

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Key words: mental health problems, suicides, young adults, suicide prevention, Navy, merchant fleet

INTRODUCTION

The world has changed a lot for the last decades, and there is a general feeling that today unprecedented global forces are shaping the health and wellbeing of the largest generation of 10 to 24-year-olds (the so-called iGen, or Generation Z) in human history. Specialists in mental health promotion and psychiatrists worldwide are expressing concerns regarding the growth of the problems of mental health in young adults. According to the most recent epidemiological studies, the prevalence of any disorder in younger people is about 20% for the last year [1–3]. Among the disorders, there are anxiety, depression, addictions, hyperactivity, psychosomatic symptoms, personality disorders, behavioural problems, and phobias. Studies and reviews provide evidence that in recent decades the prevalence of anxiety, depression and substance abuse

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in adolescents and young adults has increased most of all [4–6]. Moreover, birth cohorts comparisons testify that some personality traits, for instance, neuroticism and clinical scales of MMPI, have grown substantially too [7]. Mental health problems are more pronounced in youngsters from lower social-economic strata, though they are inherent to all social classes. Comorbidity of disorders, as well as general and mental health poor rating, is associated with suicidal thoughts and more serious manifestations of suicidal behaviour — attempted and completed suicide [3].

Analysis of the situation with suicides in adolescents and young adults shows that suicides in this contingent are growing worldwide [8, 9]. The peak in the most economically developed countries has passed, but even in the countries, where national suicide prevention programmes were implemented, suicide levels did not drop substantially. In the 90s a rise in suicide rates in young adults has been very typical to Britain, Australia, and Western America, then the focus shifted to post-soviet countries, and recently have touched Latin America, China, Korea and other countries of South-East Asia [9, 10]. It may be hypothesized that recent decades rise in rates in the countries and communities with traditional cultures are the results of the pressure of the postmodernism that promotes very liberal attitudes to life and death.

MILITARY ENVIRONMENT AS A MODEL FOR A MERCHANT FLEET

Young soldiers constitute the majority of personnel in conscription armies, many contracting specialists in the Navy are also young adults who have just graduated from military colleges or high schools. No surprise that when the time comes for the service they may 'import' their risks to the military environment. This raises several important questions: 1) how military forces can protect themselves from drafting personalities with hidden suicidal tendencies; 2) how to prevent exacerbation of mental health problems in the stressful military environment, and 3) what can be done to promote mental health and stress-resilience of the staff. One of the relevant questions is also if the knowledge accumulated within the military and the Navy in particular may be extended to civilian maritime sector given the unifying character of marine occupation with its' organisational and psychological peculiarities.

Suicides in the military may have the same risk factors as in the civilian population, i.e. mental disorder, life stress and trauma, alcohol and drugs abuse, frustrations, financial and legal problems, etc. Speaking about specific factors in the military settings, it was long supposed that combat exposure and traumatic experiences may be main additional reasons for mental health problems and suicides. Nevertheless, one of the recent studies from the United States (US) has revealed that while suicide rates for soldiers who served in Iraq and Afghanistan more than doubled from 2004 to 2009 to more than 30 suicides per 100,000, the trend among those who were never deployed nearly tripled to between 25 and 30 suicides per 100,000. Rates for similar age and sex civilians remained almost steady at 19 suicides per 100,000 during this time. These results, as the authors say, "argues indirectly against the view that exposure to combat-related trauma is the exclusive cause of the increase in Army suicides", pointing to pre-existing problems among modern youth [11].

Another part of this massive study pointed out that one in four soldiers in the army appears to suffer from at least one psychiatric disorder and one in ten has multiple disorders. Most importantly — about a third of soldiers who attempted suicide had mental disorders that developed before they joined the army: an indication of the general shift towards mental ill-health in young people and a warning that more professional efforts are needed while screening for mental health problems among recruits [12]. The authors discuss that the rise in suicides and diagnoses was the result of two recent US Army trends aimed to recruit or retain personnel. One trend was the liberalisation of screening rules and enrolment of recruits with poor education or conduct records, the other was the practice of forcing soldiers to remain in service beyond their enlistment [11, 12]. The study did not directly confirm the role of these practices, but in a more recent article dedicated to recruitment problems Mark Perry directly points that efforts to increase military size in US are hampered by poor records of potential recruits, who are undereducated, often obese and with criminal records — the trend that implies also many mental health problems [13].

The situation in different armies and different types of forces may vary. The above-mentioned study may depict specific features inherent to the US Army. On the other hand, military psychologists and psychiatrists from different parts of the world are expressing the same concerns and advocate more efforts during selection and more testing before conscription or signing the contract with a serviceman, both in the Army and the Navy. This is a questionable issue, in some armies, a lot of attention is paid to psychological testing before enrolment, while in others screening for mental health is considered useless and the focus is shifted on performance and hardiness of the serviceman [14–16].

SUICIDES IN THE NAVY — ARE THERE PECULIARITIES?

Recently, we have tried to outline some common features of suicide within the military environment [17]. The following factors may be associated with an increased risk of suicide in the military context: 1) the loss of or lack of personal freedom experienced by people entering rather

closed and authoritarian system; 2) the masculine culture in many military communities, which may leave little room for self-disclosure and peer support; 3) the risk for personal traumatic stress exposure and subsequent traumatic stress reactions; 4) the easy access to firearms; 5) the military lifestyle with frequent relocations and the break-up of supportive social structures; 6) during profound changes in social structures, when downsizing or reorganizing processes in the armed forces take place; and 7) the danger of suicide contagion and clustering of suicides in military units [17].

These specific military environment risk factors may act together with risk factors inherent to the general population (belonging to a vulnerable demographic group, chronic life stress, lack of social support, dysfunctional relations, prior suicide attempt, mental health problems, etc.). Nevertheless, suicide rates in military populations remain, in most cases, lower than in the civilian population of men of the same age. This could be attributed to the existence of protective factors that may counterbalance the situation: 1) the military is a highly organized structure and if the problem is well understood by commanders, prevention programmes may be implemented in a prompt and effective way; 2) there is a preliminary and ongoing medical control of those who are dealing with weapons and certain psychiatric conditions may be recognised early on; 3) special prevention measures may be organized and special means of reporting may be implemented that provide quick identification of suicidal persons along with their referral to specialists; 4) the military can discharge those with suicidal ideations or actions to reduce suicide risk; 5) every case of completed or attempted suicide may be thoroughly investigated producing important information for further prevention models [17].

Navy personnel in all countries that have fleets belongs to the most educated and trained due to high demands existing in the modern battleships and submarines. No surprise that suicides in the Navy are usually rather low. For instance, regular suicide statistics from the US military forces testify that suicide rates in the Navy are the lowest, followed by the Air Force, Army and Marine Corps [18]. Micklewright reported on deliberate self-harm in personnel of the Royal Navy [19] and concluded that these acts should be viewed in the context of the environment that often imposes psychological, emotional and social pressures on servicemen. In the United Kingdom (UK), detailed information on suicide in the regular Armed Forces is published by the Defence Analytical Services Agency (DASA). For the 23 years from 1984 to 2006, suicide rates in the Army ranged from 12 to 20 per 100,000, suicide rates in the Naval service ranged from 6 to 14, and from 3 to 15 per 100,000 in the Royal Air Force (RAF), most recent figures (2018) are 10 for the Army, 8 for the Navy and 4 per 100,000 for RAF [20]. Suicide rates in the young age military in the 90s exceeded rates of the same age and sex group in the general UK population; however, in the recent decades rates in the military are below the corresponding civilian age and sex groups.

Suicide rates vary significantly from country to country, while suicide rates in the military (though usually substantially lower) may be ranked in the same order, which may depict cultural, religious and other nationally resistant peculiarities [17]. On the other hand, time change in the civilian and military environments may be different. As an example, in the former USSR Navy, the time-course changes of suicide rates differed distinctly from the general population: while in the whole USSR there was lowering of suicides in 1986 (preventive effect of the 'perestroika' — democratisation and liberalisation in the country), in the Navy there was a rise in the proportion of suicides in general death structure during the period 1986 to 1995 (period of serious economic problems, fleet downsizing, lowering of the prestige of the marine professions). Only from 1998 to 2000 the percentage of suicides started to diminish. In the Navy, two-thirds of all suicides occurred among conscripted personnel during their first year of service. In 65% of the cases, the method of suicide was hanging, 20% firearms, 5.5% intoxications, 5.2% self-cutting, 2.2% jumping and finally, 1.8% drowning [21].

Though suicide rates in the Navy are low, the impact of such a tragic event on the battleship may be rather high and may induce severe psychological trauma in the crew, especially in the immediate commander-in-charge, or in the closest friends. The whole crew may be also psychologically impacted, depending on the situation. Given this, every case must be thoroughly investigated and a report should be developed according to the existing rules in every Navy, but also a debriefing should be provided for the crew. It applies also to cases when suicide of the crew member happened ashore but became known to the crew.

COMPARISONS WITH THE CARGO FLEET

The situation in the Navy and cargo fleet definitely has many similarities, especially taking into account conditions on the ships, noise, electromagnetic fields, ship movements, stressful shift work, isolation, lack of social support, remoteness from the family, etc. Moreover, if comparing with other occupations, organisational and psychological factors on merchant ships are more close to the military environment, with high level of subordination, responsibility and crew cohesion. Both in the Navy and merchant ships high demands are imposed on the staff in relation to withstanding austere and dangerous conditions of seafaring, probable fight for the buoyancy and survivability of the ship and during rescue operations.

The merchant fleet, like the Navy service, recruits young educated specialists from corresponding educational institutions, where students are the same representatives of

generation Z (Digital Natives) with their typical academic stress, loneliness in the social media and lack of social support. They definitely benefit from their advanced digital competency, like managing many tasks at once and high productivity based on abilities of surfing through web, but also may import onboard mental health problems inherent to this generation, including anxiety, depressive thoughts, hyperactivity and impulsivity. Less-educated crew members are even at a bigger risk, especially under current recruiting circumstances. This issue is worth special attention.

Economic factors that are prevailing recently in the cargo fleet seem to produce more mental health risks for workers and employees on board. Globalisation and flags of convenience companies' practices of last decades (lower standards, economic pressure, minimal crews' size, recruitment strategies oriented on lower-paid staff, etc.) changed the global seafarers' trade market, introduced shortened multilingual multinational rotating crews, eliminated medical doctors from the crews, gradually induced higher work-load and caused gaps in seafarers' rights protection [22]. All this satisfies interests of shipping companies' owners, but also provides a fertile ground for conflicts, psycho-social stress, mental health problems, alienation, and impaired social support on board. In confirmation, recent study on seafarers mental health, based on structured interviewing of 1572 merchant ships crew members of different nationalities have revealed that 25% of respondents may be qualified as having depression higher than in other working and general populations, 17% may be defined as having heightened anxiety, while 20% admitted rare and 2% — constant suicidal thoughts [23]. The working environment has been identified as the main determinant of seafarers' mental health problems, especially such factors as non-caring company culture, violence at work and low job satisfaction. Seafarers from the Philippines and Eastern Europe appeared to be the main victims of workplace violence [23].

Previously in a review of the problems of mental health and suicide among merchant fleet crews authors have outlined two conflicting tendencies that are reflected in the literature reviewed before 2017 [24]. One part of studies, especially older ones, covering period of the second half of the previous century, give an impression of a rather safe picture — pretty low rates of confirmed suicides (1.3–2.2 per 100,000) [25, 26], moderate effects of the burn-out syndrome [27], not much complaints on fatigue and distress in the self-reports, higher satisfaction with work and low repatriation rate for mental health reasons [26]. In the Polish seamen and fishermen for 40 years from 1960 to 1999 there were identified 51 suicides, which is quite low in terms of rates given that the population surveyed was 25,000 per year, even if part of cases remained hidden or attributed to other reasons [28]. Though many concerns were expressed regarding stress on the working place on board merchant ships, including unsatisfactory working conditions and psychological strain, the situation with mental health and suicide was not perceived as being worse than in other sectors of economics.

Another part of studies, especially the most recent ones, on the contrary, has reported about growing problems. For instance, studies have found that from 6% to 35% of seafarers knew colleagues who considered suicide and pointed that stress, anxiety, depression, and sleep disturbances are serious risk factors among seafarers [24]. Several most recent surveys have confirmed that stress, job strain, and high work demands are directly related to mental health problems among engine officers [29, 30] and that seafarers' lifestyles on board (smoking, sedentary behaviour, unhealthy food and lack of physical exercise) may be main contributors to lower well-being [31, 32]. It coincides with the conclusions of the most comprehensive report published up-to-date [24].

What may be the reasons for this negative development in the most recent years? Several explanations may be suggested, among them better understanding of the problem by those in charge for seafarers health and well-being and a shift towards direct questioning about mental health issues and suicidal thoughts (possibly avoided previously due to stigmatisation), which may produce more symptoms. On the other hand one cannot exclude real worsening of the situation, especially when the socio-economic context is analysed. Some authors point on already mentioned fast technological and organisational changes and the increased pressure for economic profitability that may contribute to lower well-being, for example through role conflicts or perceived stress on board [30]. On the other hand, one may agree with the opinion that the complexities of mental health problems identification in multinational and multilingual crews may be the reason [24]. The topic of mental health and suicide remains a strong taboo in many cultures, while modern trends (multinational crews, high workload, the short ship turns, work stress, job insecurity, etc.) elevate the risk of suicides. The problem becomes exposed only during direct questioning within the context of special studies and surveys. Therefore, the issue of mental health and suicides in the merchant fleet crews warrants further research and analysis.

Another systemic problem is seafarers' medical examinations and health assessments — the system is still focused on cardiovascular health, while mental health issues, especially depression and suicide risk remain obscure, either due to low attention from the medical authorities and complexities of objective evaluation, or due to workers' dissimulation of symptoms, which is easy to perform. Moreover, recruiting crews from low-income countries, which is the dominating trend in modern sea trade, often leads to falsification of medical certificates [24]. Therefore, it

may be noticed, that situation in the cargo fleet has some similarities with the tendencies noticed by US military psychiatrists mentioned above [11, 12] and that not enough attention to mental health problems as well as objective difficulties in assessment of suicide risk may contribute to problems in the merchant fleet, while situation in the Navy looks more definite.

It is also important to look at suicide on board in the context of risky behaviours, in terms of 'human factor' and accident analysis [33]. Conditions in which personnel live and work may influence physical and mental health and behaviours, both healthy and unhealthy. People's behaviours and unconscious gestures or motives can be important factors leading to a variety of accidents, from minor traumas to major accidents and deaths. Some genetic factors may be predisposing to risky behaviours while genes-environments covariations may lead to self-selection into risky environments. This may be an additional mechanism through which some individuals may carry their risks with them on board. Another question is how life stress, both in the early periods of life, and further in the working career can exacerbate these risks and lead to suicidal behaviour, and how these types of stress interact [10].

Many interdisciplinary studies are needed to understand better stress-vulnerability and resilience in young people seeking occupation associated with the sea and to develop more predictive tests to prevent those at risk from entering the occupation. It may have a value in the prevention of suicides among seafarers, both in the Navy and in cargo fleet. As to the Navy, though the military system is much more organised and disciplined, some individuals may be seeking additional sensations and stressful experiences, which can contribute to mental health problems and suicide risk. Recent advances in genomic studies and rapid accumulation of reference data may provide more objective tests for suicidality in the future, which may be used in conjunction with psychological testing and psychophysiological evaluations of stress-vulnerability and resilience.

EXPLANATIONS OF YOUTH MENTAL HEALTH PROBLEMS

One of the most important questions is why above mentioned negative tendencies in mental health and suicides in young adults became so visible in recent decades. Explanatory factors for this phenomenon include quite fundamental features of modern societies, which go beyond inequality and disadvantage. Such factors may be mentioned as modern lifestyles, social and moral conditions associated with high competitiveness, a high value of personal success and unrealistic expectations promoted in young people by the social environment and mass media. The increasing influence of mass media and modern information flows promotes violence, envy, consumerism, fear and social isolation. Other factors that may be named are the weakening of the role of the traditional family, lack of social support, poor parenting, and vague life perspectives [3]. All this means a higher level of psychosocial stress, which is accompanied by anxiety, sleep disturbances, symptoms of depression, reduced performance, or tiredness. Studies evaluate that more than 40% of youngsters have a feeling of being stressed, and a huge majority of them report they are feeling tiredness in the morning. There are also facts that academic environment and social media in many cases turns into a source of additional distress and anxiety [6].

Such a situation is a reason for serious concerns, especially taking into account that early disturbances may have an impact on the whole life. Adolescence and early adulthood are transitional periods when individuals are particularly sensitive to environmental inputs. Behaviours initiated during adolescence, such as substance use, high-risk sexual behaviour, and risky driving, contribute to poor health outcomes and mortality during later life. Young adults fare worse than adolescents in many areas, with rates of motor vehicle deaths, homicide, substance use, sexually transmitted infections, and mental health problems peaking during young adulthood. Adolescents and young adults altogether seem to have a higher level of certain disorders than older adults; moreover, about 40–50% of those who have had mental health problems in adolescence may have the same or different problems as being adults [5, 34].

Another important factor is related to meanings and values, and how they are perceived by young people in the society of post-modern. Recent sociological and psychological surveys give evidence, that for several last decades American college students much more often mentioned as "important" such life goal of "being very well off financially" instead of "developing a meaningful philosophy of life". Meaning in life declined in importance by almost half during the 1970s and 1980s, while money and success almost doubled to become the highest-rated goal, and trends have remained relatively stable since [35, 36]. In most recent decades the same shift is seen in the post-soviet space, India, and China [37]. The growing role of individualism and personal success in opposition to collectivism and social cohesion, growth of hedonism, pragmatism and moral relativism may be the result of the aggressive propagation of these values by mass media [3].

IMPLICATIONS FOR THE NAVY AND MERCHANT FLEET — BUILDING RESILIENCE AND RAISING AWARENESS

Suicide prevention is a mental health promotion. This formula becomes more and more popular among suicidologists, psychiatrists and mental health providers. The

essence of the strategy that lays behind it is that we are focusing not only on prevention itself, which implies the identification of risk groups and organising interventions, but addressing wider issues of promotion of resilience and positive functioning in wider populations. This paradigm is based on the concept of mental health, which is a complex non-psychiatric culturally sensitive phenomenon. Modern understanding of mental health includes such factors as emotions, cognition, social functioning, and sense of meaning, purpose in life. It is based on subjective well-being, self-efficacy, autonomy, coping skills, the desire for self-development and social cohesion. So being mentally healthy is something that is far beyond having no mental disturbance [38].

The complexity of the tasks in the modern Navy and merchant fleet means that the cognitive functioning and psychological stability of the staff, from the lowest to the highest level, is crucial. It imposes increased demands on the conscripts, cadets and other specialists, especially in the submarines, deep see ships and highly technological specialised ships. Young people are still joining Navy or merchant fleet to "see the world", but in many cases, this does not happen, instead they are working under stress in front of the computers, being exposed to the same factors as all modern youth, plus inevitable stressful factors of the ship environment. All this means new challenges for the Navy in terms of maintaining high morale, motivation, concentration and cognitive performance of the personnel. Given specific conditions in the Navy (remoteness, stressful environments, high workload, shift work, monotony, high responsibility, etc.) there are higher demands to the stress-resilience and emotional status of any serviceman. During the missions, more specific combat-related stressful factors may appear that may lead to acute operational stress, which in a part of the personnel can over time turn into long-lasting post-traumatic stress disorder. This can be also applied to the merchant ship's crews so far as some of them are exposed to such risks as modern piracy making the atmosphere very close to the military situation, when concerns and fears about possible attack constitute additional stress.

Many authors in military psychiatry and psychology as well as in occupational psychology have formulated important principles of medico-psychological aid, prophylaxis and rehabilitation measures aimed to prevent deferred mental health disturbances and suicides. In some countries, special programs for the Navy are developed, or special psychopathology services are created [39, 40]. In a recent article from Poland, authors are stating that advanced technology on modern ships puts high demands on operators in terms of psychophysical characteristics, mental stability, and cognitive performance. Sailing in difficult conditions, ship movements, austere meteorological conditions, complicated technical equipment, working in isolated groups, functioning within a limited space, noise, vibration, and electromagnetic waves are the factors producing chronic stress. The authors conclude that service on Navy ships requires certain psychophysical qualities and, most important, resilience to stress. They advocate proper selection among the candidates based on psychiatric and psychological counselling for military and medical jurisprudence, as well as better training for doctors and specialists in psycho-prophylaxis of military units in the field of mental hygiene [40]. In the civilian sector it may be transformed into appeal for better training for general practitioners and members of special medical-psychological expert groups involved in crew members medical examinations.

Resilience to stress is an extremely important feature for the Navy personnel, as well as merchant crews' members. According to existing views, it may be both a predisposition and a trained quality. Studies trying to measure biological, psychological, cognitive, behavioural, emotional and spiritual dimensions of resilience have revealed that regulation of fear and anxiety, impulse control and prosocial behaviour may be very important factors. Evaluation of successful servicemen has identified optimism, altruism, moral principles, humour, spirituality, goals in life and constant training as main factors of resilience [41]. There is also a great body of research proving that resilience to stress is the result of the personality development, which implies interventions from rather early childhood, for instance, exposure to mild stress sometimes referred as stress-inoculation [42]. Because of this modern approaches of selection of the staff should pay more attention to all periods of life of the candidate, including early ones. Modern studies of genetics and epigenetics of stress and resilience may soon shed light on intrinsic mechanisms of this phenomenon and possibly may produce a set of more objective predictors that may be assessed before the enrolment of the serviceman or a civilian seafarer [10].

In addition to the better and more focused selection of the staff, one of the issues is improving help-seeking behaviours by young adults in cases of psychological crisis. Military (and Navy in particular) culture may become a barrier for help-seeking when first signs of mental health disturbance or suicidal crisis emerge, thus a policy should be developed that may help to overcome this obstacle. This is absolutely true for merchant ships crews as well, so far as masculine culture is inherent to the maritime profession in general. Multicultural and multilingual cargo ship crews in this respect may exert additional problems due to restricted communication and inability of crew members and officers to notice depression or exacerbation of any other disorder, except of course most severe ones. Studies also suggest

that improving mental health literacy, reducing stigma, and enhancing the desire of young people for self-reliance may have a positive effect. Much depends also on life goals, meaning in life and self-determination, which is a deep feeling, also depending on the prestige of the seafarers' profession.

Another important practical goal is better training of the personnel, from officers to sailors. In the Navy it may be an additional task for the medical doctor on board [43]. Given limited resources in the civilian sector, better education for all crew members regarding mental health problems, anxiety, signs of depression, stress, crisis, suicidal thoughts, healthy lifestyles, and coping practices should be promoted. The atmosphere of general awareness regarding mental health issues is an important part of the healthy crew. Recent initiatives in this field like creating a Healthy Ship — a healthy lifestyle intervention, encompassing executive health, catering services, medical services, and physical training — give an excellent example that Navy can present to the merchant fleet. This intervention also implies the formation of an effective Unit Health Committee, aimed to promote a healthy lifestyle culture [44]. Many authors call for similar initiatives in the merchant fleet, including health-promoting interventions, physical exercise courses for the crew, smoking cessation, healthy cooking courses, developing positive practices that may strengthen the team spirit, social cohesion, etc. [31, 32]. The challenge, of course, would be to implement these interventions in the conditions on board, especially in the modern cargo ships with rotating crews. On the other hand, much depends on the leadership, and many positive actions may be introduced if there are a will and understanding of the importance of the problem.

CONCLUSIONS

More attention should be paid to mental health promotion and suicide prevention on board, both in the Navy and the merchant fleet. Not only direct psychological aid, but wider issues like collaboration and mutual goals understanding by officers, medical services, examination and certification system, marine educational system (both naval and civilian), families, servicemen, sea industry workers and employees and trade unions are needed. Three main strategies may be suggested: wider measures that improve general well-being and psychological context together with resilience training, better identification of those at risk together with the development of the atmosphere of confidence and help-seeking, and better education of responsible officers and crew members regarding mental health problems that may enhance early identification and timely support. Many suicides can be prevented and many problems of mental health may be solved if the general level of knowledge and awareness in the Navy and the merchant fleet will be enhanced and if officers and staff will better understand mental health determinants. It should be promoted within the whole marine educational system, both military and civilian, starting from cadets' education.

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CASE REPORT

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A cruise ship emergency medical evacuation triggered by handheld ultrasound findings and directed by tele-ultrasound

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ABSTRACT

Cruise ships travel far from shoreside medical care and present a unique austere medical environment. For the cruise ship physician, decisions regarding emergency medical evacuation can be challenging. In the event that a passenger or crew member becomes seriously ill or is injured, the use of point-of-care ultrasound may assist in clarifying the diagnosis and stratifying the risk of a delayed care, and at times expedite an emergent medical evacuation. In this report we present the first case reported in the literature of an emergency medical evacuation from a cruise ship triggered by handheld ultrasound. A point-of-care ultrasound performed by a trained cruise ship physician, reviewed by a remote telemedical consultant with experience in point-of-care ultrasound, identified an ectopic pregnancy with intraabdominal free fluid in a young female patient with abdominal pain and expedited emergent helicopter evacuation from a cruise ship to a shoreside facility, where she immediately underwent successful surgery. The case highlights a medical evacuation that was accurately triggered by utilising a handheld ultrasound and successfully directed via a tele-ultrasound consultation. American College of Emergency Physicians (ACEP) health care guidelines for cruise ship medical facilities should be updated to include guidelines for point-of-care ultrasound, including training and telemedical support.

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Key words: cruise ship medical evacuation, point-of-care ultrasound, ectopic pregnancy, tele-ultrasound

INTRODUCTION

The cruise industry estimates that 28.5 million passengers took part in a cruise in 2018 — an increase of 7% from the previous year — for an average of 7 days [1]. This number can only be expected to grow, as over 120 new ships are on order at shipyards around the world with an average capacity of over 2000 passengers, as well as crew members [2]. It is inevitable that some passengers and crew members will become seriously ill or injured while at sea, at times far away from shoreside medical facilities. Medical care aboard cruise ships is guided by American College of Emergency Physicians (ACEP) Section of Cruise Medicine's Guidelines [3]. The guideline makes recommendations for training of physicians and nurses, medications, and equipment on board to ensure that passengers and crew who become ill or injured while at sea receive the best care possible in the austere maritime environment. On board, patients are cared for by the physicians and nurses of the ship's medical centre, and the vast majority of these patients are managed on board until resolution or until the next scheduled port call. Rarely, when patient's needs exceed onboard capabilities, a diversion or emergent medical evacuation is required. Decision on an emergency medical evacuation is one of the most complex decisions the cruise ship physician has to make. Often, these decisions are undertaken with incomplete data due to the limitations of diagnostic testing on board. Increasing diagnostic certainty can help the physician make the decision to divert a ship or evacuate a patient with more accuracy and greater confidence.

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In recent years, point-of-care ultrasound (POCUS) performed by clinicians at the bedside has transformed diagnostics in emergency medicine [4]. At George Washington University, we operate a not-for-profit academic maritime medical advisory service. Our Maritime Medical Access telemedicine group, along with ultrasound faculty, have provided assistance to a cruise line through the acquisition of ultrasound equipment, development of POCUS protocols, training of physicians and nurses in POCUS, and tele-ultrasound support and interpretation after deployment of ultrasound equipment.

We present a case where ultrasound led to a dramatic shift in a patient's care and prompted helicopter evacuation. This case highlights a successful medical evacuation that was accurately triggered by utilising a handheld ultrasound and successfully directed via a tele-ultrasound practice.

CASE REPORT

A 25-year-old female crewmember presented to the ship's medical centre at 16:35 hours on a sea complaining of abdominal pain for 1 day. The pain had been of varying intensity but was now 10 out of 10 in severity. Her pain was more prominent in the right lower quadrant. There was no reported vaginal bleeding or discharge. Vital signs were normal, and the patient was afebrile. Examination was significant for a soft abdomen, with positive tenderness and voluntary guarding of the right lower quadrant. Absent were rebound tenderness or signs of an acute abdomen. The remainder of her examination was normal. Pelvic examination was deferred.

Laboratory evaluation was significant for a white blood cell count of 14 × 10^3 per mcl, a haematocrit of 29.7%, platelets of 247 × 10^3 per mcl, a C-reactive protein level of < 5 mg/L, and normal renal function and electrolytes. A urine pregnancy test was performed that indicated a new diagnosis of pregnancy; a urinalysis was normal. Last menstrual period dating placed the pregnancy at 8 weeks 3 days gestation.

Considering a wide range of important differential diagnoses including ectopic pregnancy, ovarian torsion, ruptured ovarian cyst, and appendicitis, a transabdominal pelvic ultrasound was performed by the cruise ship physician utilising a handheld ultrasound. With the finding suggestive of a ruptured ectopic pregnancy, the shoreside telemedicine team was consulted and images were transferred for review by the shoreside telemedicine team including an emergency physician with tele-ultrasound experience. The ultrasound revealed a uterus empty of a gestational sac, or any signs of intrauterine pregnancy including a yolk sac or foetal pole (Fig. 1). In addition, the ultrasound demonstrated the presence of a complex cystic mass in the adnexa (Fig. 2), and free intraperitoneal fluid in the right upper quadrant (Fig. 3).

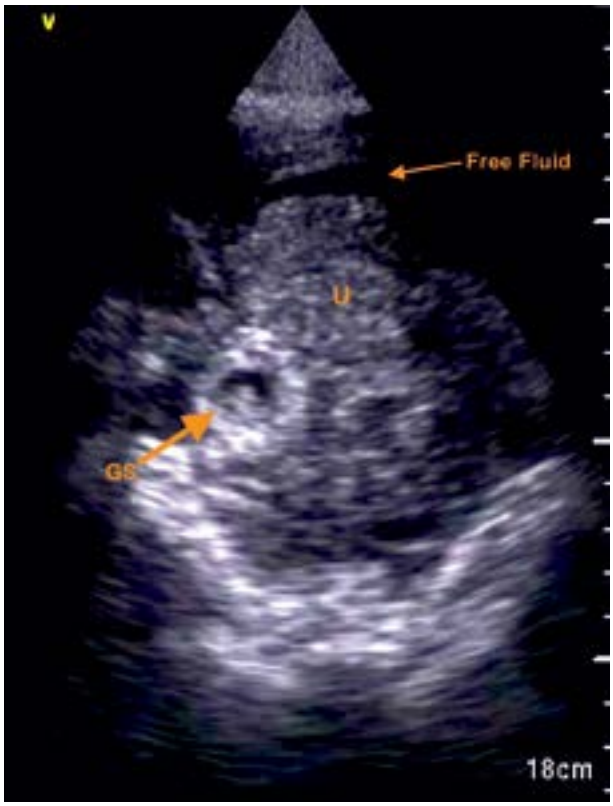

Figure 1. Transabdominal pelvic ultrasound image from a 23-year-old 8-week pregnant crewmember. Transverse view shows empty uterus (U) surrounded by anechoic free fluid (arrow), with visualised gestational sac (GS) and foetal pole to the right adnexa encircled by hyperechoic decidual ring

The vessel was at sea, with the next port call scheduled for the following morning at 08:00. As the next port had no surgical facilities, the decision was made to coordinate a helicopter evacuation with the United States Coast Guard. The evacuation was initiated by 18:31. At the point of evacuation, she had become tachycardic and hypotensive, consistent with a clinical presentation of early haemorrhagic shock. After coordination with the receiving institution, she was flown directly to a shoreside hospital, where the diagnosis of ruptured ectopic pregnancy and haemoperitoneum was confirmed. She was transferred to the operating room and underwent an emergent laparoscopic salpingectomy.

DISCUSSION

This is the first case that we have identified in the medical or maritime literature where ultrasound performed by the onboard cruise ship staff led to a successful emergency evacuation of a patient with life threatening clinical condition, resulting in expeditious surgical management. Cruise lines almost without exception prohibit pregnant women who will be in their 24th week of gestation at any point during the cruise, limiting potential medical complications

Figure 2. Transabdominal pelvic ultrasound image from a 23-year -old 8-week pregnant crewmember. Sagittal view shows empty uterus (U) with gestational sac (GS) and foetal pole can be seen in adjacent right adnexa. A thin rim of free fluid is noted around the fundus of the uterus; B — bladder

Figure 3. Transabdominal pelvic ultrasound image from a 23-year -old 8-week pregnant crewmember. Right upper quadrant view shows free intraperitoneal fluid (FF) in Morison's pouch; L — liver; K — right kidney

for patients with viable pregnancies [5]. Ectopic pregnancies often present during first and early second trimester, however, and therefore are to be found in the cruising population of pregnant women. A high index of suspicion for ruptured ectopic pregnancy is required, and ultrasound findings can help to increase clinical suspicion of ruptured ectopic pregnancy (free peritoneal fluid, empty intrauterine cavity, adnexal mass) as well as haemodynamic instability because of the resultant haemoperitoneum. Presence of free fluid in Morison's pouch may predict the need for operative management [6]. Ruptured ectopic pregnancy combines two limitations of care found in the maritime medicine environment — absent surgical capabilities, and lack of blood products.

Point-of-care ultrasound is a skill that can be very helpful to the cruise medicine physician, and a review of the ACEP' emergency ultrasound guidelines point to several indications useful to physicians working in cruise medicine who face cases of shock, vaginal bleeding, dyspnoea, abdominal pain, chest pain, change in vision, and swollen extremities, all syndromes where a diagnosis can be made easily with POCUS [4].

Ultrasound equipment has evolved rapidly over the past two decades, with large radiology cart-based systems being replaced at the point of care by smaller cart-based machines, laptop-sized machines, and truly handheld ultrasounds that can connect to a tablet or smart phone. Factors that should influence decisions about which machine to buy include what type of examinations will be done, whether superficial (e.g. for vascular access and foreign body imaging) and deep structures (e.g. transabdominal obstetrical, cardiac, and abdominal imaging) will both be imaged (as this requires two probes for vast majority of manufacturers), cost, plan for storage of images, and image quality.

Protocols for ultrasound imaging should be focused on clinically important diagnoses that impact the course of treatment for patients aboard ships. Identification of surgical emergencies such as ruptured ectopic pregnancy and intraperitoneal bleeding is paramount, as it can take critical time to get a patient at sea transferred to the care of a surgeon. Lung and cardiac ultrasound can expedite the diagnosis of patients with congestive heart failure, pneumonia, right heart strain, and pericardial effusion, leading to earlier administration of the correct therapy for patients with

unclear causes of hypotension or dyspnoea. Normal findings can be reassuring or help to rule out certain diagnoses.

One of the limiting factors for implementation of POCUS aboard cruise ships is the need for initial and ongoing training of onboard physicians. Cruise ships move 7 days a week, 52 weeks a year, providing little time to set aside for initial training or refresher courses. New physicians frequently rotate to the ship's medical centre, creating an ongoing need for initial training. Our team has found that structuring training into a port call at the home port at the end of one cruise and before the beginning of the next is feasible. One team of trainers can train multiple medical centre teams over several days, as other ships come to the home port. Pre-recording lectures to maximize hands-on scanning time during these trainings makes the best use of the small training window.

Tele-ultrasound is the use of technology to bring ultrasound from the bedside of a patient to the screen of a remote expert [7]. We use a store-and-forward tele-ultrasound system with a commercially available cloud service. Ultrasound images are obtained by the ship's physicians at the bedside and sent to our telemedicine and tele-ultrasound team along with clinical information and initial image interpretation. Our tele-ultrasound specialists may request further views to ensure that the patients receive the appropriate diagnosis and targeted therapy for their condition.

We suggest that future revisions of the ACEP Health Care Guidelines for Cruise Ship Medical Facilities should include POCUS, and cruise lines should ensure that physicians working on board have both access to ultrasound equipment as well as to training and ongoing quality assurance.

CONCLUSIONS

This case report highlights an emergent medical evacuation in a case with ruptured ectopic pregnancy that was initiated by utilising a handheld ultrasound, successfully directed via tele-ultrasound consultation. The ultrasound findings consistent with a ruptured ectopic pregnancy led to a helicopter evacuation to a coastal hospital, where the patient received expedited definitive surgical management. Training cruise ship physicians to perform POCUS and establishing tele-ultrasound and maritime protocols may streamline clinical decision-making. Future revisions of the ACEP Health Care Guidelines for Cruise Ship Medical Facilities should address the use of POCUS, and cruise lines should ensure that physicians working on cruises board have access to ultrasound equipment as well as to training, tele-medical support, and ongoing quality assurance.

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Is physical and psychological work stress associated with fatigue in Danish ferry ship employees?

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ABSTRACT

Background: *Fatigue is a recognised risk factor for safety in seafaring. While always dangerous, fatigue in ferry shipping is especially hazardous as it may jeopardise passengers' safety. To counteract fatigue, knowledge on its determinants is important. Little, however, is known on the influence from physical and psychosocial work environment factors within ferry shipping. The aim of the study was to investigate the association between work stress in terms of physical stressors, perceived job demands and job control and different dimensions of fatigue among ferry ship employees and to test whether a potential effect of work stress was mediated by sleep satisfaction.*

Materials and methods: *The design was cross-sectional. 193 respondents answered to a self-administered questionnaire including standardised scales, i.e. the Swedish Occupational Fatigue Inventory and the Copenhagen Psychosocial Questionnaire for job demands and control. The association of risk factors with fatigue was determined using hierarchical multiple linear regression analyses.*

Results: *Physical work stressors were positively associated with only one of five fatigue subscales: lack of energy. Higher levels of demands were related to more lack of energy, lack of motivation, physical exertion and sleepiness, while more control was related to lesser lack of energy, lack of motivation and sleepiness. No demand-control interaction was found. Effects of demand and control were partly mediated by sleep satisfaction.*

Conclusions: *Although limited by its cross-sectional design this study provides support for the independent relevance of demands and control for employee fatigue in ferry shipping and* for a mediating role of sleep satisfaction.

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Key words: fatigue, demand-control model, job demands, job control, psychosocial work environment, sleep satisfaction, seafaring, seafarers

INTRODUCTION

Fatigue is a recognised problem in an occupational context [1–3]. It refers to 'a state of an organism's muscles, viscera, or central nervous system, where prior physical activity and/or mental processing, in the absence of sufficient rest, results in insufficient cellular capacity or system wide energy to maintain the original level of activity and/or processing by using normal resources' [3]. Symptoms range from minor and quick to resolve by sufficient rest to severe and hard to alleviate or chronic [3].

In the working population the more chronic type of fatigue has been associated with impairments comparable to those of patients with chronic disease (e.g. fibromyalgia and temporomandibular joint dysfunction); physical discomfort, pain and memory and/or cognitive degradation [3, 4], resulting in sickness absenteeism and work disability [5, 6]. Furthermore, fatigue is a risk factor for occupational safety, particularly in the transport industry [3] including shipping [3, 7–11]. Fatigue in ferry shipping is especially hazardous as it may jeopardise passengers' safety [12, 13]. Almost 89% of ferry crew members reported that tiredness had led to loss of concentration while at work, up to one third had been involved in a fatigue-related incident or accident and a little less than one fourth had fallen asleep at work more than once a month [13, 14]. These rates are comparable to those in other transportation sectors (76%

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in seafaring [15], 71% in road transportation [16], 75–90% in aviation [17]) but considerably higher than the 16–38% reported from the general work force [18–20].

A first step towards counteracting this problem by preventive programmes is acquiring knowledge about factors determining fatigue in seafaring [7, 8]. Recent systematic reviews on fatigue in seafarers found most evidence to be available for proximal influence factors, such as sleep deprivation and irregular work-rest scheduling [8, 21, 22]. In contrast, the role of specific work tasks and working conditions, including the physical and psychosocial working environment has been investigated by too few studies to provide any conclusive evidence [21]. However, these factors have been consistently linked to fatigue in onshore working populations [18, 23–25].

According to the Demand-Control model [26], which has been widely used in international research on occupational stress since the 1980s, strain results from the experienced level of job demands as well as the level of control over tasks and the way they are performed [25–27]. The impact can occur either due to main or buffer effects. According to the former, high strain results separately from either high demands or low control or both, while the latter predicts that high demands lead to strain only when perceived control is low [26].

To the authors' knowledge no study has yet applied the Demand-Control model in ferry shipping and no studies have tested the suggested buffering effect in a seafaring context. However, a recent study tested the effect of job demands in seafarers working on board cargo ships, container ships and passenger lines and found high job demands to be associated with physical symptoms (e.g. gastrointestinal discomfort) and unhealthy behaviours (e.g. smoking) [28]. Yet another study used the main effects model in seafarers of supply vessels for the oil and gas industry and found high levels of demands as well as low levels of control associated with more fatigue [29]. However, this specific subgroup of employees may not be representative for seafarers in general.

High levels of job demand and/or low levels of job control have an adverse influence on sleep quality in land-based occupations [23]. Furthermore, the body of literature has shown that sleep deprivation and/or poor-quality are associated with higher levels of fatigue among seafarers [8, 21, 22], and it supports a mediating effect from sleep quality on other outcomes than fatigue in onshore settings (e.g. sleep fragmentation has been found to mediate the relationship between social climate and psycho-somatic complaints among full time employees in finance, health care and management [30]). Despite this, to date, a potential mediating effect from sleep-related factors on fatigue has yet to be tested in an onshore- as well as in a seafaring context.

The objective of the present article was therefore to investigate if physical work environment stressors as well as perceived job demands, and job control had an additive effect on different dimensions of fatigue among crew members and terminal workers in Danish ferry shipping. Further, an interactive effect between job demands and job control on the different dimensions of fatigue was tested. Finally, it was investigated whether a potential effect of work stress is mediated by sleep satisfaction.

MATERIALS AND METHODS

The present study was based on a cross-sectional survey design, using a standardised questionnaire battery for data collection. The checklist 'Strengthening the Reporting of Observational Studies in Epidemiology' was used for guidance of reporting [31].

PARTICIPANTS AND PROCEDURE

Participants were recruited from two Danish ferry ship companies; Company 1 operating five domestic and two internationals services (all services were included in the study) and Company 2 operating three international services (one service was included into the study). Data was collected from April to the end of September 2015. Ferry ships were laid up overnight meaning that most crew members slept at home (though still on call during their service periods), alternatively in onshore watch rooms. Therefore, preconditions, such as sleeping environments and schedules (including working early mornings, evenings and late nights) were mostly similar and both groups were considered eligible for the study and invited for participation via written information materials. The questionnaire was made available to 513 employees, electronically on the companies' intranet as well as in a printed form; Company 1: n = 281 and Company 2; n = 232 (179 terminal workers and 334 crew members), and 193 employees returned a completed questionnaire yielding a response rate of 56% and 16%, respectively. Characteristics of the study population are presented in Table 1.

The study was approved by the Danish Data Protection Agency [32]. According to Danish law questionnaire surveys like the one used in the present study do not need approval from an ethics committee (§14) [33], and consent to participate was given by 'explicit enactment', i.e. by submitting the questionnaire (§3) [32, 34].

MEASUREMENT

Outcome

Fatigue was assessed using the second version of the Swedish Occupational Fatigue Inventory (SOFI) [1]. The English version was translated into Danish using the translation/back-translation technique [35]. SOFI includes 20 symptoms of fatigue to be rated on response scales from

Table 1. Characteristics of the study population and the working environment

	Number	Per cent	Mean	SD
Age	172		47. 6	12.4
Gender (female)	19	11		
School education				
≥ 7th grade — technical school	90	57		
Gymnasium education	68	43		
Professional education				
Vocational training	77	45		
University college and university	94	55		
Professional group				
Officers	102	53		
Non-officers	91	47		
Living with a partner (yes)	135	78		
Children under 6 years old (yes)	25	15		
Ferry ship company				
Company 1	156	81		
Company 2	37	19		
Workplace				
Terminal	34	18		
Ferry ship	158	82		
Number of workdays per week	179		3.85	0.90
Typical time of work				
Day and evening	96	52		
Day, evening and night	89	48		
Sleeping at the workplace/on board (yes)	72	45		
Physical activity				
0–4 hours per week, low intensity	53	31		
≥ 2 hours per week, high intensity	119	69		
Smoking (yes)	43	25		
Sleep satisfaction (1 [low] – 10 [very high])	167		6.42	2.34
Disturbance by the physical work environment (1 [low disturbance] — 5 [high disturbance])	189		2.07	0.71
Job demands (0 [low] – 25-50-75-100 [high])	184		48.86	14.18
Job control (0 [low] – 25-50-75-100 [high])	185		48.78	18.10
SOFI — Lack of energy (0 [very low] – 6 [very high])	166		2.02	1.55
SOFI — Physical exertion (0 [very low] – 6 [very high])	166		1.21	1.31
SOFI — Physical discomfort (0 [very low] – 6 [very high])	166		1.48	1.43
SOFI — Lack of motivation (0 [very low] – 6 [very high])	166		1.56	1.45
SOFI — Sleepiness (0 [very low] – 6 [very high])	166		1.79	1.40

SOFI — Swedish Occupational Fatigue Inventory; SD — standard deviation

0 = 'not at all' to 6 = 'to a very high degree' with regard to how respondents felt when they had been most tired at work during the last 4 weeks. The instrument involves five sub-dimensions: 1) lack of energy (LE), 2) physical exertion (PE), 3) physical discomfort (PD), 4) lack of motivation (LM), and 5) sleepiness (S) with four items each [1]. A sum score

was calculated for each of the five subscales [1]. Cronbach's alphas for the subscales ranged from 0.86 to 0.93.

Exposures

Demand and control were assessed by four subscales of the Copenhagen Psychosocial Questionnaire (COPSOQ) — a validated Danish counterpart to the Job Content Questionnaire [36] ('quantitative demands' [4 items], 'work pace' [3 items], 'influence at work' [4 items], and 'opportunities for professional development' [4 items]). All 15 items were to be rated either on a 5-point scale indicating frequency ('always' to 'almost never/never') or agreement ('to a very large extent' to 'to a very small extent'). 'Quantitative demands' and 'work pace' were then added up to a total 'job demands'-scale while 'influence at work' and 'opportunity for professional development' were summed up to a summary 'job control'-scale [36]. Cronbach's alphas ranged from 0.79 to 0.82. To test the interaction between job demands and job control the two variables were first centred and then multiplied.

Covariates

Socio-demographic characteristics, such as age, gender, country of birth, school education (technical college/ /gymnasium education), professional education (vocational training/university college and university) and living with a partner (no/yes) were considered as standard covariates. Also, professional group (officers/non-officers), ferry ship company (company 1/2), workplace (ship/terminal), number of workdays per week, night work (no night work/night work [indicating shift work]), sleeping at the workplace (yes/no), children under six living at home (no/yes), physical activity (0–4 hours per week, low intensity/≥ 2 hours per week, high intensity) and smoking (no/yes) were tested [11, 22, 23, 37]. Satisfaction with sleep was assessed via a 10-point rating scale (from 'completely satisfied' to 'not satisfied at all'). Finally, five single-item questions were used for measuring physical work environment stressors (noise, vessel movements, vibrations, heat, cold) based on 5-point frequency rating scales ('almost all the time' to 'almost never'). The five measures were combined into an overall index, i.e. a sum-up score of all five items [11, 21, 22, 37].

DATA ANALYSIS

When summing up scores for the SOFI- and COPSOQ-subscales missing values were replaced by individual subscale means in accordance with the instrument's guidelines [1, 36]. Point-biserial and Pearson correlations were used to determine bivariate associations between fatigue scores and potentially associated variables, and the results are presented in Table 2. Age, gender and those individual or job characteristics which had been associated with at least one fatigue dimension on the bivariate level ($p < 0.05$), were included as potential confounding factors in the multivariable analyses. The only exception to this was 'vocational education'. Since this variable was highly correlated with 'professional group', only the latter factor was included in the subsequent analyses.

Prior to multivariable analyses, potential violations of assumptions in terms of linearity, multivariate normality, homoscedasticity and multicollinearity were checked for. Between 0 and 7 multivariate outliers were detected (standard residual > 3 standard deviations), and the respective cases were removed from the final models, leaving the sample size ranging from n = 193 (LE, LM, S) over n = 191 (PD) to n = 186 (PE).

Five models were designed for the prediction of the five fatigue dimensions. On step one, age, gender and those individual or job characteristics which had been associated with one of the fatigue dimensions on the bivariate level ($p < 0.05$) were adjusted for. Environmental stressors, job demands, job control and the demand-control interaction term were entered on step 2 (Table 3, Model 1).

To additionally test for a mediating effect of sleep satisfaction, another hierarchical model with the same covariates was run for predicting sleep satisfaction (Table 3, Model 1), after which sleep satisfaction was entered as a final variable into all five regression equations for the fatigue sub-dimensions (Table 3, Model 2). Age, sleep satisfaction, physical environment stress, job demands, and job control were entered as continuous, all others as binary variables. All analyses were conducted with SPSS Statistics 24.

RESULTS

Ninety-eight per cent of the study population were Danish citizens, 89% of whom were male, and mean age was 47.6 (range from 19 to 70) (Table 1). Approximately 50% were officers, 80% were working on board of ferries, and for 50% typical work time involved night shifts. Disturbance by the physical working environment was low to moderate on average while mean scores for demand and control were in the medium range, and for fatigue at the lower end of the scale.

As data came from individual employees nested within different organisational units (terminals and ships), multilevel analyses might have been required. Mixed effect null models showed that a maximum of 4% of the variance in fatigue could be attributed to between cluster differences (intra-class correlations: LE = 0.016, PE = 0.00, PD = 0.021, LM = 0.04, S = 0.02). Due to these low coefficients, standard multiple hierarchical linear regression was used [38].

In the initial model, physical stressors were positively associated with lack of energy ($\beta = 0.23$), physical exertion ($\beta = 0.23$), physical discomfort ($\beta = 0.25$) and sleepiness

Table 2. Bivariate correlations between personal characteristics, worksite characteristics, work stressors and different dimensions of fatigue

	SOFI — Lack of energy	SOFI — Physical exertion	SOFI — Physical discomfort	SOFI — Lack of motivation	SOFI — Sleepiness
Age	–0.02	–0.05	–0.08	–0.13	–0.13
Gender[1]	0.10	0.02	0.21**	0.06	0.14
School education[2]	0.05	–0.04	0.01	0.03	0.05
Professional education[3]	–0.11	–0.06	–0.20*	–0.12	–0.16*
Professional group[4]	0.14	0.06	0.21**	0.13	0.18*
Living with a partner[5]	0.04	0.10	0.11	0.01	0.07
Children under 6 years[6]	–0.12	–0.06	–0.10	–0.07	–0.07
Ferry ship company[7]	0.09	0.02	0.13	0.04	0.10
Workplace[8]	–0.13	–0.09	–0.16*	–0.14	–0.20*
Number of workdays per week	–0.08	–0.04	0.07	–0.13	–0.06
Typical work time[9]	0.20*	0.16*	0.26**	0.17*	0.19*
Sleeping at the workplace/on board[10]	–0.12	–0.08	–0.13	–0.13	–0.15
Physical activity[11]	–0.10	0.01	–0.04	–0.04	–0.07
Smoking[12]	0.05	0.02	0.07	0.02	–0.01
Sleep satisfaction	–0.50**	–0.38**	–0.42**	–0.50**	–0.56**
Disturbance from the physical work environment	0.39**	0.26**	0.33**	0.26**	0.30**
Job demands	0.40***	0.30***	0.27***	0,34***	0.36***
Job control	–0.25**	–0.20*	–0.17*	–0.30**	–0.27**
SOFI — Lack of energy	1	0.66***	0.70***	0.80***	0.82***
SOFI — Physical exertion	0.66***	1	0.67***	0.74***	0.72***
SOFI — Physical discomfort	0.70***	0.67***	1	0.60***	0.67***
SOFI — Lack of motivation	0.80***	0.74***	0.60***	1	0.84***
SOFI — Sleepiness	0.82***	0.72***	0.67***	0.84***	1

*Significant value: $p < 0.05$; **Significant value: $p < 0.01$; ***Significant value: $p < 0.001$; SOFI — Swedish Occupational Fatigue Inventory
[1]Female = 2; [2]Primary school = 1, secondary school = 2; [3]Vocational training = 1, university college/university = 2; [4]Officers = 1, non-officers = 2; [5]Yes = 2; [6]Yes = 2; [7]Company 1 = 1, Company 2 = 2; [8]Terminal = 1, ferry ship = 2; [9]Day and evening = 1, day, evening and night = 2; [10]Yes = 2; [11]0–4 hours per week/low intensity = 1, ≥ 2 hours per week/high intensity = 2; [12]Yes = 2

(β = 0.17). Job demands were positively associated with lack of energy, physical exertion, lack of motivation and sleepiness after controlling for potential confounders (LE, β = 0.33; PE, β = 0.21; LM, β = 0.32; S, β = 0.31; Table 3, Model 1) while negative associations with the same subscales were found for job control (LE, β = –0.26; PE, β = –0.24; LM, β = –0.36; S, β = –0.28). In contrast, for none of the outcomes did the findings suggest an interaction between job demands and job control.

Testing additionally for associations between job-related stress and sleep satisfaction showed that perceived stress from the physical environment and job demands were negatively (β = –0.19, β = –0.22) and job control positively associated with perceived sleep quality (β = 0.22). No indication for a demand-control interaction was found (Table 3, Model 1).

Adding sleep satisfaction to the models predicting fatigue showed a significant association of this factor with all five aspects of fatigue, indicating that higher subjective sleep quality was associated with less experience of fatigue (Table 3, Model 2). In these final models, physical-environment work stressors were only associated with lack of energy (β = 0.16), physical exertion (β = 0.18) and physical discomfort (β = 0.20). Higher levels of perceived demands were still significantly associated with more lack of energy (β = 0.25), lack of motivation (β = 0.25), and sleepiness (β = 0.23). Similarly, more job control was related to lesser lack of energy (β = –0.19), physical exertion (β = –0.18), lack of motivation (β = –0.28) and sleepiness (β = –0.19). Again, there was no indication of a demand-control interaction.

Comparing prior findings for the association between work stress factors and fatigue without adjustment for sleep

Table 3. Multivariable associations between physical and psychosocial work stressors, sleep satisfaction and different dimensions of fatigue

	SOFI — Lack of energy (n = 156)			SOFI — Physical exertion (n = 149)			SOFI — Physical discomfort (n = 154)			SOFI — Lack of motivation (n = 154)			SOFI — Sleepiness (n = 154)			Sleep satisfaction (n = 156)		
Model 1	β	R^2	R^2 change	β	R^2	R^2 change	β	R^2	R^2 change	β	R^2	R^2 change	β	R^2	R^2 change	β	R^2	R^2 change
Age	0.04			−0.01			0.02			0.00			−0.02			−0.05		
Gender [a]	0.01			−0.07			0.15			−0.01			0.04			−0.18*		
Workplace [b]	−0.07			−0.07			−0.01			−0.04			−0.07			−0.16		
Professional group [c]	−0.01			−0.13			0.08			−0.04			0.02			−0.09		
Typical time of work [d]	0.04	0.07		0.10	0.04		0.18*	0.13**		0.07	0.07		0.08	0.10**		0.02	0.08*	
Physical working environment	0.23**			0.23**			0.25**			0.15			0.17*			−0.19*		
Job demands	0.33***			0.21*			0.14			0.32***			0.31***			−0.22*		
Job control	−0.26**			−0.24**			−0.10			−0.36***			−0.28***			0.22**		
Demand*control	0.06	0.32***	0.25***	0.10	0.25***	0.19***	0.09	0.29**	0.12**	0.10	0.34***	0.26***	0.06	0.31***	0.22***	−0.06	0.22***	0.15***
Model 2	β	R^2	R^2 change	β	R^2	R^2 change	β	R^2	R^2 change	β	R^2	R^2 change	β	R^2	R^2 change	β	R^2	R^2 change
Age	0.02			−0.03			−0.01			−0.03			−0.05					
Gender	−0.06			−0.12			0.11			−0.06			−0.04					
Workplace	−0.13			−0.12			−0.05			−0.10			−0.15*					
Professional group	−0.04			−0.15			0.06			−0.07			−0.01					
Typical time of work	0.05	0.07		0.10	0.04		0.18*	0.13**		0.08	0.07		0.08	0.10**				
Disturbance by physical working environment	0.16*			0.18*			0.20*			0.08			0.08					
Job demands	0.25**			0.16			0.10			0.25**			0.23**					
Job control	−0.19**			−0.18*			−0.05			−0.28***			−0.19**					
Demand*control	0.04	0.32***	0.25***	0.09	0.25***	0.19***	0.07	0.29**	0.12**	0.08	0.34***	0.26***	0.04	0.31***	0.22***			
Sleep satisfaction	−0.35***	0.42***	0.10***	−0.25**	0.30**	0.05**	−0.24**	0.33**	0.04***	−0.34***	0.43***	0.09***	−0.42***	0.45***	0.13***			

Model 1: Prediction models without sleep satisfaction. Model 2: Prediction models including sleep satisfaction. β — standardized regressions coefficient; R^2 — R square; R^2 change — R square change. *Significant value: $p < 0.05$; **Significant value: $p < 0.01$; ***Significant value: $p < 0.001$; [a]Female = 2. [b]Terminal = 1, ferry ship = 2. [c]Officers = 1, non-officers = 2. [d]Day and evening = 1, Day, evening and night = 2; SOFI — Swedish Occupational Fatigue Inventory

satisfaction (Table 3, Model 1) and subsequent findings after adjustment (Table 3, Model 2) showed that in particular the significant associations for demand and control with the different aspects of fatigue remained but were reduced in size. Adding sleep satisfaction to the models significantly increased explained variance in all fatigue sub-dimensions (Table 3, Models 1 and 2) by 4% (PD) to 13% (S) with overall explained variance ranging between 30% (PE) and 45% (S).

DISCUSSION

This study aimed to test additive and interactive effects of work stress levels on different dimensions of fatigue and revealed supportive evidence only for additive effects. Effects tended to be stronger for psychological than for physical aspects of fatigue and adding sleep satisfaction improved predictive power while reducing the effect sizes for job demands and control, suggesting that parts of the effects of perceived job demands and control are mediated via sleep quality.

LIMITATIONS OF THE STUDY

Given the cross-sectional design of the study the observed associations are not interpretable as cause-effect associations. Thus, to which extent perceived demands and control increase fatigue or higher levels of fatigue contribute to perception of higher demands and lower experience of control or — most likely — there is a genuine reciprocal influence, cannot be determined. Causal ambiguity is also created by using a self-report questionnaire, and self-report measures are known to be prone to biases such as recall bias, social desirability bias and negative affectivity [39]. Thus, for instance, respondents with higher fatigue problems might be more likely to recall and report high demands and low control and vice versa. Moreover, it cannot be excluded that respondents in general underreported fatigue since high fatigue levels at work are considered problematic, even though all participants were assured confidentiality of data and were able to submit their responses without personal identification. A further limiting factor is the response rate since in particular the low response of employees from Company 2 implies the possibility of selection effects in terms of non-response/selective response and thereby potentially biased results [40]. Despite assurances of confidentiality it cannot be excluded that some of those with higher fatigue or more work stress were more reluctant to participate in the survey while reverse effects, i.e. employees with higher dissatisfaction being more motivated to participate in a work-place survey have also been known. As for external validity the low participation rate in Company 2 and in general of those working the terminals are limiting the generalisability of the study findings. Still, it should be noted that 1) other characteristics of the study sample (males in their later forties, half of whom were officers and for half of whose typical worktime involved night shifts) are in line with those of the general population of crew members working in Danish ferry shipping [41], and 2) that comparison of study participants and the total of employees did not show any significant difference in terms of age, gender, rank or working at a terminal versus on board ferry ships.

THE ROLE OF JOB DEMANDS AND JOB CONTROL

Findings from the present study are consistent with the assumption of an association between physical and psychosocial work stressors and fatigue in Danish ferry shipping employees. Perceived job demands, and job control were generally more important than disturbance from the physical working environment, which may reflect a general tendency in seafaring towards a reduction of strenuous manual labour performed primarily outdoors in inclement conditions. In the same vein, it is notable that the potential impact of job demands, and control was primarily expressed in terms of lack of energy, lack of motivation and sleepiness rather than physical exertion or discomfort [1]. This too indicates that ferry shipping nowadays might be more mentally than physically fatiguing [42], given a context characterised by time pressure and late and/or shifting working hours.

In accordance with the strain hypothesis of the demand-control model [26] results from the present study clearly support an additive effect of job demands and job control on fatigue; especially the psychological fatigue dimensions and sleepiness. No support was found for the buffer hypothesis since there was no indication of an interaction effect. This agrees with findings from many other studies in the occupational field as documented by a series of reviews [25, 27, 43]. However, it remains unclear to which extent this prevalent lack of buffering effects may be due to conceptual limitations. It has been suggested that there must be a close match between the type of demands and the available coping resource for buffering to occur [44], while broader types of measures such as the ones used in the present as well as many other studies might have problems detecting such effects [25, 27]. Interpreting present results in this light, it is suggested that a general sense of control might not be an adequate resource to buffer the effect from job demands on fatigue in a highly regulated workplace where all tasks are subjected to strict time schedules. In such circumstance's decision latitude, while still important, as reflected in the main effect found, may have less impact on the level of task demands, which might make buffering more difficult. As outlined in the introduction section, findings from other studies, though still few, suggest that psychosocial factors are linked to fatigue in ferry shipping as well as in other sectors of the seafaring industry [8, 21, 22, 28, 29]. As occupations and activities undertaken in

this industry are various, heterogeneity in psychosocial and/or fatigue profile across sectors–is possible [3, 45]. This is further supported by considering that psychosocial factors, like job demands and job control, originate from highly specific social structures and contexts [46, 47], as well as fatigue measurement may hinge upon the interpretation of words presented in measurement tools and/or depend on the interpretation of fatigue-related signs [3]. However, studies that investigate heterogeneities in profiles and associations between factors in a seafaring context are seemingly still lacking, and therefore it remains uncertain to what extent ferry crew members show different associations as compared to other sea- or land-based occupational groups. Therefore, it is important that future knowledge on psychosocial working conditions and fatigue in seafaring is derived from studies that allow for 1) an investigation of a more complex and specific nature of occupation-specific work factors and their relationship with fatigue, and 2) a comparison between type of ships and/or groups of seafarers [11, 48].

THE ROLE OF SLEEP SATISFACTION

As expected, lower job demands and higher job control were associated with higher subjective sleep satisfaction, while sleep satisfaction again attenuated the relation between job demands, job control and fatigue suggesting that a potential effect of these factors on fatigue is partly mediated by sleep quality. Associations between sleep deprivation/poor sleep quality and higher levels of fatigue have been recognised in other types of seafaring than ferry shipping [11, 21] and in other occupational branches [3, 24]. In a prospective study examining the causal direction of longitudinal relations between job demands, job control, sleep quality and fatigue among blue- and white-collar workers, higher demands over time were related to increased sleep complaints, while higher levels of job control led to fewer complaints [23]. Moreover, workers exposed to an increasing amount of high-strain work over time reported more sleep complaints, which also increased over time, while this was not the case for their counterparts in stable low strain or active jobs [23]. It is certainly plausible that a stressful psychosocial work environment negatively affects sleep, which again results in feelings of fatigue. However, fatigued employees are also likely to perceive work tasks as more demanding or to experience less control, thus reinforcing prior levels of fatigue.

It is interesting to note, though, that while sleep satisfaction was a mediator, it did not account for the whole association between job strain and fatigue, suggesting further pathways such as demotivation or burnout processes and/or differences in individual coping resources or actual coping behaviour when it comes to dealing with stressors, such as job demands [49]. Recently two studies have investigated resilience and perceived stress among merchant seafarers, and this concept was found to be cross-sectionally associated with and identified as a predictor of perceived stress (two point of measurement; 10 months follow up) [50, 51]. Therefore, untangling the complex nature of these pathways seems of great importance. It requires future studies using a greater variety of outcomes and longitudinal designs. However, such studies are not common in seafaring yet and they are also difficult to implement in this research area [21, 22].

IMPLICATIONS

The relative low fatigue levels found in this study may suggest that there is a limited need for fatigue-mitigation in the Danish ferry shipping industry. However, variations in fatigue levels may suggest that some sub-groups still require interventions, for instance those working in the terminal and/or non-officers. Further, fatigue has been found to rise over time of duty, also in ferry shipping [9, 42, 48], and even fatigue levels that are not critically high from a perspective of individual health and well-being can endanger the safety of the crew and passengers [3, 7]. In addition, the present study mainly focused on services where ferry ships were laid up overnight. Fatigue-profiles may differ between non- and overnight services, suggesting future studies to (also) include ferry ships with complete nightshift to investigate this in greater details.

Job demands and job control

Results from this study indicate that demand-reducing and control-supporting initiatives should be included into such strategies. Based on research in onshore occupations, ferry shipping companies are encouraged to focus future fatigue-prevention initiatives around staffing adequacy (e.g. adding manpower during peak times) [52–54], task variety (e.g. rotating schemes) [52–54], flexibility in working arrangements (e.g. participation in duty roster planning) [55] and participation in workplace decision making (e.g. in planning of demand-reducing and control-enforcing initiatives) [52–54], which have been found to have a posive impact on perceived job demands and job control.

Sleep satisfaction

Besides job demands and job control it seems that there is a need for also including sleep-related initiatives into fatigue-preventive strategies. In fact, sleep is an important factor to human health, and lack of sleep and poor sleep quality have been associated with risk of stress and strain among workers, including seafarers [8, 11, 21, 22]. Further, evidence has shown that the psychosocial work environ-

ment is relevant for sleep. For instance, in accordance with the results of the present study high levels of job demands and lower levels of job control have been found to have an adverse influence on sleep quality [23]. While there is general evidence in favour of psychosocial and health effects of workplace interventions [52–54], there is still a need for more research testing the impact of changes in the psychosocial work environment on sleep quality. Given positive findings, ferry ship companies might be encouraged to consider specific sleep promoting initiatives, such as offering more comfortable beds in cabins/rooms with little noise and shift-systems that support intra- (e.g. in terms of napping) and inter-shift (e.g. sufficient time between shifts) recovery [56, 57].

CONCLUSIONS

Thus, although limited by its cross-sectional design this study provides support for the independent relevance of demands and control for employee fatigue in ferry shipping and for a mediating role of sleep satisfaction. Therefore, if these findings can be confirmed by longitudinal studies, companies could be encouraged to implement demand-reducing, and control and sleep supporting initiatives, for instance in form of engaging employees in duty roster-planning in combination with comfortable beds in sleep cabins/watch rooms that support intra- and inter-shift recovery. Furthermore, to support effective future fatigue prevention programmes, studies are needed which investigate a wider range of psychosocial factors, including for instance influences from quality of leadership.

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Safety behaviour and healthy diving: a qualitative study in the traditional diverse fishermen

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ABSTRACT

Background: *Traditional divers from the Maluku Province of Indonesia have not received formal education and training related to standard diving tools. They only become accomplished at diving generation by generation. The use of non-standard diving tools increases the risk of injury and illness. This study aimed to get an overview of the health and safety behaviours of traditional divers.*

Materials and methods: *The study was qualitative, involving 15 traditional divers who used compressors for at least 1 year and who'd had decompression sickness and barotrauma as a result of diving. The data was obtained through in-depth interviews, analysed through the Colaizzi method.*

Results: *The participants' diving health and safety behaviour is triggered by the perception of the risk of diving. This is supported by the reinforcing social and environmental factors leading to the form of health and safety behaviour when diving. These behaviours include diving without planning, using a compressor, and making "sesajen" (kind of food, leaves, and water that are believed to be a form of surrender to the creator) which is an offering or present to the gods or ancestors. This behaviour causes complaints such as trauma and an increased economic burden. Some participants consider complaints as a threat and plan to stop diving. The participants made a plan before dive and declared that they would change their behaviour to ensure safety.*

Conclusions: *Health and safety behaviour related to diving must be socialised and facilitated. The establishment of a divers' community that cares about health and safety behaviour needs to become important as a support system.*

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Key words: health and safety behaviours, diving incident, traditional divers

INTRODUCTION

Traditional divers are spread across the territory of Indonesia, especially in the Coastal and Archipelago areas [1]. The diving expertise of traditional divers is obtained from generation to generation. Traditional divers have not received any formal diving education and training. The health and safety behaviour for diving is not standard. The risk of injury and illness due to non-standard behaviour when diving is increased [2].

Traditional divers total 1694 (29%) of fishermen who can dive to a 20 m depth or more. The limitations within the existing facilities and infrastructure cause the using of compressors to be an alternative to Self-Contained Underwater Breathing Apparatus (SCUBA) diving equipment. Data from 2014 to 2017 on the prevalence of barotrauma, paralysis, and the bites of marine animals increased by 25% due to the non-compliance with the health and safety diving standards [2].

Diving is a high-risk job. The increasing of work productivity refers to excellent, safe diving standards and the knowledge of the traditional divers about the risk of hazards

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in high-pressure environments [3]. Non-adherence to safety has fatal consequences such as hearing loss [4, 5]. The prevalence of ear barotrauma, which includes pain (47.9%), transient deafness with tinnitus (27.5%) and vertigo (9.9%), are some of the side-effects of non-compliance with the standard diving rules [3].

This study aimed to get an overview of the health and safety behaviour of traditional divers. The results of this study are expected to provide factual information about the health and safety behaviour of traditional divers. Health care providers will thus be able to provide interventions according to the participant's needs.

MATERIALS AND METHODS

RESEARCH DESIGN

The study used a qualitative design through semi-structured in-depth interviews.

SAMPLE

The participants of this study were the traditional divers and fishermen residing in Ambon City, West Seram District and Buru Regency Maluku Province, East Indonesia. The inclusion criteria were as follows: 1) participants with decompression sickness and barotraumas caused by diving; 2) a history of diving using a compressor; 3) a history of working as a traditional diver for at least 1 year; 4) 25–64-year-old ; 5) communicate verbally well. Based on the recruitment results, 15 participants met the inclusion criteria.

INSTRUMENT

The researcher was an instrument of the qualitative study. This means that from the beginning through to the end of the study, the researcher was actively involved in the research. The data collection was assisted by a recording device and an in-depth interview guideline list. The interview questions included: 1) the perception of the diving risks; 2) the supporting factors for the diving health and safety behaviour; 3) the form of health and safety behaviour when diving; 4) any perceived impact due to the diving action; 5) behaviour after-effects. Field notes are also used to record situations and events including the non-verbal expressions that were shown by the participants during the interviews.

TIME AND PLACE

The study was conducted from 15th January to 15th February 2019. The location of the interview was at the participant's homes. The interview was carried out in three phases: preparation, implementation, and termination.

DATA ANALYSES

The results of the data collection were examined immediately after the interview process. The interview data was analysed using the Colaizzi method consisting of seven stages, namely: 1) describing the phenomena; 2) marking keywords; 3) formulating meaning; 4) determining the theme groups; 5) integrating the theme and sub-theme descriptions; 6) formulating descriptions for a complete set of themes; 7) the validation of the research results with the participants.

ETHICAL CONSIDERATIONS

All of the participants gave their informed consent to be involved in the study. This study has been registered and it passed the research ethics committee of the Health Research Ethics Commission of the Faculty of Nursing, Airlangga University with letter number: 1244-KEPK published on 31st December 2018.

RESULTS

PARTICIPANTS' CHARACTERISTICS

In-depth interviews were carried out with the 15 participants for 30–40 min. All of the participants were men aged 22–62 years old. The length of their use of compressor varied between 2 and 40 years. The history of paralysis experienced also varied between 1 and 6 times. The characteristics of the participants have been summarised in Table 1.

THEMES

A total of 5 themes emerged from the results of the in-depth interviews. The themes include: 1) the perception of the diving risk; 2) the supporting factors of diving; 3) the form of work-based health and safety behaviour; 4) the impact of occupational health and safety behaviour; 5) the behaviour after being affected. The themes and sub-themes have been summarised in Table 2.

Perception of diving risk

This theme explains the initial views on the risks of diving. The participants considered diving at a depth of more than 100 m to be familiar to a person known to them, so the participant did the same. They think there are no health and safety risks (Table 3, quotes 1–3). Some of the participants think that their work as a diver has risks to do with health and safety, but the risk can be eliminated by prayers and "sesajen" (food, leaves, and water that is believed to be a form of surrender to the creator) which is an offering or present to the gods or ancestors (Table 3, quotes 4–5).

Supporting factors of the diving health and safety behaviour

This theme focuses on the participants' and their family's perceptions of the things that are known, experienced,

Table 1. Characteristics of respondents

Code	Gender	Age [year]	Compressor usage [year]	Paralysis history [time]
P01	Male	48	8	2
P02	Male	44	21	3
P03	Male	80	40	6
P04	Male	43	10	2
P05	Male	46	29	3
P06	Male	46	15	5
P07	Male	50	2	1
P08	Male	47	2	1
P09	Male	47	23	2
P10	Male	35	6	2
P11	Male	32	2	1
P12	Male	22	3	1
P13	Male	38	5	1
P14	Male	29	4	1
P15	Male	33	2	1

Table 2. Summary of themes and sub-themes

Themes	Sub-themes
Perception of diving risk	1. No risk 2. Risk, but can minimize by "sesajen"
Supporting factors of diving health and safety behaviour	1. Improper knowledge 2. Material support 3. Generation-to-generation habit
Form of diving health and safety behaviour	1. Without planning 2. Compressor usage 3. "Sesajen" or prayer
Impact of occupational health and safety behaviour	1. Trauma 2. Economic burden 3. Perceived health complaint
Behaviour after being affected	1. Stop diving 2. Behavioural change

and considered to strengthen the health and safety behaviour when diving. Knowledge about the risks of diving is improper. Generation-to-generation behaviour when diving causes the participant to maintain inadequate health and safety behaviour when diving (Table 3, quotes 6–7). Material support from the couples includes preparing "sesajen" before diving. This becomes a reinforcing factor for the participant to maintain their health and safety behaviour when diving (Table 3, quote 8). The strengthening factors for the participants to maintain health and safety behaviour when diving include the familial generation-to-generation habits (Table 3, quote 9).

Forms of diving health and safety behaviour

This theme explains how the forms of health and safety behaviour when diving have been carried out by the participants and how they have become part of life as a traditional diver. The participants dive without planning because their abilities and diving habits get transmitted from generation to generation (Table 3, quote 10). All of the participants use compressors as diving equipment because it is the only thing that is available and economically affordable for them (Table 3, quotes 11–12). Some of the participants prepare "sesajen" before diving. The "sesajen" is considered to be an acceptance and tribute during diving and fishing (Table 3, quotes 13–14).

Impact of occupational health and safety behaviour

This theme focuses on the participants' experience of the perceived impact on their health and safety behaviour when diving. All of the participants had experienced a history of paralysis (Table 3, quote 15). The effects of diving using a compressor were joint pain, hearing loss, and paralysis (Table 3, quote 16–17). The participants experienced disability and trauma after losing their ability to walk (Table 3, quote 18). The participants felt the economic burden due to disability. They had also increased their spending on medical treatment (Table 3, quotes 19–20). The participants had previously taken medication but stopped for financial reasons (Table 3, quote 21).

Behaviour after being affected

This theme illustrates how the participants decide on their behaviour after interpreting the impact of their health and safety behaviour on diving. The participants feel trauma

Table 3. Summary of quotes

1.	"...I'm used to it and it's my routine. No, it's not dangerous... " (P01)
2.	"...the diving was a generation-to-generation habit and procedure..." (P05)
3.	"...there is no risk. My parents were a diver. Not gradually in-depth, but directly 100 metres, and usually dive 10–12 hours without any rest..." (P12)
4.	"...it's risky. But before leaving, we prayed first and gave "sesajen"... " (P09)
5.	"...offer "sesajen" done by my wife before leaving for fishing" (P15)
6.	"...still been a diver with a compressor for many years because my parent and grandparent used to be like that, so it seems safe..." (P03)
7.	"...using a compressor is enough, "sesajen" have been helped to survive..." (P14)
8.	"...the wife prepared "sesajen" before diving as a prayer to be saved..." (P13)
9.	"...I don't know. Just follow along, grandfather, parents, older adults too. It's been descending..." (P08)
10.	"... If I want to find fish, go to the sea and dive. Diving planning procedures do not exist. Apart from that, I think there is no..." (P07)
11.	"...Use the compressor first. Parents also use compressors..." (P09)
12.	"...use compressors, people here also use compressors..." (P07)
13.	"...Preparation before diving only food and "sesajen". My wife was prepared..." (P08)
14.	"...before leaving, my wife prepares "sesajen" for the prayers and offerings of sea dwellers..." (P01)
15.	"...I've been paralyzed. Almost all fishermen who dive here have been paralyzed..." (P05)
16.	"...most often it's ear aches and pains in my leg joints ..." (P11)
17.	"...ear ache, leg pain, the worst experienced by fishermen divers here is being paralyzed..." (P14)
18.	"...Many times paralyzed. Trauma, afraid that if I dive again, I will be paralyzed again..." (P06)
19.	"...After this paralysis adds to the economic burden. Add expenses for the treatment..." (P01)
20.	"...the need for treatment and daily necessities is more expensive, more and more..." (P13)
21.	"...previously had been treated but stopped, there was no money anymore..." (P13)
22.	"...Trauma, do not want to dive again. I've had ear scars, joint pain, until paralysis. Trauma..." (P06)
23.	"...I think I still want to continue. Yes what should I do, the only work that can be done is that if my wife permits me..." (P13)
24.	"...Still, want to dive again. Yes actually afraid if it hurts again. Yes, it will do the right planning before diving..." (P04)

and they won't dive again after the paralysis (Table 3, quote 22). Some of the participants still want to dive because of their economic demands (Table 3, quote 23). Participants who plan to keep on diving again will draw up a diving plan (Table 3, quote 24).

DISCUSSION

PERCEPTION OF THE DIVING RISK

Participants assume that diving does not pose a risk to their health. This was because diving has been done generation to generation in the family [6]. Some of the other participants consider "sesajen" to reduce the risk of diving. "Sesajen" is believed to be a form of surrender to the creator. "Sesajen" is considered to be a means of earning God's protection [7]. Diving is targeted as a danger as a result of the changes in pressure, water temperature and to other underwater life [8].

SUPPORTING FACTORS OF DIVING HEALTH AND SAFETY BEHAVIOUR

The participants' perceptions of diving were not risky and "sesajen" is seen of as a means of requesting protection from God. This inaccuracy of knowledge is contradictory to the results of the research that found that the older workers have better health and safety behaviour [9]. It turns out that age is not the primary determinant of work health and safety knowledge and behaviours. Providing periodic education about the importance of health and safety behaviours also plays an important role [10].

Their wife's support in terms of "sesajen" preparation is also a reinforcing factor. Wife provides food, drinks, advice, and prayers. Most wives tend to be passive and obedient related to earning money in family [11]. This encourages the need for social support outside of the family which objectively pays attention to work-based health and safety behaviours.

Diving is the job of the participants and it is passed on from generation to generation. The participants dive according to the experience of their parents or the settlement residents around them [6]. The ability and diving procedure is learnt from the generation before and the absence of skill upgrading has become a reinforcing factor of the participants' health and safety preparation behaviour so far.

FORMS OF DIVING HEALTH AND SAFETY BEHAVIOUR

The participants dive without planning the related health and safety behaviour when diving. What they prepared was related to most of their logistical needs during the dive. This is associated with the traditional divers generally. They only dive according to the generation to generation procedure or they follow others. They were not equipped with an adequate knowledge of health and safety behaviour on diving [3].

The participants only use a compressor as their diving equipment. This is consistent with other studies stating that in general, traditional divers use a compressor [3]. The reasons for this were economic factors and an improper knowledge of safe diving procedures. Traditional divers use a compressor as an alternative [12]. The results showed that all of the traditional divers did not use complete health and safety equipment. This is one of the factors causing disease or disorders due to diving. There is a significant relationship between the use of personal protective equipment and the incidence of decompression [13].

The other supporting factor for health and safety behaviour was "sesajen". Traditional divers generally prepare "sesajen" before going diving as a form of surrender to God. It asks for abundant marine products and they can avoid catastrophe while diving. "Sesajen" consists of the food, leaves and water [14].

IMPACT OF OCCUPATIONAL HEALTH AND SAFETY BEHAVIOUR

Health problems such as hearing loss, joint pain, and paralysis were reported as being experienced by all participants. The data showed that 29.8% suffered from joint pain, 39.5% suffered from hearing loss, and 10.3% suffered from paralysis [15]. Hearing loss is caused by the failure of the process of the middle ear pressure to equalise to changes in environmental pressure. The diving technique used by traditional divers involves diving by holding their breath and taking air from the surface of the seawater. The air then flows into the compressor [3]. Decompression increases with many factors such as temperature, especially cold temperatures [16].

Several of the participants also experienced paralysis. This was related to the characteristics of the participants in the form of spending a long time becoming a traditional diver. The time from becoming diver can determine the length of a person's exposure to the risk factors [3, 17]. The longer a person works as a diver, the more they are exposed to a hyperbaric environment which can cause health problems such as paralysis [18]. In addition, diving without preparation such as a certain level of bodily fitness also contributes to the risk of paralysis. Participants who have a history of illness or disability have a risk that is 15.9 times higher when it comes to experiencing health problems that can lead to paralysis [18]. The age of the diver can also be a contributing factor to paralysis. Most of the participants were aged over 35 years old. The ideal age limit for diving is 16–35 years old, while those who are younger than 16 years old or older than 35 years old have higher risks when diving [18].

All of the participants had done more than 12 hours of diving without a resting phase. The longer the time spent diving, the more nitrogen is absorbed by the body. This can lead to undesirable things such as weakness while in the water, dizziness and feeling cold [19]. In most cases, the symptoms of decompression occur after 6 hours and they often occur within the first hour after diving [5]. The length of time spent while diving in a stressed environment is one of the risk factors for the occurrence of diving disorders, especially decompression [20].

All of the participants felt the economic burden as a result of their health problems. After the participants experience paralysis, they are unable to work. Spending money increases for the treatment of disease. This can be a new economic burden for the family. Because of the economic burden, the participants chose traditional medication from a healer. Self-medication was the first action taken by the individuals in developing countries to deal with the disease [21]. Traditional therapies used include salt compresses, trampling therapy on the seabed, and treatment such as using sago palm fronds to hit their paralyzed legs.

BEHAVIOUR AFTER BEING AFFECTED

The participants, after experiencing the effects of diving, choose to stop and some continue to become traditional divers after some consideration. The participants who decided to stop did so because of health and trauma considerations. Trauma is emotional and psychological pressure because of unpleasant events or experiences. Participants who continue to be divers with consideration will undertake health and safety planning before diving. Individual actions to prevent disease are driven by the seriousness and threat of disease to their health [22]. Perception about the severity of the threat of disease gives rise to a perception of self-vulnerability. Understanding vulnerability encourages people to adopt healthier behaviours [23]. The higher the perceived risk, the higher the chance of engaging in behaviour to reduce the said risk.

CONCLUSIONS

This research shows that the health and safety behaviour of traditional divers is sparked by the participants' perceptions of the risks of diving on their health. This is supported by the internal and external reinforcement factors of participants. Their perceptions and any reinforcing factors ultimately shape the health and safety actions of the divers. Diving without a plan, using only a compressor and "sesajen" has an impact on the health of the participants. The impact is experienced in the form of health problems, paralysis and economic burden. After being affected, the participants choose to stop being a traditional diver. Some choose to remain a diver with the consideration of making plans before diving. Health and safety when diving must be socialised and facilitated. The development of a diver's

community that cares about health and safety behaviour when diving becomes important as a support system.

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VIA MEDICA

REVIEW ARTICLE

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Follow-up of citations of maritime epidemiological injury studies

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ABSTRACT

Background: *The article is based on a review and follow-up of the citations of 13 epidemiological studies that aimed to improve maritime health and safety. While it's well-recognised that epidemiology is needed in occupational health and safety, the main research question: "How can epidemiology help workers to return healthy from the sea" was unanswered.*

Materials and methods: *The 13 articles were selected as a representative sample of different epidemiological design studies intended to contribute to improving safety management in fishing, merchant shipping and offshore industry. The PubMed, Research Gate, Cochrane-Library and Google Scholar were searched for authors that had cited our articles by using full bibliographic information and the results analysed.*

Results: *In all, 213 citation records were identified. After duplicates and records with insufficient information were removed, 123 full-text articles were eligible for evaluation with answers to the research questions: how did other authors use the studies, how has the injury epidemiology been developed, which recommendations are given for new policies and new studies and how can epidemiology help workers return safe and healthy from the sea?*

Conclusions: *The answer to the main research question is yes, epidemiological studies are not only useful but a necessary component by providing the needed evidence for successful prevention programmes.*

(Int Marit Health 2020; 71, 1: 62–70)

Key words: epidemiology, injury, fishing, seafaring, citations, maritime

INTRODUCTION

The review is based on 13 published articles that aim to improve the safety in the maritime sector and a follow-up of the citations by other authors in published studies.

While epidemiological studies in the maritime health and safety domains were rare until the 1990s, these studies can be seen as pioneering in the maritime injury epidemiology. The method of follow-up of the citing articles is a new method that is supposed to improve the methods and to find new results.

Each of the selected collection of 13 studies highlights some specific design studies in injury epidemiology (Table 1). The articles represent different types of study-design like register-based cohorts, cross-sectional questionnaire studies, case-referent study based on registers of injuries in seafaring, fishing and offshore workers in the oil and gas industry. The studies are for the main part based on the Danish fishermen and seafarers and some of them are from international collaborations.

Concerning the study populations, there are about 1.6 million merchant seafarers and 35 million fishermen and they together with the offshore workers contribute to a significant part of the European and the global economy [1]. Important common characteristic for merchant seafarers, fishermen and offshore workers is that they are away from home, staying on the ships and oil platforms at sea for weeks, months and even half of years. This poses some specific living and working conditions that is supposed to have some significant health impact in a short- and longer-time perspective.

While epidemiology of diseases has been developed over more than 100 years, the practice of occupational

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Table 1. Summary of the selected studies for review

	Materials	Methods	Main results
1. Mortality and injury			
1. Jensen (1996) Mortality in fishing	Danish commercial fishermen 1970–1985 compared to all economically active men (60974 fisherperson-years (375 deaths)	Cohort study. Standardised mortality ratio was calculated from the death register and population housing data	High mortality due to accidents, and increased risk from cancer, respiratory and cardiovascular diseases
2. Jensen et al. (2014) Fatal accidents in fishing review study	Scientific articles and reports from the maritime authorities in 8 Northern countries 1990–2014	The original incidence rates were recalculated as per 1000 person -years for international comparison of the trends	Fatal injury rates decreased by around 50% due to implemented safety programmes
3. Jensen et al. (2014) Fatal and non-fatal injuries in the offshore oil and gas production	A literature review was performed by literature search and by examining national databases	Search and examining PubMed, Embase, Google Scholar and Web of Science	Non-fatal injuries offshore decreased. The few epidemiological studies does not allow for firm conclusions
2. Injuries in fishing			
4. Jensen et al. (2005) Classification of working processes	The work processes were described and classified in 17 main and up to 13 subsidiary work tasks (n = 550)	The injuries were coded according to the developed classification system	Preparing, shooting and hauling of the gear constitute about 50% of all injuries
5. Jensen et al. (2006) Injury and time studies	Time measurements for the 17 main and 13 subsidiary working processes analysed during fishing trips in 4 vessel types	Injury reports in a 5-year period were allocated to the specific working processes and risk index numbers calculated	Especially high risk for embarking and disembarking but also for other work processes
6. Jensen (2006) Injury risk at work processes	The reported injuries (n = 550) to the National Maritime Authorities for 5-years defined the cases	A case-referent design with samples of person-time as denominator and the reported injuries as the nominators	The variations in the odds ratios of the fishermen continuously shift between low and high-risk work processes
3. Injuries in seafaring			
7. Jensen et al. (2004) Self-reported injuries — evaluation of data validity	A pilot study was conducted (n = 1068) in Finland, Denmark, the Philippines, Croatia and Spain using self-completed questionnaires	Self-reporting duty period was compared with information from the crew register of the Maritime Authority	Self-report of the duration of the latest tour of duty is useful for seafarers from merchant ships but not for ferries
8. Jensen et al. (2005) Subjective assessment of safety	A questionnaire study was carried out in 11 countries (n = 6461) seafarers who attended a regular health examination	Multivariate analyses were used to analyse the occupational safety on board, hazardous exposures and the use of personal protection equipment	Occupational safety was the lowest among ratings, seafarers < 30 years of age, in the engine rooms and dry cargo ships
4. Slips, trips and falls (STF)			
9. Jensen et al. (2000) Slips, trips and falls in fishing	Fishing injuries (n = 582) treated at the emergency ward and registered in the Nordic Medic Statistical Committee (NOMESCO) system	The proportion of fall injuries in different age groups, injury types (body lesions) and the injury mechanisms were analysed	The proportion of fall injuries in different age groups was U-shaped. STF injuries was 25% of all
10. Jensen et al. (2000) Slips, trips and falls in seafaring	A questionnaire study was carried out in 11 countries (n = 6461)	The seafarers gave information on whether they were injured during their latest tour of duty, and whether STF preceded the injury	43% were STF related. The high proportion of STF injuries came by use of a specific question, was it a STF?
11. Jensen et al. (2010) Reduction of slips trips in fishing by intervention	Fishermen tested new boots with anti-sleeping soles and tried them out under active fishing for half a year (n = 161)	Questionnaires at baseline and after half a year to determine the comfort and possible reduction of STF	The new boot had significant better comfort and feeling of firm grip when standing and walking
5. Working conditions at sea			
12. Jensen et al. (2006) Working conditions in seafaring	Seafarers in 11 countries (n = 6461) responded a questionnaire at the health examinations in the seafarers' clinics	The questions concerning the most recent tour of duty self-rated health status and the main characteristics of working conditions	Most seafarers worked every day of the week, and on average for 67–70 hours a week during periods of 2.5–8.5 months
13. Jensen et al. (2014) Social security for seafarers	Seafarers from 5 countries (n = 127) completed a questionnaire at the health examinations in the seafarers clinics	The questions concerning their knowledge about their social security status on coverage for disease and retirement	A significant part of the seafarers comes from the poorer countries without good social security systems

epidemiology was nearly non-existent until 1990 and the development of injury epidemiology and especially in the maritime setting has been a challenge. One of the main challenges is how to get valid nominator and denominator data to yield unbiased epidemiological rates-ratios. Over the latest decennia we have introduced the term "injury" for the body damage and "accident" for the preceding incident [2]. An injury can be defined as a sudden event (caused by an accident) in which an external noxious agent hurts or injures a person. The epidemiological studies of occupational injuries were sparse until the nineteen eighties and injury studies had low interest among the epidemiologists.

THE RESEARCH QUESTIONS

How did other researchers use the studies?
Which recommendations for preventive policy and prevention are there?
Which recommendations are given for new studies?
How was the maritime occupational injury epidemiology further developed?
How can epidemiology help workers to return healthy from the sea?

MATERIALS AND METHODS

The methods used in the 13 articles involved a transition from epidemiological descriptive design to more advanced statistical methods in the studies. The studies are divided in five sections: 1. Mortality and fatal injuries; 2. Injuries in fishing; 3. Injuries in seafaring; 4. Slips, trips and falls; 5. Working conditions at sea.

The 13 articles were selected as a good representative sample of studies contributing to an epidemiological analysis of the occupational risks to improve the safety management in fishing, merchant shipping and offshore industry. Since the aim of this study was to analyse descriptive studies in health and safety in fishing, the criteria were set to achieve this aim. The whole process of search and selection of the citing articles is shown in Table 2.

SEARCH FOR THE CITING ARTICLES

One by one, the 13 articles in the collection were searched in PubMed Google Scholar by using the full bibliographic information e.g. "**Jensen OC. Injury risk at the work processes in fishing: a case-referent study. European Journal of Epidemiology. 2006; 21(7): 521.** The searches were repeated in PubMed, Cochrane and Research Gate to see if more citing articles come up. The citing articles were searched from 1st October 2017 to 31th October 2018. The follow-up time for the sample of the citations varies from the first publication in 1996 to the latest included in 2014.

INCLUSION CRITERIA OF THE CITING ARTICLES

The first step was to systematise and analyse the citing articles and to define the eligibility criteria for the citation articles to be included. All types of epidemiological design, in English or Spanish were included: literature reviews, cross-sectional, cohort and case-control studies. Only peer reviewed scientific articles were included.

EXCLUSION CRITERIA OF THE CITING ARTICLES

Articles or thesis in languages not understood by the author, like Indonesian, Chinese, Finnish or other languages are excluded. Administrative reports are excluded.

ETHICAL ISSUES

The review work does not involve any personal participant and company information, and so the study does not involve ethical problems. All data is processed according to the medical duties act, as well as the guidelines for good epidemiological practice is followed.

RESULTS

In all 213 citation records were identified through database searching and additional free records were identified through other articles. After removal of 17 duplicates and 22 records with insufficient information, a total of 199 records remained for screening. Of those 76 were excluded due to either lack of full text or other problems. The final 123 full-text articles were eligible for evaluation (Fig. 1). Twenty-five were included in the quantitative synthesis and 90 studies in the qualitative synthesis the articles are distributed in the five main sections: mortality and fatal accidents, injuries in fishing, injuries in seafaring, slips, trips and falls and working conditions in seafaring. The citing articles that used this study as background with no further comments are kept out of this review.

Study 1: Mortality in Danish Fishermen [3]. The study aimed to investigate the mortality patterns in Danish commercial fishermen (1970–1985), compared to all economically active men by the use of standardised mortality ratio with 95% confidence intervals for all causes among crewmembers was increased for accidents, ischaemic heart diseases, bronchitis and emphysema compared to all economic active men. Of the 13 citations, 3 studies for comparison: [4, 5].

Study 2: A review of fatal accident incidence rate trends in fishing international [6]. The review is based on scientific journal articles and some few technical reports from the maritime authorities in Poland, United Kingdom, Norway, Iceland, Denmark, United States and Alaska and Canada. The risk of fatal injuries was reduced by around 50% to an average of about 1 per 1000 person-years. The safety programmes seem to have good effects, still the risk is

Table 2. Search and selection procedure of the citing articles

1. Search each of the 13 articles in the databases mentioned by using the full bibliographic information in Vancouver style to identify articles that have cited one or more of the 13 articles
2. Search each of the citing articles one by one in PubMed and/or Google Scholar, and to be registered in 13 separate Zotero bibliographic databases
3. The full-text of citing each article are then searched in PubMed and/or Google Scholar or Research Gate and included in the Zotero database
4. Revise the citing articles one by one, delete duplicates and mark those with and without full-text
5. Exclude citations of no relevance (based on abstract or full-text) foreign languages and not maritime health
6. Evaluate one by one the full text of the citation articles, search for "Jensen" and copy the cited texts articles
7. Copy the citations with "snapshot" and paste them in the "Citation Archives" for evaluation
8. Classify the copied information according to the 5 classification points in PRISMA: doublet, exclusion of other reason, quantitative/ /qualitative useful, full-text/non-full text in (Liberati et al. 2009)
9. Construct a "selection tree" scheme for each of the 13 articles
10. Transfer the results to a sum scheme for all the 13 articles (Fig. 1)
11. Analysis, systematise and sum up the relevance of the citations in the Results section
12. Answers the research questions based on the 13 selected articles and the citing articles
13. Sum up in the conclusions on the gained new knowledge on methods and evidence for new prevention policies
14. Sum up the recommendations from the 13 articles and the citing articles about the needed prevention, policies for prevention and for new research

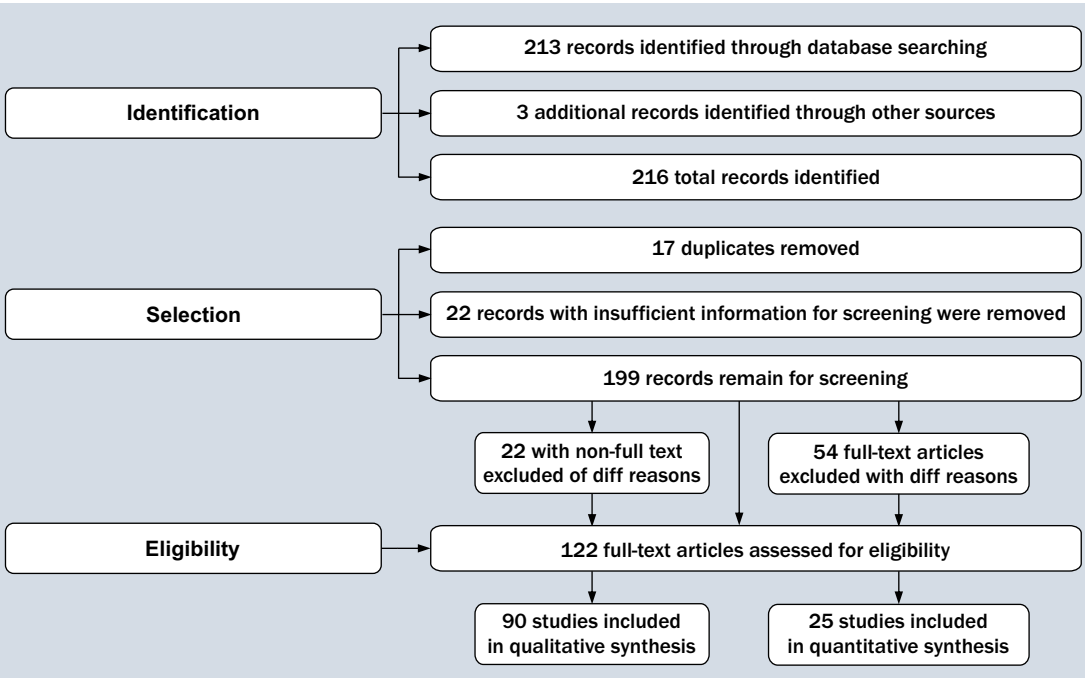

Figure 1. Selection tree of the "citing articles" included in the review

about 25 to 50 times higher than for onshore workers. Of the 13 citations, 5 were excluded, 2 doublets, 2 were used as background references and 3 for comparison of the quantitative results.

Study 3: A review of epidemiological injury studies in the oil and gas offshore industry with the objectives to evaluate the preventive programmes effect [7]. The fatal injuries in the oil and gas production in the US are seven times higher than for other workers in the US and the rate increased.

Study 4: Classification and coding of commercial fishing injuries by work processes: an experience in the Danish fresh market fishing industry [8]. This study was an answer

to the lack of a detailed classification system for fishing accidents and relates closely to Study 3. The objective was to describe all main work processes to create a new classification system to be used for injury prevention. The working processes were described and a classification catalogue with 17 main categories and up to 13 associated subsidiary categories for each of the fishing methods were prepared. All fishing injury reports to the Danish Maritime authorities for 5 years were coded according to the specific type of vessel and the specific working process where the injuries happened. The study was cited by 15 authors in the introduction of their studies and discussed in other studies.

Study 5: Injury and time studies of the working processes in fishing. The objective was to solve the methodical problem that the use of a common overall denominator, e.g. days at sea related to different working processes on board is not useful to estimate the incidence rates for the specific working processes. To solve the problem there was a need to estimate the more precise use of working time for specific working processes in typical types of professional fishing. The working time for the specific working processes in fishing was related to the number of injuries related to the same working processes [9]. The study was cited by 15 authors in the introduction of their studies but also in the discussion of some of the studies.

Study 6: Injury risk at the work processes in fishing: a case-referent study [10]. The aim of the study was to estimate the injury rate-ratios for the main work processes in commercial fishing. The problem is that epidemiological studies describe the incidence ratios only related to the main strata in the industries, while the injury incidence ratios for the specific work processes within the workplaces have not yet been studied. The study was cited by 12 authors in the introduction of their studies but also in the discussion of some of the studies.

Study 7: Self-reported injuries among seafarers. Questionnaire validity and results from an international study [11]. The aim was to test the method of self-report of injuries and length of time at risk during the latest duty period and second to study the injury incidence rate among seafarers by use of the method. 32 authors cited the study.

Study 8: Subjective assessments of safety, exposure to chemicals and use of personal protection equipment in seafaring. The objective was to describe the seafarers' assessments of the occupational safety on board, their exposure to chemicals and the use of personal protection equipment and to identify the areas for further risk assessment and preventive measures [12]. A questionnaire study was carried out in 11 countries among seafarers who attended a regular health examination. The study was cited by 11 authors, some in the introduction and others in the discussion of their studies as commented in the discussion.

Study 9: Non-fatal occupational fall and slip injuries among commercial fishermen analysed by use of the Nordic Medic Statistical Committee (NOMESCO) injury registration system [13] in order to add more detailed information about slips, trips, and falls on board fishing vessels. Data on fishing injuries treated at the emergency ward at Esbjerg Central Hospital was registered in the NOMESCO injury registration system [14] and 38 authors cited the study.

Study 10: Non-fatal occupational injuries related to slips, trips and falls in seafaring [15]. Merchant seafaring often involves hazardous occupational operations and several studies have shown increased fatal injury incidence often related to slips, trips and falls on board and falls overboard [16, 17]. In all 27 authors cited the study.

Study 11: Reduction of slips, trips and falls and better comfort using new anti-slipping boots in fishing [18]. One hundred and fifty fishermen participated in the study with a baseline questionnaire and repeated the questionnaire after they had used the new boots for half a year. The result was that the new boots were considered as much better or somewhat better by 90% of the fishermen reporting they had a good grip on the deck and a feeling of standing firmly. In all 6 authors cited the study

Study 12: Working conditions in international seafaring [19]. The objective was to describe the self-rated health and the main characteristics of the seafarers working conditions. A total of 6461 seafarers in 11 countries responded to a questionnaire concerning the most recent tour of duty. In general, the seafarers' self-rated health was good, but it declined significantly with age. 20 authors cited the study,

Study 13: Social security for seafarers globally [20]. The seafarers completed a short questionnaire concerning their knowledge about their social security status. The significant disparities in the social security coverage were pointed out among the nationalities. The solutions suggested are to implement the minimum requirements as recommended by the International Labour Organisation 2006 Convention, to survey the implementation and in the long term to struggle for a global social equality. The only one citation was from one of the co-authors.

DISCUSSION

This is to our knowledge the first study to follow-up on how other authors have cited and used a sample of studies. Contributions from the citing articles to the main research questions are identified and discussed.

HOW DID OTHER RESEARCHERS USE THE STUDIES FOR COMPARISONS?

In contrast to our Danish Study 1, the Swedish fishermen had lower mortality rates from: all causes, malignancies, respiratory and cardiovascular diseases compared to

other men [4]. The similar pattern was found for Finnish fishermen with lower mortality from: all causes, ischemic heart diseases, cerebrovascular diseases and malignant neoplasms than the general population [5]. Study 4 and 6 on classification and coding of injuries by the work processes was followed by several other authors: Syron et al. [21] utilised our system to code non-fatal injury cases to point out the most frequent work processes associated with non-fatal injuries. Krenz et al. [22] also found the "Jensen" System useful for activity classification for claims. Lucas et al. [23] applied a framework based on our system to code processes specifically related to long-liners and trawlers. McGuiness and Piniella et al. [24] points out the need for specific classification of the working processes for more effective prevention [25].

Study 7 on self-reported injuries among seafarers was used by among others Shan [26]. Study 9, on the occupational fall and slip injuries in fishermen coded according to the Nordic Medico Statistical Injury Registration System was used by Bull et al. [27] who found similar high percentages of slips, trips and falls in fishing. Study 10 on slips, trips and falls (STF) in merchant seafaring was followed by several authors confirming that STF related injuries especially in the engine rooms need to be taken in attention for better prevention [28, 29]. Study 11 on the fishermen's test of new boots with anti-slipping soles was commented by Lucas et al. [30] who mention the resistance to introduce new type of footwear and that good footwear can hinder falls overboard and save life's [30–32].

HOW WAS THE MARITIME OCCUPATIONAL INJURY EPIDEMIOLOGY FURTHER DEVELOPED?

Study 1: The methods used in epidemiology have changed radically from using paper forms to pure digitalised data over the latest half century. This great development in the epidemiology permits to handle big amount of data with advanced statistical methods, especially the multiple regression analysis [33]. Study 2: The review of fatal injuries in fishing [6], shows an overall decrease of the fatal incidence rates over the last decades. The study showed that trends can be compared for the first time with meaning for the planning of the prevention activities. In Study 5 and 6, the injury and time studies of the working processes in fishing was new and opens up for a more specific and effective prevention of the injuries in fishing. The aim was to estimate the relative risks for specific working processes in order to focus the prevention on the specific work processes. The use of the case-control study design in occupational injury studies is rare and the new method by using the samples of time for the work processes as the denominators is new. The injury epidemiology in merchant seafaring was further developed in Study 7 by asking for the precise number of days at sea in order to obtain precise denominator data for calculation of the **Incidence risks** and **relative risks** the first time. The subjective assessment of safety, exposure to chemicals and use of personal protection equipment in seafaring in an international setting was documented for the first time in Study 8. A solution to the methodological problems by using proportionate risk estimates in Study 9 was proposed by multiplication the proportions with the estimates of the incidence rates of all injuries [34]. Based on the learning from the NOMESCO Study 9, the seafarers were asked specifically whether slips trips and falls preceded the occurrence of the injury in Study 10. The method was new and not surprising that injuries related to STF on merchant ships were more frequent than the previous estimates. The experiment of the use of good footwear for fishermen in Study 11 was new and commented by various authors. In the development of epidemiology, we have moved from Haddon's Matrix to the modern epidemiological sociological model of the ethology to be used for prevention. We have also moved excellently forward since the era where "accident" epidemiology was not recognised as scientific discipline e.g. that injury epidemiology is nearly absent [35].

WHICH RECOMMENDATIONS FOR PREVENTIVE POLICY AND PREVENTION ARE THERE?

Based on the trend's analyses of fatalities in fishing in Study 2, the preventive programs seem to have good effects. Still, the authors call for continued effort to improve safety in fishing in all the studies [23, 30, 36].

According to the authors comments on Study 4, 5 and 6 the analysis of the specific risk at the different work processes is recommended to identify hazardous tasks [21]. Future prevention efforts should target work processes associated with the most frequent and most severe injuries by using time estimates for work processes in order to determine risk estimates.

Our proposal of the need for better trauma prevention on board in Study 7 was supported by several authors [37–39]. The main recommendation from Study 11 is to encourage fishermen to replace their boots as soon as they are worn out and that risk assessments of fishing vessels should include assessment of footwear. The recommendations in study 12 include that further studies are necessary to describe more closely the influence of work schedules on the health and social life of seafarers. Patella et al. [40] cite us because we supply the documentation that the engine crew suffer the highest overall levels of stress followed by the deck and engine officers. Österman and Hult [41] cite us because we say that the seafarers work and live between 2 to 8 months on board continuously exposed small possibilities for recreation together with people of various backgrounds and nationalities.

Oldenburg et al. [42] again refer to our study to find out the very long stay on board after 10 months on the conditions with permanent physical factors noise and vibration post on the working and leisure time has a physical and mental effect on the quality of life. Rydstedt et al. [43] again refer to our study concerning the engine room personnel with the highest mental health problems. Oldenburg and Jensen [44] 2012 support and cite our study about the extreme work press also mention that we found nearly 70 work all hours per week for both officers and none officers per week. In Study 8, the use of personal protective equipment was assessed to be too low among some parts of the crew and in some working areas and types and sizes of ships. Several authors cited our article and agreed there is a need to improve the safety and the prevention of the risks on board [45–47].

WHICH RECOMMENDATIONS ARE GIVEN FOR NEW STUDIES?

Several studies underscore the lack of international requirements to harmonise the registration of injuries in fishing for prevention [24, 48]. In Study 7 it was concluded that subjective data about the length of the tour for calculating the incidence rates is useful for merchant ships but not for ferries and other type or permanent employment. When the seafarers have permanent contracts specifying the number of hours or days per year, this can be used for denominator data for calculation of the injury incidence rates. Study 9: By using the NOMESCO system for occupational injuries from falls and slips (STF) some important new issues in the injury epidemiology was realised. The estimated proportion of STF-injuries was more precise and higher than seen before. An analysis based on the free text in the NOMESCO register files, revealed that one fourth of the injuries are related to falls/and slips and thus preventable and constituted 60% of all injuries to the chest. And then it was realised that giving specific attention to STF-related injuries will give the most precise estimate of STF-injuries for the prevention. To avoid a possible misclassification and underestimation of STF-injuries it was recommended to include an extra specific variable: whether falling or slipping preceded the crash phase of the injury or not. This was utilised later in the international questionnaire study among seafarers [15]. Based on the Danish and the Norwegian studies, the NOMESCO system was found useful for analysis of fishing injuries by data from the emergency rooms. Still, there is no information recorded about the working process, which hinders for effective use in the practical prevention, and this was the subject for the other studies. Study 12 on the social security for seafarers was not followed by other studies. The gap of knowledge remains and calls for more studies. It is also worth mentioning that qualitative studies should be used for further investigation in this area.

HOW CAN EPIDEMIOLOGY HELP WORKERS TO RETURN HEALTHY FROM THE SEA?

The study examples illustrate how the evidence from epidemiology contributes to identify the relative risk of fatal and non-fatal injuries and diseases.

In this way the studies are necessary as contributing components to successful prevention.

This is consistent with the definition of epidemiology as being “the study of the distribution and determinants of health-related states or events (including disease), and the application of this study to the control of diseases and other health problems” [48, 49]. The five steps to risk assessment are carried out by using knowledge from research about the risk in general and knowledge about what is the best prevention. The risk assessment comes from observations and from epidemiological knowledge about the risk in number and severity. Proposals for effective prevention measures also come from epidemiological research.

If the evaluations show there is no or too little effect of the prevention measure we need to amend the prevention type and repeat the evaluation process once more. Seen from a global perspective there is an urgent need to help with epidemiology for fishing and aquaculture in the developing countries, e.g. Latin American and African countries [50].

CONCLUSIONS

The studies have been useful and contributed to obtain better safety in fishing and seafaring and contributed with new methods in injury epidemiology. The main research question whether epidemiology can help the workers to get home safely from work is answered with a “yes”. The studies are needed to establish an optimal prevention planning like architectural plans are needed for successful building construction. To avoid biased results the epidemiological studies, need to be conducted under the highest scientific standards.

The developing countries pose a specific challenge for the epidemiology in fishing and aquaculture with millions of workers in the poorest countries. A supposed high incidence on fatal and non-fatal injuries needs urgently to be documented for political attention and effective prevention.

In a global perspective new emerging risks continue to occur, and surveillance programmes of health and safety are needed and should be developed based on the documented risks from the studies.

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Temporary and permanent unfitness of occupational divers. Brest Cohort 2002–2019 from the French National Network for Occupational Disease Vigilance and Prevention (RNV3P)

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ABSTRACT

Background: *In France, the monitoring of professional divers is regulated. Several learned societies (French Occupational Medicine Society, French Hyperbaric Medicine Society and French Maritime Medicine Society) have issued follow-up recommendations for professional divers, including medical follow-up. Medical decisions could be temporary unfitness for diving, temporary fitness with monitoring, a restriction of fitness, or permanent unfitness. The aim of study was to point out the causes of unfitness in our centre.*

Materials and methods: *The divers' files were selected from the French National Network for Occupational Disease Vigilance and Prevention (RNV3P). Only files with a special medical decision were selected, between 2002 and 2019.*

Results: *Three hundred and ninety-six professional divers are followed-up in our centre and 1371 medical decisions were delivered. There were 29 (7.3%) divers with a special medical decision, during 42 (3.1%) medical visit. Twelve (3.0%) had a permanent unfitness. The leading cause of unfitness was pulmonary diseases: emphysema (3), chronic obstructive pulmonary disorder (2), asthma (2). Sixteen (4.0%) divers had temporary unfitness. The leading causes were cardiovascular (4 times) and neurological (6 times). Twelve (3.0%) divers had had at least one decompression sickness.*

Conclusions: *Judgments of permanent unfitness for diving were rare (3.0% of divers), but were because of life-threatening disease. Medical follow-up of occupational divers was justified to decrease the risk of fatal event during occupational dives.*

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Key words: diving, occupational medicine, decompression sickness, France, contraindications

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INTRODUCTION

Many professions include underwater activities, exposing employees to hyperbaric constraints. In France, for example, professional divers may be scuba divers, carrying out construction, repair or building supervision work; aquarium officers, working on the technical side of facilities, or as veterinarians and caretakers; or scientists carrying out fauna or flora surveys, or geological or oceanographic studies. Many other professions also include underwater activities, such as coast guard work or fishing [1].

Professional divers are thus exposed to several types of risks. Depending on their specific profession, they may be exposed to risks related to biological, chemical or psychological hazards, etc. [2, 3]. All professional divers are also subject to the risks associated with diving in water, as are recreational divers. The literature reports many risks for divers, whether professional or recreational. On the one hand, we have the risk of developing a pathology related to hyperbaric stress, such as dysbaric osteonecrosis, decompression sickness, thoracic barotrauma or barotraumatic otitis, and many other pathologies [4–7]. On the other hand, there is also the risk of an accident occurring underwater, even if the origin is not hyperbaric stress in itself. For example, a fainting episode could lead to drowning.

Some of these accidents are therefore life-threatening medical emergencies. This is particularly the case for decompression sickness or drowning [8–10]. Other pathologies involve long-term functional capacities, such as spinal cord injury or dysbaric osteonecrosis [11]. For this reason, many countries have regulations and recommendations for the medical follow-up of professional divers [12, 13]. In France, the text regulating the monitoring of professional divers was adopted in 1991 and repealed in 2011 [14]. Since 2016, several learned societies (French Occupational Medicine Society, French Hyperbaric Medicine Society and French Maritime Medicine Society) have issued follow-up recommendations for professional divers, including medical follow-up and paraclinical examinations to be adapted according to the diver's health status and diving profile [14].

As in other countries, this type of approach is sometimes questioned [15, 16]. The objective of this study was to determine the conditions that led to a contraindication to a profession with hyperbaric stress, or to a restriction of diving techniques (type of gas, depths, etc.), and to determine which unfitness notices were issued in a centre carrying out professional diver fitness visits.

MATERIALS AND METHODS

This was a retrospective study of the Centre for Maritime Health at the University Hospital (Centre Hospitalier Régional Universitaire [CHRU]) in Brest, between 1st January 2002 and 31th July 2019.

The files of the 396 professional divers are recorded in our centre. The divers' files were selected from the French National Network for Occupational Disease Vigilance and Prevention (RNV3P). The data were collected anonymously on a CHRU computer, requiring no authorisation from the National Commission on Informatics and Freedom. Patients had given their prior consent for any anonymous retrospective studies of their medical data.

To be included in the study, divers had to have been seen at least once in our centre, between 2002 and 2019, for a professional diving aptitude visit (initial visit before beginning a professional diving career or follow-up visit during the diving career, according to the regulations in force in France); divers also had to have had a particular restriction (depth, type of gas, temperature etc.) or been found temporarily or permanently unfit for professional diving [14].

Divers who had not come to the centre for a professional diving follow-up consultation were excluded (i.e., those who had come for advice on recreational diving), as were those who came for a professional diving visit and were given an assessment of complete fitness for professional diving.

Files meeting the selection criteria were then manually analysed by a Centre for Professional and Environmental Pathologies (CRPPE) marine physician. Socio-professional parameters were collected: age, sex, body mass index, smoking, regular alcohol consumption, and regular sports practice. Medical histories and treatments were also collected. Professional and recreational diving profiles were compiled: length of professional and recreational diving practice, as well as the annual and lifetime number of dives, average duration and depth. The focus was on the analysis of pathologies that motivated a restriction or incapacity (type of pathology, link with diving), as well as the impact on professional practice (i.e. permanent or temporary interruption). From these data, it was possible to determine the number of cases of decompression sickness (DCS) in our cohort, since all divers who had had DCS, with the exception of barotraumatic otitis, were seen again in our centre before resuming their professional activity.

Data entry was done using Excel software, Microsoft Office 2017®. Averages and extremes were worked out on this software. The correlation analysis of pathologies was done using Biostatgv®, by χ^2 test or Fisher test, depending on the validity parameters.

RESULTS

DESCRIPTION OF THE POPULATION

Our sample included 29 divers, 22 (76%) male and 7 (24%) female. There were more women in our sample than in the source population (i.e. all divers followed in the centre), but this was not significant: 7 (24%) vs. 69 (17%) ($p = 0.32$). The average age at the time of the problemat-

Table 1. Dive profiles according to type of dive (recreational or professional)

Type of dive	Occupational dives	Recreational dives
Number of divers	22	13
Seniority [years]	9.5 (1–32)	7 (3–15)
Number of dives per year	70 (10–250)	35 (2–100)
Number of dives over lifetime	724 (10–4750)	264 (10–1000)
Depth [m]	17 (5–50)	31 (7–50)
Time [min]	64 (30–180)	70 (30–150)

Data are shown as number or mean (extreme)

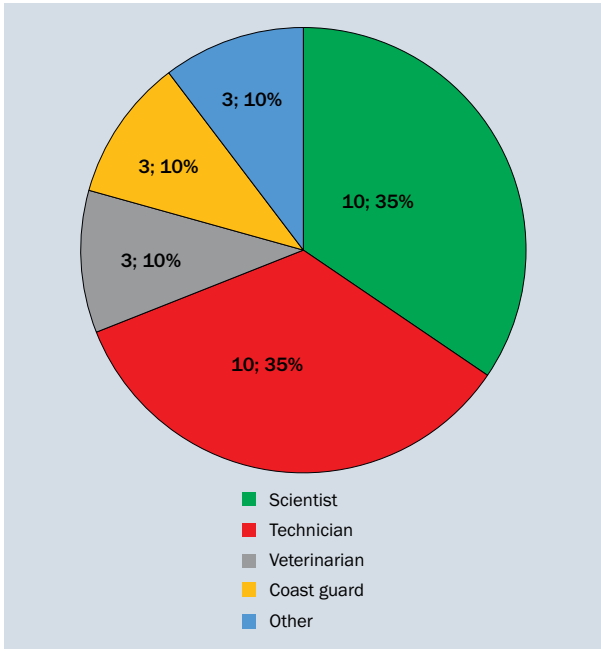

Figure 1. Distribution od divers by trade

ic diagnosis was 37 years (extremes: 23–59 years). The average length of time in professional diving was 7 years (extremes: 0–19 years). For 7 divers, the health problem was discovered during the initial examination, a regulatory prerequisite at the beginning of the professional diving career in France. It should be noted that among these 7 divers with contraindications to professional diving, 5 practiced recreational diving, with significant diving profiles: between 50 and 600 lifetime recreational dives (annual average of 30 dives per year), at depths of 30 to 50 m and durations of 60 to 120 min.

DESCRIPTION OF PROFESSIONAL ACTIVITY AND DIVE PROFILES

The majority of divers either were scientists (e.g. biology, oceanography, etc.) (10; 34%) or did different types of underwater work (10; 34%) (Fig. 1).

There were therefore 22 divers in professional activities, who made an average of 70 dives per year (extremes: 10–250 dives/year), and 7 divers were seen before the beginning of occupational diving (initial visit). Thirteen people were also engaged in recreational diving, two of whom also practiced snorkelling (Table 1).

MEDICAL DECISIONS

Medical decisions could be temporary unfitness for diving (19 times), temporary fitness with monitoring (7 times), a restriction of fitness (4 times), or permanent unfitness (12 times). The same diver may have had decisions of provisional fitness or provisional unfitness several times. This was the case for 7 divers. In total, the centre issued 42 such advisories, for 29 divers. There was a total of 1371 medical visits for 396 divers. So 3.1% of medical visits found out a contraindication or a restriction to dive, and there was 7.3% divers who had a contraindication or a restriction to dive.

Permanent unfitness for professional diving

Twelve divers had a definitive contraindication to professional diving, representing 3.0% of the divers monitored at the centre (12/396). There were 4 scientists, 1 veterinarian, 6 technicians (1 for scientific aquarium maintenance, 1 for laboratories and 4 for underwater worksites), as well as a truck driver who had an initial visit.

Three out of these 12 (25%) divers had already had a temporary restriction: 1 for a barotraumatic otitis; 1 for a work accident with a whiplash injury; and 1 following the discovery of chronic obstructive pulmonary disorder (COPD) while the assessment was being made, leading to the final contraindication.

Four out of these 12 divers (33.3%) were declared permanently unfit for professional diving during their initial visit, even if 3/4 had been practicing recreational diving for 3 to 10 years. Lung pathologies were the main cause of permanent incapacity: 8/12 (66.7%) of the cases of permanent unfitness (Fig. 2). Three of the divers had had decompression sickness at least once, including one diver who had suffered alveolar haemorrhages several times during scuba dives.

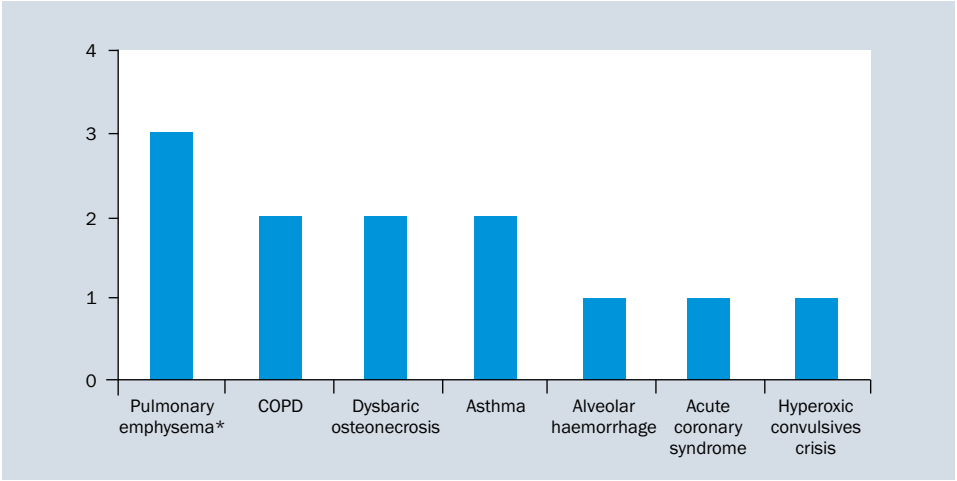

Figure 2. Causes of definitive contraindication to professional diving; *one emphysema with pneumothorax; COPD — chronic obstructive pulmonary disease

Description of temporary unfitness and restrictions

There were 19 provisional unfitness assessments, involving 16 different divers (4.0% of all divers), often to have time to explore an anomaly found during the medical examination (Table 2). There were 10 restricted fitness notices for 6 divers (Table 3).

DESCRIPTION OF DECOMPRESSION SICKNESS CASES

Twelve divers out of 396 divers followed in our centre (3.0%) had had at least one DCS incident, including 2 divers who had had 2, resulting in a total of 14 DCS incidents. Vestibular DCS was the most common (Fig. 3).

DISCUSSION

This united, focused, retrospective study provided information on the prevalence of decompression sickness among the 396 divers at this centre, and mainly, the different types of medical opinions issued in the event of a proven or suspected pathology that might increase the risk in professional diving. Only 12 (3.0%) divers reported having had a DCS incident. Similarly 12 (3.0%) divers had a permanent contraindication to the practice of a professional activity in hyperbaric environments, mainly due to pathologies of the respiratory system. And 16 (4.0%) divers had a temporary inability to heal or to complete clinical and paraclinical explorations of an abnormality discovered by chance during the medical examination.

This study had several limitations. By being carried out at a single centre, it represented the medical activity of this centre and also concerned a very particular population of divers. The divers monitored in Brest consisted mainly of scientists, veterinarians, port infrastructure security personnel and members of the coast guard. There are relatively few scuba divers working in deep water, or off shore. Similarly, this centre followed few fishermen, unlike other geographical areas [17]. This study therefore did not allow us to know the exact prevalence of DCS among divers in the regions of the west coast of France. These divers are often followed in other centres, such as those in Paris, depending on their company's headquarters. This was not the focus of our study. The purpose of this study was rather to know the fitness limitations issued by our centre and determine the pathologies that motivated them. These pathologies included DCS, but such incidents did not represent the majority. It would also be unwise to estimate the prevalence of barotraumatic otitis based on this study alone. Many divers are only seen once a year. In case of barotraumatic otitis, the care circuit in France provides for a consultation in the emergency room of a hospital (knowing that there are 2 university hospitals and a dozen hospitals in Brittany), where they are treated by an ear-nose-throat (ENT) physician. Temporary cessation of diving is generally defined as a work stoppage prescribed by the ENT physician, until the eardrum heals. In other words, not all divers with a barotraumatic otitis necessarily return to our centre for further consultation before resuming diving. Finally, it may seem surprising not to have any temporary unfitness for diving due to pregnancy, when 69 women were followed in this centre. This was also due to the care circuit in France: in the event of pregnancy, work in a hyperbaric environment is prohibited by the Labour Code. There is therefore no medical advice for diving in the case of pregnancy.

In our centre, respiratory pathologies as a whole were the leading cause of unfitness, due to the risk of decom-

Table 2. Description of provisional unfitness decisions

Organ	Pathology Number of occurrences	Further explorations	Links with diving and objectives of the medical opinion
Cardiovascular	Arterial hypertension: 3 times	Cardiological exam, cardiac ultrasound, blood work	No link Objective: avoid workplace injury
	Heart murmur Patent foramen ovale was suspected: 1 time	Cardiological exam, cardiac ultrasound	No link Objective: possible permeable oval foramen, the aim being to avoid DCS
Neurological	Vertigo: 2 times	ENT and neurological opinions, MRI	Type 2 cochleovestibular DCS related to diving Unfit for 6 months
	Paraesthesia of the lower limbs: 3 times	Neurological opinion, CT, MRI and electromyography	Type 2 spinal cord DCS Unfit for 6 months
	Epileptic seizure 1 time	Neurological opinion, MRI, EEG	Epileptic seizure in an ethyl intoxication context Unfit for 12 months
ENT	Barotraumatic otitis: 3 times	ENT opinion	Barotrauma related to diving
Musculoskeletal	Enchondroma: 1 time	Abnormality of the humeral diaphysis. CT and MRI, rheumatoid and orthopaedic opinions	No link with diving Objective: eliminate osteonecrosis Unfit for 6 weeks
	Workplace dive accident: whiplash injury: 1 time	Operation	Non-specific link Unfit during 6-month recovery period
Respiratory	Suspicion of emphysema upon X-ray: 2 times	Thoracic CT scan	No link Objective: avoid pulmonary barotrauma Unfit 1 month
	TLCO disorders: 1 time	Thoracic CT scan	No link Objective: avoid DCS
Haematologic	Lymphoproliferative disorder: 1 time	Haematological opinion	No link Objective: understand the relative risk of DCS Unfit for 1 month

CT — computed tomography; DCS — decompression sickness; EEG — electroencephalogram; ENT — ear-nose-throat; MRI — magnetic resonance imaging; TLCO — transfer factor of the lung for carbon monoxide

Table 3. Particular medical opinions

Medical opinion	Clinical situation	Number of medical advices Number of divers
Provisional fitness with the objective of reducing modifiable factors: tobacco use, sedentary lifestyle, cholesterol	Cardiovascular risk factors and risk calculation too high	6 advices; 2 divers
Restriction: diving only with air, limited depth	History of decompression sickness	2 advices; 2 divers
	Commencement of HIV treatment	1 advice; 1 diver
	History of asthma in childhood, persistence of non-specific bronchial hyper-responsiveness	1 advice; 1 diver

HIV — human immunodeficiency virus

pression sickness. Two divers (2/29) were declared unfit for professional diving due to asthma, and 1 other received diving restrictions (diving with air, max. 7 m). Several factors were taken into account in these medical decisions. For a long time, asthma contraindicated diving, both professional and recreational. Indeed, many studies have shown the risk of bronchospasm. Recent analyses have shown that this risk increases mainly in cold water or with depth [18]. Logic therefore seemed to indicate that asthma could increase the risk of bronchospasm, which, on ascent, could result in chest barotrauma. Some studies have shown this increased risk for asthmatic divers compared to non-asthmatic divers [19]. However, the available literature does not support this hypothesis [18, 20]. For this reason, several countries have updated their recommendations for recreational diving. In France, asthma contraindicated professional diving until 2011. Since the 2016 recommendations, cases can be considered individually, similar to the case-by-case approach

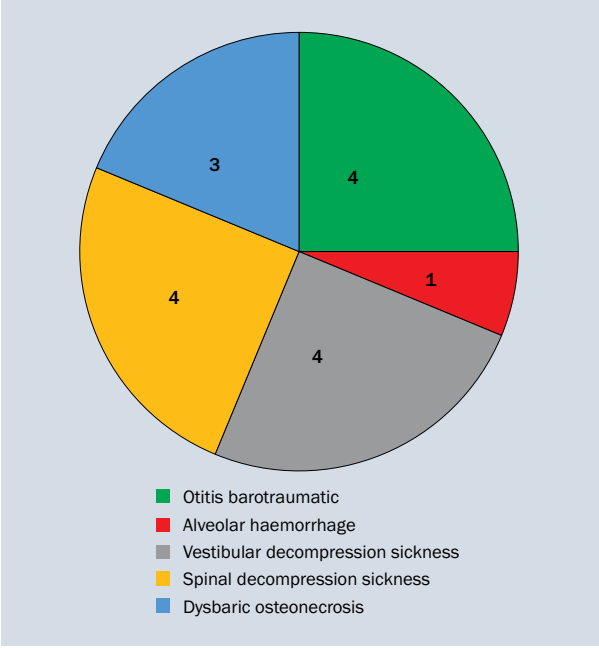

Figure 3. Distribution of decompression incidents

used with recreational diving. Medical judgments must then take into account the balance of asthma, the impact on respiratory functional explorations and the type of diving. Three divers had emphysema and one of these three had emphysema with a subpleural bubble; he had spontaneous pneumothorax at home. Two divers had COPD. Studies have not shown the development of obstructive ventilatory disorders due to diving, defined as FEV1/CV < 80% [21]. The data available in the literature only showed decreases in peripheral bronchial flow rates and transfer factor of the lung for carbon monoxide [22, 23].

It may seem surprising that temporary unfitness and/or specific fitness judgments were rendered 9 times with respect to cardiovascular risks. The question arose here, given the professional nature of the dives. Divers did not have the flexibility to schedule their dives according to their perceived "state of fitness". The aim was to limit the risk of cardiovascular incidents during a dive in people who do not have any particular physical training and a high cardiovascular risk. The aim was therefore to limit the risk of accidents and drowning [1, 14]. Recent literature also reports the hypothesis of cardiovascular effects even if dives are of short duration [24]. Åsmul et al. [24] showed that divers who did more than 150 dives per year had a higher risk of myocardial infarction than those who did fewer than 50 dives per year: risk ratio 2.91 (confidence interval 1.23–6.87). They also found a risk of high blood pressure in former divers compared to the general population.

The case of unfitness for suspected patent foramen ovale (PFO) was part of an approach to preventing decompression sickness. Studies have shown that gas bubbles can pass through the PFO and cause stroke. People with a PFO are more likely to have strokes and migraines than others, including at atmospheric pressure. In our centre, we gave a judgment of fitness for diving to divers with a PFO after transcatheter closure [25]. However, treating the PFO does not guarantee that no bubbles will pass through [26]. Before allowing diving to continue, especially for people who have had a DCS, it seems reasonable to discuss the benefit/risks balance of an intervention on a case-by-case basis [27]. It might be better for some divers to stop diving.

The decompression sickness among divers in our centre was mainly vestibular and spinal cord DCS. Most of these divers were able to return to professional diving after temporary unfitness judgments lasting 6 to 12 months. It may seem surprising that dysbaric osteonecrosis is more likely to lead to permanent disability. The decision took into account functional impact and recurrences. For example, the same diver had 2 dysbaric osteonecrosis. For central DCS, the decision to allow diving to resume was made based on the origin of the accident. If there was no pathology exposing a diver to a risk of recurrence greater than the normal risk associated with diving, and if physical and psychological recovery allowed it, the resumption of diving was possible. This was in line with the practices of other French maritime medicine centres [28]. The deliberation weighed the importance of diving for the person and his socio-professional integration, as well as the diver's psychological state. The literature reports several studies on the psychological profile of divers. Van Wijk [29, 30] showed that the psychological profiles of military divers have been stable in recent decades in the literature. However, the author pointed out that these results were not applicable to all populations. A study by Lafère et al. [31] analysed the behaviour of divers who had previously had a DCS. They found that some divers were unable to exercise caution when diving [31]. Further studies would be useful to determine how to predict whether divers will exercise caution. However, in our centre, we only followed civilian divers. They practiced diving in a professional setting, without always enjoying this exercise. Decisions could therefore not always be based on literature data. As it is often the case in medicine, this was a case-by-case analysis, often carried out in consultation with the doctors at the centre [32].

CONCLUSIONS

This study analysed the medical opinions during the monitoring of 396 professional divers in a marine medicine centre. Judgments of permanent unfitness for diving were rare (3.0% of divers). These opinions were motivated by the desire to avoid a diving accident. On 19 occasions, temporary unfitness rulings were issued, mainly in the months

following decompression illness to determine the origin of abnormalities detected during medical examinations. Finally, 3% of divers had had an incident of decompression sickness between 2002 and 2019.

The results of these years of medical monitoring showed that the French model made it possible to detect pathologies leading to a risk for divers, or pathologies caused by diving. However, our collection should be more comprehensive. For example, people who have stopped professional diving could be interviewed in order to determine the reasons why they stopped.

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Eye diseases in travelers

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ABSTRACT

Travelling has been growing in popularity over the last several decades. Eye diseases, e.g. decreased visual acuity, inflammatory or degenerative lesions, chronic diseases or eye trauma, affect all groups of travelers. The main risk factors contributing to the manifestation or exacerbation of common ocular diseases include exposure to dry air (inside the airplane cabin or in air-conditioned hotel rooms), exposure to chlorinated or salty water (swimming/bathing in swimming pools or in the sea), and sudden changes in the weather conditions. In addition, travelers to tropical destinations are at risk of ocular diseases which are rarely seen in temperate climate, e.g. onchocerciasis, loiasis, gnatostomosis, African trypanosomosis, or trachoma. The most common condition of the eye seen in travelers is conjunctivitis; it may be either of cosmopolitan (bacterial or viral infections, allergic inflammation) or tropical etiology, e.g. arboviral infections (zika, chikungunya). Given the fact that a large proportion of the general population have decreased visual acuity and many of them wear contact lenses rather than glasses, keratitis has become a common health problem among travelers as well; the major risk factors in such cases include sleeping in contact lenses, prolonged exposure to air-conditioning, working with a computer or swimming/bathing in microbiologically contaminated water (e.g. Acanthoamoeba *protozoa). Conditions affecting the cornea, conjunctiva or lens may also occur due to excessive exposure to solar radiation, especially if travelers wear glasses without a UV protection.*

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Key words: eye diseases, travelers, treatment, prevention

EPIDEMIOLOGY

The World Health Organization (WHO) has estimated that over 280 million people globally are affected by visual defect, of whom 14% have blindness and another 86% have less severe ocular problems, e.g. decreased visual acuity or inflammatory conditions. The leading causes of sight defect globally include refractive error and cataract (clouding of the lens). The highest prevalence of eye conditions is reported from China and India, i.e. the two most populous countries in the world. Population ageing is considered the major risk factor for increasing prevalence of visual defect. More than 80% of the general population over the age of 60 years old has vision defect, usually presenting as decreased acuity (presbyopia). According to the data from the statistics in Poland as much as 50% of adults declare that they wear glasses or contact lenses to correct distance or near vision defect (in the age group 50–59 it is 76%, and in the age group > 60 more than 80%). Among children under 15 years old, visual defect is seen in 50% of boys and more than 60% of girls. In Poland, the most common diseases of the eye include cataract, glaucoma, age-related macular degeneration (AMD) and diabetic retinopathy. More than 800,000 Poles (mostly patients over the age of 60) have cataract and this number is likely to grow. In 2020, it is expected to exceed one million cases in 38.5 million population. Clouding of the lens is more often seen in women (70% cases) than in men. Another common eye condition, i.e. glaucoma affects over 450,000 Poles, mostly women (70% cases), and the number of cases is constantly increasing. It is expected to reach over 600,000 cases in 2035. The data from the statistics in Poland also shows there are 1.9 million diagnosed cases of AMD, including 130,000 cases of the more advanced form of the disease, i.e. wet AMD potentially leading to vision loss (the risk increasing with age). The major risk factors for AMD

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include smoking, arterial hypertension, high cholesterol concentration and obesity. Diabetes mellitus (DM) is one of the most common chronic diseases in Poland affecting over 2 million people. Chronic hyperglycemia causes damage to the retina and thus plays a major role in the development of diabetic retinopathy. The disease affects approximately 90% of patients with type 1 DM and 60% of patients with type 2 DM who have had the disease for 20 years (diabetic retinopathy is the major cause of vision loss in patients over 65 years old), it also leads to diabetic macular edema. The data from the statistics indicates that there are 4.9 million disabled people living in Poland of whom 35% are affected by an ocular disease or have suffered an eye trauma (over 60,000 of Poles over the age of 15 years old have blindness or severe visual impairment). In general, the diagnosis of ocular conditions may be problematic because a large number of diseases affecting the eye tend to be asymptomatic at an early stage. In addition, screening for visual defects is rare in Poland (around 30% of Polish people have never been consulted by an ophthalmologist). With such a high number of patients with visual defects in the general population, it is not surprising that conditions of the eye are quite common among travelers as well [1–6].

CLINICAL PICTURE

The International Classification of Diseases ICD-10 classifies the diseases of the eye and adnexa into 11 categories: disorders of eyelid, lacrimal system and orbit; disorders of conjunctiva; disorders of sclera, cornea, iris and ciliary body; disorders of lens, disorders of choroid and retina; glaucoma; disorders of vitreous body and globe; disorders of optic nerve and visual pathways; disorders of ocular muscles, binocular movement, accommodation and refraction; visual disturbances and blindness; other disorders of the eye and adnexa. Eye conditions may also arise from injuries, poisoning or congenital disorders; however, those cases are classified outside the category listing the diseases of the eye and adnexa [1].

A great majority of patients with eye problems are treated on an out-patient basis and the most prevalent conditions include inflammation of the protective apparatus of the eye or the globe which often manifest with pain, redness, swelling of the eyelid or the globe or discharge from the conjunctival sac. In such cases patients usually complain of foreign body sensation, tearing or itching. When visual acuity is not decreased, pupils react normally and the cornea is transparent, the symptoms are suggestive of conjunctivitis or inflammation of the eyelid. If, however, the symptoms occur seasonally, it may be suggestive of an allergic reaction. In such cases it is recommended to use antihistamines rather than antibiotic or corticosteroid drops/ointments. Although they may initially reduce the symptoms, they are likely to have adverse effects on the eye in the longer perspective (dysfunction of the tear film or dysfunction of the secretory glands in the eyelid or the conjunctiva) [5].

DRY EYE SYNDROME

It is one of the most common conditions affecting the eye. It usually occurs due to inappropriate or prolonged use of topical medications for the treatment of conjunctivitis or blepharitis (inflammation of the eyelid), insufficient tear production or alternations in the quality or quantity of the tear film. The condition is associated with inadequate wetting of the cornea and the conjunctiva which causes discomfort (dry eye sensation, burning, foreign body sensation) but occasionally may lead to more severe conditions of the globe. Dry eye syndrome is a disease reflecting the modern way of life where much time is spent in poorly-ventilated or air-conditioned rooms and in front of a computer screen. Under such conditions lacrimal glands do not produce sufficient tears to compensate for the excessive tear evaporation. The major risk factors contributing to the occurrence of the dry eye syndrome during travel include: prolonged exposure to dry air (in an airplane), difficult weather conditions (low humidity, dry wind, dust) exposure to salty or chlorinated water (swimming/bathing in a swimming pool or in the sea) [5, 7–9].

EXCESSIVE TEAR PRODUCTION (WATERY EYES)

The condition (often unilateral) may be suggestive of a blocked tear duct. Acute pain, swelling and redness in the corner of the lower eyelid may be indicative of dacryocystitis (inflammation of the tear sac). Treatment of a tear drainage blockage usually requires ophthalmological/surgical intervention [5, 10].

INFLAMMATION OF THE EYE

Inflammatory lesions affecting the eye are the most common ocular conditions. They typically arise from the dysfunction of the glands which are part of the protective apparatus of the eye (the sebaceous glands of Zeis and the sweat glands of Moll in the eyelash follicles, Meibomian glands in the tarsal plate of the upper eyelid), the conjunctiva (lining the inside of the eyelid and the sclera) or the lacrimal apparatus. The infection often occurs as a result of a gland blockage (hordeolum, dacryocystitis, abscess of the eyelid) or a mechanical injury e.g. contact lens associated damage to the corneal epithelium (increased susceptibility to infections). Some inflammatory conditions may be of endogenous nature (when an infection which has already affected other organs or systems spreads to the eye). An eye infection may subsequently be carried via the angular vein and the cavernous sinus to the meninges causing neurological disorders [11].

Conjunctivitis. The condition usually affects both eyes and is the effect of either external (bacteria, viruses, allergens) or internal factors. The common signs and symptoms include burning sensation, foreign body sensation, stinging, photophobia, tearing, redness and purulent, mucous or watery discharge. The condition may be mild to severe with symptoms ranging from slight redness to massive discharge. Conjunctivitis may be self-limiting and even if it is left untreated the signs and symptoms usually subside within 2 weeks of onset. Nevertheless, patients will benefit from an early diagnosis and prompt treatment as it may help prevent chronic conjunctivitis or keratitis in the future [11].

Keratitis. The condition usually presents with severe clinical signs and symptoms (decreased visual acuity, pain, photophobia, tearing, discharge, visible corneal infiltrate). Keratitis may be of infectious or non-infectious etiology and it may lead to loss of vision. In temperate climate zones keratitis is typically of bacterial etiology, while in the tropical climate — it is usually caused by a fungal or a mixed infection. In patients wearing contact lenses inflammatory lesions (resulting from damage to the corneal surface) are usually associated with *Pseudomonas aeruginosa* infection. The common risk factors for keratitis include bacterial or viral infections of the eye surface, injuries, diabetes, and immunosuppressive treatment. Inflammation manifesting with tissue loss and corneal infiltrates may lead to scarring and perforation of the cornea and eventually to loss of vision [11].

Orbital cellulitis. It is commonly caused by the spread of an infection from the paranasal sinuses but it may also occur as a complication after a sinus or ocular surgery. The condition is serious (the risk of a generalized infection) and requires treatment on an in-patient basis [12].

Hordeolum. It is an infection of the eyelid glands (glands of Zeis, Moll or meibomian glands), which is usually caused by *Staphylococcus aureus*. Hordeolum may be either external or internal; the former results from obstruction and infection of an eyelash follicle and adjacent glands of Zeis or glands of Moll, while an internal hordeolum, results from an infection of a meibomian gland (tarsal glands), which is responsible for the production of the tear film lipid layer [12].

Chalazion. It is a chronic infection of a meibomian gland caused by obstruction of the gland and accumulation of lipid material in the eyelid leading to the formation of a cyst usually associated with redness and swelling. If a chalazion persists for more than several weeks despite treatment (topical antibiotic and hot compresses), the recommended treatment of choice remains incision and curettage [12].

Blepharitis. It is a bilateral chronic infection of the eyelid causing irritation of the eye and burning sensation. It is often associated with conjunctivitis, keratitis, formation of intrafollicular abscesses at the base of the eyelashes and disruption of tear secretion. Chronic blepharitis may lead to the growth disorder, loss or discoloration of the eyelashes [12].

Foreign body in the eye. It is usually a grain of sand, a speck of dust or a very small insect (e.g. sand fly), its presence causes discomfort, tearing, redness and pain. If patients are unable to remove the foreign body from the eye on their own, they are recommended to seek medical assistance [5].

On top of the conditions discussed above, sudden vision impairment may be associated with some systemic diseases e.g. diabetes, trauma or thrombotic lesions.

DIABETIC RETINOPATHY

It may happen that an ophthalmologist will be the first physician to diagnose a patient with diabetes (examination of the fundus). This may be the case when a patient reports to a specialist due to sudden vision impairment, which may potentially be associated with vitreous or retinal hemorrhage. Diabetic macular edema may also be responsible for sudden vision impairment in diabetic patients; mild diabetic macular edema may be associated with slightly decreased visual acuity, whereas its severe form may lead to vision loss [4].

RETINAL VASCULAR OCCLUSIONS

The condition usually occurs in the elderly patients with a history of atherosclerosis, diabetes, or arterial hypertension but may also be found in women at the childbearing age using hormonal contraceptives. The central retinal vein occlusion (CRVO) results in sudden vision impairment and requires immediate hospital treatment, whereas a branch retinal vein occlusion (BRVO) is a mild condition which may give no symptoms and may go unnoticed. In most cases both the CRVO and BRVO are unilateral [4, 13].

RETINAL HEMORRHAGE

It is a disorder of the retina which commonly occurs at high altitudes, e.g. during high altitude climbing. Exposure to hypobaric hypoxia increases retinal blood flow and leads to retinal hemorrhages (the retina is highly sensitive to hypoxic conditions). The condition is often asymptomatic, but may sometimes be associated with visual disturbances (seeing floaters or flashes of light, blurred vision, decreased acuity) due to bleeding at or around the macula. Retinal hemorrhage was found to occur in approximately 30% of climbers who reach the altitude of 4200 m a.s.l., 50–60% of climbers at 5500 m a.s.l., and supposedly in 100% climbers at 6800 m. a.s.l. If retinal hemorrhage occurs, the ophthalmologic examination will reveal optic disc hyperemia and increased vessel tortuosity in the fundus of the eye. In most cases the condition is self-limiting and retinal bleeding usually stops after 1–2 weeks [14].

RETINAL DETACHMENT

The disorder is clinically silent and often unilateral. It leads to sudden visual impairment; it usually affects the elderly patients with advanced myopia. In younger patients retinal detachment is most commonly trauma-related (the eye or head injury). Patients with retinal detachment report a decrease in the field of vision. If the macula is not involved, central vision may be preserved; however, if the macula is involved, the prognosis is much worse and lesions may be irreversible. Retinal detachment is an emergency condition and requires immediate surgical intervention [4].

EYE TRAUMA

An injury to the eye may be the result of a traffic accident as well as a sports injury or even UV radiation. It is strongly recommended that all travelers, both children and adults wear certified sunglasses for UV protection [15].

DISEASES OF THE EYE IN HOT CLIMATE CONDITIONS

Travelers to tropical or subtropical destinations, with high prevalence of pathogens or infection vectors which are specific for the hot climate areas, may develop diseases of the eye which are rarely seen in temperate climate conditions. Such conditions include visual impairment characteristic for onchocerciasis (*Onchocerca volvulus* microfilariae migrate from the skin into the conjunctiva, cornea and anterior chamber of the eye leading to keratitis, anterior and intermediate uveitis (inflammation of the iris and the ciliary body) and eventually to vision loss); conjunctivitis/foreign body in the eye in loiasis (*Loa loa* microfilariae penetrate into the subconjuntival tissues), swelling of the eyelid and conjunctiva in gnatostomosis, swelling of the eyelids in African trypanosomosis, or conjunctivitis and keratitis in trachoma. Of all the eye conditions seen in travelers to tropical or subtropical destinations conjunctivitis is the most common; in such cases conjunctivitis is either of cosmopolitan (bacterial or viral infections, allergic inflammation) or tropical e.g. arboviral infections (zika, chikungunya) etiology [16–21].

TREATMENT

The treatment of any diseases of the eye (e.g. decreased visual acuity, acute or chronic inflammatory conditions, degenerative lesions or eye trauma) requires consultation with an ophthalmologist. This must be remembered by all travelers but especially those travelling to countries where specialist healthcare is unavailable or difficult to access (a professionally equipped office of an ophthalmologist vs. a primary health care provider in remote areas of Asia or Africa). Therefore, it is recommended that travelers with underlying eye conditions take good preparations before going on a journey. They must not forget to bring their glasses or contact lenses, all the regularly taken and emergency medications as well as products for eye care (drops and wipes). If, nevertheless, eye or vision problems do occur during travel, the traveler will have to assess the nature of the condition and its severity. If the lesions are associated with exposure to external or environmental factors and the condition is mild enough to be managed individually with the available medications, there is no need to seek medical help. If, however, the lesions are more severe, travelers are strongly recommended to report to a medical facility for a consultation with an ophthalmologist (eye examination, specialist treatment). In order to establish an accurate diagnosis, an ophthalmologist must have access to the specialist ophthalmic diagnostic equipment (an ophthalmoscope for the fundus examination, a slit lamp to inspect the anterior segment of the eye/eyelids, conjunctiva, sclera, iris, lens, cornea/, tonometer to determine the intraocular pressure, etc.) [22]. The type of treatment will depend on the condition itself, the outcome of the clinical examination as well as the results of diagnostic tests. Intraocular and orbital infections of bacterial etiology require the use of systemic antibiotic therapy and the parenteral administration of antimicrobial agents. Post-traumatic or post-surgical anterior uveitis is managed with subconjunctival injections (the drug administered in this way reaches the iris, the ciliary body and the cornea through the sclera route). In case of an intraocular inflammation, the drug is injected into the anterior chamber or the vitreous humor. Topical medications (e.g. drops, suspensions and ointments) are used for the treatment of infections/inflammation of the anterior segment of the eye (strict compliance with hygiene recommendations is essential in such cases). The drugs administered into the conjunctival sac are absorbed through the cornea (topical medications may enter into the systemic circulation via the highly vascularized conjunctiva and further via the lacrimal sac and may potentially cause adverse reactions; therefore, patients must strictly comply with the recommended dosage regimens and respect the expiry date and the period after opening) [8, 12, 22, 23].

PREVENTION

In general, travelers are likely to be exposed to a number of risk factors which may result in the manifestation of acute eye conditions or the exacerbation of underlying ophthalmological diseases. The most common risk factors which cause irritation (dry eyes, burning sensation, redness) of the eye or its protective apparatus include prolonged exposure to air-conditioning (inside an airplane cabin or in a hotel room), wind, low humidity, chlorinated water in the swimming pool or salty water in the sea. If the eyes feel dry or irritated, travelers may use re-wetting eye drops. Artificial tears may be used both for prevention and treatment of

the dry eyes symptoms. A good way to stabilize the lipid layer of the tear film and prevent its evaporation is to use eye drops containing sodium hyaluronate. The drops lubricate the corneal surface and may be used with all types of contact lenses. Moisturizing eye drops are also recommended to patients with certain chronic conditions such as Sjögren's syndrome, hormonal imbalance (menopause) or patients with a history of an ophthalmologic surgery [24, 25]. Travelers who are likely to be exposed to difficult climate conditions (high temperatures, humidity, air pollution) are recommended to take good care not only of the eyes but also of their protective apparatus. A good solution is to use sterile eyelid wipes (e.g. Blephaclean) for everyday hygiene of the eyelashes and eyelids. The wipes show antibacterial, anti-inflammatory and regenerative effect and can also be used for make-up removal [22].

DRY EYE SYNDROME

Artificial tear drops are the first line treatment for patients with dry eye symptoms (the medication is short-acting and should be applied at regular intervals, several times a day; artificial tear drops should be free from preservatives as they may irritate the eye). Apart from using the right medications, one should also remember about some simple preventive measures to reduce tear film evaporation (wearing large frame glasses which provide better protection from the wind, dust or the sun; placing the computer screen below the eye level to narrow the eye opening; trying to reduce smoking and avoiding smoke-filled rooms, using rewetting eye drops while staying or working in air-conditioned rooms) [26–28].

SUNGLASSES

Sunglasses are an essential travel item, especially when travelling to areas where UV exposure is high. The most important sunglasses component is obviously the UV filter. When a person wears darkened glasses, pupils dilate because less light reaches the eye; therefore, wearing sunglasses without a UV filter actually increases the exposure to UV radiation as more sunlight enters the eye through dilated pupils. Excessive UV radiation may cause damage to the cornea, lens or retina. Travelers with a vision defect are recommended to wear both their contact lenses and sunglasses with a UV filter. If, for some reason, travelers cannot wear contact lenses (inflammatory lesions, swimming/bathing in the water) they are advised to purchase darkened prescription glasses or glasses with photochromic lenses (darkening when exposed to the sun). Sunglasses which provide protection against the UV radiation should be labeled (on the lens or frames) as 'UV400', '100% UV reduction', '100% block' or 'UV 100%'. In line with current recommendations, the UV protection filters fall into four distinct categories, depending on the level of UV transmission. Category 1 (43–80% transmission) or Category 2 are recommended on cloudy days (sun radiation is lower but still present), Category 3 (typical for most types of sunglasses) is recommended on sunny days, this category is also recommended to drivers (drivers are suggested to wear sunglasses with polarized lenses which additionally eliminate the glare). Category 4 sunglasses (3–8% transmission) are recommended to be worn in intense sunshine e.g. in snow covered mountains; they are not to be used while driving as the lens are too dark. Travelers need to keep in mind that sunglasses which are sold in the developing countries may be of low quality. Therefore, before buying a pair of sunglasses abroad it is important to check whether the lens have been certified (those which meet the requirements will be marked as follows: EN 166:2001, PN-EN ISO 12312-1:2014-02, 89/686/EWG, ISO 9001:2000) [22, 29–32].

TRAVELLING WITH CONTACT LENSES

Given the fact that a considerable proportion of travelers have decreased visual acuity and many are contact-lens wearers, it seems reasonable to discuss some general guidelines for travelling with contact lenses. First, contact lens wearers are strongly recommended to bring not only their contact lenses but also a pair of glasses as a back-up. Wearing glasses may be more comfortable then wearing contacts in some situations, e.g. during a long flight lasting 6–8 hours or more. Low humidity inside an airplane is primarily the effect of the air conditioning but also of high altitude conditions (the cabin pressure corresponds to an altitude of 1800–2400 m a.s.l.). What is more, sleeping on the plane will be much more comfortable with lenses removed. Another common problem for contact lens wearers is the exposure to dry air (e.g. an air conditioned hotel room). Dry air may cause discomfort and irritation so it is very important to keep your eyes moisturized by using rewetting drops/ /artificial tear drops or by wearing moisturized lenses. When travelling to sunny destinations (the seaside beach, high mountains, a skiing holiday), contact lens wearers must not forget about adequate UV protection. Some manufacturers are now marketing contact lenses which block the UV radiation and thus provide protection against the harmful effects of the sun [33]. Also, travelers who wear contact lenses need to take certain precautions when swimming in the pool or in the sea. The best solution is to avoid wearing contact lenses in the water. This is because contact lenses increase the risk of infection with the pathogenic microorganisms which may be present in the water. Although generally not harmful to the skin, the respiratory or the gastrointestinal system, some pathogens which are found in the water (*Acanthoamoeba* protozoa) may contaminate the lens and consequently lead to corneal inflammation [34]. Travelers must also remember to follow the contact lens hygiene recommendations (this

particularly applies to extended wear contacts), i.e. never use tap water to clean the lenses or the lens storage case (these may only be cleaned with contact lens solution) and replace the storage case at intervals recommended by the manufacturer. Compliance with the storage recommendations and replacement schedules is particularly important in tropical and subtropical destinations, where microbial contamination of water is common. In order to minimize the risk of the eye infection, travelers are recommended to switch to daily disposable lenses for the duration of their trip. Obviously, travelers will not feel comfortable wearing contact lenses if they do not follow the very basic hygiene practices such as washing their hands with soap and water or using hand sanitizer before handling the lenses or putting them in. If a traveler opts for extended wear contact lenses, they need to bring at least one extra pair in case their contacts get lost or damaged (the same applies to glasses wearers; people with vision defect should never travel without an extra pair of contacts or eyeglasses). Travelers are also reminded to keep their contacts/glasses, contact solution or eye-drops in their carry-on baggage so as not to lose them. When travelling by plane it should be reminded that all liquids must be stored in individual containers of no more than 100 mL and packed in a transparent plastic bag with a seal (e.g. a zip-lock) [22].

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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.

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

All articles should be submitted to IMH electronically online at www.intmarhealth.pl where detailed instruction regarding submission process will be provided.

Only English texts will be accepted.

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

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

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

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

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

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

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

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